California Air Resources Board

Draft Quantification Methodology

Strategic Growth Council
Affordable Housing and Sustainable Communities Program

California Climate Investments

December 6, 2024

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Section A. Introduction

California Climate Investments is a statewide initiative that puts billions of Cap-and-Trade dollars to work facilitating greenhouse gas (GHG) emissions reductions, strengthening the economy, improving public health and the environment, and providing benefits to residents of disadvantaged communities, low-income communities, and low-income households, collectively referred to as priority populations. Where applicable and to the extent feasible, California Climate Investments must maximize economic, environmental, and public health co-benefits to the State.

The California Air Resources Board (CARB) is responsible for providing guidance on estimating the GHG emissions reductions and co-benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). This guidance includes quantification methodologies, co-benefit assessment methodologies, and benefits calculator tools. CARB develops these methodologies and tools based on the project components eligible for funding by each administering agency, as reflected in the *program expenditure records*.

CARB developed this Affordable Housing and Sustainable Communities (AHSC) Quantification Methodology to provide guidance for estimating the GHG emissions reductions and selected co-benefits of each proposed project type. This methodology uses calculations to estimate GHG emissions reductions from avoided passenger vehicle miles travelled (VMT) from land use, housing, and transportation strategies that support infill, compact, and affordable housing development projects, in addition to GHG emissions reductions from solar photovoltaic (PV)electricity generation.

The AHSC Benefits Calculator Tool automates methods described in this document, provides a link to a step-by-step user guide with a project example, and outlines documentation requirements. Applicants will estimate and SGC will report the total project GHG emissions reductions and co-benefits estimated using the AHSC Benefits Calculator Tool, as well as the total project GHG emissions reductions per dollar of GGRF funds requested. The AHSC Benefits Calculator Tool is available for download on the *California Climate Investments resources webpage*.

Using many of the same inputs required to estimate GHG emissions reductions, the AHSC Benefits Calculator Tool estimates the following co-benefits and key variables from AHSC projects: Passenger VMT reductions (miles); Net density (dwelling units per acre); Renewable energy generation (kWh); Local and remote ROG emissions reductions (lbs); Local and remote NOx emissions reductions (lbs); Local and remote PM2.5 emissions reductions (lbs); Local diesel PM10 emissions reductions (lbs); Fossil fuel use reductions (gallons); Travel cost savings ($); and Energy and fuel cost savings ($). Key variables are project characteristics that contribute to a project's GHG emissions reductions and signal an additional benefit (e.g., renewable energy generated). Additional co-benefits for

which CARB assessment methodologies were not incorporated into the AHSC Benefits Calculator Tool may also be applicable to the project. Applicants should consult the *SGC AHSC Webpage* for AHSC guidelines, solicitation materials, and agreements to ensure they are meeting AHSC requirements. All CARB co-benefit assessment methodologies are available on the *California Climate Investments co-benefits webpage*.

Methodology Development

CARB and SGC developed this Quantification Methodology consistent with the guiding principles of California Climate Investments, including ensuring transparency and accountability, per the *California Climate Investments Funding Guidelines*. CARB and SGC developed this AHSC Quantification Methodology to be used to estimate the outcomes of proposed projects, inform project selection, and track results of funded projects. The implementing principles ensure that the methodology would:

- Apply at the project-level;
- Provide uniform methods to be applied statewide, and be accessible by all applicants;
- Use existing and proven tools and methods;
- Use project-level data, where available and appropriate; and
- Result in GHG emissions reduction estimates that are conservative and supported by empirical literature.

CARB assessed peer-reviewed literature and tools and consulted with experts, as needed, to determine methods appropriate for the AHSC project types. CARB also consulted with SGC to determine project-level inputs available. The methods were developed to provide estimates that are as accurate as possible with data readily available at the project level.

CARB released the Draft AHSC Quantification Methodology and Draft AHSC Benefits Calculator Tool for public comment in December 2024. This Final AHSC Quantification Methodology and accompanying AHSC Benefits Calculator Tool have been updated to address public comments, where appropriate, and for consistency with updates to the ASHC Guidelines.

