California Air Resources Board

Zero-Emission Vehicle Infrastructure Benefits Quantification Methodology

California Climate Investments

Note:
California Climate Investments is accepting public comments on this Draft Benefits Quantification Methodology for Zero-Emission Vehicle Infrastructure projects until October 21, 2026. Please submit feedback to ggrfprogram@arb.ca.gov.

DRAFT
September 2026

Table of Contents

List of Acronyms and Abbreviations 3
List of Definitions 5
List of Tables 8
Section A. Introduction 9
A.1. Background and Purpose 9
A.2. Methodology Development and Guiding Principles 9
A.3. Scope and Eligible Infrastructure Types 10
A.4. Methodology Overview 11
A.5. Tools, Data Sources, and Implementation 12
Section B. Quantification Methodology 13
B.1. Parameters, Defaults, and Data Sources 13
B.2. Quantification Period 14
B.3. Annual Electricity and Hydrogen Throughput 15
B.4. Net Energy and Vehicle Activity 20
B.5. Annual GHG Emission Reductions 22
B.6. Annual Air Pollutant Emission Reductions 25
B.7. Adjustment Factors 26
B.8. Calculation Boundaries and Supporting Rationale 29
B.9. Final Outputs and Aggregation 31
References 33

List of Acronyms and Abbreviations

Table 1. Acronyms and abbreviations used in this methodology

Acronym	Term
AB	Assembly Bill (California legislation)
AER	Annual emission reductions
ARCHES	Alliance for Renewable Clean Hydrogen Energy Systems
BEV	Battery electric vehicle
CA-GREET	California-modified Greenhouse Gases, Regulated Emissions, and Energy use in Transportation model
CalGREEN	California Green Building Standards Code
CALZI	California Zero Emission Vehicle Insights
CARB	California Air Resources Board
CEC	California Energy Commission
CI	Carbon intensity
CNG	Compressed natural gas
CO_2e	Carbon dioxide equivalent
DCFC	Direct current fast charging
dge	Diesel gallon equivalent
Diesel PM	Diesel particulate matter
EF	Emission factor
EMFAC	EMission FACtor model
EV	Electric vehicle
EVI-Pro	Electric Vehicle Infrastructure Projection tool
EVSE	Electric vehicle supply equipment
FCEV	Fuel cell electric vehicle
g	Gram
gal	Gallon
GGRF	Greenhouse Gas Reduction Fund
GHG	Greenhouse gas
H2	Hydrogen
HD	Heavy-duty
kg	Kilogram
kW	Kilowatt
kWh	Kilowatt-hour
L2	Level 2 charging
lb	Pound
LCFS	Low Carbon Fuel Standard
LD	Light-duty
LDA	Light-duty automobile, the passenger-car category in EMFAC
LDT1, LDT2	Light-duty truck categories in EMFAC
LHD1, LHD2	Light-heavy-duty truck categories in EMFAC
MD	Medium-duty
MDV	Medium-duty vehicle category in EMFAC

Acronym	Term
MJ	Megajoule
MUD	Multi-unit dwelling
N/A	Not applicable
NO_x	Nitrogen oxides
OBUS	Other-bus category in EMFAC
PEV	Plug-in electric vehicle
PHEV	Plug-in hybrid electric vehicle
$PM_{2.5}$	Fine particulate matter
QM	Quantification methodology
QP	Quantification period
ROG	Reactive organic gases
SO_x	Sulfur oxides
T6	EMFAC truck-category group used for the medium heavy-duty reference
T7	EMFAC truck-category group used for heavy heavy-duty and port/drayage references
TAER	Total adjusted emission reductions
TRT	Technical Review Team
TRUCRS	Truck Regulations Upload, Compliance, and Reporting System
UBUS	Urban/transit-bus category in EMFAC
ZEV	Zero-emission vehicle

List of Definitions

Table 2. Definitions of terms used in this methodology

Term	Definition
Adj_{Infra}	Infrastructure additionality factor representing the portion of modeled benefits associated with the funded project relative to the without-project condition; 0.50 default or documented project-specific replacement (Section B.7).
Adj_{LS}	Location adjustment for charging activity that may shift between home and non-home locations.
Adjustment factor	A multiplicative factor applied to estimated emission reductions to account for vehicle-incentive overlap, charging location, or infrastructure additionality.
Adj_{Veh}	Vehicle-incentive overlap adjustment used to account for potential overlap in benefits in California Climate Investments reporting.
AER	Annual emission reductions; subscripts identify the pollutant or reporting basis.
$AER_{GHG,y}$	Unadjusted annual lifecycle GHG emission reduction in calendar year y, reported in metric tons CO_2e/year.
$AER_{p,y}$	Unadjusted annual operational emission reduction for pollutant p in calendar year y, reported in lb/year.
Availability multiplier	Factor representing equipment or fuel-supply availability in modeled hydrogen throughput. Measured dispensing already reflects outages and is not reduced again.
Baseline scenario (counterfactual scenario)	The documented without-project condition. Existing-site energy use is subtracted where applicable; the emissions comparison uses conventional vehicles providing equivalent travel.
Carbon intensity (CI)	Lifecycle greenhouse gas emissions associated with a fuel or energy pathway, expressed per unit energy or fuel (e.g., g CO_2e/kWh, g CO_2e/gal, g CO_2e/MJ).
$C_{conv,y}$	Fuel-blended conventional lifecycle GHG emissions per vehicle mile in calendar year y, expressed in g CO_2e/mile.
Charging port	A charging connection capable of serving one vehicle at a time; the funded port count is distinct from the number of charging sites.
Co-benefits	Additional social, economic, or environmental benefits beyond GHG reductions. This QM quantifies operational NO_x, SO_x, ROG, and $PM_{2.5}$ reductions.
Conventional vehicle	A vehicle powered by an internal combustion engine using gasoline, diesel, or natural gas; used as the baseline comparator for equivalent travel.
C_{ZEV}	Lifecycle GHG emissions per kWh of electricity or kilogram of hydrogen supplied, expressed in g CO_2e/kWh or g CO_2e/kg.
Diesel PM	Particulate matter associated with diesel combustion. The $PM_{2.5}$ output includes the applicable exhaust component and is not an additional separate Diesel PM total.

Term	Definition
Drayage truck	A truck used to move freight to or from ports or intermodal facilities. The calculator uses the applicable EMFAC port-truck categories for this group.
EF	Emission factor for a pollutant, typically expressed per unit activity (e.g., g/mi).
$EF_{conv,p,y}$	Conventional emission rate for pollutant p in calendar year y, expressed in g/mile, including running, start, and idle exhaust and, for $PM_{2.5}$, tire and brake wear.
$EF_{ZEV,p,y}$	ZEV emission rate for pollutant p in calendar year y, expressed in g/mile. Exhaust is zero; $PM_{2.5}$ includes tire and brake wear for the selected BEV or FCEV.
Equivalent vehicle travel	Annual vehicle travel corresponding to the electricity or hydrogen supplied, calculated using the same-year ZEV energy consumption rate.
EVI-Pro	Electric Vehicle Infrastructure Projection tool developed by the National Laboratory of the Rockies; used to estimate charging demand and utilization patterns.
EVSE	Electric vehicle supply equipment; equipment that supplies electricity for charging plug-in vehicles.
FE	Vehicle energy or fuel consumption per mile used in the equations, such as kWh/mile, kg/mile, or gallons/mile.
$FE_{f,y}$	Fuel-specific conventional consumption per total combustion mile in calendar year y, expressed in gal/mile or dge/mile.
$FE_{ZEV,y}$	Electricity or hydrogen consumption per vehicle mile in calendar year y, expressed in kWh/mile or kg/mile.
FleetDB	CARB vehicle-population data compilation used here for selected incentive-overlap reference populations.
Fleet/depot charging	Charging that serves an identified vehicle fleet, typically at its operating or storage location.
Fuel pathway	The energy carrier enabling vehicle operation (electricity or hydrogen, and the baseline conventional fuel such as gasoline/diesel).
Grid emissions (time-of-day)	Electricity-related emissions that vary by hour. This QM uses the documented fuel pathway and does not apply a separate time-of-day benefit.
Hydrogen refueling infrastructure	Stations and equipment that dispense hydrogen fuel to enable FCEV operation.
LCFS	Low Carbon Fuel Standard program; provides lifecycle carbon intensity values for transportation fuels.
Lifecycle emissions	Emissions across fuel or electricity production, delivery, and vehicle use within the selected pathway boundary.
Load shifting	Charging activity that changes location, such as moving from home to workplace or public charging.
N	Number of funded charging ports or hydrogen stations represented by the project line.
Nameplate capacity	The rated dispensing capability of a hydrogen station, expressed in kilograms per day; it is not the amount necessarily dispensed.

