Instruction Manuals for Tier 1 Simplified Carbon Intensity Calculators

(For CR-102 of Chapter 173-424 WAC)

July 2020

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I. Starch and Fiber Ethanol

A. Introduction

This document provides detailed instructions for the use of the Simplified CI Calculator for Tier 1 Starch and Fiber Ethanol pathway applications. This Calculator is to be used to calculate the carbon intensity (CI) for ethanol produced from corn, sorghum, and/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://ecology.wa.gov/Asset-Collections/Doc-Assets/Rulemaking/AQ/WAC173-424_455_-21-04/Tier-1-Calculator-for-Starch-Fiber-Ethanol-WAC-1

The Calculator has been automated to perform CI calculations using factors from the WA-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 monthly feedstock, operational energy use, fuel production and co-product data, and transport distances used in calculating the CI of Starch and Fiber Ethanol pathways.

The Calculator also includes additional reference material such as greenhouse gas emissions factors used in WA-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 Ecology 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 Ecology 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 use of site-specific values when feasible, conditional default values are subject to initial validation during the pathway certification process to confirm that the

specified conditions are met, but are not 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., described below:

Table B.1. Color Legend

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 in order to establish the final CI, pursuant to section 95488.4(a) of the regulation.
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. 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 a detailed sample CI calculation (cells B77 through K111).
EF Tables	Reference worksheet. Contains emissions factors from the WA-GREET3.0 model used in calculation of carbon intensities.
Fuel_Specs	Reference worksheet. Contains specifications of fuels, global warming potentials of greenhouse gases, land use change and unit conversion.

E. EtOH tab

The EtOH tab contains the main CI calculation worksheet which 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 have to 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 and the EtOH Summary tab. Details for entering data in all required fields is detailed below. As provided, the EtOH tab has blank values for all applicant-specific inputs and 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 are applicable to the ethanol plant. 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 Ecology staff for LCFS Company ID.
1.4. Facility ID	Enter the Company's Facility ID. If not available, contact Ecology for LCFS 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 applied for (WDGS, MDGS, DDGS), and process fuels. Example: Midwest Corn, Ethanol, Dry Mill, MDGS, DDGS, NG. For corn/sorghum fiber ethanol pathways, also 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 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 three months of operational data 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 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, applicant must provide conversion factor used 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. No inputs are required for this field.
2.4. Corn Received	Input monthly total corn data (in bushels) received in this field for all 24 months of operation. If alternate approaches are used to inventory corn, applicant must provide conversion factor used 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 of operation. If alternate approaches are used to inventory corn, applicant must provide conversion factor

	used 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, and 2) Conditional Default for Ethanol Plants in CA 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 selected in filed 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 applicant selects "User-Defined" option in field 2.6. If option 1) of 2) is selected 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 selected 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 applicant selects "User-Defined" option in filed 2.6. If option 1) or 2) is selected 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. 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 selected 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 applicant selects "User Defined" option in field 2.12. If option 1) or 2) is selected 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 selected 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 applicant selects "User Defined" option in field 2.12. If option 1) or 2) is selected 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 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. 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. If the applicant is requesting a composite carbon intensity score, dedicated meters are not required. If alternate measurement units are used to quantify natural gas use, applicant must provide conversion factor used to report NG use in HHV.

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 of operation. If facility does not produce syrup, the applicant must input zero in Fields 2.312.35.
2.32. Syrup Produced (Calculated)	Monthly total syrup produced data (in tons) in field 2.32 will be automatically calculated. 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 of operation. If 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. 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 of operation.
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. 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 of operation.
2.43. Undenatured Ethanol Sales	Input monthly total undenatured ethanol sales data (in gallons at 60F) for all 24 months of operation.
2.44. Ending Undenatured Ethanol	Input monthly total undenatured ethanol ending inventory (in gallons at 60F) for all 24 months of operation.
2.45. Undenatured Ethanol Produced (Calculated)	Monthly total undenatured ethanol produced data (in gallons at 60F) in this field will be automatically calculated. No inputs are required for this field.
2.46. Denaturant Data Category	Field 2.46 includes options for denaturant data category in a drop down menu: 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; monthly 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)	Monthly total cellulosic enzyme use data (in lbs.) in field 2.49 will be automatically calculated. No inputs are required for this field.

2.50. Ending Cellulosic Enzyme	Input monthly total cellulosic enzyme ending inventory (in lbs.) for all 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 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 quantity attributable to sorghum, if used as a feedstock) is used to calculate 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 enable calculation of quantity of feedstock used in ethanol production. Cells which are grayed out are calculated values and do not require applicant input. The applicant must enter monthly totals for corn or sorghum received (as purchased) in bushels and total monthly beginning and ending corn or sorghum inventory in bushels. The monthly totals must be inclusive of 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) known as "corn belt states" (South Dakota, Minnesota, Iowa, Nebraska, Illinois, Michigan, Ohio, Indiana, and Wisconsin)[1] a conditional default value of 40 miles for corn transport by HDD truck is available for selection. Sorghum transport from these regions is assigned a conditional default value of 80 miles by HDD truck. If the applicant selects this option (and is appropriate based on physical location of the ethanol production facility), transport distance will be subject to one-time validation during initial certification. For ethanol plants located in Washington, a conditional default selection will include 50 mile by HDD truck transport and 1,400 mile by rail transport to Washington. If an ethanol production facility located in Washington 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

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

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

Table E.3. Monthly Average Feedstock Transport

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
6				
7				
8				
Weighted average distance and corresponding quantities to be used for monthly reporting of feedstock				
	300,000	117	450,000	778
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 which included 200 miles 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, 450,000 bushels with a weighted average distance of 778 miles by rail.				

