



**Tier 1 Simplified CI Calculator Instruction Manual**  
Sugarcane-derived Ethanol

April 20, 2023

## A. Introduction

This document provides detailed instructions for the use of the Tier 1 Simplified CI Calculator for Sugarcane-derived Ethanol (T1 Cane Ethanol Calculator). This calculator is to be used to calculate the composite carbon intensity (CI) for ethanol produced from sugarcane juice and molasses feedstocks.

**Download the T1 Cane Ethanol Calculator here:**

[LCFS Life Cycle Analysis Models and Documentation | California Air Resources Board](#)  
(Link will be active when the ISOR is published)

The T1 Cane 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 ethanol pathways. CARB will certify a single, composite CI for both feedstocks. Some CARB-approved default and conditional default input values may also be selected.

## B. T1 Cane Ethanol Calculator Overview

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

*Table B.1. Worksheets Used in the T1 Cane Ethanol Calculator*

Worksheet Name	Description
Introduction	Provides a brief introduction for the T1 Cane Ethanol Calculator.
Site-Specific Inputs	Worksheet for entering monthly operational data used for calculating the carbon intensity (CI) of the fuel pathways.
CA-GREET4.0	Reference worksheet. Contains inputs and emission factors used in calculations of carbon intensities and specifications of fuels, global warming potentials of greenhouse gases, and unit conversion values.
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.
Pathway Summary	Contains the calculated CIs for the given pathway based on the data entered in the "Site-Specific Inputs" worksheet. Also contains a section for pathway-specific operating conditions, to be completed by CARB staff prior to pathway certification.

The cells in the T1 Cane Ethanol calculator have various fill colors per the legend below:

User Input
Calculated Value
CA-GREET4.0

- “User Input” cells must be completed if the input is used by the fuel pathway. If the input is irrelevant, it may be left blank. For example, if a pathway uses externally sourced electricity as a process energy input, the quantity of electricity purchased from the grid must be entered into the user input cells under the correct field in Section 4. If the pathway does not use externally sourced (grid) electricity as process energy, the user input cells in that field may be left blank. **All User Inputs are subject to validation by an independent, third-party Verification Body as part of initial pathway certification, and subject to verification subsequent to every annual fuel pathway report (AFPR) submittal.**
- “Calculated Value” cells contain formula that provide a calculated result based on either user input data, or a value or an emissions factor (EF) from CA-GREET4.0.
- “CA-GREET4.0” cells contain input values or emissions factors from the CA-GREET4.0 life-cycle analysis model.

Calculated Value formulae and CA-GREET4.0 values cannot be modified without written permission from CARB. Approved modifications may require the use of a Tier 2 fuel pathway application (Modified Tier 1 pathway).

The Introduction tab also contains links to LCFS Website Resources for a Program Overview, downloading LCFS Life Cycle Analysis Models and Documentation (Tier 1 Pathway Calculators and Instruction Manuals), and a link to the Tier 1 fuel pathway application process.

<b>LCFS Website Resources</b>
<a href="#">LCFS Program Overview</a>
<a href="#">Tier 1 Pathway Calculators and Instruction Manuals</a>
<a href="#">Tier 1 Pathway Application Process</a>

Begin by selecting the Site-Specific Inputs worksheet (tab), then enter information for the sub-sections listed below.

### C. Site-Specific Inputs Worksheet

The Site-Specific Inputs worksheet contains the main operational data needed for the CI calculation worksheet which consists of the following major components:

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

All relevant site-specific inputs must be entered in their respective input fields.

#### *Section 1: Applicant Information*

Section 1 below asks the User to provide basic information about the fuel pathway applicant as shown in Figure C.1 below:

*Figure C.1. Fuel Pathway Applicant Information*

<b>Section 1: Applicant Information</b>	
<b>1.1 Application Number</b>	
<b>1.2 Company Name</b>	
<b>1.3 Company ID</b>	
<b>1.4 Fuel Production Facility Address</b>	
<b>1.5 Facility ID</b>	

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

*Table C.1. Input Field Instructions for Section 1 of the T1 Cane Ethanol Calculator*

<b>Field Name</b>	<b>Description</b>
1.1 Application Number	Enter the application number provided by the 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 CARB staff for LCFS Company ID.
1.4 Fuel Production Facility Address	Enter city, state, and zip code for the ethanol production facility.
1.5 Facility ID	Enter U.S EPA Facility ID. If not available, contact CARB Staff.

