Tier 1 CI Calculator for Hydrogen

Instruction Manual

October 1, 2024

Contents

I. Introduction

This document provides detailed instructions for the Tier 1 CI Calculator for Hydrogen (T1 H2 Calculator) to calculate the carbon intensities (CI) for hydrogen produced from either steam methane reformation (SMR) or electrolysis for use as a transportation fuel in California or as an input to a hydrotreated ester and fatty acid (HEFA) fuel pathway.

Click here to download the T1 H2 Calculator

The T1 H2 Calculator requires the applicant to enter monthly operational data for feedstock types and quantities, fuel production quantities, and transport distances. The calculator provides up to 4 pathway CIs, for gaseous hydrogen (GH2) and liquified hydrogen (LH2) and the option to match book-and claim of environmental attributes to their production. Each pathway CI represents a single mode for hydrogen transport (trucking, pipeline, transfill, or on-site dispensing). Applicants utilizing multiple transportation modes should submit multiple calculators or ~~submit~~ a Tier 2 application.

II. T1 H2 Calculator Overview

Table 1 provides an overview of the worksheets used in the T1 H2 Calculator.

Table 1: Worksheets Used in the T1 H2 Calculator

Worksheet Name	Description
Introduction	Provides a brief introduction for the Tier 1 H2 Calculator.
Site-Specific Inputs	Worksheet for fuel production data entry.
Pathway Summary	Worksheet that displays fuel production quantities, calculates CIs, and site-specific operating conditions.
CA-GREET4.0	Worksheet for predefined input values, emission factors, fuel specifications, and unit conversion values from the CA-GREET4.0 model.

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

User Input
Calculated Value
CA-GREET4.0 Value

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

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

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

"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 prior approval from CARB and may elevate the pathway to a Tier 2 application.

III. Site-Specific Inputs

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

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

Table 2: Instructions for Section 1 - Applicant Information

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.

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

Section 2 inputs (Table 3) provide the option to select only input fields that apply to a given pathway. Unselected inputs in Section 2 do not require corresponding user entries in Sections 3 and 4 of the worksheet.

Table 3: Instructions for Section 2 - Pathway Inputs

Field Name	Description
2.1 Pathway Type	Select whether hydrogen is produced using steam methane reformation (SMR) or electrolysis.
2.2 Hydrogen Production	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 default feedstock and process energy inputs for hydrogen production derived from CA-GREET4.0, which are not subject to verification.
2.3 SMR Feedstock	Select the feedstock used for SMR pathways. If an Electrolysis pathway is selected, these options will be disabled.
2.4 Process Energy	Select the type(s) of process energy used at the fuel production facility. If Default Value Hydrogen Production Inputs are selected, these options will be disabled.
2.5 Coproducts	Select whether the hydrogen facility exports steam coproducts for use outside the fuel pathway. If Default Value Hydrogen Production Inputs are selected, this options will be disabled.
2.6 GH2 Transport	Select the method used to transport gaseous hydrogen from the fuel production facility to fueling stations or HEFA facilities.
2.7 LH2 Transport	Select the method used to transport liquified hydrogen from the fuel production facility to fueling stations or HEFA facilities.
2.8 Book-and-Claim (B&C)	Select whether the hydrogen pathway will match environmental attributes of biomethane and/or low-CI electricity with indirect (book-and-claim) accounting. For more details, refer to LCFS Regulation section 95488.8(i).

Table 4: Instructions for Section 3 - Static Operational Data

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. A map of eGRID zones is provided in the "CA-GREET4.0" worksheet. The eGRID region may also be determined using the eGRID Power Profiler tool.1
3.2 Electricity Grid EF (gCO2e/kWh)	The grid electricity EF will be displayed based on the selection for Field 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 Light HC EF (gCO2e/MMBtu, HHV)	If the hydrogen production facility uses a light hydrocarbon (HC) stream as a feedstock or process fuel, consult with CARB to develop an appropriate emission factor.
3.4 Low-CI Electricity EF (gCO2e/kWh)	Consult with CARB to develop an appropriate emission factor for the direct supply low-CI electricity used by the hydrogen production facility. Low-CI electricity must be physically supplied directly to the production facility per LCFS Regulation section 95488.8(h). 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 fuel pathway application.
3.5 GH2 Direct to Fueling Station (miles)	Enter the distance for gaseous hydrogen transported directly from the fuel production facility to the fueling station or HEFA facility by truck using a publicly available distance estimator tool that reflects the actual transport route. If hydrogen is transported to multiple destinations, a weighted average distance may be calculated, or the mileage of the farthest route may be applied.
3.6 LH2 Direct to Fueling Station (miles)	Repeat instructions in Field 3.5 for liquified hydrogen transport.
3.7 Production to Transfill (miles)	Repeat instructions in Field 3.5 for liquified hydrogen transport to a transfill, hub or terminal.
3.8 Transfill to Fueling Station (miles)	Repeat instructions in Field 3.5 for liquified hydrogen transport from a transfill, hub or terminal to a fueling station or HEFA facility.
3.8 Hydrogen Pipeline (miles)	Repeat instructions in Field 3.5 for hydrogen transported from via pipeline from the fuel production facility to a fueling station or HEFA production facility.