For transport of feedstock, applicants must calculate the appropriate mileage for each mode of transport as described below. For rail transport, mileage must be based on the rail network maps from either BNSF Railway[2] or Union Pacific.[3] For facilities which are 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 related to reporting quantities of co-product produced during ethanol production. The co-products include distillers' grains solubles, distillers' 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 which report dry or modified DGS co-product steams will be required to 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 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 is not capable of estimating GHG emissions when energy sources other than natural gas are used for drying energy. Applicants may be required to use a Tier 2 approach using the WA-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).

For inputting co-product quantities, the applicant must include monthly total 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.

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

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

For the syrup and distiller's corn/sorghum oil co-product streams, the required inputs are similar. Moisture content for corn oil is set to a standard value of 1% and does not require an input. For syrup, 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;
- For monthly denaturant volumes (gallons), the sheet offers two options: Standard Value or User-Defined. If user selects Standard Value denaturant, a value of 2.5% is used as denaturant volume blended with ethanol. If 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 which have incorporated a Corn/Sorghum Fiber Ethanol Process (Fields 2.47 to 2.52)

For facilities which utilize a corn/sorghum fiber conversion technology process for conversion of 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. 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 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, 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) and 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 the Ecology.

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 meet or exceed the originally certified level for a given facility. Ecology requires this same demonstration as a condition of

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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.

pathway certification. At the time of initial registration, applicants must provide a copy of the RFS approval for the facility. Ongoing reports[5] must be submitted to Ecology 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 prior analysis must be updated to reflect production volumes determined using the most recent prior analysis.

Section 3: Fuel Production Energy Consumption and Fuel Transport Data

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

<div align="center">Table E.3. List of Input Fields for Section 3 of the Simplified CI Calculator</div>

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, 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 upgrading facility location. After selecting an electricity mix option, click on "**Calculate CI**" in Cell BI30. If user-defined mix is selected, input is required for 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 Ecology 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 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 Ecology staff to develop an appropriate emission factor (gCO2e/dry ton) for the biomass and input in Field 3.4.a. Alternate fuel sources and data sources used in calculating

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[5] Link to section 80.1426 of RFS code:
https://www.epa.gov/sites/production/files/201508/documents/2014-16413.pdf

	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 Ecology 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 grid	Input monthly Electricity use (in kWh) from 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 of operation.
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 Washington.
3.9.b. By HDD Truck	Input distance (in miles) by HDD truck from the Ethanol plant to Washington.
3.10. Enter Electricity Generation Emission Factor (gCO2e/kWh)	If User-Defined is selected in Field 3.1, consult with Ecology staff and input an emission factor for 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 total electricity purchased from the grid from utility invoices (in kWh). If renewable electricity from solar generation or wind power is available for use 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 higher heating value. The landfill or other source of biomethane must be physically delivered to the ethanol production facility in order to be eligible for consideration as a process fuel. The applicant must also provide details if the biogas is processed at a purification plant prior to transport to the ethanol facility. The transmission distance from the landfill (or other source of biomethane or biogas) to the ethanol production facility must be provided to Ecology staff in the supplemental documentation for use in the emission factor. For facilities which use biomass as a process fuel, monthly totals from invoices must be input in dry tons. The applicant must also input monthly weighted average moisture content of the biomass. 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 Table E.2.

Fuel Transport (Field 3.9)

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

Note: For applicants who expect to use various combinations of transport modes to ship fuel to Washington, 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 supplementary documentation provided with the application must include the CIs for each of the anticipated combinations and highlight the combination used in the Calculator.

Emission Factors and CO$_2$e Calculation Details

Applicant inputs are matched to corresponding emission factors (in CO2e) derived from the WA-GREET3.0 model. Total GHG emissions are calculated for each discrete input and all emissions are summed, including ones for standard inputs, beneath 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.

II.   Sugarcane-derived ethanol

A. Introduction
This document provides detailed instructions for the use of the Simplified CI Calculator for Tier 1 Sugarcane-derived Ethanol pathway applications. This Calculator is to be used to calculate a composite carbon intensity (CI) for Sugarcane-derived Ethanol from sugarcane-based juice and/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://ecology.wa.gov/Asset-Collections/Doc-Assets/Rulemaking/AQ/WAC173-424_455_-21-04/Tier-1-Calculator-for-Sugarcane-Derived-Ethano-1

The Calculator has been automated to perform CI calculations using factors from the WA-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 monthly feedstock, operational energy use, fuel production and co-product data, and transport distances used in calculating the CI of Sugarcane-derived Ethanol. The Calculator is designed to work independently of the WA-GREET3.0 model, but will still require operational and production data from the mill to be entered for the previous 24-months which includes at a minimum, two sugarcane harvest cycles of at least 9-month duration each.