The "Methods to Find the Cost-effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects (CMAQ)" were the basis for developing the GHG emissions reduction estimates for transit and connectivity project features.[1] The CMAQ Methods are equations for evaluating the cost-effectiveness of certain types of transportation projects, such as bicycle paths, vanpools, and new bus services. CARB and

[1] California Air Resources Board and California Department of Transportation. *Methods to Find the Cost-Effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects*. May 2005. The CMAQ Methods Guide is available on the *CARB CMAQ Program webpage*

the California Department of Transportation developed the CMAQ Methods, which are used statewide by transportation agencies to assess criteria and toxic pollutant emissions reductions from transportation projects competing for State motor vehicle fee and federal CMAQ funding. All the CMAQ Methods equations and assumptions needed for this quantification method are included in this document, and some assumptions have been modified as necessary. Therefore, the equations presented in this Quantification Methodology are referred to as Transit and Connectivity Methods. The CMAQ Methods Guide is available on the *CARB CMAQ Program webpage*

To develop VMT reduction estimates for projects that include affordable housing developments, the AHSC Benefits Calculator Tool uses information from the California Statewide Travel Demand Model,[2] metropolitan planning organizations,[3] the Institute of Transportation Engineers Trip Generation Manual and Parking Generation Manual[4], and the California Air Pollution Control Officers Association "Quantifying Greenhouse Gas Mitigation Measures" report[5] and California Emissions Estimator Model®[6]. The AHSC Benefits Calculator Tool adapts a methodology from this model for ease of use and alignment with the specific requirements of the AHSC Program.

In addition, the University of California, Berkeley, in collaboration with CARB, developed assessment methodologies for a variety of co-benefits such as providing cost savings, lessening the impacts and effects of climate change, and strengthening community engagement. Co-benefit assessment methodologies are posted on the *California Climate Investments co-benefits webpage*.

The AHSC Quantification Methodology and AHSC Benefits Calculator Tool are applicable only to AHSC project types and should not be used to estimate GHG emissions reductions or co-benefits for any projects which do not meet AHSC Program requirements.

Tools

The AHSC Benefits Calculator Tool relies on project-specific outputs from the National Renewable Energy Laboratory PVWatts® Calculator, a web-based tool that

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[2] California Department of Transportation. *California Statewide Travel Demand Model.* 2016. Available through the *Travel Demand Model webpage*.

[3] The Association of Monterey Bay Area Governments, Butte County Association of Governments, Metropolitan Transportation Commission, Sacramento Area Council of Governments, San Luis Obispo Council of Governments, and Southern California Association of Governments provided trip length data for this AHSC Quantification Methodology.

[4] Institute of Transportation Engineers. *Trip Generation Manual, 11th Edition*. 2021 found on the *ITE Trip and Generation Manual webpage*.

[5] California Air Pollution Control Officers Association. *Quantifying Greenhouse Gas Mitigation Measures*. 2010. *Available through report PDF*.

[6] California Air Pollution Control Officers Association. *California Emissions Estimator Model, version 2016.3.2*. 2017.Available through the *Caleemod website*.

estimates the electricity production of grid-connected roof- or ground-mounted solar PV systems. PVWatts calculates estimated values for the proposed system's monthly and annual electricity production. For projects that include solar PV systems, the AHSC Benefits Calculator Tool relies on estimates of solar PV electricity generation from PVWatts. PVWatts is publicly available to anyone with internet access, free of charge, and subject to regular updates to incorporate new information. The tool can be accessed at the *NREL webpage*.

In addition to the tool above, the AHSC Benefits Calculator Tool relies on CARB-developed emission factors. CARB has established a single repository for emission factors used in CARB benefits calculator tools, referred to as the California Climate Investments Quantification Methodology Emission Factor Database (Database), available on the *California Climate Investments resources webpage*. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

Applicants must use the AHSC Benefits Calculator Tool to estimate the GHG emissions reductions and co-benefits of the proposed project. The AHSC Benefits Calculator Tool and User Guide can be downloaded from the *California Climate Investments resources webpage*.