[1] United States Environmental Protection Agency, *eGRID Power Profiler tool.* (Updated June 5, 2023). *https://www.epa.gov/egrid/power-profiler#/*

Section 4 inputs (Table C.4) must be entered for each month of the operational data period. Any gaps in data reporting must comply with the Missing Data Provisions in LCFS Regulation section 95488.8(k). Quantities entered should be inclusive of the entire fuel production facility; quantities used by the facility that are outside the fuel pathway system boundary may only be excluded with written permission from CARB.

Table 5: Instructions for Section 4 - Monthly Operational Data

Field Name	Description
4.1 Reporting Month (MM/YYYY)	Enter the 24 consecutive months that reflect the most recent operational data available for the hydrogen production facility. Applications must not have an interval of greater than 3 months between the end of the operational data month and the date of submission. For fuel production facilities that have been in operation less than 24 months, 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 between 3 to 24 months.
4.2 North American Natural Gas (MMBtu, HHV)	Enter the quantity of natural gas (NG) used by the entire hydrogen production facility sourced from a common carrier NG pipeline in North America.
4.3 Light Hydrocarbons (MMBtu, HHV)	Enter the quantity of light hydrocarbons used by the entire hydrogen production facility.
4.4 Grid Electricity (kWh)	Enter the quantity of electricity sourced from the grid.
4.5 Direct Supply Low-CI Electricity (kWh)	Enter the quantity of low-CI electricity supplied directly per LCFS Regulation section 95488.8(h).
~~4.6 Submetered Electricity for Electrolysis (kWh)~~	~~Enter the quantity of submetered electricity used by the hydrogen production facility for electrolysis, if available. Electrolysis submetering is used to evaluate maximum book-and-claim quantities; in the absence of submetering a default book-and-claim value is applied.~~
4.6~~7~~ Submetered Electricity for Liquefaction (kWh)	Enter the quantity of submetered electricity used by the hydrogen production facility for liquefaction, if available. Electrolysis submetering is used to evaluate the quantities of grid electricity attributed to GH2 and LH2 pathways.
4.7~~8~~ Exported Steam (MMBtu)	Enter the quantity of steam that is exported outside the hydrogen pathway system boundary. Exported steam or its energy content reported in this field cannot be used inside the system boundary downstream of this measurement location.
4.8~~9~~ Total Hydrogen Production (kg)	Enter the quantity of all hydrogen produced at the fuel production facility, including hydrogen produced for non-transportation fuel use.

Field Name	Description
4.9~~10~~ Total Liquified Hydrogen Production (kg)	Enter the quantity of all liquefied hydrogen produced at the fuel production facility, if applicable, including liquified hydrogen produced for non-transportation fuel use.
4.10~~1~~ Dispensed at Fuel Production Facility (kg)	Enter the quantity of hydrogen that is stored as a gas at the fuel production facility prior to dispensing on-site as a transportation fuel.
4.11~~2~~ Delivered by Tube Trailer Truck (kg)	Enter the quantity of hydrogen used in LCFS pathway(s) that is shipped via tube trailer truck as a compressed gas to a vehicle fueling station or HEFA fuel production facility.
4.12~~3~~ Delivered by Pipeline (kg)	Enter the quantity of hydrogen used in LCFS pathway(s) that is shipped via hydrogen pipeline as a compressed gas to a vehicle fueling station or HEFA fuel production facility.
4.13~~4~~ Dispensed at Fuel Production Facility (kg)	Enter the quantity of hydrogen used in LCFS pathway(s) that is stored as a liquid at the fuel production facility prior to dispensing on-site as a transportation fuel.
4.14~~5~~ Delivered by Tanker Truck (kg)	Enter the quantity of hydrogen used in LCFS pathway(s) that is shipped via tanker truck as a liquid to a vehicle fueling station or HEFA fuel production facility.
4.15~~6~~ Delivered via Transfill (kg)	Enter the quantity of hydrogen used in LCFS pathway(s) that is shipped to a transfill station as a liquid, then transferred to a gaseous tube trail truck for transport to a vehicle fueling station or HEFA fuel production facility.