Term	Definition
NO_x	Nitrogen oxides; reported here on a vehicle operational basis.
Operating year	A year indexed from the start of project operation, distinct from a calendar year.
PEV	Plug-in electric vehicle (includes BEVs and PHEVs).
$PM_{2.5}$	Particulate matter with aerodynamic diameter ≤ 2.5 micrometers; a criteria pollutant.
Program operating period	The required period during which funded infrastructure must be maintained and operated under program terms.
QP (Quantification period)	Inclusive number of operating calendar years represented in the benefits estimate, subject to any documented project-specific final-year limit.
ROG	Reactive organic gases; reported here on a vehicle operational basis.
Rulemakings (regulatory requirements)	Requirements that may affect the funded scope or operating period. Applicable project-specific limits are documented by the administering agency.
Running-exhaust emissions	Emissions released through a vehicle's exhaust during operation; distinct from upstream fuel emissions and non-exhaust sources.
SO_x	Sulfur oxides; reported here on a vehicle operational basis.
TAER	Total adjusted emission reductions over the quantification period after the vehicle-incentive overlap, location, and infrastructure additionality factors.
Throughput	Electricity delivered or hydrogen dispensed over a stated period, expressed on the applicable per-port or per-station basis.
$U_{f,y}$	Annual conventional consumption of fuel f in calendar year y, in gallons or diesel-equivalent gallons per infrastructure unit.
Upstream emissions	Emissions associated with fuel production and delivery. They are included in lifecycle GHG calculations. However, this QM reports air pollutants on a vehicle operational basis (no upstream emissions).
Utilization	Use of infrastructure over time. Electric charging is expressed as annual energy per port; capacity-based hydrogen utilization is dispensing relative to station capacity.
U_y	Annual electricity supplied per charging port or hydrogen dispensed per station in calendar year y, after existing-site baseline subtraction, expressed in kWh/port/year or kg/station/year.
Vehicle adoption	Changes in ZEV adoption that may be associated with infrastructure availability. No separate adoption multiplier is added to station throughput.
Vehicle travel effects	Changes in vehicle use associated with infrastructure. The calculations use equivalent travel for the ZEV and conventional-vehicle comparisons.
ZEV	Zero-emission vehicle: a BEV or FCEV with no tailpipe emissions in any operating mode.
ZEV-enabled scenario	The scenario in which infrastructure supplies electricity or hydrogen, including PHEV electric operation. ZEV subscripts in the equations identify this operating pathway, not incentive eligibility.

List of Tables

Table 1. Acronyms and abbreviations used in this methodology 3
Table 2. Definitions of terms used in this methodology 5
Table 3. Principal inputs and reference basis 14
Table 4. Variables of Equation (1): Inclusive quantification period 15
Table 5. Light-duty electric utilization defaults (2030 projections) 16
Table 6. Medium- and heavy-duty electric utilization defaults (2030 projections) 16
Table 7. Hydrogen ramp shapes by operating year 18
Table 8. Variables of Equation (2): Capacity-based light-duty annual throughput 18
Table 9. Variables of Equation (3): Demand-based annual hydrogen throughput 19
Table 10. Variables of Equation (4): Freight capacity ramp 20
Table 11. Variables of Equation (5): Annual energy above the existing-site baseline 21
Table 12. Variables of Equation (6): Equivalent travel and conventional fuel consumption 22
Table 13. Variables of Equation (7): Fuel-blended conventional emissions per mile 23
Table 14. Variables of Equation (8): Conversion of a project-specific carbon intensity 24
Table 15. Variables of Equation (9): Annual GHG emission reductions before adjustments 24
Table 16. Variables of Equation (10): Annual air pollutant emission reductions before adjustments 25
Table 17. Variables of Equation (11): Vehicle incentive overlap factor 26
Table 18. Vehicle incentive overlap factors 27
Table 19. Variables of Equation (12): Energy-weighted overlap for a known fleet 28
Table 20. Variables of Equation (13): Total adjusted emission reductions 31
Table 21. Variables of Equation (14): Reported annual average 32

Section A. Introduction

A.1. Background and Purpose

California Climate Investments uses billions of Cap-and-Invest dollars to fund projects that reduce harmful emissions, protect public health, strengthen local economies, and support natural environments. With a strong focus on communities most impacted by pollution and limited access to resources, California Climate Investments helps build a more equitable and sustainable future.

As part of California Climate Investments, many programs fund zero-emission vehicle (ZEV) infrastructure (electric charging and hydrogen refueling) to support the transition away from conventional fossil-fueled transportation and support innovation, development, and deployment of zero-emission transportation.

This document provides a transparent and conservative quantification methodology (QM) to estimate the emissions benefits facilitated by ZEV infrastructure. The QM supports program needs, including consistent estimation and reporting of benefits over the required operating period. Because infrastructure emission benefits are indirect (infrastructure enables vehicle activity rather than directly producing emission reductions), the QM states assumptions explicitly, accounts for potential overlaps of emission benefits with other programs, and aligns with existing California Air Resources Board (CARB) quantification practices.

A.2. Methodology Development and Guiding Principles

CARB developed this QM consistent with the guiding principles of transparency, accountability, and conservative estimation. The QM is used to estimate benefits for proposed ZEV infrastructure projects and support consistent reporting for funded projects over the required operating period. These principles are consistent with the California Climate Investments Funding Guidelines (CARB, 2024).

The implementing principles ensure that the QM:

- Applies at the project level and supports program implementation and reporting needs, using project-level information where available and appropriate;
- Can be applied consistently throughout California and is accessible to program users;
- Uses existing and proven methods, including established CARB tools, datasets, and quantification approaches where available; and
- Produces estimates that are conservative, transparent, and supported by empirical data or established CARB programs.

During development, CARB staff studied peer-reviewed literature, operational datasets, and existing CARB quantification approaches relevant to ZEV infrastructure. CARB staff from multiple internal divisions were consulted, and external subject-matter experts reviewed the model through the Technical Review Team (TRT) to identify project inputs available for program implementation, ensure consistency with CARB quantification practices, and account for

potential overlap in benefits across programs. Recommendations were incorporated where feasible and consistent with the methodology's scope and available data.

CARB infrastructure experts reviewed hydrogen and electric charging utilization assumptions across passenger vehicles, buses, and trucks; incentive program experts reviewed vehicle-incentive overlap factors; Low Carbon Fuel Standard (LCFS) experts reviewed fuel carbon intensity (CI) assumptions; and CARB vehicle emissions inventory experts reviewed fleet-average energy consumption and emission-rate inputs.

A.3. Scope and Eligible Infrastructure Types

This QM applies to ZEV infrastructure projects located in California and supports applicable California Climate Investments programs, including the California Energy Commission (CEC) Clean Transportation Program, where applicable. The scope includes both electricity and hydrogen fuel pathways and covers multiple vehicle classifications and charging/refueling facility installation contexts.

