DRAFT
TIER 1 CI CALCULATION AND OPERATING CONDITIONS MANUAL
FOR
LCFS SIMPLIFIED CI CALCULATOR
—
Landfill Biomethane
Calculator Version: SIMCAL_RNG_001

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) pathways. The finished fuel pathways from RNG sourced from landfill gas include: Compressed Natural Gas, Liquefied Natural Gas and Liquefied and subsequently Compressed Natural Gas. Each specific input requirement 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.

The draft data Simplified CI Calculator is available at:
https://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/110617rng_draftcalculator.xlsm

This calculator is expected to replace the existing Tier 1 calculator in pathway application packages. **All data provided by the applicant (in yellow cells) in the "LFG" tab of the calculator are subject to verification unless specifically exempted.** The calculator requires the applicant to add facility information and verifiable feedstock production, operational energy use and fuel production data used in calculating the CI of landfill biogas derived RNG pathways.

This calculator also includes additional reference material such as greenhouse gas emissions factors used in CA-GREET3.0 and reference fuel specifications. Also included with the calculator is a detailed calculation with breakdown of the calculations used to determine the CI of the fuel pathways.

B. Definition

Below is a list of definitions for the input data values used in the calculator:

Site Specific - An input value, or the raw operational data used to calculate an input value, which is required to be unique to the facility, pathway, and feedstock. All site-specific inputs that appear in the operational data summary form must be measured, metered or otherwise documented, and verifiable, e.g., consumption of utility natural gas or grid electricity at a fuel-production facility must be documented by invoices from the utility. Under this potential framework, an application might be rejected as incomplete if a site-specific input value cannot be determined.

Conditional Default - A conservative input value established by CARB staff, which may be used under specified conditions, that is not subject to further conformance review. In a

situation in which an applicant cannot provide the necessary information to determine and validate site-specific values, a conditional default may be used as a necessary substitute for the site-specific value. The conditions under which this value must be used are specific to each situation and would be defined by CARB staff accordingly. Conditional default values would be subject to validation that the specified conditions are met, but would not be subject to further verification, with the rationale that the value is based on reasonable assumptions and is sufficiently conservative to encourage use of site-specific values when feasible.

Standard Value - An input value that would not appear in the CI application operational data summary form and could not be modified to a site-specific value unless the applicant receives permission from the Executive Officer. These values are intended to be the same for all applicants of a given fuel type, and therefore would not be subject to CI conformance evaluation by CARB or third-party verifiers. Examples of standard values include the pipeline transmission distance for fossil natural gas; methane leakage factors for biogas upgrading, and much of the background data used in CA-GREET3.0 model, including emission factors, truck capacities, and farming inputs.

C. Color Legend Used in the Calculator

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

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
LFG Summary	Summary worksheet. Contains an overall summary of the operational data inputs entered in the "LFG" tab of the calculator and calculated CIs.
LFG	Main operational data inputs and 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 CI calculation section.
EF Table	Reference worksheet. Contains greenhouse gases emissions factors from the CA-GREET 3.0 model used in calculation of carbon intensities.
References	Reference worksheet. Includes standard values and assumptions related to the CI calculations in the Calculator.
Fuel_Specs	Reference worksheet. Contains specifications of fuels, global warming potentials of greenhouse gases, and carbon and sulfur ratios of greenhouse gas species.
Misc.	Reference worksheet. Contains information used in CI calculations such as tailpipe emissions and LNG boil-off emissions.

EF Table Tab

This tab includes CI factors used in calculating CIs in the Calculator. All factors are expressed in gCO2e/MJ. These are developed from CA-GREET 3.0 and from landfill gas pathway applications certified in the LCFS program during the period January 2016 through July 2017. The factors are included for biogas extraction and processing, CNG compression, LNG production and transport,

Example 1: Cell C162 lists a factor of 0.66 when NG is used for processing. When NG is used as a process fuel in LNG production, the contribution to pathway CI is 0.66 gCO2e/MJ for every 10,000 Btu (in LHV) of NG used in processing. Other value for NG used in processing proportionally scales emissions.

