Tier 1 Simplified CI Calculator Instruction Manual

Biomethane from Anaerobic Digestion of Organic Waste

April 28, 2023

PRELIMINARY DRAFT FOR PUBLIC COMMENTS

A. Introduction

This document provides detailed instructions for biomethane from anaerobic digestion of organic waste (OW) pathway applications.

The Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Organic Waste (T1 OW Calculator) calculates the carbon intensity (CI) of biomethane produced from biogas generated by the anaerobic digestion of landfill-diverted food scraps, urban landscaping waste, and other OW feedstocks such as agricultural residues and OW recovered from mixed municipal solid waste.

Biomethane is also referred to as Renewable Natural Gas (RNG), Bio-Compressed Natural Gas (Bio-CNG) when delivered to CNG vehicles, Bio-Liquified Natural Gas (Bio-LNG) when delivered to LNG vehicles, or Bio-Liquified-Compressed Natural Gas (Bio-L-CNG) when delivered to CNG vehicles after being transported to the fueling station as LNG.

Download the T1 OW Calculator here:

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

The T1 OW Calculator requires the applicant to add monthly operational data, feedstock types and quantities, fuel production quantities, and transport distances to calculate the CI of OW pathways. Some CARB-approved default and conditional default input values may also be selected.

B. T1 OW Calculator Overview

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

Table B.1. Worksheets Used in the T1 OW Calculator

Worksheet Name	Description
Introduction	Provides a brief introduction for the T1 OW Calculator.
Site-Specific Inputs	Users enter organic waste feedstock and biomethane production data required to calculate the fuel pathway CI.
Pathway Summary	Calculates pathway-specific CIs and operating conditions, to be completed by CARB staff prior to pathway certification.
CA-GREET4.0	Contains predefined input values, emission factors, fuel specifications, and unit conversion values.

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

User Input
Calculated Value
CA-GREET4.0 Value

- "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 or hidden by deselecting the input checkbox in Section 2. For example, if a pathway uses natural gas as a process energy, the quantity of natural gas used must be entered into the user input cells under the correct field in Section 4. If the pathway does not use natural gas as a process energy, the user input cells in that field may be left blank or hidden by deselecting the appropriate Section 2 checkbox. **All User Inputs are subject to verification as part of initial pathway certification and annual fuel pathway reporting.**
- "Calculated Value" cells contain formula that provide a calculated result based on either user input data or CA-GREET4.0. In some instances, a "Calculated Value" cell may display a blank or "N/A" value if that input is not relevant based on user inputs.
- "CA-GREET4.0" cells contain input values from the CA-GREET4.0 model.

Calculated Value formula and CA-GREET4.0 values cannot be modified without written permission from CARB. Approved modifications will elevate the pathway to a Tier 2 application.

C. Site-Specific Inputs Worksheet

The Site-Specific Inputs worksheet contains the main CI calculation worksheet which consists of the following sections:

- 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 the respective input fields. Once all site-specific inputs for a given facility have been entered, the pathway CIs for the various streams will be displayed in the Pathway Summary worksheet.

Begin by selecting the Site-Specific Inputs worksheet, then enter information for Sections 1 thru 4 per the instructions given in Tables C.1 thru C.4 below.

Section 1: Applicant Information

Table C.1. Input Field Instructions for Section 1 of the T1 OW Calculator

Field Name	Description
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 ID	Enter U.S EPA Facility ID. If not available, contact CARB staff.

Section 2: Pathway Inputs

Section 2 provides the option to select only input fields that apply to a given pathway, which removes unused inputs from Sections 3 and 4 of the worksheet. 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.1 below shows the various input options permitted in the T1 OW Calculator.

