California Air Resources Board

# Quantification Methodology

## California Department of Transportation
## Low Carbon Transit Operations Program

## California Climate Investments


**FINAL**
**December 30, 2020**

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## List of Acronyms and Abbreviations

| Acronym | Term |
|---|---|
| CARB | California Air Resources Board |
| Caltrans | California Department of Transportation |
| CB | commuter bus |
| CC | cable car |
| CMAQ | Congestion Mitigation and Air Quality |
| CR | commuter rail |
| Diesel PM | diesel particulate matter |
| DMU | diesel multiple unit |
| DO | directly operated |
| DR | demand response |
| DT | demand response taxi |
| EMU | electric multiple unit |
| FB | ferryboat |
| GGRF | Greenhouse Gas Reduction Fund |
| GHG | greenhouse gas |
| HR | heavy rail |
| kWh | kilowatt hours |
| lbs | pounds |
| LCTOP | Low Carbon Transit Operations Program |
| LR | light rail |
| MB | bus |
| MG | monorail/automated guideway |
| MJ | megajoule |
| $MTCO_2e$ | metric tons of carbon dioxide equivalent |
| $NO_x$ | nitrous oxide |
| PM | particulate matter |
| $PM_{2.5}$ | particulate matter with a diameter less than 2.5 micrometers |
| $PM_{10}$ | particulate matter with a diameter less than 10 micrometers |
| PT | purchased transportation |
| RB | bus rapid transit |
| ROG | reactive organic gas |
| SAFE | Safer Affordable Fuel-Efficient Vehicles Rule |
| SR | streetcar rail |
| TAC | transit and connectivity |
| TB | trolley bus |
| VMT | vehicle miles traveled |
| VP | vanpool |
| YR | hybrid rail |

**List of Definitions**

| Term | Definition |
|---|---|
| Adjustment Factor | Discount factor applied to annual ridership to account for transit-dependent riders. |
| Baseline Vehicle | The vehicle that is currently owned/in operation that will be replaced by a new zero- or near zero-emission vehicle purchase, or the vehicle that would have been purchased if not for this project (e.g., 2022 diesel bus). |
| CMAQ Methods | 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. |
| Co-benefit | A social, economic, or environmental benefit as a result of the proposed project in addition to the GHG reduction benefit. |
| Directly Operated | Transportation service provided directly by a transit agency, using their employees to supply the necessary labor to operate the revenue vehicles. This includes instances where an agency's employees provide purchased transportation (PT) services to the agency through a contractual agreement. |
| Energy and Fuel Cost Savings | Changes in energy and fuel costs to the transit operator as a result of the project. Savings may be achieved by changing the quantity of energy or fuel used, conversion to an alternative energy or fuel source/vehicle, or renewable energy or fuel generation to displace existing fuel purchases. |
| Fuel/Energy Reduction | Quantification method that identifies projects that result in using less fuel or energy from existing transit services, or producing renewable energy/fuel. This includes projects that reduce transit vehicle miles traveled (VMT) and idling, or generate renewable electricity. For example, optimizing bus routes to reduce diesel fuel usage or installing solar panels to displace grid electricity is a project that would use the "fuel/energy reduction" quantification method. |
| Increased Ridership | Quantification method that identifies projects that result in increased ridership for existing routes. This may include projects that increase service levels, reliability, safety, or decrease travel times. For example, implementing integrated ticketing and improving scheduling systems is a project that would use the "increased ridership" quantification method. |

| Term | Definition |
|---|---|
| Key Variable | Project characteristics that contribute to a project's GHG emission reductions and signal an additional benefit (e.g., passenger VMT reductions, renewable energy generated). |
| New Service | Quantification method that identifies projects that result in a new transportation service. This may include expansion of an existing service. For example, constructing a new rail line or adding new buses to an existing transit route is a project that would use the "new service" quantification method. |
| Project Type | For the purposes of the LCTOP Quantification Methodology, eligible projects fall into fifteen project types that meet the objectives program and for which there are methods to quantify GHG emission reductions. |
| Purchased Transportation | Transportation service provided to a public transit agency or governmental unit from a public or private transportation provider based on a written contract. The provider is obligated in advance to operate public transportation services for a public transit agency or governmental unit for a specific monetary consideration, using its own employees to operate revenue vehicles. |
| Quantification Period | Number of years that the project will provide GHG emission reductions that can reasonably be achieved and assured. Sometimes referred to as "Project Life" or "Useful Life". |
| Vehicle Replacement | Identifies projects that replace a baseline vehicle(s) with a new vehicle(s) without resulting in new service. |
| Technology Conversion | Quantification method that identifies projects that result in the use of cleaner vehicles, technologies, or fuels. For example, replacing existing diesel buses with electric buses or using renewable natural gas instead of fossil natural gas is a project that would use the "technology conversion" quantification method. |
| Travel Cost Savings | Changes in travel costs to the user as a result switching travel modes. |
| Unlinked Passenger Trips | Number of passengers who board public transportation vehicles. |

# Section A. Introduction

California Climate Investments is a statewide initiative that puts billions of Cap-and-Trade dollars to work facilitating greenhouse gas (GHG) emission 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 emission reductions and co-benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). This guidance includes quantification methodologies, co-benefit assessment methodologies, benefits calculator tools, and associated user guides. CARB develops these methodologies and tools based on the project types eligible for funding by each administering agency, as reflected in the program expenditure records available at: www.arb.ca.gov/cci-expenditurerecords.

For the California Department of Transportation (Caltrans) Low Carbon Transit Operations Program (LCTOP), CARB staff developed this LCTOP Quantification Methodology and accompanying LCTOP Benefits Calculator Tool to provide guidance for estimating the GHG emission reductions and selected co-benefits of each proposed project type. This methodology uses calculations to estimate GHG emission reductions and avoided GHG emissions from transit operation and capital projects.

The LCTOP Benefits Calculator Tool automates methods described in this document, outlines documentation requirements, and provides a link to a step-by-step user guide with project examples. Projects will report the total project GHG emission reductions and co-benefits estimated using the LCTOP Benefits Calculator Tool as well as the total project GHG emission reductions per dollar of GGRF funds. The LCTOP Benefits Calculator Tool is available for download at: www.arb.ca.gov/cci-resources.