Example 2: Cell C150 lists a factor of 0.58 for electricity used in processing. When electricity is used as a process fuel for biogas extraction, for each kWh of electricity used, the contribution to the pathway CI is 0.58 gCO2e/MJ. Based on electricity use, the factor proportionally scales emissions.

References Tab

This sheet details standard inputs in the Calculator for CNG/LNG/L-CNG pathways. These inputs are not subject to change by the applicant. Most of these inputs are from the Argonne GREET1 2016 version. The standard inputs include:

- U. S. Average mix for feedstock production'
- CA e-grid mix for CNG dispensing in California
- LFG extraction efficiency, electricity usage for biogas extraction from a landfill and methane leakage rate for biogas upgrading
- Boil-off parameters related to LNG transport
- Energy use for regasification for L-CNG

Fuel_Specs Tab

This sheet includes fuel specifications (i.e., HHV, LHV, density, carbon ratio) for various process fuels, Global Warming Potentials of various greenhouse gases, carbon and sulfur ratios of greenhouse gas species, sulfur content in gasoline and diesel and unit conversions.

Misc. Tab

This tab includes factors for tailpipe emission factors, boil-off effects from HD trucks which transport LNG,

E. Calculator Details (the "LFG" tab)

The "LFG" tab contains the main CI calculation worksheet which consists of the following major components:

- Pathway Summary and Estimated CI (g/MJ)
- Section 1. Applicant Operational Data Inputs for Biomethane Production
- Section 2. Operational Data Inputs for Biomethane Production
- Section 3. Operational Data Inputs for CNG, LNG, and L-CNG Production
- CI Calculation

Pathway Summary and Estimated CI (g/MJ)

This section contains the calculated CIs, corresponding quantities and pathway descriptions for landfill gas to CNG, LNG and L-CNG. The final results are displayed here after data is input and user clicks the Calculate button in section 3 of the LFG tab.

Section 1. Applicant Operational Data Inputs for Biomethane Production

This section of the calculator requires inputs related to facility identification, including the applicant's company name, location of the landfill, location(s) of CNG fueling facilities in California and, if applicable, location of LNG production, location of LNG and L-CNG dispensing facilities.

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. Company ID	Enter U.S. EPA Company ID. If not available, contact CARB for LCFS Company ID.
1.3. Facility ID	Enter the Company's Facility ID. If not available, contact CARB for LCFS Facility ID.
1.4. Landfill Name and Location	Location of the landfill. Example: "AAA Landfill in Sacramento , CA"
1.5. CNG Dispensing Location	California CNG Stations (for more than one station, use the Standard Centroid location).
1.6. LNG Production Location	Location of LNG production facility (Street, City, State).
1.7. LNG and/or L-CNG Dispensing Location	LNG/L-CNG Stations in California.

Section 2. Operational Data Inputs *for Biomethane Production*

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

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

Field Name	Description
2.1. Select Regional Electricity Mix for Biomethane	Applicants must choose the e-grid zone corresponding to the zip code for the region where the landfill processing plant is located. For processing/upgrading biogas plants in the U. S., applicants must select one of 26 e-grid mixes, one Brazilian, one Canadian and one user-defined mix included in the pull down menu. All facilities in the U. S. must select one of 26 e-grid zones available for the U. S. If processing facility is located outside the U.S., the applicant must select 'user-defined' and enter details of energy mix as required in 2.1.a.
2.1.a. Enter data for User Defined Mix (Feedstock Production)	If other sources of electricity are used, the applicant must select "user-defined mix" in 2.1, and click the button in 2.1.a. In a popup window, applicant must input appropriate details for electricity, crude and natural gas. Applicants must consult with CARB staff prior to completing the inputs in the popup window. Details of the inputs to the popup window are provided in Figure E.1.
2.2. Provisional Pathway?	If available data is less than 24 months, then applicant must select "Yes", else "No".
2.3. Monthly Data	Label for all 24 months for which data inputs are required. No inputs are required for 2.3
2.4. Inlet Raw LFG Extraction Flow, (metered)	To account for monthly total raw biogas sourced from the landfill collection system, a facility must install a dedicated flow measurement system with temperature measurement to enable reporting of gas at 1 atm. pressure and 60°F (dry gas flow corrected for moisture). 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 will not be acceptable). Flow data for 24 months of operation must be input in this field.
2.5. Methane Content (% Methane)	This field requires reporting monthly weighted average methane concentration. Measurement of methane must occur every 30 minutes (at a minimum) using instrumentation capable of electronic archival (manual recording will not be acceptable). The methane measurement system must be calibrated per manufacturer's requirement and scaled to measure the entire potential range of methane concentration in the biogas. Monthly weighted average methane concentration data (in dry biogas) for