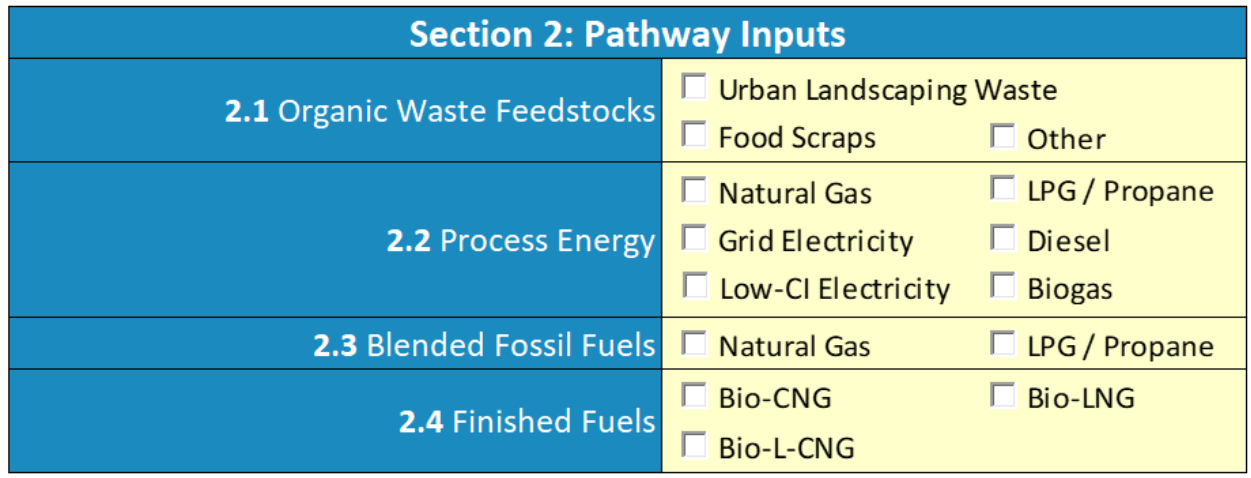

Figure C.1. OW Calculator Input Selection Panel

Table C.2. Input Field Instructions for Section 2 of the T1 OW Calculator

Field Name	Description
2.1 Organic Waste Feedstocks	Select feedstock(s) being used by the fuel pathway. "Food Scraps" and "Urban Landscaping Waste" feedstock categories utilize CARB-approved values for determining avoided methane emissions, and are subject to the following definitions: "Food Scraps" (FS) is characterized as the portion of municipal solid waste (MSW) derived from plants or animals that is associated with the preparation or consumption for humans or other animals. Qualifying sources for FS include residential collection and commercial food service operations at various institutions, including hotels, restaurants, schools, prisons, stadiums, etc. Feedstocks collected from food processing/manufacturing facilities, food distribution/storage facilities, and grocery stores do *not* meet the definition of FS unless they are demonstrated to be 1) unrecoverable for human or other animal consumption and 2) predominantly disposed at landfills (rather than e.g., wastewater treatment plants; liquid waste feedstocks including those with high moisture, or fat, oil, and grease (FOG) content are not typically landfilled). "Urban Landscaping Waste" (ULW) is defined as material resulting from any public or private landscaping activities such as leaves, grass clippings, plants, prunings, shrubs, branches, and stumps. FS and ULW may either be sourced from designated containers at their points of origin (source-separated) or the organic portion of mixed MSW that is separated at a materials recovery facility (MRF). If OW is separated at a MRF, the applicant must either demonstrate the fractions of recovered feedstock that meets the definitions of FS and/or ULW, or model the feedstock as "Other Organic Waste" (OOW). Any feedstocks that do not meet the FS or ULW requirements may be modeled OOW. The "other organic waste" category is intended to be a User-Defined category, in which the applicant provides information on the moisture content of the material, fraction of degradable organic carbon, fraction of DOC that is decomposed, and whether the material is normally disposed of in a landfill, compost facility, combusted at a biomass power plant, or used as animal feed, for example. The applicant must provide additional information for OOW in fields 3.10-3.12.
2.2 Process Energy	Select the type(s) of process energy used at the fuel production facility.
2.3 Blended Fossil Fuels	Select the type(s) of fossil fuels blended with biomethane prior to pipeline injection, if applicable.
2.4 Finished Fuels	Select the type(s) of finished fuels.