Using many of the same inputs required to estimate GHG emission reductions, the LCTOP Benefits Calculator Tool estimates the following co-benefits and key variables from LCTOP projects:

- Local reactive organic gas (ROG) emission reductions (lbs),
- Remote ROG emission reductions (lbs),
- Local nitrous oxide ($NO_x$) emission reductions (lbs),
- Remote $NO_x$ emission reductions (lbs),
- Local Particulate Matter with a diameter less than 2.5 micrometers ($PM_{2.5}$) emission reductions (lbs),
- Remote $PM_{2.5}$ emission reductions (lbs),

- Local Diesel Particulate Matter (PM) emission reductions (lbs),
- Remote Diesel PM emission reductions (lbs),
- Passenger Vehicle Miles Traveled (VMT) reductions (miles),
- Fossil fuel use reductions (gallons),
- Renewable energy generated in kilowatt hours (kWh),
- Fossil fuel energy use reductions (kWh),
- Passenger travel cost savings ($), and
- Energy and fuel cost savings ($).

Additional co-benefits for which CARB assessment methodologies were not incorporated into the LCTOP Benefits Calculator Tool may also be applicable to the project. Applicants should consult the LCTOP guidelines, solicitation materials, and agreements to ensure they meet LCTOP requirements. All CARB co-benefit assessment methodologies are available at: www.arb.ca.gov/cci-cobenefits.

## Methodology Development

CARB and Caltrans developed this LCTOP Quantification Methodology consistent with the guiding principles of California Climate Investments, including ensuring transparency and accountability,[1] 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:

- Applies at the project-level;
- Provides uniform methods to be applied statewide and is accessible by all applicants;
- Uses existing and proven tools and methods;
- Uses project-level data, where available and appropriate; and
- Results in GHG and air pollutant emission 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 LCTOP project types. CARB also consulted with Caltrans 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 LCTOP Quantification Methodology and Draft LCTOP Benefits Calculator Tool for public comment on November 30, 2020. This Final LCTOP Quantification Methodology and accompanying LCTOP Benefits Calculator Tool have been updated to address public comments, where appropriate.

Congestion Mitigation and Air Quality (CMAQ) Methods were used as the basis for developing the GHG emission reduction estimates for certain project features,

[1] California Air Resources Board. www.arb.ca.gov/cci-fundingguidelines

specifically transit and connectivity (TAC) features.[2] The CMAQ Methods are a set of equations for evaluating the cost-effectiveness of certain types of transportation projects, including bicycle paths, vanpools, and new bus service. CARB and the California Department of Transportation developed the CMAQ Methods, which are used statewide by transportation agencies to assess criteria and toxic pollutant emission reductions from transportation projects competing for State motor vehicle fee and federal CMAQ funding. All of 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 used in this Quantification Methodology are referred to as TAC Methods. The CMAQ Methods document can be accessed at: www.arb.ca.gov/planning/tsaq/eval/eval.htm.

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. As they become available, co-benefit assessment methodologies are posted at: www.arb.ca.gov/cci-cobenefits.

## Tools

The LCTOP 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 at: http://www.arb.ca.gov/cci-resources. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

Applicants must use the LCTOP Benefits Calculator Tool to estimate the GHG emission reductions and co-benefits of the proposed project. The LCTOP Benefits Calculator Tool can be downloaded from: http://www.arb.ca.gov/cci-resources.

## 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 quantified projects. CARB updated the previous version of the LCTOP Quantification Methodology[3] to enhance the analysis and provide additional clarity. The changes include:

[2] California Air Resources Board. 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. www.arb.ca.gov/planning/tsaq/eval/eval.htm.
[3] Quantification Methodology for FY 2018-19. January 10, 2019. https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/caltrans_lctop_finalqm_18-19.pdf

- Updated GHG emission factors for passenger auto and fuel consumption factors for vans to account for the Final Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule;
- Updated fuel carbon intensities to 2019-weighted averages.

## Program Assistance

CARB staff will provide feedback on the quantification portions of the LCTOP Allocation Requests to check if the methods described in this document are used to reasonably estimate GHG emission reductions and air pollutant emission co-benefits for the proposed project. Applicants should use the following resources for additional questions and comments:

- Questions on this document should be sent to: GGRFProgram@arb.ca.gov.
- For more information on CARB efforts to support implementation of GGRF investments, see: www.arb.ca.gov/caclimateinvestments.
- Questions pertaining to LCTOP should be sent to: LCTOPcomments@dot.ca.gov.

# Section B. Methods

The following section provides details on the methods supporting emission reductions in the LCTOP Benefits Calculator Tool.

## Project Types

Caltrans developed 15 project types that meet the objectives of LCTOP and have methods to quantify GHG emission reductions.[4] Other project features may be eligible for funding under LCTOP; however, each project requesting GGRF funding must include at least one of the following:

- Provision of a new expanded/enhanced transit service;
- Creation of new alternative transportation services (e.g., new or expanded car-sharing program);
- 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, construction, and installation of renewable energy/fuel for transit facilities in support of new expanded/enhanced transit service;
- Purchase of expansion zero-emission vehicle(s) (may include equipment/infrastructure);
- Purchase of replacement zero-emission vehicle(s) (may include equipment/infrastructure);
- Purchase, construction, and/or installation of infrastructure, equipment, or facilities to support zero-emission vehicle(s);
- 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;
- Purchase and construction of active transportation facilities that connect to stops/stations and encourage ridership;
- Implementation of free or reduced fares; and
- Network/fare integration.

[4] https://dot.ca.gov/programs/rail-and-mass-transportation/low-carbon-transit-operations-program-lctop

## General Approach

Methods used in the LCTOP Benefits Calculator Tool for estimating the GHG emission reductions and air pollutant emission co-benefits by quantification method are provided in this section. These methods account for emission reductions from displaced vehicle miles traveled, vehicle and equipment replacement, and the generation and use of renewable fuels/energy. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

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

**Table 1. General Approach to Quantification by Method**

| |
|---|
| New Service |
| *Emission Reductions = Emission Reductions from Displaced Autos – Emissions from New Service* |
| Increased Ridership |
| *Emission Reductions = Emission Reductions from Displaced Autos* |
| Technology Conversion |
| *Emission Reductions = Emissions from Displaced (Baseline) Vehicle – Emissions from New Vehicle* |
| Fuel/Energy Reductions |
| *Emission Reductions = Emission Reductions from Reduced Fuel/Energy Usage or Displaced Fuel/Energy Usage from Renewable Energy/Fuel Production* |

Based upon the project type selected, one or a combination of the four quantification methods shown in Table 1 will apply. The 15 project types fall into five possible quantification method combinations, including additional optional quantification methods available dependent upon the project type, as shown in Table 2.

