Instruction Manual
Tier 1 CI Calculator for Sugarcane Ethanol

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This document was prepared by
Oregon Department of Environmental Quality
Clean Fuels Program
700 NE Multnomah Street, Suite 600
Portland Oregon, 97232
Contact: Bill Peters
Phone: 503-863-6259
www.oregon.gov/deq

State of Oregon
DEQ Department of Environmental Quality

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800-452-4011 | TTY: 711 | deqinfo@deq.oregon.gov

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Introduction

This document provides detailed instructions for the use of the Tier 1 CI Calculator for Sugarcane Ethanol (T1 Sugarcane Ethanol Calculator). This calculator is to be used to calculate the composite carbon intensity for ethanol produced from sugarcane juice and molasses feedstocks in Brazil for use as a transportation fuel in Oregon.

[Download the T1 Sugarcane Ethanol Calculator](#)

The T1 Sugarcane Ethanol Calculator requires the applicant to add monthly operational data which includes sugarcane throughput, sugarcane transport distances to the mill, sugarcane juice and molasses quality, fuel production quantities, and co-product (surplus electricity exports from cogeneration activities) information to calculate the CI of sugarcane juice and molasses-derived ethanol pathways. DEQ will certify a single, composite CI for both feedstocks. Some DEQ-approved default and conditional default input values may also be selected.

T1 Sugarcane Ethanol Calculator overview

The following table provides an overview of the worksheets used in the T1 Sugarcane Ethanol Calculator.

Table 1: Worksheets Used in the T1 Sugarcane Ethanol Calculator

Worksheet Name	Description
Introduction	Provides a brief introduction for the T1 Sugarcane Ethanol Calculator.
Site-Specific Inputs	Worksheet for entering monthly operational data used for calculating the carbon intensity (CI) of the fuel pathways.
Calculated Parameters	This worksheet determines the Mass Allocation Ratio (MAR) applicable to upstream impacts for the sugarcane molasses-to-ethanol pathway. It also permits the applicant to model the theoretical output of finished sugar and ethanol produced based upon the sucrose content and other information provided in "Site-Specific Inputs" above. When the theoretical outputs of ethanol and finished sugar match the reported production of ethanol and finished sugar, a material balance has been achieved.
Pathway Summary	Worksheet that displays fuel production quantities, calculates aggregated CI impacts and composite CIs, and site-specific operating conditions.

Worksheet Name	Description
OR-GREET4.0	Worksheet for predefined input values, emission factors, fuel specifications, and unit conversion values from the OR-GREET4.0 model.

The cells in the T1 Sugarcane Ethanol Calculator have various fill colors per the legend below:

User Input
Calculated Value
OR-GREET4.0 Value

To calculate the fuel pathway CI, the user must enter site-specific data into "User Input" fields if that field in Section 2 is relevant to the fuel pathway. If the input field is not relevant to the fuel pathway, it may be left blank.

All User Inputs are subject to verification as part of initial pathway certification and annual fuel pathway reporting. If a fuel pathway has additional emissions inside the system boundary that are not captured in the User Input fields, a Tier 2 application is required to document and account for those emissions.

"Calculated Value" cells contain formula that provide a calculated value based on user input data or OR-GREET4.0. In some instances, a "Calculated Value" cell may display a blank value if that input is not relevant or insufficient user input data has been entered.

"OR-GREET4.0" cells contain input values from the OR-GREET4.0 model. Calculated Value formula and OR-GREET4.0 values cannot be modified without prior approval from DEQ and may elevate the pathway to a Tier 2 application.

Site-specific inputs worksheet

The Site-Specific Inputs worksheet consists of the following major components:

- Section 1. Applicant Information
- Section 2. Pathway Inputs
- Section 3. Static Operational Data
- Section 4: Monthly Operational Data

An explanation of each field in Section 1 is provided in Table 2 below:

Table 2: Instructions for Section 1 - Applicant Information

Field Name	Description
1.1 Application Number	Enter the application number provided by the Alternative Fuels Portal (AFP).
1.2 Company Name	Enter the company name as entered in the AFP.
1.3 Company ID	Enter the company ID as generated by the AFP. If not available, contact DEQ staff for LCFS Company ID.
1.4 Fuel Production Facility Address	Enter Mill name, City, State, and Country for the ethanol production facility.
1.5 Facility ID	Enter U.S EPA Facility ID. If not available, contact DEQ.