Updates

CARB staff periodically review each quantification methodology and benefits calculator tool to evaluate their effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified. CARB updated the AHSC Quantification Methodology from the previous version to enhance the analysis and provide additional clarity (email the *GGRF Program Email* to request a copy of previous versions). The changes include:

- Updated fuel type Energy Economy Ratios based on most recent Emission Factor Database updates, added Energy Economy Ratios for hydrogen fuels relative to electricity.
- Updated calculator's user interface of Fixed-Transit Input Tab to align with Low Carb Transit Operations Program calculator user interface.
- Added input cell to Fixed-Transit Input Tab to account for the renewable energy generated as a direct result of this project to charge the new service vehicles.
- Incorporated the Clean Mobility Benefits Calculator methods and user interface into the AHSC calculator. Tab allows applicants to estimate the benefits of shared mobility projects such as carshare, vanpool, and bikeshare. It can also estimate bike and pedestrian infrastructure projects. The Active Transportation tab was removed.
- Added an additional row to the Affordable Housing Tab to estimate the benefits of a second housing project and provided clarification in the user guide about quantifying multi-building projects.

- Updated back-end calculations to be more efficient, fixed various known bugs.
- Provided clarification throughout calculation and user guide in response to applicant questions and feedback.

Program Assistance

Applicants should use the following resources for additional questions and comments:

- Questions on this document should be sent to the GGRF program email.
- For more information on CARB efforts to support implementation of GGRF investments, see the California Climate Investments webpage.
- Questions pertaining to AHSC should be sent to the AHSC program email.

Section B. Methods

The following section provides details on the methods supporting emissions reductions in the AHSC Benefits Calculator Tool.

Project Types

SGC developed project types that meet the objectives of the AHSC program and for which there are methods to quantify GHG emissions reductions based on the *program guidelines*. Each project requesting AHSC funding must include at least one of the following in the AHSC Benefits Calculator Tool:

- Construction or substantial rehabilitation of affordable housing, including mixed-use development, and related infrastructure;
- Transit passes for residents;
- Grid-connected solar PV system;
- New or expanded fixed-route transit service or transit improvement that leads to ridership increase;
- New or expanded carshare, vanpool, or micromobility projects;
- Bike and Pedestrian infrastructure projects;
- Transit fare reductions/subsidies.

General Approach

Methods used in the AHSC Benefits Calculator Tool for estimating the GHG emissions reductions and air pollutant emission co-benefits by activity type are provided in this section. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

These methods account for emissions reductions from displaced passenger VMT, vehicle and equipment replacement, and fossil fuel energy that is displaced by solar PV generation.

In general, the GHG emissions reductions, air pollutant emissions co-benefits, and key variables are estimated in the AHSC Benefits Calculator Tool using the quantification approaches by project type outlined in Table 1 below.

Table 1. General Approach to Quantification by Method

Affordable housing development or residential transit subsidy
Emissions Reductions=Emissions from avoided passenger VMT
Solar PV electricity generation
Emissions Reductions=Estimated solar energy generation* emission factor

New or expanded service and subsidies for shared mobility projects
Emissions Reductions=Emissions from displaced autos- emissions that project vehicles create
Bike and Pedestrian Infrastructure
Emissions Reductions=Emissions of the passenger autos that are displaced by the project.
New or expanded fixed-route transit service
Emissions Reductions=Emissions reductions from displaced autos - emissions from new service
Fixed-route transit ridership increase from fare reductions, installation of equipment and infrastructure
Emissions Reductions=Emissions from displaced autos
Technology Conversion
Emissions Reductions=Emissions from Displaced (Baseline) Vehicle – Emissions from New Vehicle

A. Emissions reductions from Affordable Housing Development and Residential Subsidies

Both the GHG emissions reductions and air pollutant emissions reductions from affordable housing developments and subsidies are estimated as the difference between the avoided passenger VMT from the proposed project compared to a baseline scenario. Equations 1 through 4 are used to estimate unmitigated VMT for the baseline scenario. [7]

Equation 1: Average Daily Trips per Dwelling Unit

$$Average\ Daily\ Trips = \frac{(Weekday\ Trips * 5) + Saturday\ Trips + Sunday\ Trips}{7\ days}$$

Table 2. Variable Definitions for Equation 1: Average Daily Trips per Dwelling Unit

Variable	Variable Definition	Units
Average Daily Trips	Average daily trip rate per dwelling unit for applicable dwelling type	Trips/dwelling unit-day
Weekday Trips	Average weekday trip rate er dwelling unit for applicable dwelling type	Trips/dwelling unit
Saturday Trips	Average Saturday tri rate per dwelling unit for applicable dwelling type	Trips/dwelling unit
Sunday Trips	Average Sunday trip rate per dwelling unit for applicable dwelling type	Trips/dwelling unit

[7] Equations 1 through 4 use a methodology and trip type and link percentages described in Appendices A and D of the *User's Guide for CalEEMod Version 2016.3.2*. Available through the *CalEEMod User-guide*. Trip rates are derived from the *Trip Generation Manual, 11th Edition* accessible through the *ITE Trip and Generation Manual webpage*. Trip lengths not provided by metropolitan planning organizations are calculated for multi-county regions from the California Statewide Travel Demand Model. Available through the *travel demand model webpage*.