**Table 2. Project Types by Quantification Method**

| Project Type | Method |
|---|---|
| Provision of a new expanded/enhanced transit service | New Service (Optional Technology Conversion and Fuel/Energy Reductions) |
| Creation of new alternative transportation services (e.g., new or expanded car-sharing program) | New Service (Optional Technology Conversion and Fuel/Energy Reductions) |
| Purchase, construction, and/or installation of infrastructure to support zero-emission or low-emission vehicles in support of new expanded/enhanced transit service | New Service (Optional Technology Conversion and Fuel/Energy Reductions) |
| Purchase, construction, and installation of equipment and facilities needed to provide expanded/enhanced transit service | New Service (Optional Technology Conversion and Fuel/Energy Reductions) |
| Implementation of free or reduced fares | Increased Ridership (Optional Fuel/Energy Reductions) |
| Network/fare integration | Increased Ridership (Optional Fuel/Energy Reductions) |
| Purchase, construction, and/or installation of transit-related amenities or infrastructure to encourage increased transit ridership | Increased Ridership (Optional Fuel/Energy Reductions) |
| Purchase and construction of active transportation facilities that connect to stops/stations and encourage ridership | Increased Ridership (Optional Fuel/Energy Reductions) |
| Purchase and installation of equipment on transit vehicles to encourage increased transit ridership | Increased Ridership (Optional Fuel/Energy Reductions) |
| Purchase expansion zero-emission vehicle(s) (may include equipment/infrastructure) | Technology Conversion (Optional Fuel/Energy Reductions) |
| Purchase replacement zero-emission vehicle(s) (may include equipment/infrastructure) | Technology Conversion (Optional Fuel/Energy Reductions) |
| Purchase, construction, and/or installation of infrastructure, equipment, or facilities to support zero-emission vehicle(s) | Technology Conversion (Optional Fuel/Energy Reductions) |
| Purchase of expansion zero-emission vehicle(s) and equipment/infrastructure in support of new expanded/enhanced transit service | New Service and Technology Conversion (Optional Fuel/Energy Reductions) |
| Purchase of replacement vehicle(s) and equipment/infrastructure in support of new expanded/enhanced transit service | New Service and Technology Conversion (Optional Fuel/Energy Reductions) |
| Purchase, construction, and installation of renewable energy/fuel for transit facilities in support of new expanded/enhanced transit service [5] | New Service and Fuel/Energy Reductions |

[5] For solar projects, use the National Renewable Energy Laboratory PVWatts Calculator to calculate the annual energy (kWh) expected to be generated from the solar panels. The energy generated will be

# A. Emission Reductions from New Service

Equation 1 estimates both the GHG and air pollutant emission reductions from New Service, calculated as the difference between the emission reductions from displaced autos and emissions associated with operation of the new service.

**Equation 1: Emission Reductions from New Service**

$$E = E_{Reduced} - E_{New}$$

| Where, | | | Units |
|---|---|---|---|
| $E$ | = | Net emission reductions | $MTCO_2e$ or lbs |
| $E_{Reduced}$ | = | Total emission reductions from displaced auto VMT | $MTCO_2e$ or lbs |
| $E_{New}$ | = | Total emissions from new service | $MTCO_2e$ or lbs |

Equation 2 calculates the total emission reductions associated with auto VMT displaced by the new service.

**Equation 2: Emission Reductions from Displaced Auto VMT**

$$E_{Reduced} = \frac{E_{Reduced\_Yr1} + E_{Reduced\_YrF}}{2} \times QP$$

| Where, | | | Units |
|---|---|---|---|
| $E_{Reduced}$ | = | Total emission reductions from displaced auto VMT | $MTCO_2e$ or lbs |
| $E_{Reduced\_Yr1}$ | = | Emission reductions from displaced autos in first year | $MTCO_2e$ or lbs |
| $E_{Reduced\_YrF}$ | = | Emission reductions from displaced autos in final year | $MTCO_2e$ or lbs |
| $QP$ | = | Quantification period | years |

Equation 3 calculates the annual emission reductions associated with auto VMT displaced from the project.

**Equation 3: Annual Emission Reductions from Displaced Auto VMT**

$$E_{Reduced\_Yr} = \frac{AutoVMT_{Displaced\_Yr} \times EF_{Yr}}{CF}$$

| Where, | | | Units |
|---|---|---|---|
| $E_{Reduced\_Yr}$ | = | Annual emission reductions from displaced auto VMT | $MTCO_2e$/yr or lbs/yr |
| $AutoVMT_{Displaced\_Yr}$ | = | Estimated annual VMT displaced attributed to the operation of the new service | miles/yr |
| $EF_{Yr}$ | = | Emission factor in the first or final year (based on weighted fleet average) | grams/mile |
| $CF$ | = | Conversion factor | grams/MT or grams/lb |

entered into the LCTOP Calculator Tool as a Fuel/Energy Reduction with electric selected as the fuel type. The PVWatts tool can be accessed at: http://pvwatts.nrel.gov/.

Equation 4 calculates the annual auto VMT displaced by the new service.

**Equation 4: Annual Auto VMT Displaced**

$$AutoVMT_{Yr} = R_{Yr} \times A \times L$$

| Where, | | | Units |
|---|---|---|---|
| $AutoVMT_{Yr}$ | = | Annual auto VMT displaced in the first or final year | miles |
| $R_{Yr}$ | = | Annual increase in unlinked passenger trips directly associated with the first or final year of the project | riders |
| $A$ | = | Adjustment factor to account for transit dependency. Use documented, project-specific data or system average developed from recent, statistically-valid survey or default. Applicants may use default values in Appendix A for similar service. | unitless |
| $L$ | = | Estimated length of average unlinked passenger trip directly associated with the project, calculated as passenger-miles divided by unlinked trips. Applicants may use data reported to National Transit Database (Appendix A) for similar service. | mile(s) per rider |

Equation 5 calculates the total emissions associated with the operation of the new service.

**Equation 5: Emissions from New Service**

$$E_{New} = AE_{New} \times QP$$

| Where, | | | Units |
|---|---|---|---|
| $E_{New}$ | = | Total emissions from new service | $MTCO_2e$ or lbs |
| $AE_{New}$ | = | Average annual emissions from new service | $MTCO_2e$/yr or lbs/yr |
| $QP$ | = | Quantification period | years |

Equation 6 calculates the annual emission estimates associated with the operation of the new service. For train and ferry services, annual emissions may alternatively be calculated based upon inputs for annual fuel consumption. Train services include heavy rail, light rail, and diesel multiple units/electric multiple units (DMUs/EMUs).