B. Color legend used in the calculator
The Calculator uses the following color legend to differentiate required inputs, calculated values, etc., described below:

Table B.1. Color Legend

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 in order to establish the final CI, pursuant to section 95488.4(a) of the regulation.
Calculator	Main calculation worksheet that contains fields requiring user input, as well as some parameters calculated by the worksheet. The end product of this worksheet is a calculation of a composite CI for a sugarcane-based ethanol pathway. Calculations in light gray and light blue cells are automatically calculated but dependent on user input provided 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. Contains greenhouse gas emissions factors (EF) from the WA-GREET3.0 model used in calculation of carbon intensities. No user interface is necessary in this tab.
EF General	Generalized worksheet for the development of the EF's for GHG impact assessments, and aggregation of well-to-wheels impacts. The factors are developed from WA-GREET3.0 or other equivalent models. No user interface is necessary in this tab.
Fuel_Specs	Reference worksheet for CI Calculations. Includes emissions factors derived from WA-GREET3.0 model, standard values, and assumptions related to the Calculator. No user interface is necessary in 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 applicable fields in the worksheet. The Calculator tab requires that the applicant provide facility information, feedstock information, operational 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 (gCO2e/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. 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 ID's. If not available, contact Ecology for LCFS Company and Facility ID's.
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". 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. 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 required.

1.9 Regional Electric Mix (Feedstock/Fuel)	29-Brazilian Mix (Standard for Brazil). No input required.
1.10 Choose Applicable Burn Area Evaluation for Cane Farms, then Click "SELECT" button	Choose from drop-down menu based on location; Standard for Sao Paulo State, or Standard for Non-Sao Paulo States. Additional details are provided below 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 for which the Burn Area Evaluation was based upon. No input 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 are selected in Field 1.10. No input required.

Additional Details for Section 1

Fields 1.10 and 1.11

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

a) Standard for Sao Paulo State, or
b) Standard for 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. Select "Standard for Non-Sao Paulo States" if the ethanol plant/sugar mill sources all of its feedstock from non-Sao Paulo
States, for which a standard mechanized harvesting level of 65 percent is applied. Click the "SELECT" button after making the selection to clear the previous value. Selecting either of these options exempts verification of mechanized harvesting levels implemented at applicant sourced sugarcane farms during initial validation, and on-going 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 a user input here.
2.2 Anhydrous Ethanol Transport Distance (km) by Truck to Port	Transport distance of ethanol from 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)	Standard distance of 40 miles and does not require user input.
2.6 Ethanol Transport Distance by Truck from Oregon Terminal to Refueling Station (miles)	Standard distance of 50 miles and does not require user input.

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 and sugar production, and electricity cogenerated or procured from the grid. The input data must span 24 months inclusive of two sugarcane harvest cycles of at least 9month duration each. For provisional pathway applications, a minimum of 3-months data will be considered. 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 monthly total 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 sourced by the mill from applicant-owned and partnership farms (metric tonnes). This is a calculated value and does not require an 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 necessary.
3.8 Amount of Externally Acquired or Purchased Bagasse[6]	Input monthly total quantity of additional sugarcane bagasse sourced from external sources for cogeneration (metric tonnes). Input required only 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). Input is not required for this field.
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 quanties of ethanol produced from externally purchased or acquired molasses (m^3). This volume shall be estimated based upon the quality and quantity of every batch of external molasses acquired for the production of ethanol. 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.

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

3.15 Fraction Sucrose Entering Sugar Production (monthly weighted average)	Input monthly weighted fraction of sucrose (fermentable or crystalline sugars) in juice that enters the sugar production process (tonne per metric tonne cane). Values must be verifiable from batch laboratory samples, and values recorded in enterprise production systems (ATR or TRS). See additional details below 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 Table D.3.
3.19 Hydrous Ethanol Production (Reported at 20 C / 68F)	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 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 necessary. Additional details are provided below 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)	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 the production of ethanol. This volume can be estimated from the quality and quantity of every batch of externally acquired molasses.[7] 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

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

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:

$$\text{Quality of external molasses acquired} = \frac{metric\ tonnes\ of\ fermentable\ sugars\ in\ external\ molasses}{metric\ tonne\ of\ standard\ molasses}$$

Table D.4. Example for determining the volume of ethanol produced from external 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 (which is a proxy for crystalline and fermentable sugars in sugarcane juice) in the juice entering 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 prior to the juice entering the sugar production process. These losses have been estimated to be approximately one percent of the total amount of sucrose. Therefore, if the amount of 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 production systems as ATR or TRS (or total reduced sugars after losses). The monthly weighted average value is referred in the Calculator as the "eta_j" parameter.

Field 3.18 and 3.21

If ethanol is produced from externally-sourced molasses, the quantity of ethanol 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 yields of ethanol from each feedstock using total production quantities of ethanol and finished sugar, as well as 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 Dropdown 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 at the far right in the "Analyze" box.

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

G-K Model Parameter	Description
4.1 nj (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 pretreatment 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 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 that is 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 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. Input value for facility weighted average over 24 months of production. The user may choose the "User Defined" option in Cell E77 and then input a Site Specific value in Cell F77, or choose Standard Value in Cell E77. After choosing either option (and entering a user-defined value if the UserDefined option was selected), click F9 to update the sheet. The UserDefined 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. Input value for facility weighted average over 24 months of production. The user may choose the "User Defined" option in Cell E78 and then input a Site Specific value in Cell F78, or choose 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 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 Table D.4. No user input is necessary.
4.10 Differences between modeled and adjusted reported	This is a calculated value, and is based upon the difference of the modeled and adjusted reported ethanol production numbers. The objective is for this value to be zero. This cell will report an imbalance

ethanol production numbers (dry gal) (Calculated)	when a "Solver" solution cannot be found. Additional details are provided below 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)	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. This is accomplished 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 subwindow 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 an input with a constraint less than or equal to 1.0.