## Section 2: Pathway Inputs

Section 2 provides the User the option to select or declare only input fields that apply to a given pathway. Figure C.2 below shows the various input options permitted in the T1 Cane Ethanol Calculator. 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.

Figure C.2. Cane Ethanol Calculator Input Selection Panel

Section 2: Pathway Inputs	
2.1 Pathway CIs	Composite
2.2 Feedstocks	<input type="checkbox"/> Sugarcane Juice <input type="checkbox"/> Sugarcane Molasses
	<input type="checkbox"/> Externally-Sourced Molasses**
2.3 Process Energy	<input type="checkbox"/> Sugarcane Bagasse <input type="checkbox"/> Grid Electricity
	<input type="checkbox"/> Externally-Sourced Bagasse or Biomass**
2.4 Coproducts	<input type="checkbox"/> Surplus Co-generated Electricity for Export
2.5 Finished Products	<input type="checkbox"/> Anhydrous Ethanol <input type="checkbox"/> Hydrous Ethanol
	<input type="checkbox"/> Finished or Table Sugar
2.6 Fuel Transport & Distribution	<input type="checkbox"/> HD Truck Transport in Brazil and California
	<input type="checkbox"/> Pipeline Transport in Brazil**
	<input type="checkbox"/> Ocean Transport
2.7 Port of Ethanol Export	
2.8 Ethanol Sold	Anhydrous Only; Udenatured
2.9 Choose Region the for Burn Area Evaluation	

\*\* Requires an Operating Condition from CARB

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

Table C.2. 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 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 <b>from sugarcane farming, transport, and processing</b> can be attributed to the molasses pathway.
2.2 Feedstocks	The applicant may select one or all <b>of</b> the selection choices. A fuel pathway cannot be obtained for ethanol produced from externally-sourced molasses feedstock. CARB must be alerted if this occurs, as the ethanol produced from externally sourced molasses is not within the system boundary considerations, <b>and must be excluded from total ethanol produced</b> . An Operating Condition from CARB 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 CARB. <b>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.</b>
2.4 Coproducts	Select the co-product if surplus cogenerated electricity is exported to the public grid.
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 CARB 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 California.
2.8 Ethanol Sold	No selection is necessary here as only undenatured anhydrous ethanol is eligible for export which is subsequently denatured in California.
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: Static Operational Data

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. Figure C.3 below depicts these parameters.

Figure C.3. Static Operational Data

<b>Section 3: Static Operational Data</b>	
<b>3.1</b> Grid Electricity Region	Brazil
<b>3.2</b> User Defined Grid Electricity CI (gCO <sub>2</sub> e/kWh)	Consult CARB Staff for Value
<b>3.3</b> Biomass CI (gCO <sub>2</sub> e/dry metric ton)	Consult CARB Staff
<b>3.4</b> Denaturant Accounting	Default 2.5% CARBOB Blend
<b>Ethanol Transport</b>	
<b>3.5</b> From Ethanol Plant By Truck (km)	
<b>3.6</b> By Pipeline (km)	
<b>3.7</b> Ocean Transport Route to California	
<b>3.8</b> By Ocean Tanker (km)	
<b>3.9</b> California Port to Terminal (miles)	40
<b>3.10</b> Terminal to Re-fueling Stations (miles)	50
<b>3.11</b> Applicable Credit for Mechanized Harvesting	

Each parameter is discussed in Table C.3 below:

Table C.3. Input Field Instructions for Section 3 of the T1 Cane Ethanol Calculator  
(Static Operational Data)