**Equation 6: Annual Emissions from New Service**

$$AE_{New} = \frac{NSVMT \times NSEF \times HDR}{CF}$$ **Or (for train/ferry service only)** $$AE_{New} = \frac{NSFuel \times FuelEF \times HDR}{CF}$$

| *Where,* | | | Units |
|---|---|---|---|
| $AE_{New}$ | = | Average annual emissions from new service | $MTCO_2e$/yr or lbs/yr |
| *NSVMT* | = | Estimated annual VMT attributed to the operation of the new service | miles |
| *NSEF* | = | Emission factor based on service type, in the mid-year of the project | grams/mile |
| *NSFuel* | = | Estimated annual fuel attributed to the operation of the new service - only available for train and ferry services | unit of fuel |
| *FuelEF* | = | Emission factor based on fuel type, and engine tier for train, in the mid-year of the project | grams/unit of fuel |
| *HDR* | = | Hybrid discount rate (0.8), if applicable | unitless |
| *CF* | = | Conversion factor | grams/MT or grams/lb |

# B. Emission Reductions from Increased Ridership

Equation 7 estimates the GHG and air pollutant emission reductions from Increased Ridership as the emission reductions from displaced auto VMT.

**Equation 7: Emission Reductions from Increased Ridership**

$$E = E_{Reduced}$$

| Where, | | | Units |
|---|---|---|---|
| $E$ | = | Net emission reductions | $MTCO_2e$ or lbs |
| $E_{Reduced}$ | = | Total emission reductions from displaced auto VMT | $MTCO_2e$ or lbs |

Equation 8 calculates the total emission reductions associated with auto VMT displaced.

**Equation 8: Emission Reductions from Displaced Auto VMT**

$$E_{Reduced} = \frac{E_{Reduced\_Yr1} + E_{Reduced\_YrF}}{2} \times QP$$

| Where, | | | Units |
|---|---|---|---|
| $E_{Reduced}$ | = | Total emission reductions from displaced auto VMT | $MTCO_2e$ or lbs |
| $E_{Reduced\_Yr1}$ | = | Emission reductions from displaced autos in first year | $MTCO_2e$ or lbs |
| $E_{Reduced\_YrF}$ | = | Emission reductions from displaced autos in final year | $MTCO_2e$ or lbs |
| $QP$ | = | Quantification period | years |

Equation 9 calculates the annual emission reductions associated with auto VMT displaced.

**Equation 9: Annual Emission Reductions from Displaced Auto VMT**

$$E_{Reduced\_Yr} = \frac{AutoVMT_{Displaced\_Yr} \times EF_{Yr}}{CF}$$

| Where, | | | Units |
|---|---|---|---|
| $E_{Reduced\_Yr}$ | = | Annual emission reductions from displaced auto VMT | $MTCO_2e$/yr or lbs/yr |
| $AutoVMT_{Displaced\_Yr}$ | = | Estimated annual VMT displaced attributed to the operation of the new service | miles/yr |
| $EF_{Yr}$ | = | Emission factor in the first or final year (based on weighted fleet average) | grams/mile |
| $CF$ | = | Conversion factor | grams/MT or grams/lb |
| $E_{Reduced\_Yr}$ | = | Emission reductions from displaced autos per year | $MTCO_2e$/yr or lbs/yr |

Equation 10 calculates the annual auto VMT displaced from the project.

**Equation 10: Annual Auto VMT Displaced in Miles per Year**

$$AutoVMT_{Yr} = R_{Yr} \times A \times L$$

| *Where,* | | | Units |
|---|---|---|---|
| $AutoVMT_{Yr}$ | = | Annual auto VMT displaced in the first or final year | miles |
| $R_{Yr}$ | = | Annual increase in unlinked passenger trips directly associated with the first or final year | riders |
| *A* | = | Adjustment factor to account for transit dependency. Use documented, project-specific data or system average developed from recent, statistically-valid survey or default. Applicants may use default values in Appendix A for similar service. | unitless |
| *L* | = | Estimated length of average unlinked passenger trip directly associated with the project, calculated as passenger-miles divided by unlinked trips. Applicants may use data reported to National Transit Database (Appendix A) for similar service. | mile(s) per rider |

# C. Emission Reductions from Technology Conversion

Equation 11 estimates both the GHG and air pollutant emission reductions from Technology Conversion as the difference between the emissions associated with the baseline vehicle and emissions associated with the new vehicle.

**Equation 11: Emission Reductions from Cleaner Vehicles / Technology / Fuels**

$$E = E_{Vehicle\_Baseline} - E_{Vehicle\_New}$$

| Where, | | | Units |
|---|---|---|---|
| $E$ | = | Net emission reductions | $MTCO_2e$ or lbs |
| $E_{Vehicle\_Baseline}$ | = | Total emissions from baseline vehicle | $MTCO_2e$ or lbs |
| $E_{Vehicle\_New}$ | = | Total emissions from new vehicle | $MTCO_2e$ or lbs |

Equation 12 calculates the emissions associated with the baseline and new vehicles.

**Equation 12: Emissions from Baseline or New Vehicle**

$$E_{Vehicle} = AE_{Vehicle} \times QP$$

| Where, | | | Units |
|---|---|---|---|
| $E_{Vehicle}$ | = | Total emissions from baseline or new vehicle(s) | $MTCO_2e$ or lbs |
| $AE_{Vehicle}$ | = | Average annual emissions from the baseline or new vehicle | $MTCO_2e$/yr or lbs/yr |
| $QP$ | = | Quantification period | years |

Equation 13 calculates the annual emissions associated with the baseline and new vehicles. For train and ferry services, annual emissions may be calculated based upon inputs for annual fuel consumption. Train services include heavy rail, light rail, and DMUs/EMUs.

