

User Manual for Woody Biomass-to-Hydrogen Simplified Carbon Intensity (CI) Calculator



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Contents

- I. Introduction 1
- II. T1 Biomass to Hydrogen Overview 1
- III. Site Specific Inputs 2
- IV. Avoided Emissions Worksheet 7
- V. Pathway Summary Worksheet 7
- VI. CA-GREET4.0 Worksheet 8

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 woody biomass residues via gasification or pyrolysis in California for use as a transportation fuel in California or as an input to a hydrotreated ester and fatty acid (HEFA) fuel pathway.

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). 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 Biomass to Hydrogen Overview

Table 1 provides an overview of the worksheets used in the T1 CI Calculator for Biomass to Hydrogen.

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.
Avoided Emissions	Avoided emissions are calculated using emission factors derived from the California Biomass Residue Emissions Characterization (C-BREC) model.

The cells in the T1 Biomass to Hydrogen 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. The calculator tool includes emissions associated with biomass collection and preprocessing prior to delivery to the fuel plant based on default data in the CA-GREET4.0 model for forest residues.

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 formulas 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 formulas 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: Biomass Heating Value
- Section 3: Biochar Properties
- Section 4: Static Operational Data
- Section 5: 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.
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) allow the user to select the biomass heating value used in the tool.

Table 3: Instructions for Section 2 – Biomass Heating Value

Field Name	Description
2.1 Biomass Heating Value	<p>Select one of the three options to define the biomass heating value:</p> <ul style="list-style-type: none"> • GREET Default: Use the default biomass heating value from the CA-GREET model. • Regional: Use a region-specific biomass heating value. • User Defined: Input a custom biomass heating value. If this option is selected, the user must also enter a value in 2.2.
2.2 User Defined Biomass Heating Value (Btu/dry ton, HHV)	If you selected "User Defined" in 2.1, enter the biomass heating value in Btu per dry ton on a higher heating value (HHV) basis.

Section 3 inputs (Table 4) allow the user to select the biochar properties (heating value and carbon content) used in the tool. This data is only relevant to fuel pathways that produce biochar as a co-product.

Table 4: Instructions for Section 3 – Biochar Properties

Field Name	Description
3.1 Biochar Data	Select one of the two options to define the biochar characteristics: <ul style="list-style-type: none"> • GREET Defined: Use default biochar data from the CA-GREET model. • User Defined: Enter custom biochar data. If this option is selected, additional fields (3.2 and 3.3) must be completed.
3.2 Heating Value (Btu/dry ton, LHV)	If you selected "User Defined" in 3.1, enter the heating value of the biochar in Btu per dry ton, on a Lower Heating Value (LHV) basis. This value represents the energy content of the biochar on a dry basis.
3.3 Carbon Content (% Dry Wt.)	Enter the carbon content of the biochar as a percentage of its dry weight (% dry wt.). The carbon content is used to determine the carbon balance for the production process.

Section 4 (Table 5) allows the user to enter static operational data, including the regional grid electricity mix, low-CI electricity emission factor and hydrogen transport distances.

Table 5: Instructions for Section 4 - Static Operational Data

Field Name	Description
4.1 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
4.2 Electricity Grid EF (gCO ₂ e/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.
4.3 Low-CI Electricity EF (gCO ₂ e/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.
4.4 GH ₂ 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.

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

4.5 LH2 Direct to Fueling Station (miles)	Repeat instructions in Field 3.5 for liquified hydrogen transport.
4.6 Production to Transfill (miles)	Repeat instructions in Field 3.5 for liquified hydrogen transport to a transfill, hub or terminal.
4.7 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.
4.8 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.