Vehicle Classes Covered

- Light-duty (LD) vehicles
- Medium-duty (MD) vehicles
- Heavy-duty (HD) vehicles

Fuel Pathways Covered

- Electricity (LD/MD/HD)
- Hydrogen (LD/MD/HD)

Infrastructure Types Covered

1) Electric Vehicle Supply Equipment (EVSE)

    - Level 2 (L2) charging
    - Direct Current Fast Charging (DCFC)

2) Hydrogen refueling infrastructure

    - Hydrogen refueling (H_2) stations enabling fuel cell electric vehicle (FCEV) operation

Facility / Location Types Covered

- Residential, including single-family homes and multi-unit dwellings (MUD)
- Public sites
- Workplace/community sites
- Fleet depots

Greenhouse Gas Emission Reductions and Co-Benefits

This QM estimates greenhouse gas (GHG) emission reductions, expressed as carbon dioxide equivalent (CO_2e), and selected co-benefits from ZEV infrastructure projects. Co-benefits are defined as social, economic, or environmental benefits of a project beyond its GHG emission

reduction benefit. For this QM, co-benefits include vehicle operational air pollutant emission reductions for nitrogen oxides (NO_x), sulfur oxides (SO_x), reactive organic gases (ROG), and fine particulate matter ($PM_{2.5}$), to the extent supported by available emission factors and consistent treatment across vehicle classes.

The reported air pollutant benefits are emission-mass reductions. They do not represent changes in ambient concentrations, exposure, or health outcomes.

A.4. Methodology Overview

Core Quantification Approach

The QM estimates emissions benefits as the difference between:

- a conventional-vehicle comparison, in which conventional vehicles provide equivalent travel activity; and
- a ZEV-enabled scenario, in which electricity or hydrogen supplies energy for vehicle operation.

The methodology quantifies benefits separately for each calendar year, applies the applicable adjustment factors, and sums the adjusted annual results over the quantification period (QP).

Electric Charging (EVSE)

For electric charging, the methodology uses annual charging-port utilization (kWh of energy dispensed per charging port per year) by charging infrastructure type and site context. Utilization is converted to vehicle activity using same-year energy consumption rates. Conventional fuel use and emissions are estimated for equivalent travel activity from the plug-in electric vehicle (PEV). Lifecycle GHG emissions are quantified using CI inputs for each fuel pathway, and air pollutant emission reductions are quantified using vehicle operational emission factors (not the full lifecycle impact). Charging for plug-in hybrid electric vehicles (PHEVs) is included only for their electric driving activity.

Hydrogen Refueling

For hydrogen refueling, the QM applies the same framework using hydrogen throughput, the same-year FCEV hydrogen consumption rate, and applicable CI inputs to estimate emissions relative to the conventional-vehicle comparison.

Adjustments, Limits, and Additionality

Because ZEV infrastructure enables emission benefits indirectly, the QM applies adjustments and limits to estimate the benefits associated with funded projects. These include:

- Vehicle-incentive overlap adjustments to account for potential overlap in benefits between vehicle and infrastructure programs' investments;
- Location adjustments for charging activity that could otherwise occur at another location;
- An infrastructure additionality factor representing the project relative to the without-project condition; and

- An existing-site energy baseline, where applicable, and documented limits on the operating period.

Quantification Period

The quantification period is the required operating period under program terms, subject to any documented project-specific end-year limit.

A.5. Tools, Data Sources, and Implementation

Calculator Implementation

Users must use the ZEV Infrastructure Benefits Calculator to estimate the GHG emission reductions and co-benefits of proposed projects. The calculator applies the equations presented in this document and aggregates results from per-unit estimates to project totals.

The user must include separate project lines where vehicle group, infrastructure type, annual utilization, fuel pathway, location, or operating period differs. The infrastructure count and utilization must use the same per-port or per-station basis.

Project-Level Inputs

Project-level inputs include:

- Infrastructure project description and location, including project address, latitude/longitude, and census tract;
- Project timeline, including project start date and project end date (dates when the infrastructure is operational for ZEV drivers);
- Infrastructure characteristics, including infrastructure type, vocation, location type, capacity, and the number of charging ports or hydrogen stations;
- Vehicle types served by the infrastructure;
- Utilization, reported as annual utilization per unit:
  - EVSE: annual electricity delivered per charging port (kWh/port/year);
  - Hydrogen: annual hydrogen dispensed per station (kg/station/year) and, where applicable, hydrogen station capacity (kg/day) and fleet deployment;
- Fuel CI, infrastructure additionality, known-fleet incentive overlap, and existing-site baseline inputs, with supporting project documentation.

Supporting Factors and Data Sources

Supporting factors used in the calculations are drawn from established CARB programs and datasets, including:

- vehicle energy consumption and operational emission factors by vehicle class, geography, and calendar year;
- lifecycle CI values for electricity, hydrogen, gasoline, diesel, and natural gas; and
- adjustment factors and quantification limits used to address vehicle-incentive overlap, charging location, infrastructure additionality, and the operating period.

The calculator uses EMission FACtor (EMFAC) 2025 model reference data by vehicle group and calendar year. County data are applied where supported; otherwise, the statewide reference is used. The reference version and geography are retained with the calculation results.

Updates and Version Control

Key inputs may change over time due to updates in underlying datasets and program assumptions. CARB staff periodically review and update the QM and calculator to maintain accuracy and consistency. Updates may be triggered by:

- updates to vehicle energy consumption and emission factors, including EMFAC-based inputs;
- updates to lifecycle CI values for electricity and hydrogen; and
- incorporation of new operational datasets relevant to utilization or throughput, including hydrogen station throughput datasets when available.

Each update is documented with a version number, date, summary of changes, and identification of affected tables and equations.

Retain the calculator version, input data, selected reference geography, calculation trace, and supporting records for project-specific values. The administering agency determines and documents project inputs under the applicable program requirements.

Section B. Quantification Methodology

B.1. Parameters, Defaults, and Data Sources

- User-provided project inputs: project start and end year, location and infrastructure type, vehicle type, number of charging ports or hydrogen stations, and annual utilization, where available.
- Default utilization factors: annual EVSE utilization rates by charging type and location provided by the CEC using Electric Vehicle Infrastructure Projection (EVI-Pro) 3 results from its Assembly Bill (AB) 2127 Second Assessment (Davis et al., 2024), or documented project-specific utilization provided by the user. Hydrogen throughput methods are described in Section B.3.2.
- Vehicle energy consumption and emission factors: energy consumption rates and operational air pollutant factors derived from EMFAC by vehicle group and calendar year. Each operating year uses its corresponding reference values.
- Lifecycle CI values: fuel CI values sourced from CARB's LCFS program.
- Adjustment factors and conversions: vehicle-incentive overlap (Adj_{Veh}), location (Adj_{LS}), and infrastructure additionality (Adj_{Infra}) factors as defined in Section B.7, and the unit conversions in the annual emissions equations.

Table 3. Principal inputs and reference basis

Input	Units or basis	Source
Infrastructure count	Charging ports or hydrogen stations (an EVSE device may have several ports)	Project design and funding scope
Annual energy delivered	kWh/port/year or kg/station/year	Documented project use or the matching utilization method
Operating period	First and final calendar years when the infrastructure is operational	Grant or contract operating requirement
Vehicle energy consumption	kWh/mile or kg/mile	EMFAC 2025 by group and year
Conventional fuel consumption	gal/mile or diesel gallon equivalent (dge)/mile	EMFAC 2025 fuel-specific aggregate
Air pollutant emission rate	g/mile	EMFAC 2025 operational emission reference
Fuel carbon intensity	g CO_2e/MJ, converted to g CO_2e/fuel unit	LCFS reference or documented project pathway
Adjustment factors	Fractions from zero to one	Section B.7
Existing-site baseline	Same annual energy units as the project	Documented without-project operation

First select the Light-duty or Medium- and heavy-duty vocation, then the applicable vehicle group. The calculator groups vehicles as Passenger Auto, Class 2b-3, Transit Bus, School Bus, Other Bus, Medium Heavy-Duty, Heavy Heavy-Duty, and Drayage Truck. Passenger Auto combines passenger cars (LDA), light-duty trucks (LDT1 and LDT2), and medium-duty vehicles (MDV). Class 2b-3 uses light-heavy-duty truck categories (LHD1 and LHD2) for the EMFAC operating reference. Transit, school, and other buses use the urban bus (UBUS), school bus (SBUS), and other bus (OBUS) categories, respectively. Medium Heavy-Duty combines the applicable T6 categories. Heavy Heavy-Duty uses non-port T7 categories, while Drayage Truck uses the T7 port categories. Heavy Heavy-Duty project totals exclude Drayage Truck activity.