3. Check box "Make Unconstrained Variables Non-Negative." 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. A new window "Solver Results" will open up. 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 still been found, then check the juice shares in Field 3.14 (fraction 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. Additionally, 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 output 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 is alerting the applicant to a constraint in output that cannot be increased or decreased as a result of 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 is an indication 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" is used to apportion 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 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 parameters, the applicant should verify the accuracy of the model 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 produced from sugarcane juice feedstock (dry gal). No user input is necessary.
5.2 Sugarcane Juice-to-Ethanol Yield (Calculated)	Yield of ethanol 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 produced from sugarcane molasses feedstock (dry gal). No user input is necessary.
5.4 Molasses-to-Ethanol Yield (Calculated)	Yield of ethanol 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 amount of 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 (gCO₂e/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 enable the determination of 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 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 enable the determination of 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 WA-GREET3.0 model proposed for adoption. The CI Calculations provide an aggregation of each GHG impact that results from application of agricultural inputs, crop harvesting, transport to fuel production facility, fuel production, transport 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.

III. Biodiesel and Renewable Diesel

A. Introduction

This document provides detailed instructions for the use of the Simplified CI Calculator for Tier 1 Biodiesel (BD) and Renewable Diesel (RD) pathway applications. This Calculator is to 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://ecology.wa.gov/Asset-Collections/Doc-Assets/Rulemaking/AQ/WAC173-424_455_-21-04/Tier-1-Calculator-for-Renewable-Diesel-WAC-173-1

The Calculator has been automated to perform CI calculations using factors from the WA-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 monthly feedstock, operational energy use, fuel production and co-product data, and transport distances used in calculating the CI of BD and RD.

This Calculator also includes additional reference material such as greenhouse gas emissions factors used in WA-3.0 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 Ecology 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:

Table B.1 Color Legend

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 corresponding fuel volumes for the various streams. The tab includes a toggle for 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 in order to establish final CIs, pursuant to section 95488.4(a) of the regulation.
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 WA-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 WA-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 WA-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 the production of biodiesel and renewable diesel.
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 (applies generally 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 Ecology for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact Ecology 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 on "Calculate" and Fields 2.2 and 2.3 will appear.
2.2. Specify 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 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 Ecology staff to develop 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 not available on the tabs for these feedstocks**.
2.5.Select Oil Extraction	Field 2.5 provides option to select either Standard or User-Defined oil extraction for Soy Oil. If 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 Ecology staff to develop 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 lieu 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 Ecology staff to develop 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 Ecology staff to develop 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 own 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 Ecology staff to develop 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 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)	Monthly feedstock used (in lbs.) is automatically calculated 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 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 quantity of feedstock used in biofuel production. Cells which are grayed out are calculated values and do not require applicant input. The first input field is the monthly beginning inventory of feedstock (in lbs.). Input monthly totals for feedstock received (as purchased) in lbs. and total monthly ending feedstock inventory in lbs. The monthly total 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 transport, staff suggests a calculation methodology detailed below. The example detailed is for Soy Oil transported to a biomass-based diesel production facility. The same suggested approach could be used for all feedstocks used in 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 transport, and also transport which includes more than one mode of transport to ship feedstock from the source to the biomass-based diesel production facility.

Table D.3. Monthly Average Feedstock Transport

	Modes of Transport					
Actual soyoil (lbs.) transported by corresponding mode of transport and miles transported						
	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 sheet above:						
Entry 1	For the month, the facility received 100,000 lbs. by a mode which included 50 miles by truck followed by 1200 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 followed by 250 miles by barge.					
Entry 5	For the month, the facility also received 50,000 lbs. using only rail transport for a distance of 1000 miles.					
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 transport of feedstock, applicants must calculate the appropriate mileage for each mode of transport as described below. For rail transport, mileage must be based on the rail network maps from either BNSF Railway[8] or Union Pacific.[9] For facilities which are not directly located on the BNSF or Union Pacific rail network, applicants

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

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

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.[10] Nautical miles calculated by the online mapping system must be converted to miles using the conversion factor of 1 nautical mile/1.152 miles.[11]

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 applicant, facility location. This section also provides a summary of pathway CIs corresponding to inputs in the feedstock tabs and the BD-Production tab. All CI values are calculated based on relevant site-specific inputs which have to 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.

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.

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[10] Example of an online nautical distance mapping system: https://www.marinetraffic.com/en/voyageplanner

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

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)[12]

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, gCO$_2$e/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 Ecology staff to develop a user defined emission factor for electricity mix. Data sources for User-Defined electricity mixes must be

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[12] 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.

	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 Ecology 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 BD production facility. Consult with Ecology 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 Ecology 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 Ecology 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 Ecology 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 Ecology 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 Ecology staff to develop the appropriate energy density factor for distillate bottoms, free fatty acids and other coproducts, as applicable, for co-product credit (Btu/lb. for LHV). Enter it in Field 2.19.a. below the monthly inputs. To ensure coproduct credit, appropriate evidence of end-use of all coproducts must be demonstrated in the Supplemental Documentation submitted with the Simplified CI Calculator. Coproduct 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 are 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 that there is 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 coproduct will be credited provided that there is evidence of its end use disposition for useful purpose.

2.22. Other Coproducts (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, coproduct 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 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 transported by Ocean Tanker to a blending terminal in Washington. If User-Defined is selected, consult Ecology staff to develop 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 [13] one from Brazil, one from Canada, one representing the U.S average, and one for User-Defined region[7]).

Biodiesel Transportation (field 2.23)

For transport of finished fuel to Washington, 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 Washington.

Note: For applicants who expect to use various combinations of transport modes to ship fuel to Washington, 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 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

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[13] EPA, 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 Ecology staff to develop emission factors for User-Defined electricity.

detailed in this tab and in the "BD RD Summary" tab. Details for entering data in all required fields is detailed below.