**Equation 13: Annual Emissions from Baseline or New Vehicle**

$$AE_{Vehicle} = \frac{VMT \times VehicleEF \times HDR}{CF} \quad \textbf{Or (for train/ferry only)} \quad AE_{Vehicle} = \frac{Fuel \times FuelEF \times HDR}{CF}$$

| Where, | | | Units |
|---|---|---|---|
| $AE_{Vehicle}$ | = | Average annual emissions from the displaced or new vehicle | $MTCO_2e$/yr or lbs/yr |
| $VMT$ | = | Estimated annual VMT of the vehicle to be acquired | mile/yr |
| $VehicleEF$ | = | Emission factor, based on project-specific inputs for the current or new vehicle, from the mid-year of the project | grams/mile |
| $Fuel$ | = | Estimated annual fuel of the vehicle to be acquired, only available for train and ferry services | unit of fuel |
| $FuelEF$ | = | Emission factor based on fuel type, and engine tier for train, for the displaced or new vehicle, in the mid-year of the project | grams/unit of fuel |
| $HDR$ | = | Hybrid discount rate (0.8), if applicable | unitless |
| $CF$ | = | Conversion factor | grams/MT or grams/lb |

For the acquisition of a new zero-emission vehicle where there is no current vehicle to be replaced, applicants will enter current vehicle information of the newest available fossil fuel-equivalent vehicle. For example, if the project was to purchase a zero-emission vehicle that would be operational in 2021, the applicant should input a 2021 model year fossil fuel vehicle in place of the current vehicle information.

For the acquisition of a new vehicle where there is a current vehicle to be replaced, the LCTOP Calculator Tool requires project-specific inputs regarding the current vehicle to calculate the emission estimates.

# D. Emission Reductions from Fuel/Energy Reduction

Equation 14 estimates the GHG and air pollutant emission reductions from Fuel/Energy Reduction as the emission reductions from reduced fuel or energy usage.

**Equation 14: Emission Reduction Estimates from Fuel/Energy Reduction**

$$E = AE_{Fuel/Energy} \times QP$$

| Where, | | | Units |
|---|---|---|---|
| $E$ | = | Net emission reductions | $MTCO_2e$ or lbs |
| $AE_{Fuel/Energy}$ | = | Annual emission reductions from fuel/energy reduction | $MTCO_2e$/yr or lbs/yr |
| $QP$ | = | Quantification period | years |

Equation 15 calculates the annual GHG emission reductions associated with fuel/energy reduction.

**Equation 15: Annual GHG Emission Reductions from Fuel/Energy Reduction**

$$AE_{Fuel/Energy\_GHG} = \frac{Fuel \times FuelEF \times ED}{CF}$$

| Where, | | | Units |
|---|---|---|---|
| $AE_{Fuel/Energy\_GHG}$ | = | Annual GHG emission reductions from fuel/energy reduction | $MTCO_2e$/yr |
| *Fuel* | = | Estimated annual fuel/energy reductions | unit of fuel/yr |
| *FuelEF* | = | GHG emission factor, based on fuel type and mid-year of the project | grams/MJ |
| *ED* | = | Energy density, based on fuel type | MJ/ unit of fuel |
| *CF* | = | Conversion factor | grams/MT |

Equation 16 calculates the annual air pollutant emission reductions associated with fuel/energy reduction.

**Equation 16: Annual Air Pollutant Emission Reductions from Fuel/Energy Reduction**

$$AE_{Fuel/Energy\_AP} = \frac{Fuel \times FuelCR \times FuelEF}{CF}$$

| Where, | | | Units |
|---|---|---|---|
| $AE_{Fuel/Energy\_AP}$ | = | Annual air pollutant emission reductions from fuel/energy reductions | lbs/yr |
| *Fuel* | = | Estimated annual fuel/energy reductions | unit of fuel/yr |
| *FuelCR* | = | Fuel consumption rate of the vehicle from the mid-year of the project | miles/unit of fuel |
| *FuelEF* | = | Air pollutant emission factor based on fuel type, from the mid-year of the project | grams/mile |
| *CF* | = | Conversion factor | grams/MT |

# Section C. References

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

California Air Resources Board. (2019). California Climate Investments Quantification Methodology Emission Factor Database. http://www.arb.ca.gov/cci-resources

California Air Resources Board, California Department of Transportation. (2005). 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. https://www.arb.ca.gov/planning/tsaq/eval/eval.htm

Federal Transit Administration. National Transit Database. https://www.transit.dot.gov/ntd

National Renewable Energy Laboratory. (2012). Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics. https://www.nrel.gov/docs/fy13osti/56487.pdf

National Renewable Energy Laboratory. (2017). PV Watts Calculator. https://pvwatts.nrel.gov/

# Appendix A. Default Lookup Tables

CARB staff developed these recommended values for applicants to use for the length of the average unlinked passenger trip and baseline average fare cost, by agency or statewide, by mode, and by type of service using 2017 Annual data from the National Transit Database[6]. These values were calculated by dividing passenger miles traveled by unlinked passenger trips. Adjustment factors were developed by the Institute of Transportation Studies based on a review of research on transit dependency and data from the 2013 California Household Travel Survey[7].

**List of Acronyms and Abbreviations**

| Acronym | Term |
|---|---|
| CB | commuter bus |
| CC | cable car |
| CR | commuter rail |
| DO | directly operated |
| DR | demand response |
| DT | demand response taxi |
| FB | ferryboat |
| HR | heavy rail |
| LR | light rail |
| MB | bus |
| MG | monorail/automated guideway |
| PT | purchased transportation |
| RB | bus rapid transit |
| SR | streetcar rail |
| TB | trolley bus |
| VP | vanpool |
| YR | hybrid rail |

[6] Federal Transit Administration. National Transit Database. Available at https://www.transit.dot.gov/ntd.
[7] Handy, Susan, Elisa Barbour, Alissa Kendall, Jamey Volker (2019) Updated Default Values for Transit Dependency and Average Length of Unlinked Transit Passenger Trips, for Calculations Using TAC Methods for California Climate Investments Programs. Institute of Transportation Studies, University of California, Davis.
https://ww3.arb.ca.gov/cc/capandtrade/auctionproceeds/transit_factors_technical_081319.pdf