Section 5 of the calculator allows book-and-claim matching from up to 24 individual RNG or Low-CI Electricity pathways. Quantities entered in this section are with respect to the entire operational data period, and do not require monthly data.

Table 6: Instructions for Section 5 - Book-and-Claim Accounting

Field Name	Description
5.1 Fuel Pathway Code	Enter the fuel pathway code(s) (FPC) for up to 24 LCFS-certified RNG pathways used to match book-and-claim RNG environmental attributes to NG used as a feedstock for hydrogen production.
5.2 CI Score (gCO_2e/MJ, LHV)	Enter the certified CI score associated with each RNG pathway FPC.
5.3 RNG Pathway Pipeline Distance (miles)	Enter the pipeline distance from the RNG injection location to the CNG station in California as calculated by the certified RNG pathway. If the

Field Name	Description
	pipeline distance is not available from the RNG pathway holder, consult with CARB.
5.4 H2 Pathway Pipeline Distance (miles)	Enter the pipeline distance from the RNG injection location to the hydrogen production facility using a publicly available web-based driving distance estimator.
5.5 Quantity Matched to GH2 (MMBtu, HHV)	Enter the total quantity of RNG matched from each pathway to gaseous hydrogen produced at the fuel production facility for the entire operational data period. Maximum matchable Book-and-Claim quantities are calculated on the 'Pathway Summary' worksheet.
5.6 Quantity Matched to LH2 (MMBtu, HHV)	Enter the total quantity of RNG matched from each pathway to liquified hydrogen produced at the fuel production facility for the entire operational data period. Maximum matchable Book-and-Claim quantities are calculated on the 'Pathway Summary' worksheet.
5.7 Fuel Pathway Code	Enter the fuel pathway code(s) (FPC) for up to 24 LCFS-certified Low-CI Electricity pathways used to match book-and-claim Low-CI Electricity environmental attributes to grid electricity used as a process input for hydrogen production.
5.8 CI Score (gCO_2e/kWh)	Enter the certified CI scores associated with each Low-CI Electricity pathway FPC.
5.9 Quantity Matched to GH2 (kWh)	Enter the total quantity of Low-CI Electricity matched from each pathway to gaseous hydrogen produced at the fuel production facility for the entire operational data period. Maximum matchable Book-and-Claim quantities are calculated on the 'Pathway Summary' worksheet.
5.10 Quantity Matched to LH2 (kWh)	Enter the total quantity of Low-CI Electricity matched from each pathway to gaseous hydrogen produced at the fuel production facility for the entire operational data period. Maximum matchable Book-and-Claim quantities are calculated on the 'Pathway Summary' worksheet.

IV. Pathway Summary Worksheet

The Pathway Summary worksheet calculates the CI of each fuel pathway from operational data and user selections in the Site-Specific Inputs worksheet.

The top section of this worksheet (Applicant Information and Hydrogen Production Quantities) provides application identification information and a summary of site-specific inputs entered by the user.

In the T1 H2 Calculator, there are up to six possible pathways per application based on the combination of liquid and/or gaseous hydrogen production, and pathways for matching of hydrogen book-and-claim (B&C) attributes from RNG or Low-CI Electricity. Matching all B&C environmental attributes under a separate pathway allows for that pathway to achieve a

lower CI score. The verification body will confirm that hydrogen reported under the B&C pathways does not exceed the reportable quantities calculated in this worksheet.

The Carbon Intensity Calculations section 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 hydrogen pathways. 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 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. A completed version of this worksheet is shared with the applicant for review and approval prior to pathway certification.

V. CA-GREET4.0 Worksheet

The CA-GREET4.0 Worksheet contains predefined input values from the CA-GREET4.0 model. These input values cannot be modified without written permission from CARB, which will elevate the application to a Tier 2 pathway.