Section 1: Applicant Information, Pathway Summary, and Estimated CI

Table F.1 includes fields requiring inputs related to applicant, facility location. This section also provides a summary of pathway CIs corresponding to inputs in the feedstock tabs and the RD-Production tab. All CI values are calculated based on relevant site-specific inputs which have to 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 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", 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

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, 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 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 Ecology 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 Ecology 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 Ecology 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 Ecology 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 Ecology 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 Ecology 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 Ecology 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 Ecology 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 coproduct 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, coproduct 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 Ecology 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 coproducts used as a process fuel, and the energy density value for each co-product used as a process fuel must be input as
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 coproduct 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, coproduct 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 that there is evidence of its end use disposition for useful purpose. Users shall input applicable unit for the "Other" coproducts.
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 RD production facility to either a port or rail yard for further transport. Additional RD transportation details are provided below 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 transported by Ocean Tanker to a blending terminal in Washington. If User-Defined is selected, consult Ecology staff to develop 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 [14], one from Brazil, one from Canada, one representing the U. S. average, and one for User-Defined region[9]).

Renewable Diesel Transportation (field 2.20)

For transport of finished fuel to Washington, 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 Washington.

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[14] EPA, 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   [9] Applicants must consult Ecology staff to develop emission factors for User-Defined electricity.

Note: For applicants who expect to use various combinations of transport modes to ship fuel to Washington, 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.

IV. LNG and L-CNG from North American Natural Gas

A. Introduction

This document provides detailed instructions for the use of 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://ecology.wa.gov/Asset-Collections/Doc-Assets/Rulemaking/AQ/WAC173-424_455_-21-04/Tier-1-Calculator-for-LNG-WAC-173-424-07-15-22

The Calculator has been automated to perform CI calculations using factors from the WA-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 WA-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 Ecology 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:

Table B.1. Color Legend

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 in order to establish the final CI, pursuant to section 95488.4(a) of the regulation.
NA NG	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 WA-GREET3.0 model used in calculation of 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. 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 Ecology for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, If not available, contact Ecology 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", else "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).
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 Washington (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 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. If 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 Ecology 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 use 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 LNG transport and distribution section. No input is required for field 2.7.
2.7.a. Select to affirm LNG delivery trucks are equipped with BoilOff Recovery	If trucks transporting LNG are equipped to recover "Boil-Off", select "Yes" 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 LCNG dispensing station in Washington in field 2.7.b. Additional details are included below Table D.2.
2.8. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 2.1, consult with Ecology 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 all data are input 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. 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, in order to minimize the risk of exceeding the certified CI as a result of changes in the supply chain.

Section3. 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.

V.   Biomethane from North American Landfills

A. Introduction

This document provides detailed instructions for the use of 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://ecology.wa.gov/Asset-Collections/Doc-Assets/Rulemaking/AQ/WAC173-424_455_-21-04/Tier-1-Calculator-for-Biomethane-Landfill-WAC-1

The Calculator has been automated to perform CI calculations using factors from the WA-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 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 also includes additional reference material such as greenhouse gas emissions factors used in WA-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 Ecology 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:

Table B.1. Color legend

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, pursuant to section 95488.4(a) of the regulation.
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 WA-GREET3.0 model used in calculation of 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 Ecology for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact Ecology for LCFS Facility ID.
1.4. Landfill Location	Location of the landfill. Example: "AAA Landfill in Sacramento, CA"
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 Washington CNG dispensing station (Street, City, State). For multiple stations, use Seattle 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 LCNG 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 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, 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. If upgrading facility is located outside the U.S., select "User Defined Mix". For facilities which 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 Ecology 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 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 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 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 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 in addition to ensuring emission factor for user defined mix is included in Field 2.14.
2.10. Buy Back fossil NG to boost Btu prior to 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 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 2.12.
2.11. Propane used to boost Btu prior to 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 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 Washington in field 2.13.a. If fuel is sent to multiple stations, use the Standard Station Centroid of Seattle as the endpoint. Additional details below 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 Table D.2.
2.14. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 2.1, consult with Ecology 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 which use biogas to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation and consult Ecology staff prior to submission of a pathway application. A dedicated meter to quantify biogas-derived electricity in kWh must be used to report 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 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 are 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, applicant must report metered quantity of biogas used 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 which use buyback natural gas (NG) or propane to boost the Btu of biomethane prior to 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 total 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 party. 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 prior to any blending with nonrenewable 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 & 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 which use multiple dispensing stations, applicants using multiple dispensing stations may use driving distance from a landfill in the U.S. or Canada to Seattle, WA 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, in order to minimize the risk of exceeding the certified CI as a result of 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 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, 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. 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 Ecology 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 verifier during 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 24 months in field 3.5.
3.6. LNG Transport and Distribution	This field serves as a label for LNG transport and distribution section. No input is required for field 3.6.
3.6.a. Select to affirm LNG delivery trucks are equipped with BoilOff 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 station	Input distance from liquefaction facility to the intended LNG or LCNG dispensing station in Washington in field 3.6.b. Additional details are included below Table D.3.
3.7. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 3.1, consult with Ecology 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 all data are input 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. 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, in order to minimize the risk of exceeding the certified CI as a result of 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.