Section 2 provides the User the option to select or declare only input fields that apply to a given pathway. If a fuel pathway has additional emissions inside the system boundary that are not listed in Section 2, a Tier 2 application is required to document and account for those emissions.

An explanation of each field in Section 2 is provided in Table 3 below:

Table 3: Input Field Instructions for Section 2 of the T1 Cane Ethanol Calculator

Field Name	Description
2.1 Pathway CIs	No selection is necessary as the Tier 1 Simplified CI Calculator for Sugarcane-derived Ethanol only determines a composite CI for both sugarcane juice and sugarcane molasses-derived ethanol. The composite CI is determined from individual CIs calculated for each feedstock based upon the total GHG emissions and fuel production quantities. Since the molasses feedstock is a by-product of the finished sugar production process, only part of the upstream GHG impacts from sugarcane farming, transport, and processing can be attributed to the molasses pathway.
2.2 Feedstocks	The applicant may select one or all the selection choices. A fuel pathway cannot be obtained for ethanol produced from externally sourced molasses feedstock. DEQ must be alerted if this occurs, as the ethanol produced from externally sourced molasses is not within the system boundary considerations and must be excluded from total ethanol produced. An Operating Condition from DEQ is required for externally sourced molasses used for ethanol production.
2.3 Process Energy	Select the type(s) of process energy used at the fuel production facility. Use of externally sourced bagasse or biomass requires an Operating Condition from DEQ. If bagasse or biomass is being imported for electricity cogeneration, electricity produced from externally sourced bagasse or biomass will be excluded from the co-product credit.
2.4 Coproducts	Select the co-product if surplus cogenerated electricity is exported to the public grid.

Field Name	Description
2.5 Finished Products	Select the type(s) of ethanol sold at the fuel production facility. If finished or table sugar is also produced at the mill, it must be indicated here, as the quantity is integral to achieving a material balance.
2.6 Fuel Transport & Distribution	Select all the transport and distribution modes of ethanol that are applicable to the fuel pathway. If "Pipeline Transport in Brazil" is selected, an Operating Condition from DEQ will be required.
2.7 Port of Ethanol Export	Use the drop-down menu to indicate the port in Brazil used for export of ethanol by ocean tanker to Oregon.
2.8 Ethanol Sold	No selection is necessary here as only undenatured anhydrous ethanol is eligible for export which is subsequently denatured in Oregon.
2.9 Choose Region for the Burn Area Evaluation	The Selection choices here include the "Standard for Sao Paulo" State, or the "Standard for Non-Sao Paulo States."

Section 3 lists some static operational parameters needed for the fuel pathway CI determination; some are default parameters for the fuel ethanol pathway, and some inputs need to be provided by the applicant.

Each parameter is discussed in Table 4 below:

Table 4: Instructions for Section 3: Static Operational Data

Field Name	Description
3.1 Grid Electricity Region	The electricity mix corresponding to the production of ethanol from sugarcane in Brazil is the "Brazil" average mix. No other option is available.
3.2 Biomass-to-Bagasse Equivalent Multiplier	If externally sourced biomass other than bagasse is imported by the Mill, a Biomass-to-Bagasse Equivalent Multiplier is required for input into Field 4.10. DEQ Staff must be consulted for a Pre-Validation Operating Condition.
3.3 Denaturant Accounting	No denaturant is assumed to be added at the point of export. All denaturant is added to the anhydrous ethanol at the Oregon port of import, and GHG emissions from denaturant addition are assessed at this point. The "Default Value" of denaturant addition (2.5% (v/v) CBOB) is applicable to the sugarcane ethanol pathway.
3.4 Ethanol Transport in Brazil by Truck (km)	Enter the total mileage for ethanol transport by heavy-duty truck (HDT) from the ethanol production facility direct to the port of export to Oregon by Ocean Tanker, or an intermediate terminal used to transport ethanol by pipeline. Truck transport mileage (km) may be determined using a publicly available web-based driving distance estimator such as "Google Maps" or equivalent search site.