Field Name	Description
3.1 Grid Electricity Region	From the drop-down Menu in the yellow cell to the right, select the applicable regional eGrid electricity mix for the ethanol production facility. The electricity mix corresponding to the production of ethanol from sugarcane in Brazil is the "Brazil" average mix. CARB Staff must be consulted before any other regional mix is selected.
3.2. User Defined Grid Electricity CI (gCO <sub>2</sub> e/kWh)	Requires pre-approval from CARB when the applicable electricity mix is not the default ("Brazil") eGrid mix. An emissions factor (gCO <sub>2</sub> e/kWh) based upon the electricity resource mix for the region will be proposed by CARB.
3.3 Biomass CI (gCO <sub>2</sub> e/dry metric ton)	Consult with CARB Staff to develop an emissions factor if externally sourced biomass other than bagasse is used as a process fuel or for cogeneration purposes. An Operating Condition would be necessary to determine "equivalent bagasse units" for externally sourced biomass reported in Section 4, Field 4.10, of the Site-Specific Input tab.
3.4 Denaturant Accounting	No denaturant is assumed to be added at the point of export but GHG emissions are assessed nonetheless. All denaturant is added to the anhydrous ethanol at the California port of import, and hence the "Default Value" of denaturant addition (2.5% (v/v) CARBOB) is applicable to the sugarcane ethanol pathway.
3.5 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 California 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.
3.6 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.
3.7 Ethanol Transport Route to California	Use the drop-down menu at the right to choose an ocean transport route to California. 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 CARB consent.



Field Name	Description
3.8 Ethanol Transport by Ocean Tanker to California (km)	Enter the total distance (km) for ethanol transport by Ocean Tanker from the Brazilian port of export to the final California 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.
3.9 California Port to Terminal (miles)	A default value represents the transport distance for ethanol transported from the California port of import to the Terminal where ethanol is blended with CARBOB for distribution to refueling stations.
3.10 Terminal to Refueling Stations (miles)	A default value represents the transport distance for ethanol transported from the California blending terminal where ethanol was blended with CARBOB for distribution to refueling stations.
3.11 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.

#### Section 4: Monthly Operational Data

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 LCFS Regulation section 95488.8(k). Feedstock quantities should be reported inclusive of moisture content (as wet metric tons or tonnes sugarcane, or metric tons externally sourced molasses).

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 C.4 below.

Table C.4. Input Field Instructions for Section 4 of the T1 Cane Ethanol Calculator

Field Name	Description
4.1 Reporting Month (Month/YYYY)	Enter the 24 consecutive months that reflect the most recent operational data available for the ethanol production facility. For fuel production facilities that have been in operation less than 24 months, or for facilities that CARB determines have met the process change requirements of LCFS Regulation section 95488.9(c), the operational data submitted is permitted to range from 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 an 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 CARB.
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." CARB must be notified, and an Operation Condition from CRAB 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.
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 <sup>3</sup> ). 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 (m <sup>3</sup> ). 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 (m <sup>3</sup> ). 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.

Field Name	Description
4.21 Adjusted Hydrous Ethanol Produced (Calculated)	Hydrous ethanol produced less calculated ethanol from externally acquired molasses (m <sup>3</sup> ). No user input is required for this calculated parameter.
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 <sup>3</sup> ).

Additional details for Table C.4 input parameters:

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

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

$V_{s,e}$  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.

## D. Calculated Parameters

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 D.1. Other calculated parameters and outputs are discussed in Table D.2.

Table D.1. Description of Calculator Worksheet Inputs for Section 5

Field Name	Description
5.1 $\eta_j$ (tonnes of fermentable sugars in juice/tonne of cane) (Calculated)	<p>“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.</p> <p>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.</p>
5.2 $\eta_s$ (tonnes of sucrose in final sugar/tonne of sucrose into sugar factory) (Calculated)	<p>“eta_s” is the fraction of sucrose that enters sugar production and is converted into finished sugar.</p> <p>It is a calculated parameter, and no user input is necessary.</p>
5.3 Sucrose in molasses (tonnes sucrose in molasses/tonne of sugarcane) (Calculated)	<p>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.</p>
5.4 $\eta_e$ (dry tonnes of EtOH/tonne offermentable sugars into distillery) (Calculated)	<p>“eta_e” represents the conversion efficiency of a sugar molecule into ethanol.</p> <p>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.</p>
5.5 LHV of anhydrous Ethanol (MMBtu/dry ton EtOH)	<p>LHV of ethanol (MMBtu/dry ton). This is a standard value, and no user input is necessary.</p>