VI.   Biomethane from Anaerobic Digestion of Wastewater Sludge

A. Introduction

This document provides detailed instructions for the use of 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://ecology.wa.gov/Asset-Collections/Doc-Assets/Rulemaking/AQ/WAC173-424_455_-21-04/Tier-1-Calculator-for-Biomethane-Sludge-WAC-17-1

The Calculator has been automated to perform CI calculations using factors from the WA-GREET3.0 model. Applicants are required to 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 derived from the anaerobic digestion of wastewater sludge at a POTW.

This Calculator also includes additional reference material such as greenhouse gas emissions factors used in WA-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 Ecology 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:

Table B.1. Color Legend

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 in order to establish the final CI, pursuant to section 95488.4(a) of the regulation.
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 included below.
EF Table	Reference worksheet. Contains greenhouse gas emissions factors from the WA-GREET3.0 model used in calculation of 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 Ecology for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact Ecology 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 Washington CNG dispensing station (Street, City, State). For multiple stations, use Seattle 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 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, a Brazilian average mix, a Canadian average 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 upgrading facility is located outside the U.S., select "User Defined Mix." For facilities which 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 Ecology 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 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. 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 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 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 prior to 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 Table D.2.
2.9. Propane used to boost Btu prior to 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 specification. 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 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 Table D.2.
2.11. NG pipeline Transmission	This field includes a label for NG pipeline transmission and does not require an input.
2.11.a From upgrading facility to CNG Station	Input distance from biogas processing facility to the intended CNG station in Washington in field 2.11.a. If fuel is sent to multiple stations, use the Standard Station Centroid of Seattle as the endpoint. Additional details can be found below 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 Table D.2.
2.12. Specify GHG Emissions Factor for Electricity Mix	If "User Defined Mix" is selected in field 2.1, consult with Ecology 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 which use biogas to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation and consult Ecology staff to determine a user-defined emissions factor. A

dedicated meter to quantify biogas-derived electricity in kWh must be used to report 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 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, 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 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 2.8 and 2.9)

For biogas upgrading facilities which use buyback natural gas (NG) or propane to boost the Btu of biomethane prior to 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 total 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 party. This reporting is consistent with quantities reported for RIN generation under the RFS, which is based

on the Btu of the pipeline quality biogas after treatment, and prior to 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 & 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 which use multiple dispensing stations, applicants using multiple dispensing stations may use driving distance from the POTW in the U.S. or Canada, to Seattle, Washington 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, in order to minimize the risk of exceeding the certified CI as a result of 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, a Brazilian average mix, a Canadian average 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. Note, if the "User Defined Mix" is selected, consult with Ecology 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 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 verifier during 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 LNG transport and distribution section. No input is required for field 3.6.
3.6.a. Select to affirm LNG delivery trucks are equipped with BoilOff 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 Washington in field 3.6.b. Additional details are included below Table D.3.

3.7. Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 3.1, consult with Ecology 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, in order to minimize the risk of exceeding the certified CI as a result of 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. Standard inputs and corresponding GHG emissions are detailed in this section.

VII. Biomethane from Anaerobic Digestion of Dairy and Swine Manure

A. Introduction

This document provides detailed instructions for the use of 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 and swine manure is 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://ecology.wa.gov/Asset-Collections/Doc-Assets/Rulemaking/AQ/WAC173-424_455_-21-04/Tier-1-Calculator-for-Biomethane-Manure-WAC-17-1

The Calculator has been automated to perform CI calculations using factors from the WA-GREET3.0 model. Applicants are required to 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 dairy and swine manure digesters.

This Calculator also includes additional reference material such as greenhouse gas emissions factors and reference fuel specifications used in WA-GREET3.0, and certain emission factors from the Compliance Offset Protocol Livestock Projects (November 2014). 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 the Ecology of the Washington Air Resources Board.

The applicant may only enter values or make selections in input fields designated by Ecology 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:

Table B.1. Color Legend

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	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 in order to establish the final CI, pursuant to section 95488.4(a) of the regulation.
Manure-to-Biogas (LOP Inputs)	Calculation worksheet that is based on selected equations from the "Compliance Offset Protocol Livestock Projects"[15] ("LOP" hereafter). The user inputs related to baseline and project methane emissions are indicated in yellow cells, automatically calculated values are in gray cells.
Avoided Emissions	Avoided methane calculation worksheet. Contains the values related to baseline and project methane emissions and the quantification of avoided methane and diverted CO_2 from land application.
Biogas-toRNG	Calculation worksheet that 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	Reference worksheet. Contains greenhouse gas emissions factors from the WA-GREET3.0 model and the LOP used in calculation of carbon intensities.

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[15] 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	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. 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 NonAnaerobic 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 (PECH4,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, and users can enter information for up to six livestock categories in six corresponding sub-sections.
L1.(1-6).2 Livestock Average Mass	The typical average mass of the livestock selected in L1.(1-6).1. See Table A.1 in the LOP.

L1.(1-6).3 Maximum CH₄ 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	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	Number of reporting days in the reporting month.
L1.(1-6).9 Average Temperature	Monthly average ambient temperature in degree 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 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 options that is applicable. If the volatile solids retention time in the anaerobic storage/treatment system is less than or equal to 30 days, or if the month following the complete drainage and cleaning of solid buildup from the anaerobic storage/treatment system, the volatile solids retained in the system from the previous month must be set to zero.
L1.(1-6).14 Carryover from Previous Month	The difference between the VS available for degradation and the VS degraded from previous month. If this is the first year of the project, 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	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 NonAnaerobic Storage/Treatment Systems	The fraction of manure (volatile solids) that would be sent to the non-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. Sitespecific 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 nonanaerobic 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	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 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 in which it is taken and for 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	Results of the monthly quantity of methane that is 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.(16).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	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 sources in the waste treatment and storage category 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 nonBCS related sources.
L5.5 Project Methane Emissions, non-BCS	The modeled project methane emissions from sources in the waste treatment and storage category 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 (*CH4 vent*)	Results of monthly quantity of methane that is vented to the atmosphere due to the digester venting events. These are calculated values based on the $CCCC_4\ vvvvvvvv,$ 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 calculated value based on the 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 calculated value based on the Equation 5.9 from the LOP.
P1.4.d Digester leakage	Results of monthly quantity of methane leakage from the digester.