	24 months of operation must be input in this field.
2.6. Facility Total NG from Utility Invoices	This field requires monthly total fossil NG use from a pipeline source (or other) in mmBtu from utility invoices (reported in HHV). Invoices from a utility (or equivalent) must be used to support NG use. Monthly total NG use for 24 months must be input in this field. If additional buyback gas is sourced from the pipeline or other sources to boost Btu of biomethane to meet pipeline specifications, monthly quantity of this gas must not be included in this field. Applicant must however, provide details of quantities of NG (in mmBtu) used for this purpose with the supplemental information document to be included with the application.
2.7. Facility Total Diesel from Invoices	This field requires monthly total diesel use (in gallons at ambient temperature) to be input supported by invoices from purchaser. Monthly total diesel use for 24 months must be input in this field.
2.8. Facility Total Propane (LPG) from Invoices	This field requires monthly total propane use (in gallons at ambient temperature) to be input supported by invoices from purchaser. Monthly total propane used for 24 months must be input in this field. If additional propane is used to boost Btu of biomethane to meet pipeline specifications, it must not be included in this field. Applicant must however, provide details of quantities of propane (in gallons) used for this purpose with the supplemental information document to be included with the application.
2.9. Specify Other Fuel Parameters	If another fuel source is used for biogas processing, monthly total use (in mmBtu reported as HHV) must be input in 2.9. A popup window (see Figure E.2) includes input fuel parameters for this fuel source used in processing which is not included in this sheet. Monthly total energy use for 24 months must be input in this field.
2.10. Facility Total Electricity from Utility Invoices	This field requires monthly total electricity use from the grid in kWh from utility invoices. Monthly total electricity use for 24 months must be input in this field.
2.11. Biomethane Product Gas, (metered)	This field requires biomethane injected into the pipeline in mmBtu (as HHV) to be input supported by third-party (i.e., pipeline operator) invoices to support injected quantity. Any fossil NG or fossil propane blended with biomethane to meet pipeline specifications must be subtracted from the injected quantity (in mmBtu). Monthly total biomethane injected into the pipeline for 24 months must be input in this field.
2.12. NG pipeline Transmission	This field includes a label for NG pipeline transmission and does not require an input.

2.12.a. From processing facility to the Standard Centroid CNG stations.	Distance from processing facility to CNG stations must be input in this section. If supplying to multiple CNG stations in California, standard centroid location must be used when calculating distance.
2.12.b. From processing facility to LNG plant	Distance from processing facility to liquefaction facility must be input in this section.
"Calculate" Button	After all data in Section 2 are entered, click the "Calculate" button in Section 2 to complete feedstock CI calculation.