Use the vehicle group and reference geography that match the project.

B.2. Quantification Period

The quantification period shall be the number of years that the EVSE or hydrogen station is required to be maintained and operated, as established by grant or contract terms. If an administering agency documents a project-specific final eligible year, the calculator applies that earlier end years. A statewide vehicle-sales target is not automatically treated as a universal end date for infrastructure benefits.

Equation 1. Inclusive quantification period

$$QP = Y_{end} - Y_{start} + 1$$

Table 4. Variables of Equation (1): Inclusive quantification period

Variable	Variable Definition	Units
QP	Quantification period	years
Y_{start}	First calendar year of operation	year
Y_{end}	Effective final calendar year of operation	year
1	Inclusive-count adjustment, so a one-year project has a quantification period of one year	year

Y_{start} and Y_{end} are the first and effective final calendar years. A one-year project, therefore, has a quantification period of one year. Where the opening year represents only part-year operation, the annual utilization assumption must reflect that operating period rather than implying a full year of use. Retain the treatment in the project documentation.

B.3. Annual Electricity and Hydrogen Throughput

B.3.1. Electric Charging Throughput

Determine annual electricity delivered per port for the applicable charging type and location.

Annual EVSE utilization rates (in kWh per charging port per year) were derived by the CEC based on data from EVI-Pro 3 used for the CEC's AB 2127 Second Assessment Report (Davis et al., 2024). Developed by the U.S. Department of Energy's National Laboratory of the Rockies, EVI-Pro 3 simulates the state's electric vehicle (EV) fleet for 2025–2035 using travel diaries and allocates charging events to home, work, public, and DCFC charging based on the driver's schedule, charging access, and the vehicle's charging acceptance rate. The light-duty defaults in Table 5 represent projected utilization in 2030. Use documented project utilization where it better represents the funded equipment.

For L2 charging, the model assumes one charging port per EV at single-family residential locations. Workplace and public L2 charging allow shared use during the modeled charging periods. A charging port may serve several vehicles in a day; therefore, annual electricity delivered reflects all charging sessions, vehicle charging capability, and hours of use. For DCFC, utilization is set for each power level rather than averaged across all DCFC equipment. For shared-power equipment, total port demand must remain feasible under the site power limit.

Hydrogen utilization uses station capacity, fleet demand, and the applicable operating-year or calendar-year deployment pattern. Section B.3.2 describes the data sources, reference values, and project-specific options.

Table 5. Light-duty electric utilization defaults (2030 projections)

Charging setting	Charging level or power	2030 projected use (kWh/port/year)
Home single-family L2	L2	3,832.5
Home multifamily L2	L2	5,748.75
Public L2	L2	5,584.5
Workplace L2	L2	9,787.5
Fleet L2	L2	9,787.5
Public DCFC	50 kW	50,370
Public DCFC	150 kW	131,400
Public DCFC	250 kW	186,150
Public DCFC	350 kW	214,620

Medium- and heavy-duty charging uses the 2030 projected utilization values in Table 6 for the corresponding vocation-specific depot or public charging reference. These values differ from light-duty values even when charging power is the same. Where the default does not represent the fleet schedule, document annual project energy instead. Electric utilization is constant across project years when a single annual value is entered; a hydrogen deployment curve must not be applied to electric charging.

Table 6. Medium- and heavy-duty electric utilization defaults (2030 projections)

Charging setting	Power	2030 projected use (kWh/port/year)
Fleet/depot	20 kW	25,086.97
Fleet/depot	50 kW	25,424.23
Fleet/depot	100 kW	48,671.38
Fleet/depot	150 kW	52,228.30
Public fast charging	350 kW	136,624.01
Public fast charging	500 kW	210,118.78
Public fast charging	750 kW	287,068.18
Public fast charging	1,000 kW	352,693.62
Public fast charging	1,500 kW	414,734.70

The utilization values in Tables 5 and 6 are based on 2030 projections and are rounded for readability. They do not represent observed current utilization. The calculator retains the underlying precision. Select the matching reference row or document a project-specific annual value; do not infer a new default from charging power alone. For project-specific electricity use, identify whether the value is measured or forecast, the source and period represented, and the number of ports included. Express the input in kWh per port per year and explain its applicability to expected project operation, including any annualization or partial-year treatment. Retain outages reflected in measured totals; do not deduct the same downtime again.

B.3.2. Hydrogen Refueling Throughput

Hydrogen refueling uses the common emissions comparison in Sections B.4 through B.7, with hydrogen-specific throughput, vehicle energy consumption, and lifecycle CI inputs. The methods below establish annual hydrogen throughput for light-duty retail, transit, and freight applications.

Selection of annual hydrogen throughput

A documented annual measured or site-specific dispensing value takes precedence over the modeled methods. Without that value, light-duty retail uses the AB 8 capacity-based utilization curve; freight uses a capacity ramp unless a deployment plan invokes demand-based calculation; transit and other fleet applications use vehicle demand where sufficient inputs are supplied. For project-specific dispensing, identify whether the value is measured or forecast, the source and period represented, and the number of stations included. Express the input in kg per station per year and explain its applicability to expected project operation, including any annualization or partial-year treatment. Document how equipment and fuel-supply outages are represented, consistent with the availability controls below.

Light-duty retail hydrogen

The AB 8 method applies the operating-year fractions in Table 7 to the entered station nameplate capacity (kg/day) and 365 days. This is an idealized growth scenario, not observed use at every retail station. It holds at 85 percent after operating year 10 (McKinney et al., 2015).

Table 7. Hydrogen ramp shapes by operating year

Operating year	AB 8 retail fraction	Transit fleet shape	Freight shape
1	0.02	0.080	0.062
2	0.08	0.160	0.083
3	0.23	0.248	0.132
4	0.411621	0.339	0.227
5	0.518379	0.432	0.338
6	0.605607	0.549	0.477
7	0.679357	0.657	0.607
8	0.743242	0.752	0.724
9	0.799593	0.867	0.854
10	0.85	1.000	1.000

Equation 2. Capacity-based light-duty annual throughput

$$U_{\text{with,y}} = C_{\text{station}} \times u_k \times 365$$

Table 8. Variables of Equation (2): Capacity-based light-duty annual throughput

Variable	Variable Definition	Units
$U_{\text{with,y}}$	Annual throughput with the project	kg/station/year
C_{station}	Entered station nameplate capacity used for modeled throughput	kg/day
u_k	AB 8 light-duty utilization fraction in Table 7 for operating year k	unitless
365	Calendar days per year	days/year

C_{station} is the entered station nameplate capacity in kg/day used for modeled throughput; u_k is the AB 8 light-duty fraction in Table 7 for operating year k. For a capacity increment, clearly identify the increment as the capacity basis and reconcile it with the existing-site baseline to avoid double-counting the baseline. Here, y identifies the calendar year, and k identifies the operating year; the first calendar year of operation corresponds to operating year 1.

Keep the selected basis visible with the results. The site-specific dispensing option requires an annual kg input.

Transit and other fleet hydrogen

For a documented fleet deployment plan, annual demand is the number of vehicles in service multiplied by kg consumed per vehicle per calendar day and 365. Limit modeled daily demand to the selected fraction of station capacity where capacity is available. The default maximum utilization is 50 percent.

Equation 3. Demand-based annual hydrogen throughput

$$U_{\text{with,y}} = 365 \times \min(F_y \times d, C_{\text{station}} \times u_{\text{max}})$$

Table 9. Variables of Equation (3): Demand-based annual hydrogen throughput

Variable	Variable Definition	Units
$U_{\text{with,y}}$	Annual throughput with the project	kg/station/year
F_y	Number of vehicles served per station in year y	vehicles/station
d	Hydrogen consumed per vehicle per calendar day	kg/vehicle/day
C_{station}	Entered station nameplate capacity used for modeled throughput	kg/day
u_{max}	Selected maximum capacity fraction	unitless
365	Calendar days per year	days/year

F_y is the number of vehicles served per station in year y; d is kg per vehicle per calendar day; u_{max} is the selected capacity fraction. A fleet-wide vehicle count must be allocated consistently among stations. If no capacity is entered, the calculation uses the documented fleet demand without a capacity constraint; verify that the proposed station design can supply it.