Field Name	Description
3.5 Ethanol Transport in Brazil by Pipeline (km)	Enter the total distance (km) for ethanol transported by Pipeline from the intermediate fuel terminal to the point of export (port or terminal) where the ethanol would be stored for subsequent loading onto an ocean tanker. This mode may involve the transport of ethanol from the fuel production facility by HDT to an intermediate terminal for intermodal transfer by pipeline. Only the pipeline distance is to be entered here.
3.6 Ethanol Transport Route to Oregon	Use the drop-down menu at the right to choose an ocean transport route to Oregon. Possible choices are Via the Panama Canal; Via Cape Horn, or Via the Cape of Good Hope. The applicant may not change the ethanol transport route without DEQ consent.
3.7 Ethanol Transport by Ocean Tanker to Oregon (km)	Enter the total distance (km) for ethanol transport by Ocean Tanker from the Brazilian port of export to the final Oregon port where ethanol is imported. The ocean transport distance (km) may be determined using a publicly available web-based sea distance calculator, or the distance provided by the ocean freight carrier.
3.8 Oregon Port to Terminal (miles)	A default value represents the transport distance for ethanol transported from the Oregon port of import to the Terminal where ethanol is blended with CBOB for distribution to refueling stations.
3.9 Terminal to Refueling Stations (miles)	A default value represents the transport distance for ethanol transported from the Oregon blending terminal where ethanol was blended with CBOB for distribution to refueling stations.
3.10 Applicable Credit for Mechanized Harvestings	Based upon the selection made in Field 2.9, a value of either 80 percent or 65 percent is returned to this cell. No User Input is necessary.

Operational data must be entered into the fields in Section 4 for each month of the operational data period. Fields that do not apply to the fuel pathway may be left blank (for example, records for non-sugarcane harvest months, or when the ethanol plant is not in operation). The applicant should however enter a value of "0.0" if there is nothing to report (for example, if no sugarcane was procured from Partnership or Terceiros farms during a harvest month, that field should be reported as "0.0"). Any gaps in data reporting must comply with the Missing Data Provisions in OAR 340-253-0450(13). Feedstock quantities should be reported inclusive of moisture content (as wet metric tons or tonnes sugarcane, or metric tons externally sourced molasses).

Quantities entered should be inclusive of the entire fuel production facility; quantities used by the facility that are outside the fuel pathway system boundary may only be excluded with written permission from DEQ.

Feedstock Parameters are to be provided in Fields 4.1 through 4.10. Process Energy use must be reported in Fields 4.12 and 4.13. Process Parameters related to sugarcane shares and sucrose quality should be provided in Fields 4.14 and 4.15. Fuel and Co-Product Production

data for the operational months should be provided in Fields 4.16 through 4.22. Specifics for each Field above fields are discussed in Table 5 below.

Table 5: Instructions for Section 4 - Monthly Operational Data

Field Name	Description
4.1 Reporting Month (MM/YYYY)	Enter the 24 consecutive months that reflect the most recent operational data available for the ethanol production facility. Applications must not have an interval of greater than 3 months between the end of the operational data month and the date of submission. For fuel production facilities that have been in operation less than 24 months, the operational data submitted is permitted to range between 3 to 24 months.
4.2 Applicant-owned Farms (Propria Farms)	Input monthly total quantity of sugarcane sourced from applicant owned (Propria) sugarcane farms (metric tons or tonnes).
4.3 Transport Distance from Applicant-Owned Farms (weighted average)	Enter monthly weighted average sugarcane transport distance by HDD Truck to mill from applicant-owned farms (km).
4.4 Partnership Farms (Terceiros Farms)	Enter monthly total quantity of sugarcane sourced from partnership (Terceiros) sugarcane farms (metric tons or tonnes).
4.5 Transport Distance from Partnership Farms (weighted average)	Enter monthly weighted average sugarcane transport distance by HDD Truck to mill from partnership farms (km)
4.6 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 a user input.
4.7 Filter Cake Transport & Distribution Distance (Calculated)	This field includes filter cake transport distance to the fields and is a calculated standard value (cane transport distance plus two miles). No user input necessary.
4.8 Externally Sourced Molasses	Input monthly total quantity of sugarcane molasses sourced (or purchased) from external mills for ethanol production purposes (metric tons or tonnes).
4.9 Ethanol Produced from Externally Sourced Molasses	This volume shall be estimated based upon the quality and quantity of every batch of external molasses acquired to produce ethanol. An Operating Condition is required from DEQ.
4.10 Externally Sourced Bagasse	Input monthly total quantity of additional sugarcane bagasse sourced from external sources for cogeneration purposes (metric tons or tonnes). Input required only if additional bagasse is sourced from external sources or intra-mill transfer. If non-bagasse biomass is imported, then the quantity must be entered as "bagasse equivalents." DEQ must be notified, and an Operation Condition from DEQ is required.