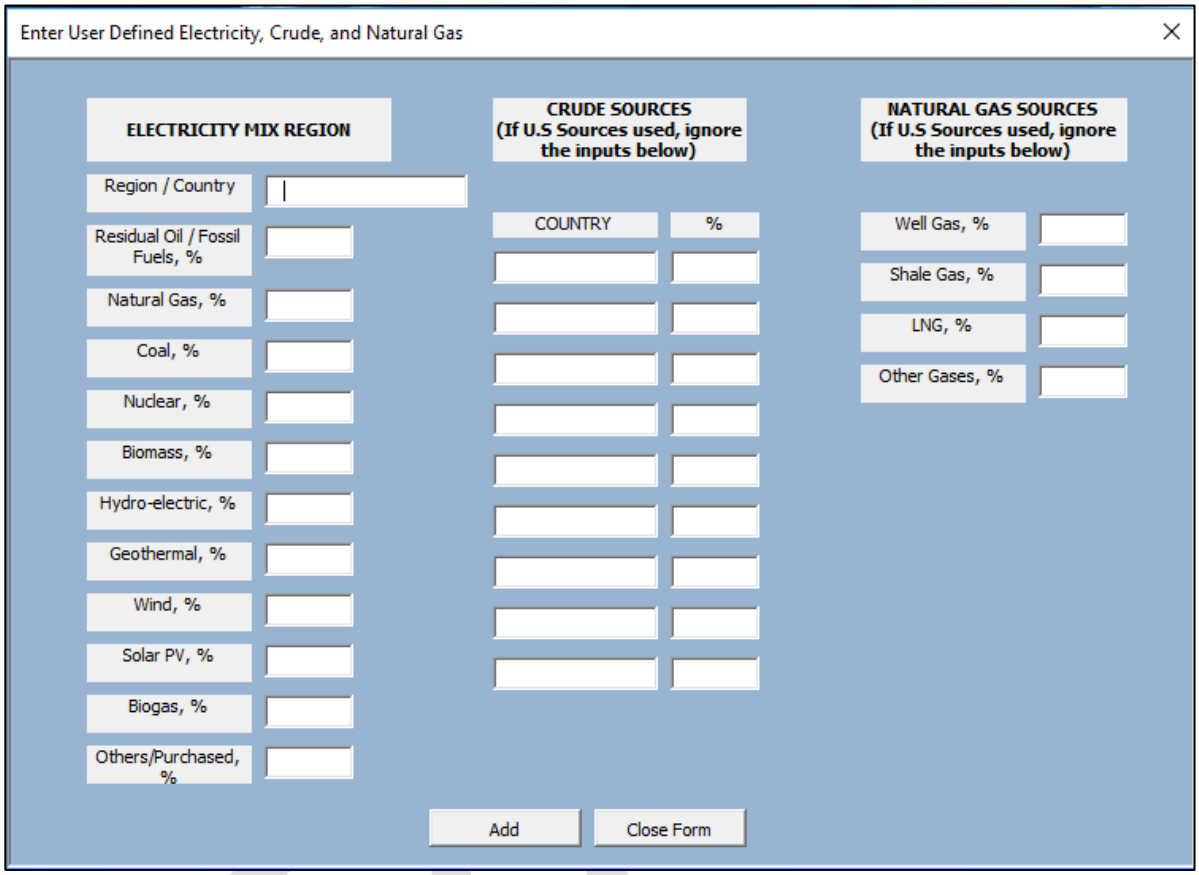
Biomethane injected into the pipeline (Field 2.11)

The monthly total quantity of biomethane input in field 2.11 must correspond to the quantity of biomethane (in MMBtu) injected into the pipeline and must be supported by invoices from the pipeline operator. However, since this quantity may include propane or other fossil additives blended with biomethane to meet pipeline specifications, the use of any non-renewable gas must be explicitly disclosed through invoices and added to the process energy inputs to biogas processing. The quantity entered in field 2.11 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 must subtract all fossil inputs (including quantities used in a flare, thermal oxidizer, or biogas processing) from renewable biomethane (in mmBtu) injected into the pipeline.

Figure E.1 depicts a popup window when applicant elects to use "user-defined" option in field "2.1.a. Enter data for User Defined Mix (Feedstock Production)". The popup window provides input options for user-defined electricity, crude and natural gas. This is primarily included to allow landfills for non-U. S. regions to calculate their GHG emissions from processing of biogas. Applicants must consult with CARB staff prior to utilizing user-defined options.

