CALIFORNIA
AIR RESOURCES BOARD

Tier 1 Simplified CI Calculator Instruction Manual

Hydrogen Produced from Steam Methane Reformation or Electrolysis

February 21st, 2023

A. Introduction

This document provides detailed instructions for the use of the Tier 1 Simplified CI Calculator for Hydrogen (T1 H2 Calculator). This calculator is to be used to calculate the carbon intensity (CI) for hydrogen produced from either steam methane reformation (SMR) or electrolysis and used either as a transportation fuel or as a process input for alternate transportation fuels.

Download the T1 H2 Calculator here:

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

The T1 H2 Calculator requires the applicant to add monthly operational data, fuel production quantities, and transport distances to calculate the CI of hydrogen pathways. Some CARB-approved default and conditional default input values may also be selected.

B. T1 H2 Calculator Overview

The following table provides an overview of the worksheets used in the T1 H2 Calculator.

Table B.1. Worksheets Used in the T1 H2 Calculator

Worksheet Name	Description
Introduction	Provides a brief introduction for the Tier 1 H_2 Calculator.
Site-Specific Inputs	Worksheet for entering project input data used for calculating the carbon intensity (CI) of the pathway.
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.
CA-GREET4.0	Reference worksheet. Contains inputs and emission factors from used in calculations of carbon intensities and specifications of fuels, global warming potentials of greenhouse gases, and unit conversion values.

The cells in the T1 H2 calculator have various fill colors per the legend below:

User Input
Calculated Value
CA-GREET4.0

- "User Input" cells must be entered if the input is relevant to 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.
- "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 may require a Tier 2 pathway application.

C. Site-Specific Inputs Worksheet

The Site-Specific Inputs worksheet contains the main 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 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.

Section 1: Applicant Information

Begin by selecting the Site-Specific Inputs worksheet, then enter information for the following input sections listed in Tables C.1 – C.4 below.

Table C.1. Input Field Instructions for Section 1 of the T1 H2 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 Address	Enter city, state, and zip code for the hydrogen 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 option to select only input fields that apply to a given pathway, which hides irrelevant inputs in Section 4 of the worksheet. Figure 1 below shows the various input options permitted in the T1 H2 Calculator. If a fuel pathway has additional emissions inside the system boundary that are not listed in Section 2, a Tier 2 application will be required.

Figure C.1. T1 H2 Calculator Input Selection Panel

Table C.2. Input Field Instructions for Section 2 of the T1 H2 Calculator

Field Name	Description
2.1 Pathway Type	Select whether hydrogen is produced using steam methane reformation (SMR) or electrolysis.
2.2 Hydrogen Production Inputs	Select Site-Specific or Default Value for production inputs. The Site-Specific option requires entering facility-specific feedstock and process energy data into Section 4 of the worksheet. The Default Value option applies conservative default feedstock and process energy inputs for hydrogen production from CA-GREET4.0, which are not subject to verification. For either option, hydrogen transport and distribution data remains a user input.
2.3 Process Energy	Select the type(s) of process energy used at the fuel production facility. If Default Value Hydrogen Production Inputs are selected, this field will be disabled.
2.4 Book-and-Claim (B&C) Inputs	Select whether the hydrogen pathway will match biomethane and/or low-CI electricity environmental attributes using indirect (book-and-claim) accounting. For more details, refer to LCFS Regulation section 95488.xx.
2.5 Fuel Type Produced	Select whether the hydrogen leaves the fuel production facility as gaseous hydrogen or liquified hydrogen.

Table C.3. Input Field Instructions for Section 3 of the T1 H2 Calculator

Field Name	Description
3.1 Grid Electricity Region	If the hydrogen 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 "CA-GREET4.0" worksheet. The eGRID region may also be determined using the eGRID Power Profiler tool.
3.2 Grid CI (gCO₂e/kWh)	The grid electricity CI will be displayed based on selection in 3.1. If User-Defined is selected in Field 3.1, consult with CARB to develop an emission factor for a user-defined grid electricity mix.