Field Name	Description
4.11 Electricity Generated from Externally Sourced Bagasse	This is a calculated parameter and is dependent upon the physical properties of steam exiting the generator (kWh). Input is not required from the user for this field. This quantity is not eligible for the surplus cogenerated electricity export co-product credit.
4.12 Electricity Purchased from the Public Grid	Input monthly total electricity purchased from the public grid (kWh).
4.13 Surplus Cogenerated Electricity Exported	Input monthly total surplus, cogenerated electricity exported from the sugarcane ethanol plant (kWh).
4.14 Juice Share for Sugar Production (weighted average)	Input monthly weighted average share (%) of sugarcane juice allocated to finished or table sugar production. This number must be verifiable by enterprise production/data collection systems.
4.15 Fraction Sucrose Content of Sugarcane Juice (monthly weighted average)	Input monthly weighted fraction of sucrose (total fermentable sugars) in juice that enter the sugar production process (tonne per tonne (m.t.) cane). Values must be verifiable from batch laboratory samples, and values recorded in enterprise production systems post-crush, but typically after pre-treatment (pH adjustment and decantation) of the juice (ATR or TRS). Losses from point of crush may be empirically determined.
4.16 Anhydrous Ethanol Produced (Reported at 20 °C/68 °F)	Input monthly total volume of anhydrous ethanol produced (m^3). Ethanol must be reported at 20°C/68 °F. Instructions for ethanol volume conversion are provided below this table.
4.17 Moisture Content (Anhydrous Ethanol)	Input monthly weighted average moisture content (%) in anhydrous ethanol produced. The fuel pathway applicant must maintain records of frequency of sampling for continuous production (batch, daily, or random), as well as the test-method for moisture content determination.
4.18 Adjusted Anhydrous Ethanol Produced	Anhydrous ethanol produced less calculated ethanol from externally acquired molasses (m3). No user input is required for this calculated parameter.
4.19 Hydrous Ethanol Produced (Reported at 20 °C / 68 °F)	Input monthly total volume of hydrous ethanol produced (m3). Ethanol must be reported at 20 °C/68 °F. Instructions for ethanol volume conversion are provided below this table.
4.20 Moisture Content (Hydrous Ethanol)	Input monthly weighted average moisture content (%) in hydrous ethanol produced. The fuel pathway applicant must maintain records of frequency of sampling for continuous production (batch, daily, or random), as well as the test-method for moisture content determination.
4.21 Adjusted Hydrous Ethanol Produced (Calculated)	Hydrous ethanol produced less calculated ethanol from externally acquired molasses (m^3). No user input is required for this calculated parameter.

Field Name	Description
4.22 Finished or Table Sugar Produced	Input monthly total quantity of finished or table sugar produced (metric tonnes).
4.23 Total Ethanol Production (Reported at 20 °C / 68 °F) (Calculated)	This is a calculated value and does not require user input. Monthly total volume of anhydrous and hydrous ethanol produced is reported in this field on a dry basis (m^3).