Section 5 inputs (Table 6) 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 6: Instructions for Section 5 - Monthly Operational Data

Field Name	Description
5.1 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.
5.2 Biomass tons (as is)	Enter the total quantity of biomass consumed during the reporting month, measured in tons (as-is). This value represents the biomass mass including its moisture content.
5.3 Biomass Moisture Content (% Mass)	Enter the monthly average moisture content of the biomass, expressed as a percentage of its mass (%).
5.4 Biomass Energy Input mmBtu (HHV)	This is the calculated value based on the user selection of biomass energy content (2) and entries of biomass tons (5.2) and biomass moisture content (5.3)
5.5 Heavy Duty Truck Transport Distance (mi, one way)	Enter the one-way transport distance, in miles (mi), that the biomass traveled by heavy-duty truck to reach the facility.
5.6 Natural Gas (MMBtu, HHV)	Enter the amount of natural gas consumed during the reporting month, measured in MMBtu (Higher Heating Value, HHV).
5.7 Propane (LPG) (gallons at 60°F)	Enter the amount of propane consumed during the reporting month, measured in gallons at standard temperature (60°F). This includes propane used as a startup fuel for biomass boilers or gasifiers, for backup power generation or any auxiliary equipment involved in the production process.
5.8 Diesel (gallons at 60°F)	Enter the amount of diesel fuel consumed during the reporting month, measured in gallons at standard temperature (60°F). This includes diesel used for vehicles, machinery, or any auxiliary equipment involved in the production process.
5.9 Grid Electricity (kwh)	Enter the quantity of electricity sourced from the grid.

5.10 Direct Supply Low-CI Electricity (kWh)	Enter the quantity of low-CI electricity supplied directly per LCFS Regulation section 95488.8(h).
5.11 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.
5.12 Submetered Electricity for Compression (kWh)	Enter the amount of submetered electricity used for the compression process, measured in kilowatt-hours (kWh).
5.13 Ammonia (100% Basis) (tons)	Enter the amount of ammonia used in the process, measured in tons, on a 100% basis.
5.14 Urea (100% Basis) (tons)	Enter the amount of ammonia used in the process, measured in tons, on a 100% basis.
5.15 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.
5.16 Biochar (tons)	Enter the amount of biochar produced during the biomass conversion process, measured in tons.
5.17 Total Hydrogen Production (kg)	Enter the quantity of all hydrogen produced at the fuel production facility, including hydrogen produced for non-transportation fuel use.
5.18 Total Liquefied Hydrogen Production (kg)	Enter the quantity of all liquefied hydrogen produced at the fuel production facility, if applicable, including liquefied hydrogen produced for non-transportation fuel use.
5.19 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.
5.20 Delivered by Tube Trailer Truck (kg)	Enter the quantity of hydrogen that is shipped via tube trailer truck as a compressed gas to a vehicle fueling station or HEFA fuel production facility.
5.21 Delivered by Pipeline (kg)	Enter the quantity of hydrogen that is shipped via hydrogen pipeline as a compressed gas to a vehicle fueling station or HEFA fuel production facility.
5.22 Dispensed at Fuel Production Facility (kg)	Enter the quantity of hydrogen that is stored as a liquid at the fuel production facility prior to dispensing on-site as a transportation fuel.
5.23 Delivered by Tanker Truck (kg)	Enter the quantity of hydrogen that is shipped via tanker truck as a liquid to a vehicle fueling station or HEFA fuel production facility.
5.24 Delivered to Transfill (kg)	Enter the quantity of hydrogen 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.

IV. Avoided Emissions Worksheet

The Avoided Emissions tab calculates the emissions that would have occurred if the biomass used in electricity production had not been utilized (e.g., left in the forest or burned). User inputs are required in the yellow cells to define the sourcing and management of the biomass.

Field Name	Description
Amount (or fraction) of residues derived from this source	Use as many or as few rows as you have distinct sources for feedstock. Values here could be expected feedstock mass or fraction. They are weighting factors to be used in taking the average value for use elsewhere in the tool.
Ecoregion ID	Enter ecoregion number based on map or interactive webtool linked below.
Treatment Type	Select "commercial harvest" if primary treatment target is removal of large, merchantable trees. Select "thinning" if smaller-diameter trees are targeted to reduce overstocking, restore forest health, and mitigate fire risk.
Residue Disposition	Select what whether residue is piled or scattered following primary harvest/treatment activity.
Would residue be burned if not removed?	Select what would be done with residue if not removed from the field
Reference Emission Per MT residue Mobilized	Reference emissions are based on look up table values derived from the C-BREC model (https://schatzcenter.org/cbrec/)

V. 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 Electricity Pathway Summary) provides application identification information and a summary of site-specific inputs entered by the user.

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 electricity pathways. The applicant may opt to apply a conservative margin of safety to the electricity 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 electricity 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.

VI. 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.

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