3.3 Low-CI Electricity CI (gCO$_2$e/kWh)	If the hydrogen production facility has a direct, physical connection to a low-CI electricity source, consult with CARB staff to develop an appropriate emission factor for Low-CI electricity reported in Field 4.4. The low-CI electricity source must be described in detail in the Supplemental Documentation submitted with the T1 H2 Calculator.
3.4 B&C RNG FPC	If book-and-claim (B&C) of biomethane (RNG) is selected, enter the fuel pathway code (FPC) of the LCFS-certified biomethane pathway that will be used to match environmental attributes.
3.5 B&C RNG CI (gCO$_2$e/kWh)	If book-and-claim of biomethane is selected, enter the CI corresponding to the FPC entered in Field 3.5.
3.6 B&C Electricity FPC	If book-and-claim of low-CI electricity is selected, enter the fuel pathway code of the LCFS-certified low-CI electricity pathway that will be used to match environmental attributes.
3.7 B&C Electricity CI (gCO$_2$e/kWh)	If book-and-claim of low-CI electricity is selected, enter the CI corresponding to the FPC entered in Field 3.3.
3.8 H$_2$ Transport Distance (miles)	Enter total mileage for hydrogen transport from production facility to the fueling station based on the actual transport route, including any transfill or terminal waypoints. Transport mileage may be determined using a publicly available web-based driving distance estimator. If truck transport serves multiple fueling stations, a weighted average distance may be calculated, or the mileage of the farthest route may be applied.

Section 4: Monthly Operational Data

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 controls 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.xx.

Table C.4. Input Field Instructions for Section 4 of the T1 H2 Calculator

Field Name	Description
4.1 Reporting Month (MM/YYYY)	Enter the 24 consecutive months that reflect the most recent operational data available for the hydrogen 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.xx, the operational data submitted is permitted to range between 3 to 24 months.
4.2 Natural Gas (MMBtu, HHV)	Enter monthly total quantity of natural gas used by the hydrogen production facility for hydrogen production and processing, including natural gas used for steam methane reforming as a feedstock or process energy, on site hydrogen liquefaction, compression, and storage.
4.3 Grid Electricity (kWh)	Enter monthly total quantity of grid electricity used by the hydrogen production facility as a process energy for hydrogen production and processing, including electricity used for steam methane reforming, on site hydrogen liquefaction, compression, and storage.
4.4 Direct Supply Low-CI Electricity (kWh)	Enter monthly total quantity of directly-supplied low-CI process energy used by the hydrogen production facility. For more details, refer to LCFS Regulation section 95488.xx.
4.5 Maximum Matchable Quantity (MMBtu, HHV)	This field calculates the maximum quantity of matchable RNG attributes for a given month of hydrogen production. No user input permitted.
4.6 Quantity Matched (MMBtu, HHV)	Enter monthly total quantity of RNG environmental attributes matched to NG feedstock used for hydrogen production for each month of operational data. Quantity entered cannot exceed the maximum matchable quantity in Field 4.5.
4.7 Maximum Matchable Quantity (kWh)	This field calculates the maximum quantity of matchable low-CI electricity attributes for a given month of hydrogen production. No user input permitted.
4.8 Quantity Matched (kWh)	Enter monthly total quantity of low-CI electricity environmental attributes matched to grid electricity used for hydrogen production for each month of operational data. Quantity entered cannot exceed the maximum matchable quantity in Field 4.7.
4.9 Hydrogen Produced (kg)	Enter the monthly total quantity of hydrogen produced by the facility.
4.10 Gaseous Hydrogen (kg)	Enter monthly total quantity of hydrogen produced at fuel production facility that is sent to fueling stations as a compressed gas.

4.11 Liquified Hydrogen (kg)	Enter monthly total quantity of hydrogen produced at fuel production facility that is sent to fueling stations as a liquid.

D. Pathway Summary Worksheet

The Pathway Summary worksheet aggregates site-specific user input data to calculate the carbon intensity of each fuel pathway in the T1 H2 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, LCA Parameters, Finished Fuel Quantities) provide a summary of site-specific inputs entered by the user. They also provide a loss factor calculation and factor in book-and-claim attributes retired for the operational data period to show the maximum reportable quantities of finished fuel under each pathway.

In the T1 H2 Calculator, there are three possible pathways shown in columns I thru J: a pathway without Book-and-Claim (B&C) attributes, a pathway with B&C of RNG, and a pathway with B&C of Low-CI Electricity. One B&C source is permitted per hydrogen pathway with RNG or Low-CI Electricity (as entered in Fields 3.4-3.7 and 4.6-4.9). The pathway holder may report fuel transactions under the B&C pathways up to the match limit specified in cells J11 and K11 of the Pathway Summary worksheet. Any additional H2 fuels transactions beyond this match limit must be reported under the "Without B&C Attributes" pathway.

The Carbon Intensity (CI) 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 each 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 the certified CI.

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,[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 CARB and will elevate the pathway application to a Tier 2 status.

---

[1] https://greet.es.anl.gov/index.php
[2] https://www.epa.gov/egrid
[3] https://arb.ca.gov/emfac/
[4] https://eao.stanford.edu/research-project/opgee-oil-production-greenhouse-gas-emissions-estimator