Table C.3. Input Field Instructions for Section 3 of the T1 OW Calculator

Field Name	Description
3.1 Grid Electricity Region	If the biomethane production facility uses grid electricity, select the electricity mix corresponding to the region where the facility is located. The calculator includes 27 eGRID zone mixes, Brazilian average mix, Canadian average mix and User Defined Mix included in the drop-down menu. A map of eGRID zones is provide in the "Predefined Inputs" worksheet. The eGRID region may also be determined using the eGRID Power Profiler tool.
3.2 Grid Electricity EF (gCO_2e/kWh)	The grid electricity EF will be displayed based on the 3.2 selection. If User-Defined is selected in Field 3.2, consult with CARB to develop a grid electricity mix EF.
3.3 Low-CI Electricity EF (gCO_2e/kWh)	Consult with CARB staff to develop an appropriate emission factor for the low-CI electricity used by the ethanol production facility. Low-CI electricity must be physically supplied directly to the production facility per LCFS Regulation section 95488.8(h); indirect accounting ("book-and-claim") is not permitted for ethanol pathways. The low-CI electricity source and all data sources used in calculating emission factors must be described in detail in the Supplemental Documentation submitted with the T1 OW Calculator.
3.4 Distance to CNG Station (miles)	If applying for a Bio-CNG pathway, enter the distance from the biogas upgrading facility to the CNG fueling station in California. Driving distances between the two locations may be determined using a publicly available web-based driving distance estimator. If pipeline transport serves multiple distribution routes in California, a weighted average distance may be calculated, the California centroid (Bakersfield, CA) may be used, or the distance of the farthest route may be applied.
3.5 LNG Facility ID	Enter U.S EPA Facility ID for LNG or L-CNG production. If not available, contact CARB staff.
3.6 Distance to LNG Facility (miles)	If applying for a Bio-LNG or Bio-L-CNG pathway, enter the distance from biogas processing facility to the liquefaction facility. For pipeline transport distance from a biogas processing facility to a liquefaction facility, driving distances between the two locations may be determined using a publicly available web-based driving distance estimator.
3.7 Liquefaction EF (gCO_2e/gallon)	If applying for a Bio-LNG or Bio-L-CNG pathway, enter the most recent validated/verified emission factor for the LNG facility, as calculated using the Tier 1 Simplified CI Calculator for Liquified Natural Gas. Data sources must be documented in the Supplemental Documentation attached with the Simplified CI Calculator.

3.8 LNG Trucking Distance (miles)	Enter distance from liquefaction facility to the intended Bio-LNG or Bio-L-CNG fueling station in California. Driving distance between any two locations may be determined using a publicly available web-based driving distance estimator if fuel is dispensed at a single station. If multiple fueling stations are utilized, a volume weighted average transport distance based on 24 months of sales records must be used for LNG distribution to fueling facilities. Alternatively, the applicant may elect to use a more conservative value, such as the distance to the farthest fueling facility, to minimize the risk of exceeding the certified CI because of changes in the supply chain.
3.9 LNG Truck Type	Enter the truck type used to transport Bio-LNG to dispensing station(s) in California.
3.10 OOW - % Diverted from Landfill	Enter the mass fraction (dry basis) of OOW feedstock(s) that would have otherwise been landfilled on a regional and/or industry-wide basis. Supplemental documentation of this diversion rate calculations and literature sources must be provided and approved by CARB staff.
3.11 OOW - TDOC (% dry basis)	Enter the total degradable organic carbon (TDOC) value for the OOW feedstock. If the composition of OW feedstock varies over time, enter the weighted average TDOC value for the operational data period. To determine the TDOC value for a feedstock, the most recent edition of CARB's Greenhouse Gas Emissions Inventory list of TDOC values for common OOW feedstocks may be referenced,[1,2] or a site-specific TDOC value based on independent laboratory analysis may be approved by CARB using the EPA equations TT-7 or TT-8.[3]
3.12 OOW - DANF (%)	Enter the Decomposable Anaerobic Fraction (DANF) value for the OOW feedstock. If the composition of OW feedstock varies over time, enter the weighted average DANF value for the operational data period. To determine the DANF value for a feedstock, the most recent edition of CARB's Greenhouse Gas Emissions Inventory list of DANF values for common OOW feedstocks may be referenced,[1,2] or a default value of 0.5 may be approved by CARB depending on the specific feedstock.

[1] https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/ghg_inventory_00-20_method_update_document.pdf
[2] https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/ghg_inventory_tsd_00-14.pdf
[3] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-TT