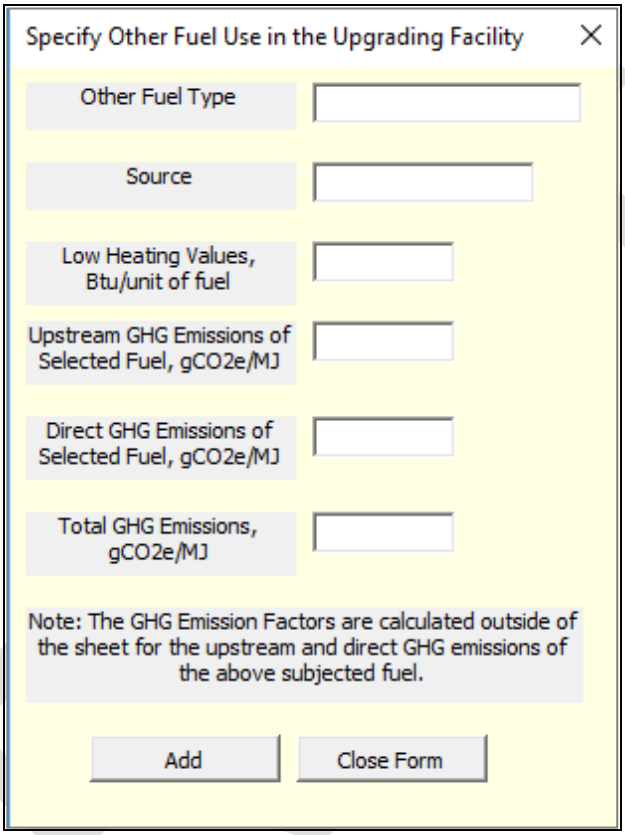
Figure E.1. Popup Window for "User-Defined" Option for Biomethane Production for field "2.1.a. Enter data for User Defined Mix (Feedstock Production)"



The Calculator uses a standard fueling facility parameter for all NG pathways, whether from fossil or renewable sources and dispensed as CNG. A compression efficiency of 97 percent (based on weighted average representative compression energy data for CNG certified pathways in 2016) is used as a standard value for all CNG pathways.

Figure E.2 depicts a popup window when applicant elects to use the "2.9. Specify Other Fuel Parameters" option. The popup window provides input options for user-defined energy used in biomethane production. Applicants must consult with CARB staff prior to utilizing user-defined options.

Figure E.2. Popup Window for field "2.9. Specify Other Fuel Parameters" Option for Biomethane Production



Pipeline transport distance for renewable natural gas (Fields 2.12a and 2.12b)

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. For RNG to CNG pathways, staff suggests developing a common methodology for calculating pipeline transmission distance from an RNG processing facility to California CNG fueling facilities. Applicants would continue to use the coordinates of the processing facility as the start-point of this transportation leg, but would use a common endpoint in mapping the distance. To determine the endpoint, staff is considering coupling the list of CNG fueling facilities with the volume throughput data from the 2017 Q1 reporting cycle (available after June 30, 2017) to determine a volume weighted RNG centroid. This centroid would be used as the transmission pipeline endpoint when determining the distance input value. 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. Operational Data Inputs for LNG, and L-CNG Production

Table E.3. provides details of inputs for LNG and L-CNG pathways. Additional details are included following Table E.3.

Table E.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	Applicants must choose the e-grid zone corresponding to the zip code for the region where the LNG plant is located. Same options as field 2.1.
3.2. NG from NG purchase invoices	This field requires input of monthly total NG purchased from a pipeline source (or other) in mmBtu and supported by utility invoices (reported in HHV). Invoices from a utility (or equivalent) must be used to support NG purchased. Monthly total NG purchased for 24 months must be input in this field. Renewable attributes to support NG purchases must be provided to verifier during on-site audit.
3.3. LNG Production from Production Log	This field requires input of monthly total LNG produced in gallons (reported at ambient temperature). 24 months of LNG production must be input in this field. During an on-site audit, production logs must be supported by corresponding sales of LNG (in gallons reported at ambient temperature).
3.4. NG as process fuel from Calculation (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	This field requires monthly total electricity use from the grid in kWh from utility invoices. Monthly total electricity use for 24 months must be input in this field.
3.6. Electricity from Other Sources	If additional electricity is sourced from non-grid sources, applicant must input monthly total use (in kWh) in this field. Monthly total additional electricity use for 24 months must be input in this field.
3.6.a. Specify Parameters	If other sources of electricity are used, applicant must click the "Specify Parameters" button in 3.6.a. In the popup window (see Figure E.3.), applicant must input appropriate factors for electricity generation. Applicant must consult with staff prior to completing the inputs in the pop-up window.
3.7. LNG Transport and Distribution	This field serves as a label for LNG transport and distribution section. No input is required for field 3.7.