Equation 2: Primary Trip Length

$$Primary\ Trip\ Length = (H\text{-}W\ Length * H\text{-}W\ Share) + (H\text{-}S\ Length * H\text{-}S\ Share) + (H\text{-}O\ Length * H\text{-}O\ Share)$$

Table 3. Variable Definitions for Equation 2: Primary Trip Length

Variable	Variable Definition	Units
Primary Trip Length	County-specific average length of urban or rural primary-home-base trip	Miles
H-W Length	County-specific average length of urban or rural trip between home and work	Miles
H-W Share	Statewide default percentage or primary home-base trips which are between home and work (42.3%)	%
H-S Length	County-specific average length of urban or rural trip between home and shopping	Miles
H-S Share	Statewide default percentage or primary home-based trips which are between home and shopping (19.6%)	%
H-O Length	County-specific average length or urban or rural trip between home and locations other than work or shopping	Miles
H-O Share	Statewide default percentage or primary home-based trips which are between home and other locations (38.1%)	%

Equation 3: Overall Trip Length

$$\begin{aligned} &Overall\ Trip\ Length \\ &= (Primary\ Trip\ Length * Primary\ Share) \\ &+ (Primary\ Trip\ Length * 25\% * Diverted\ Share) \\ &+ (0.1\ miles * Passby\ miles\ Share) \end{aligned}$$

Table 4. Variable Definitions for Equation 3: Overall Trip Length

Variable	Variable Definition	Units
Overall Trip Length	County-specific average length of urban or rural overall home-based trip	Miles
Primary Trip Length	County-specific average length of urban and rural primary home-based trip, from Equation 2	Miles
Primary Share	Statewide average percentage of home-based trips which are primary (86%)	%
Diverted Share	Statewide average percentage of home-based trips which are diverted (11%)	%
Pass-by Share	Statewide average percentage of home-based trips which are pass-by (3%)	%

Equation 4: Annual Unmitigated VMT

$$\begin{aligned} &Annual\ Unmitigated\ VMT \\ &= Average\ Daily\ Trips * Overall\ Trip\ Length * Total\ Units * 365\ days \end{aligned}$$

Table 5. Variable Definitions for Equation 4: Annual Unmitigated VMT

Variable	Variable Definition	Units
Annual Unmitigated VMT	Annual VMT by residents of housing development without VMT mitigation measures	Miles/year
Average Daily Trips	Average daily trip rate per dwelling unit for applicable dwelling type, from Equation 1	Trips/dwelling unit*day
Overall Trip Length	Count-specific average length or urban or rural overall home-based trip, from Equation 3	Miles
Total Units	Number of dwelling units in affordable housing development	Dwelling units

Equations 5 through 16 are used to calculate the expected percent reductions in passenger VMT[8] resulting from the characteristics of the affordable housing development.

[8] Equations 5 through 16 use methodologies and elasticities described in the *Quantifying Greenhouse Gas Mitigation Measures* report. *Access the report PDF.*

Equation 5: VMT Reductions from Increased Density

$$Density\ VMT\ Reductions = \left(\frac{Density - Required\ Density}{Required\ Density}\right) * 7\%$$

Table 6. Variable Definitions for Equation 5: VMT Reductions from Increased Density

Variable	Variable Definition	Units
Density VMT Reductions	VMT reductions associated with increased net density over required baseline, capped at 30%	%
Density	Net density of affordable housing development	Dwelling units/acre
Required Density	Required baseline net density per Project Area Type, defined by the AHSC Guidelines (See Table 7)	Dwelling units/acre

Table 7. Minimum Net Density by Project Area Type

Project Area Type	Minimum Net Density (Dwelling units per acre)
TOD	30
ICP	20
RIPA	15

Equations 6 and 7 are applicable to mixed-use developments only.