Ethanol volumes produced and subsequently exported to Oregon must be reported at standardized temperatures in Brazil (at 20°C/68°F) and in Oregon (at 15.55°C/60°F). All liquid fuel amounts reported in the AFP must be adjusted to standard temperature conditions of 15.55°C/60°F using the following equation:

$V_{s,e} = V_{a,e} \times (-0.0006301 \times T + 1.0378)$, where

$V_{s,e}$ is the standardized volume of ethanol at 60 °F, in gallons; and $V_{a,e}$ is the standardized volume of ethanol at T °F, in gallons; and T is the actual temperature of the batch, in °F.

Once all site-specific inputs for a given facility have been entered, the applicant may proceed to the "Calculated Parameters" worksheet where the final pathway CIs for the various feedstocks will be calculated and displayed in the "Pathway Summary" worksheet.

Calculated Parameters worksheet

Section 5 in the "Calculated Parameters" worksheet determines the fuel ethanol production yields from juice and molasses feedstocks and calculates the mass allocation ratio (MAR) 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. Alternatively, standard, predefined parameters that define the molasses quality may be selected.

These parameters are called the Gopal-Kammen Model Parameters and are discussed 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 5. Other calculated parameters and outputs are discussed in Table 6.

Table 6: Description of Calculator Worksheet Inputs for Section 5

Field Name	Description
5.1 ηj (tonnes of fermentable sugars in juice/tonne of cane) (Calculated)	"eta_j" is a monthly weighted average parameter assigned to the fraction of sucrose in the juice that enters the finished sugar or ethanol production process. Due to some process losses associated with pre-treatment and pH adjustment, eta_j is not the same as the amount of sucrose measured after the cane crush (post-crush), or at the gate. No user input is necessary.
5.2 ηs (tonnes of sucrose in final sugar/tonne of sucrose into sugar factory) (Calculated)	"eta_s" 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.
5.3 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.
5.4 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 typically lower. It is a calculated parameter, and no user input is necessary.
5.5 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.
5.6 Choose "m_s" (tonnes of sucrose in final sugar/tonnes of final sugar product)	"m_s" 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 E16 (drop-down menu) and then input a Site-Specific Value in Cell F16 or choose Standard Value in Cell E16. 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 supplementary documentation attached with the Simplified CI Calculator.

Field Name	Description
5.7 Choose "m_m" (tonnes of fermentable sugars in standard molasses/tonne of standard molasses)	"m_m" 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 E17 and then input a Site-Specific value in Cell F17 or choose Standard Value in Cell E17. 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 Supplementary Documentation attached to the Simplified CI Calculator.
5.8 Modeled ethanol production (dry gal) (Calculated)	This calculated value 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 F23 and G23). Additional details are provided below Table 7. No user input is required.
5.9 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 7. No user input is necessary.
5.10 Differences between modeled and adjusted reported ethanol production numbers (dry gal) (Calculated)	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 when a "Solver" solution cannot be found. Additional details are provided below Table 7. No user input is necessary.
5.11 Modeled finished sugar production (metric tons or tonnes) (Calculated)	This cell is a calculated value based upon the yield of finished sugar predicted in the G-K parameters table (Cell F20).
5.12 Reported finished sugar production (metric tons or tonnes) (Calculated)	This cell is a calculated value based upon the monthly weighted average finished sugar production numbers reported by the applicant.
5.13 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.
5.14 Mass Allocation Ratio (MAR) (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 5, the sugarcane juice-to sugar share (Field 4.14 of the Site-Specific Inputs tab (Cell R33)) 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:

Select "Data" from the spreadsheet header menu above. Then Click the "Solver" icon menu above to the far right of the Header. If the "Solver" functionality is not visible, see instructions in Appendix A of this document to install this feature in Microsoft Excel. A "Solver Parameters" window will open. **Ensure that the "Set Objective" at the top of the window refers to Cell E27 and is set to a value of 0.0.** It is imperative that the applicant follow this instruction; else succussive iterations may not result in a material balance being achieved. <u>When a version of the older Simplified CI Calculator for Sugarcane-derived Ethanol is concurrently open, the "Set Objective" function in Solver may revert to Cell E88. This should be corrected.</u>

The variable cells "eta_s" and "eta_e" must be specified (separated by a comma) in the next sub-window entitled "By Changing Variable Cells:" Do not change any of the constraints defined in the "Subject to the Constraints" window (0.38 > eta_e < 0.48, and eta_s < = 0.99). Cell F29 must include an input with a constraint less than or equal to 1.0.