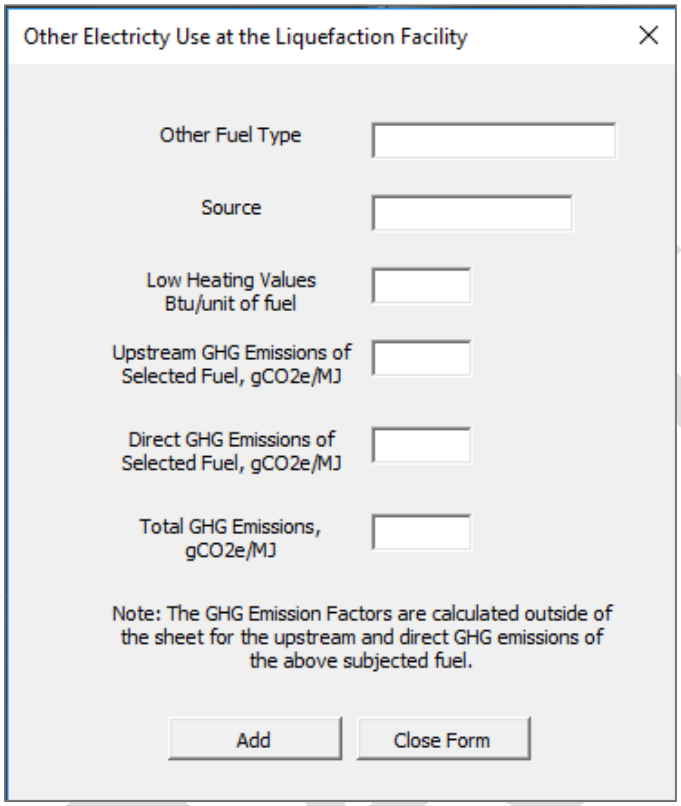
3.7.a. Select to affirm truck and storage tanks are equipped with Boil-Off Recovery	If trucks transporting LNG are equipped to recover "Boil-Off", then must select "Yes" else "No" in this field.
3.7.b. Enter LNG Transport Distance from Liquefaction Plant to stations by Heavy Duty Diesel Truck	Actual transport distance from LNG production facility to LNG (or L-CNG) dispensing facility using a HDD truck. If multiple dispensing facilities exist, an approach similar to the centroid approach used for CNG must be used (field 2.12.a.). If trucks supply LNG to both LNG and L-CNG stations, applicant must consult CARB staff to use a weighted average conservative transport distance in this field. Also, if trucks with and without "boil-off" are used to transport LNG, applicants must consult CARB staff to input the most conservative weighted average transport distance in this field.
3.7.c. Enter LNG Transport Distance from Liquefaction Plant to stations by Heavy Duty LNG Truck	To be used if Heavy Duty LNG trucks are used to transport LNG to dispensing stations. Same requirements as inputs in field 3.7.b.
"Calculate" Button	After all data in Section 3 are entered, click the "Calculate" button in Section 3 to initiate pathway CI calculation.

Transport of LNG to dispensing facility (Fields 3.7.b and 3.7.c)

A volume weighted average transport distance based on two years of sales records must be used for LNG distribution by truck from liquefaction facilities to fueling facilities. If multiple dispensing facilities exist, an approach similar to the centroid approach described in fields 2.12.a and 2.12.b. 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.

Figure E.3 depicts a popup window when applicant elects to use the "Specify Parameters" option in field 3.6.a. The popup window provides input options for user-defined electricity used in LNG production. Applicants must consult with CARB staff prior to utilizing user-defined options.

Figure E.3. Popup Window for the "Specify Parameters" Option in Field 3.6.a. for Electricity from Other Sources in field



CI Calculation

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 in cells A60 through N163 in the LFG tab. Calculations are based on representative inputs used in the input cells in this calculator. None of the user-defined options have been used in the calculations.