Equation 6: Land Use Index

$$Land\ Use\ Index = -\left(\frac{4 * (0.01 * ln0.01) + \left(\left(\frac{RS}{RS+MS}\right) * ln\left(\frac{RS}{RS+MS}\right)\right) + \left(\left(\frac{MS}{RS+MS}\right) * ln\left(\frac{MS}{RS+MS}\right)\right)}{ln6}\right)$$

Table 8. Variable Definitions for Equations 6: Land Use Index

Variable	Variable Definition	Units
Land Use Index	Measure of diversity of land use in mixed-use development	N/A
RS	Space for residential uses in mixed-use development	Square feet
MS	Publicly accessible space for commercial or social services uses in mixed-use development	Square feet

Equation 7: VMT Reductions from Increased Land Use Diversity

$$Diversity\ VMT\ Reductions = \left(\frac{Land\ Use\ Index - 0.15}{0.15}\right) * 9\%$$

Table 9. Variable Definitions for Equation 7: VMT Reductions from Increased Land Use Diversity

Variable	Variable Definition	Units
Diversity VMT Reductions	VMT reductions associated with increased net density over required baseline, capped at 30%, with increase in land use diversity capped at 500%	%
Land Use Index	Measure of diversity of land use in mixed-use development, from Equation 6	N/A

Equation 8: VMT Reductions from Increased Destination Accessibility

$$Accessibility\ VMT\ Reductions = \left(\frac{housing\ development\ employment\ density - county\ employment\ density}{county\ employment\ density}\right) * 7\%$$

Table 10. Variable Definitions for Equation 8: Reductions from Increased Destination Accessibility

Variable	Variable Definition	Units
Accessible VMT Reductions	VMT reductions associated with increased employment density caped at 30%	%
Employment Density	Number of jobs per acres of specific geography, obtained through Policy Map.[9]	Jobs/acre

Equation: 9 VMT Reductions form Integration of Affordable Housing

$$Affordability\ VMT\ Reductions = \left(\frac{Affordable\ Units}{Total\ Units}\right) * 4\%$$

Table 11. Variable Definitions for Equation 9: Reductions from Integration of Affordable Housing

Variable	Variable Definition	Units
Affordability VMT Reductions	VMT reductions associated with integration of affordable dwelling units into housing development, capped at 4%	%
Affordable Units	Number of affordable dwelling units in affordable housing development	Dwelling units
Total units	Number of dwelling units in affordable housing development	Dwelling units

[9] Employment Density is obtained through the Policy Map mapping tool which uses Data from the EPA Smart Location Database. Access the mapping tool through the *Policy Map webpage*.

Equation 10: VMT Reductions from Land Use Measures

$$Land\ Use\ VMT\ Reductions = 1 - (1 - Density\ VMT\ Reductions) * (1 - Diversity\ VMT\ Reductions) * (1 - Accessibility\ VMT\ Reductions) * (1 - Affordability\ VMT\ Reductions)$$

Table 12. Variable Definitions for Equation 10: Total VMT Reductions from Land Use Measures

Variable	Variable Definition	Units
Land Use VMT Reductions	VMT reductions associated with all land use measures, capped according to Project Area Type (See Table 13)	%
Density VMT Reductions	VTM reductions associated with increased density over required baselines, capped at 35%, from Equation 5	%
Diversity VMT Reductions	VMT reductions associated with increased land use diversity over baselines, capped at 30%, from Equation 7	%
Accessibility VMT Reductions	VMT reductions associated with increases destination accessibility capped at 30%, from Equation 8	%
Affordability VMT Reductions	VMT reductions associated with integration of affordable dwelling units into housing development, capped at 4%m from Equation 9	%

Table 13. Maximum VMT Reductions by Project Area Type[10]

Project Area Type	Land Use Measures	Land Use, Parking, and Traffic Calming Measures	Total
TOD	65%	70%	75%
ICP	30%	35%	40%
RIPA	5%	10%	15%

[10] VMT reduction caps are aligned with the "urban" location type from the *Quantifying Greenhouse Gas Mitigation Measures* report for TOD, "compact infill" for ICP, and "suburban" for RIPA. *Access the report PDF*.