**Table A-1. Length of Average Trip and Adjustment Factor by Mode**

| Mode Type | Mode | Type of Service | Length of Average Trip (Miles/Trip) | Adjustment Factor |
|---|---|---|---|---|
| Commuter Bus (Express/Intercity) | CB | DO | 17.57 | 0.705 |
| Commuter Bus (Express/Intercity) | CB | PT | 21.83 | 0.705 |
| Cable Car | CC | DO | 1.26 | 0.479 |
| Commuter Rail | CR | PT | 25.69 | 0.867 |
| Demand Response | DR | DO | 9.08 | 0.540 |
| Demand Response | DR | PT | 9.94 | 0.540 |
| Demand Response Taxi | DT | PT | 12.35 | 0.540 |
| Ferryboat | FB | DO | 10.85 | 1 |
| Ferryboat | FB | PT | 15.01 | 1 |
| Heavy Rail | HR | DO | 11.48 | 0.794 |
| Light Rail | LR | DO | 5.44 | 0.685 |
| Bus (Local) | MB | DO | 3.77 | 0.561 (Transit Bus)<br>0.585 (Shuttle) |
| Bus (Local) | MB | PT | 4.27 | 0.561 (Transit Bus)<br>0.585 (Shuttle) |
| Monorail/Automated Guideway | MG | PT | 3.18 | 0.479 |
| Bus Rapid Transit | RB | DO | 6.56 | 0.542 |
| Streetcar Rail | SR | DO | 1.43 | 0.479 |
| Trolley Bus | TB | DO | 1.48 | 0.479 |
| Vanpool | VP | DO | 42.28 | 0.879 |
| Vanpool | VP | PT | 44.27 | 0.879 |
| Hybrid Rail | YR | PT | 8.58 | 0.738 |

**Table A-2. Length of Average Trip and Average Fare Cost by Transit Agency**

| Agency | Mode | Type of Service | Length of Average Trip | Average Fare Cost per Trip |
|---|---|---|---|---|
| Access Services | DR | PT | 11.47 | $2.22 |
| Access Services | DT | PT | 14.69 | $2.39 |
| Alameda-Contra Costa Transit District | CB | DO | 14.19 | $2.49 |
| Alameda-Contra Costa Transit District | DR | PT | 10.47 | $3.81 |
| Alameda-Contra Costa Transit District | MB | DO | 3.28 | $1.36 |
| Alameda-Contra Costa Transit District | MB | PT | 13.03 | $2.48 |
| Altamont Corridor Express | CR | PT | 42.86 | $6.85 |

| Agency | Mode | Type of Service | Length of Average Trip | Average Fare Cost per Trip |
|---|---|---|---|---|
| Anaheim Transportation Network | MB | PT | 1.98 | $0.55 |
| Antelope Valley Transit Authority | CB | PT | 42.05 | $8.53 |
| Antelope Valley Transit Authority | DR | PT | 9.18 | $2.21 |
| Antelope Valley Transit Authority | MB | PT | 7.15 | $1.13 |
| Butte County Association of Governments | DR | PT | 4.33 | $2.09 |
| Butte County Association of Governments | MB | PT | 4.92 | $1.11 |
| California Vanpool Authority | VP | DO | 42.28 | $3.27 |
| Central Contra Costa Transit Authority | DR | PT | 9.89 | $3.55 |
| Central Contra Costa Transit Authority | MB | DO | 4.54 | $1.12 |
| City of Commerce Municipal Buslines | DR | DO | 9.36 | $0.00 |
| City of Commerce Municipal Buslines | MB | DO | 4.03 | $0.00 |
| City of Elk Grove | CB | PT | 13.46 | $1.80 |
| City of Elk Grove | DR | PT | 6.27 | $5.17 |
| City of Elk Grove | MB | PT | 4.00 | $1.34 |
| City of Fairfield - Fairfield and Suisun Transit | CB | PT | 20.40 | $3.88 |
| City of Fairfield - Fairfield and Suisun Transit | DR | PT | 9.63 | $4.94 |
| City of Fairfield - Fairfield and Suisun Transit | MB | PT | 3.17 | $1.03 |
| City of Gardena Transportation Department | DR | DO | 3.17 | $0.50 |
| City of Gardena Transportation Department | MB | DO | 3.20 | $0.77 |
| City of Glendale | DR | PT | 5.26 | $1.09 |
| City of Glendale | MB | PT | 2.20 | $0.62 |
| City of La Mirada Transit | DR | PT | 2.86 | $0.77 |
| City of Los Angeles Department of Transportation | CB | PT | 17.00 | $3.03 |
| City of Los Angeles Department of Transportation | DR | PT | 4.69 | $0.92 |
| City of Los Angeles Department of Transportation | DT | PT | 2.18 | $2.77 |
| City of Los Angeles Department of Transportation | MB | PT | 1.55 | $0.37 |
| City of Petaluma | DR | PT | 3.90 | $2.23 |
| City of Petaluma | MB | PT | 2.76 | $0.64 |
| City of Redondo Beach - Beach Cities Transit | DR | PT | 4.43 | $0.85 |

| Agency | Mode | Type of Service | Length of Average Trip | Average Fare Cost per Trip |
|---|---|---|---|---|
| City of Redondo Beach - Beach Cities Transit | MB | PT | 4.10 | $0.84 |
| City of Riverside Special Transportation | DR | DO | 7.79 | $2.11 |
| City of San Luis Obispo | MB | PT | 3.10 | $0.62 |
| City of Santa Rosa | DR | PT | 5.46 | $3.13 |
| City of Santa Rosa | MB | DO | 3.94 | $0.77 |
| City of Santa Rosa | MB | PT | 3.00 | $10.28 |
| City of Tulare | DR | PT | 5.38 | $2.27 |
| City of Tulare | MB | PT | 4.36 | $0.84 |
| City of Turlock | DR | PT | 7.42 | $3.01 |
| City of Turlock | MB | PT | 3.33 | $0.56 |
| City of Visalia - Visalia City Coach | CB | PT | 45.01 | $7.69 |
| City of Visalia - Visalia City Coach | DR | PT | 7.69 | $3.93 |
| City of Visalia - Visalia City Coach | MB | PT | 6.26 | $0.90 |
| Culver City Municipal Bus Lines | DR | DO | 2.03 | $0.45 |
| Culver City Municipal Bus Lines | MB | DO | 3.33 | $0.63 |
| El Dorado County Transit Authority | CB | DO | 31.03 | $5.37 |
| El Dorado County Transit Authority | DR | DO | 11.22 | $10.25 |
| El Dorado County Transit Authority | MB | DO | 8.97 | $1.47 |
| Foothill Transit | MB | PT | 7.62 | $1.19 |
| Fresno Area Express | DR | PT | 7.30 | $1.30 |
| Fresno Area Express | MB | DO | 2.60 | $0.79 |
| Gold Coast Transit | DR | PT | 7.45 | $2.62 |
| Gold Coast Transit | MB | DO | 4.25 | $0.81 |
| Golden Empire Transit District | DR | DO | 6.48 | $2.69 |
| Golden Empire Transit District | MB | DO | 3.59 | $0.84 |
| Golden Gate Bridge, Highway and Transportation District | DR | PT | 11.82 | $4.09 |
| Golden Gate Bridge, Highway and Transportation District | FB | DO | 10.85 | $8.05 |
| Golden Gate Bridge, Highway and Transportation District | MB | DO | 18.65 | $4.79 |
| Imperial County Transportation Commission | DR | PT | 18.47 | $2.09 |
| Imperial County Transportation Commission | MB | PT | 9.91 | $0.83 |
| Kings County Area Public Transit Agency | DR | PT | 3.75 | $1.92 |
| Kings County Area Public Transit Agency | MB | PT | 6.46 | $0.73 |
| Laguna Beach Municipal Transit | MB | DO | 2.22 | $0.04 |