Check box "Make Unconstrained Variables Non-Negative." Choose "GRG Nonlinear" for the Solving Method. Then Click the "Solve" button at the bottom or select "Close" and select the "Calculate CI" button.

The Solver will go through several iterations to find a solution. A new window "Solver Results" will open. 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. If a Solver solution has not been found (i.e., there is an imbalance between the modeled and reported quantities of ethanol and finished sugar), the applicant may need to manually repeat the iteration by clicking on the "Calculate CI" button. The applicant is once again advised to open Solver and check that the "Set Objective" functionality at the top of the window refers to Cell E27, and its value is set to 0.0.

Click "OK" when Solver has found a solution. The mass allocation ratio (MAR) has been calculated to determine upstream impacts, and its value depicted in Cell G30.

If an imbalance is reported, it alerts the user/applicant that there could be something wrong with the raw input data. The applicant is advised to check the data in Section 4 and Section 5 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. Check the juice shares in Field 4.14 (fraction juice allocated to sugar production), and the amount of sucrose in Field 4.15 that enters sugar production (fraction of sucrose in the cane juice that enters sugar production). The level of sucrose (eta_j), input 5.1, could be lower due to process losses even if measured higher at the gate or after the sugarcane

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.

Once the parameters have been finalized, reopen Solver, select the "Solve" button or select "Close" button and then select "Calculate CI;" repeating the iteration manually. With each iteration, the imbalance will reduce until there is no difference between reported and modeled quantities of ethanol and finished sugar.

Additional details for Table 6 calculated parameters

Field 5.10 "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 E27 may indicate that a difference of 10,000 gallons of ethanol exists between the reported production quantities and the modeled quantity from each feedstock.

Field 5.11 "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 4. 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 5.14. "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, gC0$_2$e/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 5 of the Calculated Parameters tab/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 4 table of Site-Specific Inputs worksheet has 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 E27 of the Calculator worksheet. In this case, the applicant must repeat the steps in Section 5, 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 6) 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 3) 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 6: Verify Fuel and Co-Product Production Information

Section 6 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 7 below.

Table 7: List of calculated fields for Section 5 of the Calculated Parameters worksheet

Field Name	Description
6.1 Ethanol Produced from Sugarcane Juice (Calculated; dry gal).	Ethanol produced from sugarcane juice feedstock (reported in dry gallons). No user input is necessary.
6.2 Juice-to-Ethanol Yield (Calculated; gal/tonne cane)	Yield of ethanol from sugarcane processed at the mill (dry gal per metric ton) from sugarcane juice feedstock. No user input is necessary.
6.3 Ethanol Produced from Molasses, (Calculated; dry/gal)	Ethanol produced from sugarcane molasses feedstock (dry gal). No user input is necessary.
6.4 Molasses-to-Ethanol Yield (Calculated; gal/tonne cane)	Yield of ethanol from sugarcane processed at the mill (dry gal per metric ton cane) from molasses feedstock. No user input is necessary.
6.5 Total Ethanol Produced (Calculated; dry gal)	Total ethanol produced from cane juice and molasses (dry gal). No user input is necessary.
6.6 Total Finished Sugar Produced, metric tons or tonnes (Calculated; metric tons)	Calculated quantity of finished sugar produced at the mill; it should match the total production input based on 24-month data (metric tons). No user input is necessary.
6.7 Net Surplus Cogenerated Electricity Exported (Calculated; kWh)	Net (of purchases) amount of surplus cogenerated electricity exported, in kWh. No user input is necessary.
6.8 Net Electricity Credited to Pathway (Calculated; kWh)	Net amount of surplus cogenerated electricity credited to the pathway (kWh) after cogenerated electricity from externally-sourced biomass is backed out (Section 4, Field 4.11). No user input is necessary.
6.9 Electricity Co-Product Credit (Molasses Feedstock) (Calculated; (kWh/gal)	Net amount of surplus cogenerated electricity credited to the pathway (kWh) per gallon of ethanol produced from Molasses feedstock. No user input is necessary.