Equation 11: VMT Reductions from Limited Parking Supply

$$Parking\ Supply\ VMT\ Reductions = \left(\frac{Total\ Units * Parking\ Rate - Parking\ Space}{Total\ Units * Parking\ Rate}\right) * 50\%$$

Table 14. Variable Definitions for Equation 11: VMT Reductions from Limited Parking Supply

Variable	Variable Definition	Units
Parking Supply VMT Reductions	VMT reductions associated with limited residential parking supply, capped at 12.5%	%
Total Units	Number of dwelling units in affordable housing development	Dwelling units
Parking Rate	Average peak parking demand per dwelling unit for applicable dwelling type	Vehicles/units
Parking Space	Number of residential parking spaced in affordable housing development	Parking spaces

Equation 12: VMT Reductions from Unbundled Parking Cost

$$Unbundled\ Parking\ VMT\ Reductions = Unbundled\ Cost * \left(\frac{12\ months}{\$4{,}000}\right) * 0.4 * 85\%$$

Table 15. Variable Definitions for Equation 12: VMT Reductions from Unbundled Parking Cost

Variable	Variable Definition	Units
Unbundled Parking VMT Reductions	VMT reductions associated with unbundled residential parking cost, capped at 20%	%
Unbundled Cost	Monthly unbundled cost for on-site residential parking	$/month

Equation 13: Total VMT Reductions from Parking Measures

$$Parking\ VMT\ Reductions = 1 - (1 - Parking\ Supply\ VMT\ Reductions) * (1 - Unbundled\ Parking\ VMT\ Reductions)$$

Table 16. Variable Definitions for Equation 13: Total VMT Reductions from Parking Measures

Variable	Variable Definition	Units
Parking VMT Reductions	VMT reductions associated with all parking measures, capped at 20%	%
Parking Supply VMT Reductions	VMT reductions associated with limited residential parking supply, capped at 12.5%, from Equation 11	%
Unbundled Parking VMT Reductions	VMT reductions associated with unbundled residential parking costs, capped at 20%, from Equation 12	%

Equation 14: VMT Reductions from Traffic Calming Measures

$$Traffic\ Calming\ VMT\ Reductions = 1\%$$

Table 17. Variable Definitions for Equation 14: VMT Reductions from Traffic Calming Measures

Variable	Variable Definition	Units
Traffic Calming VMT Reductions	VMT reductions associated with traffic calming measures within ½ mile of affordable housing development	%

Equation 15: VMT Reductions from Residential Transit Subsidy

$$Subsidy\ VMT\ Reductions = Elasticity * \frac{Recipients}{Total\ Units} * \frac{Duration}{30\ years}$$

Table 18. Variable Definitions for Equation 15: VMT Reduction from Residential Transit Subsidy

Variable	Variable Definition	Units
Subsidy VMT Reductions	VMT reductions associated with transit passes for residents, capped at 20%	%
Elasticity	Elasticity of VMT specific to annual value of transit passes to residents and urban and rural project setting	N/A
Recipients	Number of dwelling units receiving transit passes in affordable housing development	Dwelling units
Total units	Number of dwelling units in affordable housing development	Dwelling units
Duration	Number of years for which transit passes are funded	years

Equation 16: Total VMT Reductions

$$Total\ VMT\ Reductions = Land\ Use\ VMT\ Reductions + Parking\ VMT\ Reductions + Traffic\ Calming\ VMT\ Reductions + Subsidy\ VMT\ Reductions$$

Table 19. Variable Definitions for Equation 16: Total VMT Reductions

Variable	Variable Definition	Units
Total VMT Reductions	VMT reductions associated with all mitigation measures, capped according to Project Area Type (See Table 13)	%
Lande Use VMT Reductions	VMT reductions associated with all land use measures, capped according to Project Area Type, from Equation 10	%
Parking VMT Reductions	VMT reductions associated with all parking measures, capped at 20%, from Equation 13	%
Traffic Calming VMT Reductions	VMT reductions associated with traffic calming measures withing ½ mile of affordable housing development, from Equation 14	%
Subsidy VMT Reductions	VM T Reductions Associated with transit passes for residents, capped at 20%, from Equation 15	%

Equation 17: Annual Avoided VMT

$$Annual\ Avoided\ VMT = Annual\ Unmitigated\ VMT * Total\ VMT\ Reductions$$

Table 20. Variable Definitions for Equation 17: Annual Avoided VMT

Variable	Variable Definition	Units
Annual Avoided VMT	Annual reductions in baseline residential VMT	Miles/year
Annual unmitigated VMT	Annual VMT by residents of housing development without VMT mitigation measures, from Equation 4	Miles/year
Total VMT Reductions	VMT reductions associated with all mitigation measures, from Equation 16	%

Equation 18: Total Avoided VMT

$$Total\ Avoided\ VMT = Annnual\ Avoided\ VMT * 30\ years$$

Table 21. Variable Definitions for Equation 18: Total Avoided VMT

Variable	Variable Definition	Units
Total Avoided VMT	Reductions in baselines residential VMT for quantification period of affordable housing development (30 years)	Miles
Annual Avoided VMT	Annual reductions in baseline residential VMT	Miles/year

Equation 19 is used to estimate emissions reductions from the avoided VMT associated with the affordable housing development and transit subsidies for residents.