Section P2. Avoided CH$_4$ Emissions Calculation Details

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

Section P3. Avoided CO$_2$ Emissions Calculation Details

This section contains an example 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 Ecology for LCFS Company ID.
1.3 Facility ID	Enter the Company's Facility ID. If not available, contact Ecology for LCFS Facility ID.
1.4 Digester Location (Street, City, State)	Location of the anaerobic digester. Example: "AAA Livestock Manure Digestion Facility in Sacramento". 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 Washington CNG dispensing station (Street, City, State). For distribution to multiple Washington stations, use Seattle as the endpoint in determining the (the Standard Station Centroid location). See additional details below 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 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 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 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. If upgrading facility is located outside the U.S., select "User Defined Mix". For facilities which 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 Ecology 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 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 Total Raw Biogas Flow (metered)	Input monthly total raw dry biogas flow (in Standard Cubic Feet at 60°F, 1 atm) data for 24 months (at least 3 months if provisional) of operation. Specific requirements detailed below Table F.2.
2.5 Biomethane Content (% Methane)	Input monthly weighted average methane concentration in raw dry biogas for 24 months (at least 3 months if provisional) of operation. Specific requirements detailed below 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 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 3 months if provisional) of operation. Specific requirements detailed below Table F.2.
2.8 Diesel (baseline manure transport and handling)	Input monthly total diesel use (in gallons at ambient temperature) to transport and handling manure in the baseline case for 24 months (at least 3 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 3 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 3 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 3 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 the digestion process.
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 3 months if provisional) of operation.
2.14 Diesel (digester project manure transport and handling)	Input monthly total diesel use (in gallons at ambient temperature) in transporting and handling manure for the digestion process for 24 months (at least 3 months 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 3 months if provisional) of operation.
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 (a least 3 months if provisional) in this field.
2.19 Buy Back fossil NG to boost Btu prior to 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 specification. This quantity is not used in CI calculations. Subtract this quantity of fossil NG when reporting pipeline injected biomethane in fiel 2.23. Additional details are included below Table F.2.

2.20 Propane used to boost Btu prior to 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 specification. 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 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 3 months 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 3 months if provisional). The quantity must be supported by the sales receipts. See additional details below 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 3 months if provisional). Assuming 100% biomethane content.
2.25 On-site Electricity Production	Input monthly total electricity produced from the biomethane for 24 months (at least 3 months if provisional).
2.26 Export Electricity	Input monthly total electricity produced from the biomethane and exported for 24 months (at least 3 months if provisional).
2.27 NG pipeline Transmission	This field includes a label for NG pipeline transmission and does not require an input.
2.27.a From upgrading facility to CNG Station	Input distance from biogas processing facility to the intended CNG station in Washington. If fuel is sent to multiple stations, use the Standard Station Centroid of Seattle as the endpoint. Additional details below Table F.2.
2.27.b From upgrading facility to LNG plant	Input distance from biogas processing facility to the liquefaction facility. This is required only if the pathway application includes LNG and L-CNG pathways. Additional details below Table F.2.
2.28 Specify GHG Emission Factor for Electricity Mix	If "User Defined Mix" is selected in field 2.1, consult with Ecology 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 are 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, 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 manufacturer's requirement and 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 which use biomethane to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation and consult Ecology staff prior to submission of a pathway application. A dedicated meter to quantify biomethane-derived electricity in kWh (Field 2.16) must be used to report 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 which use buyback natural gas (NG) or propane to boost the Btu of biomethane prior to 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 and/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 actual quantity injected into the pipeline that was purchased by the local utility or other party. This is consistent with quantities reported for RIN generation under the RFS, which is based on the Btu of the pipeline quality biogas after treatment, and prior to 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 which use multiple dispensing stations, applicants using multiple dispensing stations may use driving distance from a digester in the U.S. or Canada to Seattle, WA 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, in order to minimize the risk of exceeding the certified CI as a result of 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 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, 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. 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 Ecology 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 3 months 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 verifier during 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 3 months 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 use from the grid in kWh for 24 months (at least 3 months if provisional).
3.6 LNG Transport and Distribution	This field serves as a label for LNG transport and distribution section. No input is required for this field.
3.6.a Select to affirm LNG delivery trucks are equipped with BoilOff 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 station	Input distance from liquefaction facility to the intended LNG or LCNG dispensing station in Washington. Additional details are included below 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" else "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 Ecology 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 all data are input 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. If multiple dispensing facilities are utilized, a volume weighted average transport distance based on 24 months (at least 3 months 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, in order to minimize the risk of exceeding the certified CI as a result of 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

VIII. Biomethane from Anaerobic Digestion of Organic Waste

A. Introduction

This document provides detailed instructions for the use of 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://ecology.wa.gov/Asset-Collections/Doc-Assets/Rulemaking/AQ/WAC173-424_455_-21-04/Tier-1-Calculator-for-Biomethane-Organic-Waste-1