The transit planning rate of 15.5 kg per bus per day is based on modeled hydrogen demand in the Gold Coast Transit District rollout plan (Stantec Consulting Services Inc., 2022, Table 12). The calculator applies this rate on a calendar-day basis. A documented project rate can replace it. The EMFAC 2025 rate basis uses the average per-vehicle daily hydrogen consumption over the selected operating years. These station-demand rates are separate from the same-year kg/mile rates used in the emissions equations. Service-day observations must be converted to a calendar-day basis before using a 365-day annual multiplier.

Additional calendar-day fleet planning inputs are 2.7 kg per school bus, 6.0 kg per other bus, and 2.5 kg per Class 2b-3 vehicle. These are planning inputs for the corresponding fleet selection, not substitutes for a documented project duty cycle. A project-specific daily rate or the applicable EMFAC basis may be used.

Without an applicant transit plan, the capacity-based transit method estimates a mature fleet using 30 kg/day of station capacity per bus and applies the normalized transit fleet shape in Table 7. The 30 kg/day sizing ratio follows the Golden Empire Transit District rollout plan (Golden Empire Transit District, 2020, Table 12), which provides 2,520 kg/day of fueling capacity for 84 buses. School Bus, Other Bus, and custom fleet methods have no automatic fleet ramp; provide a deployment plan or supported vehicle count and an appropriate fuel-use rate. This plan was selected because, to the best of our knowledge, it was the only rollout plan identified that explicitly reported both hydrogen fueling capacity and the corresponding fleet size. The source and any fallback are identified in the calculation trace.

Freight hydrogen

Without a custom deployment plan, the freight method applies the Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES) Class 8 shape (Fulton et al., 2024) in Table 7 to the station capacity and selected maximum utilization. The operating-year option begins the shape

at station opening. The calendar-year option anchors the shape to 2027 through 2036, retaining the first or last shape value outside that interval. The selected time basis must be recorded; the two options are not the same forecast.

Equation 4. Freight capacity ramp

$$U_{with,y} = C_{station} \times u_{max} \times s_y \times 365$$

Table 10. Variables of Equation (4): Freight capacity ramp

Variable	Variable Definition	Units
$U_{with,y}$	Annual throughput with the project	kg/station/year
$C_{station}$	Entered station nameplate capacity used for modeled throughput	kg/day
u_{max}	Selected maximum capacity fraction	unitless
s_y	Normalized ARCHES Class 8 freight activity factor applied in calendar year y under the selected time basis (Table 7)	unitless
365	Calendar days per year	days/year

s_y is the selected freight shape. A custom fleet plan uses Equation 3 instead. For demand-based freight calculations, the default consumption rate is the EMFAC 2025 average over the project years where available. The ARCHES planning option uses 40 kg per vehicle per calendar day; this rate also serves as the freight fallback when the reference rate is unavailable. A documented project rate takes precedence. Do not apply both capacity and fleet-demand ramps to the same activity.

Availability and expansion controls

The availability multiplier defaults to one. Apply a selected multiplier only to modeled hydrogen throughput, before baseline subtraction. Measured annual dispensing already reflects downtime and is not reduced again. Represent equipment and hydrogen-supply outages once; the retail ceiling and fleet utilization cap are not additional downtime factors.

B.4. Net Energy and Vehicle Activity

For existing-site expansions, estimate the with-project and without-project annual throughput on the same per-unit basis. Subtract the without-project throughput before calculating benefits. A new site has a zero existing-site energy baseline, but it still receives the additionality and overlap adjustments in Section B.7.

Equation 5. Annual energy above the existing-site baseline

$$U_y = \max(0, U_{\text{with,y}} - U_{\text{without,y}})$$

Table 11. Variables of Equation (5): Annual energy above the existing-site baseline

Variable	Variable Definition	Units
U_y	Annual electricity supplied per charging port or hydrogen dispensed per station, after applicable existing-site baseline subtraction	kWh/port/year or kg/station/year
$U_{\text{with,y}}$	Annual throughput with the project	Same as U_y
$U_{\text{without,y}}$	Annual throughput without the project	Same as U_y

The baseline may be a documented annual value or year-specific plan. A year-specific plan takes precedence over the flat annual value, and its last value continues through later project years. Do not use an added-capacity-only throughput estimate and then subtract the same baseline energy a second time. Explain how the baseline and funded unit count were reconciled. Hydrogen availability controls, when selected for modeled throughput, are applied before this subtraction.

Conversion to Vehicle Activity and Conventional Fuel Use

Estimate equivalent annual vehicle travel from net energy supplied, then calculate conventional fuel consumption for the same travel activity.

The energy consumption rate expresses energy per mile. For electric operation, it is the total electric energy divided by electric vehicle miles traveled, including the electric operation represented by PHEVs. For FCEVs, it is total hydrogen consumption divided by fuel-cell vehicle miles. Conventional fuel consumption is aggregated separately for diesel, gasoline, and natural gas, using total combustion vehicle miles as the common denominator. PHEV gasoline consumption remains in the gasoline component. These are travel-weighted consumption ratios.

Equation 6. Equivalent travel and conventional fuel consumption

$$V_y = \frac{U_y}{FE_{ZEV,y}} \; ; \quad U_{f,y} = V_y \times FE_{f,y}$$

Table 12. Variables of Equation (6): Equivalent travel and conventional fuel consumption

Variable	Variable Definition	Units
V_y	Equivalent annual vehicle travel per infrastructure unit	miles/unit/year
U_y	Annual electricity supplied per charging port or hydrogen dispensed per station, after applicable existing-site baseline subtraction	kWh/port/year or kg/station/year
$FE_{ZEV,y}$	Electricity or hydrogen consumption per vehicle mile in calendar year y	kWh/mile or kg/mile
$FE_{f,y}$	Fuel-specific conventional consumption per total combustion mile	gal/mile or dge/mile
$U_{f,y}$	Conventional consumption for fuel f	gal/unit/year or dge/unit/year

Use the same-year values for each project year. EMFAC 2025 supplies the hydrogen consumption rate directly; this pathway does not infer FCEV consumption from a generic energy economy ratio. The reference data retain fuel-specific consumption so that buses and trucks with a mix of diesel, gasoline, and natural gas are not represented by a single fuel. The EMFAC 2025 model provides these reference rates (CARB, 2025a). Where a same-year conventional GHG rate is unavailable, the calculator uses positive project-year fuel-consumption averages with the corresponding fuel carbon intensities, followed by its conventional-consumption fallback where needed.

For sparse ZEV reference series, the calculator uses the median of positive energy consumption rates across the project years as a consistency check. A missing or zero rate, or a rate below one-half or above twice that median, is replaced by the median. For an even number of available rates, the median is the average of the two middle values. The trace identifies affected years. A project with no usable ZEV energy consumption rate cannot produce a valid estimate.

B.5. Annual GHG Emission Reductions

Estimate annual lifecycle GHG emission reductions for the electricity or hydrogen supplied by the project.

Scope of Emissions: The GHG calculation accounts for the full lifecycle of electricity, hydrogen, and conventional fuels, including emissions from the production, transport, distribution, and use in the vehicle. As described in the next section, for air pollutants, the methodology quantifies vehicle running, start, and idle exhaust and net tire and brake wear for $PM_{2.5}$ and does not include upstream air pollutant emissions from fuel production, transport, or distribution (NO_x, SO_x, ROG, and $PM_{2.5}$ results). Identifying consistent air pollutant emission

factors for upstream fuel or electricity production activity is not straightforward. It depends on varying local and regional air pollution control requirements for fuel production facilities or power plants, the age of these facilities, and their technologies.

Calculate the conventional lifecycle GHG emissions associated with equivalent vehicle travel, then subtract lifecycle emissions associated with the electricity or hydrogen supplied. CI includes fuel production and delivery as well as use. Do not add a separate upstream GHG reduction to these results (CARB, 2025b, 2026).