3.13 Landfill Gas Collection Efficiency (%)	Select either the default value for the landfill gas collection efficiency (GCE), or enter a site-specific, measured value at the landfill(s) from which the feedstock was diverted. The GCE is defined as the quantity of methane collected by a landfill's gas collection and control system (GCCS) divided by the total quantity of methane generated. When proposing a site-specific GCE, the quantity of methane generated must be calculated as the sum of gas collected by the GCCS and the quantity of fugitive methane emissions measured over the landfill surface for a period of no less than one year. Consistent mass, energy, or volumetric units and operational data periods must be used to determine gas collected and fugitive emissions. Consult with CARB staff in advance to receive approval of the site-specific emissions measurement plan for a landfill-specific gas collection efficiency. Continuous measurements with electronic archival is required. Only direct measurements may be utilized to calculate the collection efficiency; data extrapolation or modeling estimates are not accepted. Further guidance on measurement requirements will be detailed in a methodology approved by the Executive Officer. The efficiency calculation must be based on the operational data period for the fuel pathway application and updated in each Annual Fuel Pathway Report . Applicants seeking to use a site-specific GCE must demonstrate from which landfill(s) the feedstock was diverted using historic bills of lading or waste collection routes. If the feedstocks were diverted from multiple landfills, the weighted average GCE must be calculated based on the mass of feedstock anaerobically degradable organic carbon (ANDOC) that would have been sent to each landfill. Applicants must also show that the landfills reported in this field under the site-specific option comply with or surpass the gas collection requirements listed in Article 4, Subarticle 6, sections 95460 to 95476, title 17 of the California Code of Regulations.[4] If a landfill's collection system does not meet these requirements, the default collection efficiency value will be applied. Approved landfill-specific gas collection efficiency values are not confidential and can be utilized by any LCFS pathway holder that can demonstrate diversion from the same landfill. The Executive Officer has the right to publish approved site-specific efficiency values (monthly basis).

[4] landfillfinalfro Methane Emissions from Municipal Solid Waste Landfills Regulation (ca.gov)

Section 4: Monthly Operational Data

Monthly operational data for all fields selected by the user in Section 2 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 either be unselected using the Pathway Input options in Section 2 or may be left blank. Any gaps in data reporting must comply with the Missing Data Provisions in LCFS Regulation section 95488.8(k).

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

Field Name	Description
4.1 Reporting Month (MM/YYYY)	Enter the monthly 24 consecutive months that reflect the most recent operational data available for the fuel 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 ULW Received (wet short tons)	Enter the monthly as-received quantity of ULW received.
4.3 ULW Moisture Content (%)	Enter the monthly as-received, weighted average moisture content of the ULW feedstock. Moisture content sampling must be on an as-received basis. Sampling and analysis protocols will be determined by CARB as a pathway-specific operating condition.
4.4 ULW Transport Distance (weighted average miles)	Enter the monthly weighted average distance for ULW feedstock(s) sourced by the fuel production facility. Transport distance is measured as the driving distance from the point of diversion from the feedstock's alternate destination to the fuel production facility. Driving distances between the two locations may be determined using a publicly available web-based driving distance estimator.
4.5 FS Received (wet short tons)	Enter the monthly quantity of FS received by the fuel production facility, as measured at a weigh-in station.
4.6 FS Moisture Content (%)	Enter the monthly as-received, weighted average moisture content of the FS feedstock. Moisture content sampling must be on an as-received basis. Sampling and analysis protocols will be determined by CARB as a pathway-specific operating condition.
4.7 FS Transport Distance (weighted average miles)	Enter the monthly weighted average distance for FS feedstock(s) sourced by the fuel production facility. Transport distance is measured as the driving distance from the point of diversion from the feedstock's alternate destination to the fuel production facility. Driving distances between the two locations may be determined using a publicly available web-based driving distance estimator.