| Agency | Mode | Type of Service | Length of Average Trip | Average Fare Cost per Trip |
|---|---|---|---|---|
| Livermore / Amador Valley Transit Authority | DR | PT | 6.02 | $4.14 |
| Livermore / Amador Valley Transit Authority | MB | PT | 4.62 | $1.22 |
| Long Beach Transit | DR | PT | 4.76 | $1.66 |
| Long Beach Transit | MB | DO | 3.23 | $0.61 |
| Los Angeles County Metropolitan Transportation Authority dba: Metro | HR | DO | 5.00 | $0.78 |
| Los Angeles County Metropolitan Transportation Authority dba: Metro | LR | DO | 7.31 | $0.78 |
| Los Angeles County Metropolitan Transportation Authority dba: Metro | MB | DO | 4.03 | $0.82 |
| Los Angeles County Metropolitan Transportation Authority dba: Metro | MB | PT | 4.72 | $0.43 |
| Los Angeles County Metropolitan Transportation Authority dba: Metro | RB | DO | 6.56 | $0.78 |
| Los Angeles County Metropolitan Transportation Authority dba: Metro | VP | PT | 44.79 | $3.93 |
| Marin County Transit District | DR | PT | 8.10 | $3.33 |
| Marin County Transit District | MB | PT | 4.09 | $1.08 |
| Modesto Area Express | DR | PT | 6.84 | $2.87 |
| Modesto Area Express | DT | PT | 4.90 | $1.69 |
| Modesto Area Express | MB | PT | 4.26 | $0.89 |
| Montebello Bus Lines | DT | PT | 2.16 | $0.29 |
| Montebello Bus Lines | MB | DO | 3.25 | $0.76 |
| Montebello Bus Lines | MB | PT | 2.90 | $1.20 |
| Monterey-Salinas Transit | CB | DO | 40.49 | $16.91 |
| Monterey-Salinas Transit | DR | PT | 8.58 | $2.59 |
| Monterey-Salinas Transit | MB | DO | 6.21 | $2.14 |
| Monterey-Salinas Transit | MB | PT | 3.71 | $1.92 |
| Napa Valley Transportation Authority | CB | PT | 30.84 | $2.33 |
| Napa Valley Transportation Authority | DR | PT | 7.19 | $2.43 |
| Napa Valley Transportation Authority | MB | PT | 7.42 | $0.69 |
| North County Transit District | CR | PT | 26.44 | $4.04 |
| North County Transit District | DR | PT | 12.97 | $3.83 |
| North County Transit District | MB | PT | 4.32 | $0.95 |
| North County Transit District | YR | PT | 8.58 | $1.06 |
| Norwalk Transit System | DR | PT | 3.41 | $1.14 |
| Norwalk Transit System | MB | DO | 4.19 | $0.88 |
| Omnitrans | DR | PT | 14.01 | $3.78 |

| Agency | Mode | Type of Service | Length of Average Trip | Average Fare Cost per Trip |
|---|---|---|---|---|
| Omnitrans | MB | DO | 5.14 | $1.01 |
| Omnitrans | MB | PT | 3.12 | $1.08 |
| Orange County Transportation Authority | CB | DO | 21.11 | $1.68 |
| Orange County Transportation Authority | CB | PT | 19.28 | $1.44 |
| Orange County Transportation Authority | DR | PT | 11.29 | $4.42 |
| Orange County Transportation Authority | DT | PT | 3.02 | $3.44 |
| Orange County Transportation Authority | MB | DO | 3.35 | $0.99 |
| Orange County Transportation Authority | MB | PT | 3.88 | $0.97 |
| Orange County Transportation Authority | VP | PT | 34.51 | $3.95 |
| Paratransit, Inc. | DR | DO | 9.74 | $4.20 |
| Paratransit, Inc. | DR | PT | 10.46 | $7.07 |
| Paratransit, Inc. | DT | PT | 8.37 | $4.47 |
| Peninsula Corridor Joint Powers Board dba: Caltrain | CR | PT | 21.77 | $4.96 |
| Peninsula Corridor Joint Powers Board dba: Caltrain | MB | PT | 3.47 | $0.00 |
| Placer County Department of Public Works and Facilities | CB | PT | 20.11 | $5.37 |
| Placer County Department of Public Works and Facilities | DR | DO | 11.84 | $3.53 |
| Placer County Department of Public Works and Facilities | DR | PT | 3.41 | $0.73 |
| Placer County Department of Public Works and Facilities | DT | PT | 15.71 | $3.54 |
| Placer County Department of Public Works and Facilities | MB | DO | 7.64 | $1.05 |
| Placer County Department of Public Works and Facilities | MB | PT | 3.09 | $0.67 |
| Placer County Department of Public Works and Facilities | VP | PT | 33.94 | $2.79 |
| Pomona Valley Transportation Authority | DR | PT | 5.50 | $0.81 |
| Pomona Valley Transportation Authority | DT | PT | 4.81 | $1.94 |
| Redding Area Bus Authority | DR | PT | 8.86 | $3.26 |
| Redding Area Bus Authority | MB | PT | 6.99 | $1.02 |
| Riverside Transit Agency | CB | DO | 19.49 | $3.83 |
| Riverside Transit Agency | CB | PT | 23.22 | $2.08 |
| Riverside Transit Agency | DR | PT | 11.28 | $3.68 |
| Riverside Transit Agency | DT | PT | 17.51 | $4.05 |
| Riverside Transit Agency | MB | DO | 6.27 | $0.90 |
| Riverside Transit Agency | MB | PT | 6.64 | $1.33 |