Equation 7. Fuel-blended conventional emissions per mile

$$C_{conv,y} = \sum_{f} FE_{f,y} \times C_f$$

In Equation 7, f represents diesel, gasoline, and natural gas. C_f is the lifecycle emissions per fuel unit. Natural gas is represented as fossil compressed natural gas (CNG) on the dge basis used by the vehicle reference. This conversion uses the diesel per-gallon carbon content multiplied by the CNG-to-diesel carbon-intensity ratio. It does not assume a renewable natural gas pathway.

Table 13. Variables of Equation (7): Fuel-blended conventional emissions per mile

Variable	Variable Definition	Units
$C_{conv,y}$	Fuel-blended lifecycle GHG emissions per conventional vehicle mile in calendar year y	g CO_2e/mile
$FE_{f,y}$	Fuel-specific conventional consumption per total combustion mile	gal/mile or dge/mile
C_f	Lifecycle emissions per unit of conventional fuel f	g CO_2e/gal or g CO_2e/dge
f	Conventional fuel: diesel, gasoline, or fossil CNG	N/A

Use the lifecycle CI values and corresponding per-fuel-unit factors documented in the applicable calculator version for electricity, hydrogen, gasoline, diesel, and fossil CNG. These inputs are maintained with the calculator and may be updated as CARB source data are revised without requiring an annual revision of this methodology. Retain the calculator version, source vintage, and values used with the project calculation. Use the stored per-fuel-unit factors at their full precision and round only the reported outputs. A project-specific electricity or hydrogen CI may replace the default when supported by an LCFS-certified pathway or a program-accepted result from California-modified Greenhouse Gases, Regulated Emissions, and Energy use in Transportation (CA-GREET) 4.0 or an LCFS simplified calculator applicable to the project. Retain the pathway identifier or model result, applicable fuel-supply basis, CI value and units, and administering-agency acceptance. A renewable-energy description alone does not establish zero lifecycle emissions performance. A blank input retains the reference default. Zero or negative values require the same supporting documentation and acceptance. The selected electricity or hydrogen CI, whether a reference or documented project-specific value, is held constant across the quantification period for each project line. Future changes in grid or hydrogen-supply CI are not automatically projected. Vehicle energy consumption and emission rates continue to use the applicable calendar-year values.

Equation 8. Conversion of a project-specific carbon intensity

$$C_{ZEV} = CI_{ZEV} \times ED_{ZEV}$$

Table 14. Variables of Equation (8): Conversion of a project-specific carbon intensity

Variable	Variable Definition	Units
C_{ZEV}	Lifecycle GHG emissions per kWh of electricity or kilogram of hydrogen supplied	g CO_2e/kWh or g CO_2e/kg
CI_{ZEV}	Project-specific carbon intensity of the electricity or hydrogen pathway	g CO_2e/MJ
ED_{ZEV}	Energy density: 3.6 MJ/kWh for electricity; 120 MJ/kg for hydrogen	MJ/kWh or MJ/kg

CI_{ZEV} is entered in g CO_2e/MJ. ED_{ZEV} is 3.6 MJ/kWh for electricity and 120 MJ/kg for hydrogen. Document an LCFS-certified pathway or a program-accepted CA-GREET, LCFS simplified-calculator, or custom estimate, including model version, feedstock, production process, delivery assumptions, and the applicable system boundary. A hydrogen model output alone is not evidence of pathway certification. Tier 1 simplified hydrogen methods and Tier 2 CA-GREET methods must be used only for pathways within their respective scope (CARB, 2025b, 2026).

Equation 9. Annual GHG emission reductions before adjustments

$$AER_{GHG,y} = \frac{N \times U_y \times \left(\frac{C_{conv,y}}{FE_{ZEV,y}} - C_{ZEV}\right)}{1{,}000{,}000}$$

Table 15. Variables of Equation (9): Annual GHG emission reductions before adjustments

Variable	Variable Definition	Units
$AER_{GHG,y}$	Unadjusted annual lifecycle GHG emission reduction in calendar year y for the project line	metric tons CO_2e/year
N	Number of charging ports or hydrogen stations represented by the calculation	ports or stations
U_y	Annual electricity supplied per charging port or hydrogen dispensed per station, after applicable existing-site baseline subtraction	kWh/port/year or kg/station/year
$FE_{ZEV,y}$	Electricity or hydrogen consumption per vehicle mile in calendar year y	kWh/mile or kg/mile
$C_{conv,y}$	Fuel-blended lifecycle GHG emissions per conventional vehicle mile in calendar year y	g CO_2e/mile
C_{ZEV}	Lifecycle GHG emissions per kWh of electricity or kilogram of hydrogen supplied	g CO_2e/kWh or g CO_2e/kg
1,000,000	Grams per metric ton	g/metric ton

B.6. Annual Air Pollutant Emission Reductions

NO_x, SO_x, ROG, and $PM_{2.5}$ reductions use running, start, and idle exhaust rates in grams per mile. $PM_{2.5}$ also includes tire and brake wear for both conventional vehicles and the selected BEV or FCEV. ZEV exhaust is zero. The calculation does not estimate upstream air pollutant emissions from fuel production and transport, ambient concentrations, or health impacts.

Equation 10. Annual air pollutant emission reductions before adjustments

$$AER_{p,y} = \frac{N \times \frac{U_y}{FE_{ZEV,y}} \times (EF_{conv,p,y} - EF_{ZEV,p,y})}{453.6}$$

Table 16. Variables of Equation (10): Annual air pollutant emission reductions before adjustments

Variable	Variable Definition	Units
$AER_{p,y}$	Unadjusted annual reduction for pollutant p in calendar year y	lb/year
N	Number of charging ports or hydrogen stations represented by the calculation	ports or stations
U_y	Annual electricity supplied per charging port or hydrogen dispensed per station, after applicable existing-site baseline subtraction	kWh/port/year or kg/station/year
$FE_{ZEV,y}$	Electricity or hydrogen consumption per vehicle mile in calendar year y	kWh/mile or kg/mile
$EF_{conv,p,y}$	Conventional emission rate for pollutant p in calendar year y, including running, start, and idle exhaust and, for $PM_{2.5}$, tire and brake wear	g/mile
$EF_{ZEV,p,y}$	ZEV emission rate for pollutant p in calendar year y: zero exhaust, plus tire and brake wear for $PM_{2.5}$ from the selected BEV or FCEV	g/mile
p	Pollutant: NO_x, SO_x, ROG, or $PM_{2.5}$	N/A
453.6	Grams per pound	g/lb

Here, p identifies the pollutant, both EF terms are in g/mile, and $AER_{p,y}$ is in lb/year. The conversion uses 453.6 grams per pound. Select the corresponding vehicle group, calendar year, and available county reference. The regulations-removed EMFAC 2025 reference is used without applying a second regulatory adjustment to its rates.

For each vehicle group and year, the reference divides summed process emissions by the corresponding vehicle miles traveled. Conventional factors include gasoline, diesel, and natural-gas vehicles; BEV and FCEV wear factors are calculated separately. PHEVs are excluded from these factor groups. Running, start, and idle exhaust are summed once, without adding total exhaust again. Converting start and idle inventories to per-mile rates assumes the modeled relationship between those activities and travel. Where county activity is unavailable, the calculator uses the same-year statewide factor for the same vehicle group and technology and

records the substitution. If no statewide wear factor is available, the $PM_{2.5}$ result is unavailable, not zero. The reference construction follows the EMFAC2025 process definitions (CARB, 2025a).

B.7. Adjustment Factors

Section B.8 explains the calculation boundaries and supporting rationale.

Apply the vehicle incentive overlap, location, and infrastructure additionality factors once to the emission differences from Sections B.5 and B.6. These factors have different purposes. They are model adjustments, not three independently measured probabilities. Document their bases so that project evidence is not used to make duplicate reductions for the same effect. Existing-site baseline subtraction removes the site's expected throughput without the funded project before emissions are calculated. The location adjustment addresses electric charging that could otherwise occur at another location. Infrastructure additionality represents the portion of the resulting modeled benefits associated with the funded project relative to the without-project condition. When documenting a project-specific additionality factor, identify how existing-site activity and charging-location shifts have already been treated so that the same activity or effect is not deducted again.