Field Name	Description
6.10 Electricity Co-Product Credit (Cane Juice Feedstock) (Calculated; kWh/gal)	Net amount of surplus cogenerated electricity credited to the pathway (kWh) per gal ethanol produced from Sugarcane juice feedstock. No user input is necessary.
6.11 Composite Electricity Co-Product Credit (Calculated; kWh/gal)	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 4 of the Site-Specific Inputs worksheet (see "Pathway Summary" worksheet and Certified Fuel Pathway Composite Carbon Intensity (gCO$_2$e/MJ Denatured Ethanol, LHV).

Pathway Summary worksheet

The Pathway Summary worksheet aggregates site-specific user input data to calculate the carbon intensity of each fuel pathway, along with a composite CI for both sugarcane juice and molasses derived ethanol pathways, in the T1 Cane Ethanol Calculator. This worksheet also serves as a location where a Margin of Safety may be added to the composite pathway CI prior to pathway certification. Pathway-specific Operation Conditions may be added by DEQ Staff in the box below the Certified CI Summary.

The top sections of this worksheet (Applicant Information, Finished Fuel Quantities) provide a summary of site-specific inputs entered by the user. The fuel producer may report any quantity of undenatured, anhydrous ethanol produced at the facility and sold as a transportation fuel in Oregon up to the quantity listed in Cell H9 of the Finished Fuels Quantity table (gallons of denatured ethanol units).

The Carbon Intensity (CI) calculations section of this worksheet provides aggregated impacts from all fuel pathway categories which include feedstock production and transport, molasses production, ethanol production, co-product credit from surplus export of cogenerated electricity, and finished fuel transport. These aggregated GHG impacts may be examined to see their contribution to the overall CI of the finished fuel.

The applicant may opt to apply a conservative margin of safety to the fuel pathway CI to ensure that the pathway remains compliant with the certified CI. This is done by adding a value in Cell I37 (yellow-celled input).

The final section of this worksheet provides a space for DEQ Staff to publish Operating Conditions associated with the pathway. These Operating Conditions are developed after the initial application for certification is made. A completed version of this worksheet is shared with the applicant for review and approval prior to pathway certification.

OR-GREET4.0 Worksheet

The OR-GREET4.0 Worksheet contains predefined input values from several sources, including CA-GREET 4.0, Argonne National Labs GREET 2022,[1] EPA eGRID,[2] CARB EMFAC,[3] Purdue University GTAP and Stanford OPGEE[4] models. These input values cannot be modified without written permission from DEQ, and if modified, will elevate the pathway application to a Tier 2 status.

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[1] Wang, M., Elgowainy, A., Uisung, L., Kwang, B., Bafana, A., Benavides, P., Burnham, A., Cai, H., Cappello, V., Chen, P., gan, Y., Gracida-Alvarez, U., Hawkins, T., Iyer, R., Kelly, J., Kim, T., Kumar, S., Kwon, H., Lee, K., Liu, X., Lu, Z., Masum, F., Mg, C., Ou, L., Reddi, K., Siddique, N., Sun, P., Vyawahare, P. Xu, H., & Zaimes, G., *GREET1 2022, October Release*. Center for Transportation Research, Argonne National Laboratory (accessed November 2, 2022).

[2] United States Environmental Protection Agency, *eGRID Power Profiler tool.* (Updated June 5, 2023).

[3] California Air Resources Board, *EMFAC v1.0.2*. (Released April 2022).

[4] Brandt, A.R., Masnadi, M.S, Rutherford, J.S., El-Houjeiri, Vafi, K., H.M., Langfitt Q., Duffy, J., Sleep, S., Pacheco, D., Dadashi, Z., Orellana, A., MacLean, H., McNally, S., Englander, J., & Bergerson, J., *Oil Production Greenhouse Gas Emissions Estimator OPGEE v.3.0b*. (Updated on May 14, 2022).