The Calculator has been automated to perform CI calculations using factors from the WA-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 WA-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 Ecology 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:

Table B.1. Color Legend

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 in order to establish the final CI, pursuant to section 95488.4(a) of the regulation.
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 predetermined. 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 blockflow 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	Worksheet that illustrates the fate of user defined organic waste that do 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	Reference worksheet. Contains greenhouse gas emissions factors from the WA-GREET3.0 model used in calculation of 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 Ecology for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact Ecology 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 Washington CNG dispensing station (Street, City, State). For multiple stations, use Seattle as the endpoint (the Standard Station Centroid location). See additional details 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 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 below Table D.3.
1.10 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. 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 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, a Brazilian average mix, a Canadian average 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 upgrading facility is located outside the U.S., select "User Defined Mix." Facilities which 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 Ecology 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 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 in support of the monthly estimate in the Supplemental Documentation, and 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. 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 that would be disposed of by landfill (in absence of anaerobic digestion). The fraction diverted 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 degradable organic fraction (DOC). Some materials have predetermined 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 actually 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. Value may be used to estimate the DOC factor of such organic waste. Value must be representative of 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. Value may be used to estimate the DOC factor of such organic waste. Value must be representative of 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 use for digestate or compost load out, or fuel use for windrow composting, 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 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 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 that is consumed by the facility boiler, or destroyed by the flare or thermal oxidizer (TO) in the event the facility is unable to process or upgrade the gas.
2.14. Biogas Upgrading -Tail Gas to Flare/TO (MMBtu, HHV)	Enter metered amounts of tail gas methane that is destroyed by the flare or thermal oxidizer (TO) prior to release to 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 prior to 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 specification. This quantity is not used in CI calculations. Subtract this quantity of fossil NG when reporting pipeline injected biomethane in field 2.19. See additional details below Table D.2.
2.18. Propane used to boost Btu prior to 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 specification. 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 Table D.2.
2.19. Biomethane Injected into Pipeline (metered) (MMBtu, HHV)	Input monthly total biomethane injected into the pipeline in MMBtu (as HHV) for each month. 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 Table D.2.
2.20. NG Pipeline Transmission	This field includes a label for NG pipeline transmission and does not require an input.
2.20.a From upgrading facility to CNG Station	Input pipeline distance from biogas processing facility to the intended CNG station in Washington. For onsite dispensing, assume that the pipeline distance is 1 mile. If fuel is sent to multiple stations, use the Standard Station Centroid of Seattle as the endpoint. Additional details can be found below Table D.2.
2.20..b From upgrading facility to LNG plant	Input pipeline distance from biogas processing facility to the liquefaction facility. This is required only if the application includes LNG and L-CNG fuel pathways. Additional details can be found below 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 Ecology 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 which use biogas to generate electricity for biogas upgrading, applicants must declare the use of on-site electricity generation, and consult with Ecology staff prior to submission of a pathway application for the appropriate emissions factor. 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 used 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 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, applicant must report 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 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 2.17 and 2.18)

For biogas upgrading facilities which use buyback natural gas (NG) or propane to boost the Btu of biomethane prior to 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 total 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. The quantity entered 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 party. 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 pipeline quality biogas after treatment, and prior to 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 which use multiple dispensing stations, applicants using multiple dispensing stations may use driving distance from the digester facility in the U.S. or Canada, to Seattle, Washington 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, in order to minimize the risk of exceeding the certified CI as a result of 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

	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, a Brazilian average mix, a Canadian average 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 selecting an electricity mix option, click the "**Calculate**" button. Note, if "User Defined Mix" is selected, consult with Ecology 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.
3.1. Select Regional Electricity Mix for LNG Production	
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 verifier during 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 24months of operation in field 3.5.
3.6. LNG Transport and Distribution	This field serves as a label for LNG transport and distribution section. No input is required for field 3.6.
3.6.a. Select to affirm LNG delivery trucks are equipped with BoilOff 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 Washington in field 3.6.b. Additional details are included below Table D.3.
3.7. Specify GHG Emissions Factor for Electricity Mix	Only displayed when "User Defined Mix" is selected in field 3.1. Consult with Ecology 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 all data are input 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. 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, in order to minimize the risk of exceeding the certified CI as a result of 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. Standard inputs and corresponding GHG emissions are detailed in this section.

E. 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 human 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 Washington, 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 Washington, 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. Based on the Washington state-average MSW characterization,[16] 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, fraction of degradable organic carbon, fraction of DOC that is decomposed, and whether the material is normally 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 certain organic waste cannot be classified into any categories provided in the list, 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 equivalent method approved by Ecology) and used to determine the DOC of such feedstock.
   b. If the analytical tests cannot be performed, applicant may estimate the feedstock-specific DOC using the equation[17] below:

$$DOC = F_{DOC} \; \frac{\% \, Volatile \, Solids}{100\%} \; x \; \frac{\% \, Total \, Solids}{100\%}$$

   Where:
   - F_{DOC} is the fraction of the volatile residue that is degradable organic carbon (weight fraction); use 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)[18] test (or equivalent method approved by Ecology) can be used to determine the DOC_f of such feedstock.[19]
   b. If the analytical tests cannot be performed, use default value of 0.5.

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[16] 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: http://www.calrecycle.ca.gov/Publications/Documents/1546/20151546.pdf

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

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

[19] 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, 335342

Note that all user-defined values must meet the requirements of the monitoring plan for entities required to validate or verify pursuant to sections 95491.1(c).

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