Vehicle incentive overlap

Vehicle and infrastructure investments can support the same vehicle operation. The vehicle incentive overlap factor reduces the infrastructure estimate to minimize overlapping benefits in California Climate Investments reporting. It uses a segment- and fuel-specific remaining fraction unless a documented known-fleet factor is supplied. It is an aggregate estimate of overlap, not a project-by-project reconciliation of reported benefits. Without project-specific evidence, the default factor cannot establish that all overlap has been removed for an individual project.

Equation 11. Vehicle incentive overlap factor

$$Adj_{Veh} = 1 - S_{overlap}\ ;\quad S_{overlap} = \frac{Z_{incentive}}{Z_{reference}}$$

Table 17. Variables of Equation (11): Vehicle incentive overlap factor

Variable	Variable Definition	Units
Adj_{Veh}	Fraction of estimated benefits retained after accounting for vehicle-incentive overlap	unitless
$S_{overlap}$	Applicable overlapping incentive share, from zero to one	unitless
$Z_{incentive}$	Number of vehicles associated with the overlapping incentives	vehicles
$Z_{reference}$	Matched reference vehicle population	vehicles

$S_{overlap}$ is the applicable overlapping incentive share, from zero to one. $Z_{incentive}$ is the number of vehicles associated with overlapping incentives, and $Z_{reference}$ is the matched reference-vehicle population. The reference population must be positive, and the incentive numerator must be a

subset of that population. For the segment defaults, the incentive numerator and vehicle universe are matched by vehicle group, powertrain, fuel, period, and counting basis. Light-duty factors use California Zero Emission Vehicle Insights (CALZI) incentive data, restricted to the Greenhouse Gas Reduction Fund (GGRF)-funded share, and CEC cumulative sales, with a 2023 anchor (CEC, 2026; Center for Sustainable Energy, 2026). Medium- and heavy-duty factors use incentivized-vehicle and deployment records from CALSTART, a clean transportation organization, across the included programs; Class 2b-3 also uses CARB's vehicle-population data compilation (FleetDB), and drayage uses a Truck Regulations Upload, Compliance, and Reporting System (TRUCRS) registration and incentive vehicle-identifier match.

Table 18. Vehicle incentive overlap factors

Vehicle group	Electric pathway	Hydrogen pathway
Passenger Auto	0.74	0.392
Class 2b-3	0.960	1.000
Transit Bus	0.182	0.520
School Bus	0.194	1.000
Other Bus	0.8950	0.4431
Medium Heavy-Duty	0.243	1.000
Heavy Heavy-Duty	0.560	0.580
Drayage Truck	0.420	0.000

Other Bus uses the statewide fuel fallback rather than a measured Other Bus overlap rate. A value of 1.000 for a hydrogen segment with no vehicles in its matched source universe means no deduction is represented by that table entry; it is not proof that an individual project has no overlapping incentives. Class 2b-3 combines substantially different consumer-pickup and commercial-van uses. Use documented fleet information where it better represents the project fleet. The reference factors in Table 18 remain constant across the quantification period for a given calculation. Revisions are documented through QM and calculator version updates, as described in Section A.5.

For an identifiable fleet, calculate the overlapping share using the fleet's share of station energy use, not only the number of vehicles. A vehicle-count share is suitable only when equal station use is justified. Record the fleet or agency, relevant incentive programs and funding sources, and the vehicle-use evidence. The resulting remaining fraction, from zero to one, replaces the Table 18 value; it is not multiplied by that value. Anonymous public users retain the appropriate segment default.

Equation 12. Energy-weighted overlap for a known fleet

$$S_{\text{overlap}} = \frac{\sum_v E_v \times s_v}{\sum_v E_v}$$

Table 19. Variables of Equation (12): Energy-weighted overlap for a known fleet

Variable	Variable Definition	Units
S_{overlap}	Energy-weighted overlapping incentive share for a known fleet	unitless
E_v	Energy supplied to vehicle v over the represented period	kWh or kg
s_v	Documented overlapping incentive share for vehicle v	unitless
v	Individual vehicle in the documented fleet	N/A

E_v is the energy supplied to vehicle v over the represented period, and s_v is its documented overlapping incentive share. Use consistent energy units within the project line and a positive total energy denominator. Forecast station-use shares may be used for planning when documented; observed activity supports the operating-period estimate.

Location adjustment

The location adjustment factor is 1.000 for home electric charging and all hydrogen refueling projects, and 0.8595 for non-home electric charging, including workplace, public, and fleet/depot locations. The charging-location reduction does not apply to hydrogen refueling. The 0.8595 factor retains 85.95 percent of the modeled benefit. Its underlying load-shifting basis concerns charging that could otherwise occur at another location; it is not a project-specific measurement for every infrastructure type (Ambiel et al., 2023).

The location adjustment does not account for additional GHG benefits from charging at specific times of day. Any project-specific fuel CI must be supported by its energy pathway and must not duplicate a separately applied adjustment. Shifting charging to hours with lower grid CI may provide additional GHG benefits distinct from a change in charging location. Future iterations of this methodology may consider time-of-day charging effects, subject to the availability of suitable data, methods, and resources. No separate time-of-day benefit is included in this version.

Infrastructure additionality

The infrastructure additionality factor represents the portion of the modeled benefits associated with the funded project relative to the without-project condition. It is separate from the vehicle-incentive overlap and location factors.

The default infrastructure additionality factor is 0.50. A documented project-specific factor from zero to one may replace it. With all other inputs unchanged, 0.50 produces half the benefits calculated with 1.00. This is a model assumption, not a measured statewide

additionality rate. The literature reviewed to date does not provide sufficient evidence to establish a broadly applicable, empirically derived infrastructure additionality factor (Burra et al., 2024; Gifford & Barbier, 2026; Ledna et al., 2022; van Dijk et al., 2022; White et al., 2022). The default will be reviewed in future iterations of the methodology and updated if additional supporting data become available. The administering agency selects the project-specific input and retains evidence describing the without-project condition and the represented share of activity. The default provides a consistent starting point where project-specific evidence is unavailable. Supporting evidence for an alternative may include fleet deployment plans, expected station use, existing service, and practical charging or refueling alternatives. The documentation may explain how this evidence supports the selected factor.

In Advanced Inputs, the infrastructure route selects the default or project-specific factor. A project-specific selection requires both the numerical factor and supporting evidence. Zero can also be a valid selection. A value left in the project-specific factor cell has no effect while the default route is selected. Existing-site baseline subtraction occurs before these adjustments; it does not replace the additionality factor.

B.8. Calculation Boundaries and Supporting Rationale

Applicable project limits

Program staff determine the funded activity and operating period under applicable program requirements. Exclude infrastructure or activity already required for the specific project where the program requires benefits beyond those requirements. Document the project-specific determination and any end-year limit used in the calculator. A statewide vehicle-sales target is not automatically applied as a universal end date for every infrastructure project.

For construction subject to building requirements, distinguish required installations from the additional funded scope. Record the applicable requirement and the number of units or activity included in the estimate. Do not change a factor or project year solely because an unrelated requirement applies to a different vehicle class or site. These requirements include the California Green Building Standards Code (CalGREEN), where applicable. Program staff distinguish installations required for the specific construction project from additional funded installations. Vehicle-sales requirements and site-specific installation requirements address different activities; the applicable requirement must be evaluated for the funded project rather than treated as a single statewide infrastructure end date.

Vehicle Adoption: Several research studies suggest that the installation of EV infrastructure may support PEV adoption, although the strength of the relationship varies by study and context (Cole et al., 2023; Springel, 2021). Survey research found no direct or indirect relationship between public charging density in participants' residential postal codes and whether they had considered purchasing a PEV; noticing charging infrastructure was associated with prior interest and purchase consideration (Hoogland et al., 2024). No separate adjustment factor for induced PEV demand is added in this QM. Project-specific evidence about vehicle deployment or electric operation is represented through the utilization and infrastructure additionality inputs. Research on vehicle incentives also highlights the difficulty of attributing PEV purchases to an

individual program when multiple incentives interact (Chakraborty et al., 2024). The literature distinguishes statistical relationships between charging supply and vehicle adoption from evidence that an individual infrastructure project causes additional purchases. Published elasticity estimates, therefore, are not applied as a separate multiplier to the energy-based benefits calculation.