Field Name	Description
5.6 Choose "ms" (tonnes of sucrose in final sugar/tonne of final sugar product)	<p>"m<sub>s</sub>" represents the purity of the finished sugar product. Input value for facility weighted average over 24 months of production.</p> <p>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.</p>
5.7 Choose "mm" (tonnes of fermentable sugars in standard molasses/tonne of standard molasses)	<p>"m<sub>m</sub>" 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.</p> <p>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.</p>
5.8 Modeled ethanol production (dry gal) (Calculated)	<p>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 D.1. No user input is required.</p>
5.9 Adjusted reported ethanol production number (dry gal) (Calculated)	<p>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.1. No user input is necessary.</p>
5.10 Differences between modeled and adjusted reported ethanol production numbers (dry gal) (Calculated)	<p>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 D.1. No user input is necessary.</p>
5.11 Modeled finished sugar production (metric tons or tonnes) (Calculated)	<p>This cell is a calculated value based upon the yield of finished sugar predicted in the G-K parameters table (Cell F20).</p>

Field Name	Description
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:

1. 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 up. Ensure that the "Set Objective" refers to cell \$E\$27 and is set to a value of 0.0.
2. The variable cells "eta\_s" and "eta\_e" must be specified (separated by a comma) in the next sub-window entitled "By Changing Variable Cells:" Do not change any of the constraints defined in the "Subject to the Constraints" window ( $0.38 > \text{eta}_e < 0.48$ , and  $\text{eta}_s \leq 0.99$ ). Cell \$F\$29 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 or select "Close" and select the "Calculate CI" button.
4. 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.
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 4 and Section 5 for accuracy until a solution has been found, and all constraints and optimality conditions have been

satisfied. Select the "Solve" button or select "Close" button and then select "Calculate CI;" repeating the iteration manually. 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 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 ( $\eta_{sj}$ ), 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.

Additional details for Table D.1 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, gCO<sub>2</sub>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 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 E27 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 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 D.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 D.2 below.

*Table D.2. 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 allocation between co-products. 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.
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<sub>2</sub>e/MJ Denatured Ethanol, LHV).

## E. 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 CARB 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 California 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.

The final section of this worksheet provides a space for CARB Staff to publish Operating Conditions associated with the pathway. These Operating Conditions are developed after the initial application for certification is made.

## F. CA-GREET4.0 Worksheet

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

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<sup>1</sup> <https://greet.es.anl.gov/index.php>

<sup>2</sup> <https://www.epa.gov/egrid>

<sup>3</sup> <https://arb.ca.gov/emfac/>

<sup>4</sup> <https://eao.stanford.edu/research-project/opgee-oil-production-greenhouse-gas-emissions-estimator>

## APPENDIX A

(Instruction to Install "Solver" Functionality in Microsoft Excel)

## INSTRUCTIONS TO INSTALL "SOLVER" ADD-IN FUNCTIONALITY IN MICROSOFT EXCEL

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.

In the Dialogue Box Select "Solver Add-in" either in the "Active Application," or "Inactive Application Add-ins." Click OK.

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. Select "Add-ins" on the Left Side Menu.
4. In the Dialogue Box Select "Solver Add-in" either in the "Active Application," or "Inactive Application Add-ins." Click OK.
5. If you don't see the "Solver Add-in," do the following:
6. At the Bottom of the Dialogue Box, Select or Manage "Excel Add-Ins" from the Drop-down Menu. Then Select "Go."
7. An "Add-Ins" Window will Open. In the Window, Select or Check the Box for "Solver Add-in," and the Box for "Analysis ToolPak." Then Click OK.
8. In the Dialogue Box Select "Solver Add-in" either in the "Active Application," or "Inactive Application Add-ins." Click OK.