4.8 OOW Received (wet short tons)	Enter the monthly quantity of OOW received by the fuel production facility, as measured at a weigh-in station.
4.9 OOW Moisture Content (%)	Enter the monthly as-received, weighted average moisture content of the OOW feedstock. Moisture content sampling must be on an as-received basis. Sampling and analysis protocols will be determined by CARB as a pathway-specific operating condition.
4.10 OOW Transport Distance (weighted average miles)	Enter the monthly weighted average distance for OOW feedstock(s) sourced by the fuel production facility. Transport distance is measured as the driving distance from the point of diversion from the feedstock's alternate destination to the fuel production facility. Driving distances between the two locations may be determined using a publicly available web-based driving distance estimator.
4.11 Biogas Collected (ft^3 @ 60°F, 1 atm)	Enter the monthly volume of raw (unprocessed) biogas collected. Biogas measurements require a dedicated flow measurement system with temperature measurement to enable reporting of gas flow at 1 atm pressure and 60°F (dry gas flow corrected for moisture). The flow measurement system must be calibrated per manufacturer's requirement and scaled to measure the entire range of potential flow of biogas. Measurement must be continuous, and all data must be electronically archived. Manual recording is not acceptable.
4.12 Methane Content (%v/v CH_4/dry LFG)	Enter the monthly weighted average methane content of the biogas on a volumetric, moisture-corrected basis. Methane measurement must be recorded every 15 minutes (at a minimum) with instrumentation capable of electronic archival (manual recording will not be acceptable). The methane measurement system requires calibration per manufacturer's requirement and scaled to measure the entire potential range of methane concentration in the biogas.
4.13 Biogas Sent to Boiler (ft^3 @ 60°F, 1 atm)	Enter the monthly volume of biogas that is combusted on-site in a boiler as a heat and or power source for the fuel pathway.
4.14 Natural Gas (MMBtu, HHV)	Enter the monthly quantity of natural gas used by the fuel production facility as process energy, excluding natural gas used for blending prior to injection. If dedicated metering for natural gas used for blending is not installed or not verifiable, all NG used by the facility must be reported and considered used for upgrading biogas.
4.15 Grid Electricity (kWh)	Enter the monthly quantity of grid electricity used by the fuel production facility as process energy.
4.16 Direct Supply Low-CI Electricity (kWh)	Enter monthly quantity of directly-supplied low-CI electricity used by the biomethane production facility as process energy. For more details, refer to LCFS Regulation section 95488.xx.

4.17 LPG or Propane (gallons)	Enter the monthly quantity of liquified petroleum gas (LPG) or propane used by the facility as process energy, including any quantity used for flaring and excluding any quantity used for blending prior to injection. If dedicated metering for LPG or propane used for blending is not installed or not verifiable, all LPG or propane used by the facility must be reported (and considered used for upgrading biogas)
4.18 Diesel (gallons)	Enter the monthly quantity of diesel fuel used by the fuel production facility as process energy.
4.19 Flared Gas (MMBtu, HHV)	Enter the monthly quantity of tail gas from the upgrading unit that is sent to a flare or thermal oxidizer (TO).
4.20 Natural Gas Blended (MMBtu, HHV)	Enter the monthly quantity of natural gas blended with biomethane and injected into the common carrier pipeline. Dedicated metering must be installed to substantiate quantities of NG used for this purpose.
4.21 LPG or Propane Blended (gallons)	Enter the monthly quantity of LPG or propane blended with biomethane and injected into the common carrier pipeline. Dedicated metering must be installed to substantiate quantities of LPG or propane used for this purpose.
4.22 Total Gas Injected or Dispensed On-Site(MMBtu, HHV)	Enter the monthly total quantity of gas injected into the common carrier pipeline or dispensed on-site for vehicle fueling in California, including any blended gas in 4.20 and 4.21. Injected quantities should match financial transaction records between the injecting party and the pipeline operator.

D. Pathway Summary Worksheet

The Pathway Summary worksheet aggregates site-specific user input data to calculate the CI of each fuel pathway in the T1 OW Calculator. This worksheet also serves as a location where a Margin of Safety may be added to each pathway CI prior to pathway certification and pathway-specific Operation Conditions may be added by CARB staff.

The top sections of this worksheet (Applicant Information, Avoided Emissions, Finished Fuel Quantities) provide a summary of site-specific inputs entered by the user.

The Carbon Intensity Calculations Section of this worksheet provides a summary of each fuel production stage along with its calculated emissions and stage-specific CIs. The CIs are then summed to provide a CI associated with the CNG pathway. The applicant may opt to apply a conservative margin of safety to the fuel pathway CI to ensure that the pathway remains compliant with certified CIs. The final section of this worksheet provides a space for CARB staff to publish Operating Conditions associated with the pathway.

E. CA-GREET4.0 Worksheet

The CA-GREET4.0 Worksheet contains predefined input values from several sources, including Argonne National Labs GREET 2022,[5] EPA eGRID,[6] CARB EMFAC,[7] Purdue University GTAP and Stanford OPGEE[8] models. These input values cannot be modified without written permission from CARB and will elevate the pathway application to a Tier 2 status.

[5] https://greet.es.anl.gov/index.php
[6] https://www.epa.gov/egrid
[7] https://arb.ca.gov/emfac/
[8] https://eao.stanford.edu/research-project/opgee-oil-production-greenhouse-gas-emissions-estimator