| Agency | Mode | Type of Service | Length of Average Trip | Average Fare Cost per Trip |
|---|---|---|---|---|
| Sacramento Regional Transit District | DR | DO | 2.59 | $1.38 |
| Sacramento Regional Transit District | LR | DO | 6.01 | $1.29 |
| Sacramento Regional Transit District | MB | DO | 3.46 | $1.53 |
| San Diego Association of Governments | VP | PT | 48.70 | $3.11 |
| San Diego Metropolitan Transit System | CB | PT | 24.51 | $4.17 |
| San Diego Metropolitan Transit System | DR | PT | 10.38 | $4.52 |
| San Diego Metropolitan Transit System | LR | DO | 5.61 | $1.04 |
| San Diego Metropolitan Transit System | MB | DO | 4.51 | $1.02 |
| San Diego Metropolitan Transit System | MB | PT | 3.25 | $1.00 |
| San Francisco Bay Area Rapid Transit District | HR | DO | 13.72 | $3.64 |
| San Francisco Bay Area Rapid Transit District | MG | PT | 3.18 | $5.58 |
| San Francisco Bay Area Water Emergency Transportation Authority | FB | PT | 15.01 | $7.07 |
| San Francisco Municipal Railway | CC | DO | 1.26 | $4.34 |
| San Francisco Municipal Railway | DR | PT | 6.17 | $2.29 |
| San Francisco Municipal Railway | LR | DO | 2.73 | $0.77 |
| San Francisco Municipal Railway | MB | DO | 2.15 | $0.77 |
| San Francisco Municipal Railway | SR | DO | 1.43 | $0.77 |
| San Francisco Municipal Railway | TB | DO | 1.48 | $0.77 |
| San Joaquin Regional Transit District | CB | PT | 44.30 | $4.45 |
| San Joaquin Regional Transit District | DT | PT | 5.83 | $3.73 |
| San Joaquin Regional Transit District | MB | DO | 3.53 | $0.82 |
| San Joaquin Regional Transit District | MB | PT | 4.56 | $0.82 |
| San Luis Obispo Regional Transit Authority | DR | DO | 7.85 | $3.05 |
| San Luis Obispo Regional Transit Authority | MB | DO | 11.05 | $1.31 |
| San Mateo County Transit District | DR | PT | 8.10 | $2.51 |
| San Mateo County Transit District | DT | PT | 11.89 | $2.38 |
| San Mateo County Transit District | MB | DO | 3.61 | $1.32 |
| San Mateo County Transit District | MB | PT | 6.19 | $1.34 |
| Santa Barbara Metropolitan Transit District | MB | DO | 4.09 | $1.12 |
| Santa Clara Valley Transportation Authority | DR | PT | 10.24 | $3.45 |
| Santa Clara Valley Transportation Authority | DT | PT | 10.68 | $2.86 |
| Santa Clara Valley Transportation Authority | LR | DO | 5.25 | $0.88 |
| Santa Clara Valley Transportation Authority | MB | DO | 5.18 | $0.88 |

| Agency | Mode | Type of Service | Length of Average Trip | Average Fare Cost per Trip |
|---|---|---|---|---|
| Santa Clara Valley Transportation Authority | MB | PT | 3.68 | $0.00 |
| Santa Clarita Transit | CB | PT | 24.78 | $3.03 |
| Santa Clarita Transit | DR | PT | 6.11 | $1.14 |
| Santa Clarita Transit | MB | PT | 4.23 | $0.84 |
| Santa Cruz Metropolitan Transit District | CB | DO | 31.21 | $5.42 |
| Santa Cruz Metropolitan Transit District | DR | DO | 7.24 | $4.08 |
| Santa Cruz Metropolitan Transit District | DT | PT | 7.23 | $2.09 |
| Santa Cruz Metropolitan Transit District | MB | DO | 4.27 | $1.52 |
| Santa Maria Area Transit | DR | PT | 7.40 | $0.44 |
| Santa Maria Area Transit | MB | PT | 3.73 | $1.02 |
| Santa Monica's Big Blue Bus | DR | PT | 2.27 | $0.41 |
| Santa Monica's Big Blue Bus | MB | DO | 3.81 | $0.89 |
| Solano County Transit | CB | PT | 13.78 | $2.50 |
| Solano County Transit | DR | PT | 5.36 | $2.21 |
| Solano County Transit | MB | PT | 2.64 | $2.43 |
| Sonoma County Transit | DR | PT | 12.17 | $3.77 |
| Sonoma County Transit | MB | PT | 8.33 | $1.49 |
| Southern California Regional Rail Authority dba: Metrolink | CR | PT | 29.15 | $5.79 |
| SunLine Transit Agency | DR | DO | 12.02 | $2.05 |
| SunLine Transit Agency | MB | DO | 6.86 | $0.65 |
| The Eastern Contra Costa Transit Authority | DR | PT | 6.00 | $3.08 |
| The Eastern Contra Costa Transit Authority | MB | PT | 7.23 | $1.11 |
| Torrance Transit System | DT | PT | 5.20 | $1.74 |
| Torrance Transit System | MB | DO | 4.95 | $0.66 |
| Transit Joint Powers Authority for Merced County | DR | PT | 6.36 | $3.69 |
| Transit Joint Powers Authority for Merced County | MB | PT | 6.22 | $1.57 |
| Unitrans - City of Davis/ASUCD | MB | DO | 2.15 | $0.79 |
| Ventura Intercity Service Transit Authority | CB | PT | 20.34 | $1.60 |
| Ventura Intercity Service Transit Authority | DR | PT | 3.18 | $1.75 |
| Ventura Intercity Service Transit Authority | MB | PT | 4.37 | $0.85 |
| Victor Valley Transit Authority | CB | PT | 52.89 | $10.12 |
| Victor Valley Transit Authority | DR | PT | 13.17 | $2.96 |
| Victor Valley Transit Authority | MB | PT | 6.74 | $1.08 |
| Victor Valley Transit Authority | VP | PT | 48.72 | $4.17 |

| Agency | Mode | Type of Service | Length of Average Trip | Average Fare Cost per Trip |
|---|---|---|---|---|
| Western Contra Costa Transit Authority | CB | PT | 23.95 | $4.12 |
| Western Contra Costa Transit Authority | DR | PT | 8.15 | $1.35 |
| Western Contra Costa Transit Authority | MB | PT | 7.29 | $1.10 |
| Yolo County Transportation District | DR | PT | 12.25 | $4.88 |
| Yolo County Transportation District | MB | PT | 10.63 | $1.67 |
| Yuba-Sutter Transit Authority | CB | PT | 39.33 | $4.48 |
| Yuba-Sutter Transit Authority | DR | PT | 5.87 | $1.83 |
| Yuba-Sutter Transit Authority | MB | PT | 3.05 | $0.65 |