Equation 19: Auto Emissions reductions from Affordable Housing Development and Residential Transit Subsidies

$$Emission\ Reductions = \left(\frac{Annual\ Avoided\ VMt * EF_{yr\,1} + Annual\ Avoided\ VMT * EF_{yrf}}{2}\right) * 30\ years * U^{-1}$$

Table 22. Variable Definition for Equation 19: Auto Emissions reductions for Affordable Housing Development and Transit Subsidies

Variable	Variable Definition	Units
Auto Emissions reductions	Auto GHG or criteria and toxic air pollutant emissions reductions for quantification period of affordable housing development (30 years)	$MTCO_{2e}$ or lbs
Annual Avoided VMT	Annual reductions in baselines residential VMT, from Equation 17	Miles/year
EF_{yr1}	County-specific auto vehicle emission factor for first year of project life	g/mile
EF_{yrF}	County-specific auto vehicle emission factor for final year of project life	g/mile
U	Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb

B. Emissions Reductions from Solar PV Generation

The AHSC Benefits Calculator Tool uses the quantification methods described in the Low-Income Weatherization Program (LIWP) for estimating the GHG emissions reductions and air pollutant emission co-benefits of solar PV projects.

Of the 4 project types available for quantification in the LIWP quantification methodology, the following project types are eligible in the AHSC program and can be to be quantified in the AHSC Benefits Calculator Tool:

- Solar PV Generation

The specific quantification methods used to estimate the benefits of this eligible project type is described in the LIWP Quantification Methodology available on the *California Climate Investments resources webpage*.

C. Emissions Reductions from Shared Mobility Projects

The AHSC Benefits Calculator Tool uses the quantification methods described in the Clean Mobility Benefit Quantification Methodology for estimating the GHG emissions reductions and air pollutant emission co-benefits of shared mobility projects.

Of the 9 project types available for quantification in the Clean Mobility Benefit Quantification Methodology, the following project types are eligible in the AHSC program and can be quantified in the AHSC Benefits Calculator Tool:

- New or Expanded Service
- Subsidies
- Bike Infrastructure
- Pedestrian Infrastructure

The specific quantification methods used to estimate the benefits of these eligible project types are described in the Clean Mobility Benefits Quantification Methodology available on the *California Climate Investments resources webpage.*

D. Emissions Reductions from Fixed-Route Transit Projects

The AHSC Benefits Calculator Tool uses the methods developed for the Low Carbon Transit Operations (LCTOP) program for estimating the and air pollutant emission co-benefits of fixed-route transit projects.

Of the 15 project types available for quantification in the LCTOP Quantification Methodology, the following project types are eligible in the AHSC program and can be to be quantified in the AHSC Benefits Calculator Tool:

- Provision of a new expanded/enhanced transit service;
- Purchase of replacement vehicle(s) and equipment/infrastructure in support of new expanded/enhanced transit service;
- Purchase, construction, and installation of equipment and facilities needed to provide expanded/enhanced transit service;
- Purchase of expansion zero-emission vehicle(s) and equipment/infrastructure in support of new expanded/enhanced transit service;
- Purchase, construction, and/or installation of infrastructure to support zero-emission or low-emission vehicles in support of new expanded/enhanced transit service;
- Purchase and installation of equipment on transit vehicles to encourage increased transit ridership;
- Purchase, construction, and/or installation of transit-related amenities or infrastructure to encourage increased transit ridership;
- Implementation of free or reduced fares; and
- Network/fare integration.

The specific quantification methods used to estimate the benefits of these eligible project types, as well as default lookup tables, are described in the LCTOP Quantification Methodology available on the *California Climate Investments resources webpage*.

Section C. References

The following references were used in the development of this Quantification Methodology and the AHSC Benefits Calculator Tool.

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