Vehicle Travel: Infrastructure may also affect electric vehicle use, such as by increasing the electric-operation portion of PHEV travel (instead of gasoline miles) or supporting trips to charging stations. Charging-pattern studies document mixed use of home, workplace, and public infrastructure (Lee et al., 2020; Nicholas et al., 2016). The PHEV electric-operation portion is represented in the electricity utilization and energy-consumption inputs. For consistent benefits reporting, the emissions comparison uses equivalent vehicle travel in the ZEV and conventional-vehicle scenarios. No separate travel benefit is added for the same energy use. Dedicated trips to charging or refueling stations can differ from trips made to obtain conventional fuel. This methodology does not separately estimate that difference or assume an additional travel reduction; it compares emissions for the equivalent travel supported by the quantified energy use.

The adjusted emission reductions for EVSE and hydrogen station projects are calculated by applying the vehicle-incentive overlap, location, and infrastructure additionality factors once, as shown in Section B.9.

B.9. Final Outputs and Aggregation

Equation 13. Total adjusted emission reductions

$$TAER_q = Adj_{Veh} \times Adj_{LS} \times Adj_{Infra} \times \sum_{y=Y_{start}}^{Y_{end}} AER_{q,y}$$

Table 20. Variables of Equation (13): Total adjusted emission reductions

Variable	Variable Definition	Units
$TAER_q$	Total adjusted emission reductions for output q	metric tons CO_2e for GHG; lb for air pollutants
Adj_{Veh}	Fraction of estimated benefits retained after accounting for vehicle-incentive overlap (Section B.7)	unitless
Adj_{LS}	Location adjustment: 1.000 for home electric charging and hydrogen; 0.8595 for non-home electric charging	unitless
Adj_{Infra}	Infrastructure additionality: 0.50 default or documented project-specific replacement	unitless
$AER_{q,y}$	Unadjusted annual reduction for output q in calendar year y, including the infrastructure count	metric tons CO_2e/year or lb/year
q	Output: GHG, NO_x, SO_x, ROG, or $PM_{2.5}$	N/A
y	Calendar year from the first through the effective final operating year	year
Y_{start}	First calendar year of operation (see Table 4).	year
Y_{end}	Effective final calendar year of operation (see Table 4).	year

Equation 14. Reported annual average

$$AER_{q,average} = \frac{TAER_q}{QP}$$

Table 21. Variables of Equation (14): Reported annual average

Variable	Variable Definition	Units
$AER_{q,average}$	Reported annual average reduction for output q	metric tons CO_2e/year or lb/year
$TAER_q$	Total adjusted emission reductions for output q	metric tons CO_2e for GHG; lb for air pollutants
QP	Quantification period	years

The index q denotes GHG or an individual air pollutant (NO_x, SO_x, ROG, or $PM_{2.5}$). TAER is in metric tons CO_2e for GHG and pounds for air pollutants. $AER_{q,y}$ already includes the infrastructure count in Equations 9 and 10; do not multiply by that count again. Apply each adjustment factor once. For benefits reporting, use the project-period total. The annual-average output may be used for other purposes and does not replace the year-specific calculation.

Sum project lines only after verifying that they represent distinct funded units or allocated shares of activity. For mixed fleets, divide station energy among vehicle groups on a documented basis before calculating each line; do not assign the full site throughput to every group. Retain unrounded values until aggregation. A negative emission difference indicates an estimated increase under the selected inputs and must not be silently described as a reduction.

References

Ambiel, P., Tal, G., & Jenn, A. (2023). *Evaluating the emissions benefits of investor-owned utility electric vehicle charging infrastructure programs in California*. 36th Electric Vehicle Symposium and Exposition (EVS36).

Burra, L. T., Al-Khasawneh, M. B., & Cirillo, C. (2024). Impact of charging infrastructure on electric vehicle adoption: A synthetic population approach. *Travel Behaviour and Society, 37*, Article 100834.

CARB. (2024). *Funding guidelines for agencies that administer California Climate Investments*.

CARB. (2025a). *EMFAC2025*.

CARB. (2025b). *LCFS life cycle analysis models and documentation*.

CARB. *LCFS pathway certified carbon intensities*. Retrieved 2026.

CEC. (2026). *New ZEV sales in California* [Data dashboard]. Retrieved 2026.

Center for Sustainable Energy. (2026). *California zero emission vehicle insights* [Data dashboard]. Retrieved 2026.

Chakraborty, D., Hardman, S., Hoogland, K., Chakraborty, A., Tal, G., Garcia Sanchez, J. C., & Konstantinou, T. (2024). *Measuring the emissions and socioeconomic benefits of CARB's incentives and regulatory programs: The light-duty vehicle sector programs* (Contract No. 21AQP002). Institute of Transportation Studies, University of California, Davis.

Cole, C., Droste, M., Knittel, C., Li, S., & Stock, J. H. (2023). Policies for electrifying the light-duty vehicle fleet in the United States. *AEA Papers and Proceedings, 113*, 316–322.

Davis, A., Hoang, T., Lopez, T., Lu, J., Nguyen, T., Nolty, B., Rillera, L., Schell, D., & Wofford, M. (2024). *Assembly Bill 2127 second electric vehicle charging infrastructure assessment: Assessing charging needs to support zero-emission vehicles in 2030 and 2035* (Publication No. CEC-600-2024-003). CEC.

Fulton, L., Levin, J., & Moss, D. (2024). *ARCHES transportation white paper*. Alliance for Renewable Clean Hydrogen Energy Systems.

Gifford, T., & Barbier, E. (2026). The role of charging infrastructure and income on electric vehicle adoption. *Energy Policy, 211*, Article 115098.

Golden Empire Transit District. (2020). *ICT rollout plan*.

Hoogland, K., Kurani, K. S., Hardman, S., & Chakraborty, D. (2024). If you build it, will they notice? Public charging density, charging infrastructure awareness, and consideration to purchase an electric vehicle. *Transportation Research Interdisciplinary Perspectives, 23*, Article 101007.

Ledna, C., Muratori, M., Brooker, A., Wood, E., & Greene, D. (2022). How to support EV adoption: Tradeoffs between charging infrastructure investments and vehicle subsidies in California. *Energy Policy, 165*, Article 112931.

Lee, J. H., Chakraborty, D., Hardman, S., & Tal, G. (2020). Exploring electric vehicle charging patterns: Mixed usage of charging infrastructure. *Transportation Research Part D: Transport and Environment, 79*, Article 102249.

McKinney, J., Bond, E., Crowell, M., & Odufuwa, E. (2015). *Joint agency staff report on Assembly Bill 8: Assessment of time and cost needed to attain 100 hydrogen refueling stations in California* (Publication No. CEC-600-2015-016). CEC.

Nicholas, M. A., Tal, G., & Turrentine, T. S. (2016). *Advanced plug-in electric vehicle travel and charging behavior interim report* (Research Report UCD-ITS-RR-16-10). Institute of Transportation Studies, University of California, Davis.

Springel, K. (2021). Network externality and subsidy structure in two-sided markets: Evidence from electric vehicle incentives. *American Economic Journal: Economic Policy, 13*(4), 393–432.

Stantec Consulting Services Inc. (2022). *ZEB strategy and rollout plan: Gold Coast Transit District ZEB rollout and implementation plan* (Final report). Gold Coast Transit District.

van Dijk, J., Delacrétaz, N., & Lanz, B. (2022). Technology adoption and early network infrastructure provision in the market for electric vehicles. *Environmental and Resource Economics, 83*, 631–679.

White, L. V., Carrel, A. L., Shi, W., & Sintov, N. D. (2022). Why are charging stations associated with electric vehicle adoption? Untangling effects in three United States metropolitan areas. *Energy Research & Social Science, 89*, Article 102663.