

California Air Resources Board

**Greenhouse Gas Quantification Methodology for
Air Resources Board
Low Carbon Transportation Program
Consumer-Based Light-Duty Projects**

**Greenhouse Gas Reduction Fund
Fiscal Year 2016-17**



December 16, 2016

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Section A. Introduction

The goal of California Climate Investments (CCI) is to reduce greenhouse gas (GHG) emissions and further the purposes of the Global Warming Solutions Act of 2006, known as Assembly Bill (AB) 32. The California Air Resources Board (ARB) is responsible for providing the quantification methodology to estimate the GHG emission reductions from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). ARB develops these methodologies based on the project types eligible for funding by each administering agency, as reflected in the program Expenditure Records available at:

<https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/expenditurerecords.htm>.

The ARB Low Carbon Transportation Program (LCT) is comprised of 16 different project types. A subset of these projects, referred to as Consumer-Based Light-Duty Projects, provide incentives for the purchase or lease of advanced technology light-duty passenger vehicles and have been grouped together for this quantification methodology. ARB staff developed this quantification methodology to estimate GHG emission reductions from supported advanced vehicle technology types (Sections B and C), provide instructions for documenting and supporting the estimate (Section D), and outline the process for tracking and reporting GHG emission reductions once a project is funded (Section E). The emission reduction calculations detailed in this quantification methodology are based on the methods described in the Fiscal Year (FY) 2016-17 Funding Plan for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Project, Appendix A - Emission Reduction: Quantification Methodology¹, which ARB developed through a public process.

LCT Consumer-Based Light-Duty Projects

The LCT Consumer-Based Light-Duty Projects reduce GHG emissions by providing incentives for advanced vehicle technology types, such as conventional hybrid, plug-in hybrid, battery-electric, and fuel cell passenger vehicles. ARB has identified four LCT Consumer-Based Light-Duty Projects:

1. Clean Vehicle Rebate Project (CVRP)

CVRP provides vehicle rebates on a first-come, first-served basis to California residents, businesses, non-profit organizations and government entities that purchase or lease plug-in hybrid, battery-electric, or fuel cell vehicles to achieve GHG emission reductions.

¹ https://www.arb.ca.gov/msprog/ajip/fundplan/proposed_fy16-17_fundingplan_full.pdf

2. Public Fleets in Disadvantaged Communities

Incentives for Public Fleets in Disadvantaged Communities offers rebates to public fleets located in or serving disadvantaged communities for plug-in hybrid, battery-electric, and fuel cell vehicles.

3. Enhanced Fleet Modernization Program (EFMP) Plus-Up

EFMP Plus-Up provides incentives to lower-income consumers, living within or near disadvantaged communities, to voluntarily retire their existing older, higher-emitting vehicle and replace it with a newer advanced technology vehicle or alternate transportation mobility option. Advanced technology replacement vehicles include new or used conventional hybrid, plug-in hybrid, battery-electric or fuel cell vehicles meeting EFMP Plus-Up requirements. Alternative transportation mobility options such as transit passes or car sharing are additional options available for consumers in lieu of a replacement vehicle. For consumers purchasing battery-electric replacement vehicles, additional incentives are also available for residential electric vehicle service equipment installations.

4. Financing Assistance

Light-Duty Financing Assistance offers financing options to low-income or disadvantaged individuals in disadvantaged communities in order to improve financing options for low-income individuals interested in purchasing advanced technology vehicles.

Methodology Development

ARB developed this quantification methodology consistent with the guiding implementation principles of CCI, including ensuring transparency and accountability.² This quantification methodology will be used to estimate the GHG emission reductions for awarded funds and implemented projects. The implementing principles ensure that the methodology will:

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

² California Air Resources Board. Funding Guidelines for Agencies Administering California Climate Investments. December 21, 2015. <http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/arb-funding-guidelines-for-ca-climate-investments.pdf>. Accessed on September 12, 2016.

ARB will quantify and report GHG emission reduction estimates using two approaches:

1. Awarded funds. Estimates will be quantified using the methods described in Section B upon funding allocation.
2. Implemented Projects. Estimates will be quantified using the methods described in Section C as projects are implemented.

These estimates are calculated using equations listed in Section B and Section C and the emission factors and project data assumptions in Appendix A.

Program Assistance

ARB staff will ensure that the quantification methods described in this document are properly applied to estimate the GHG emission reductions for the project types.

- Questions on this quantification document should be sent to:
GGRFProgram@arb.ca.gov.
- Questions not related to this quantification document, but pertaining LCT Consumer-Based Light-Duty Projects should be sent to:

1. **CVRP**

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2. **Public Fleets in Disadvantaged Communities**

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3. **EFMP Plus-Up**

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or

Nicholas Nairn-Birch
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4. **Financing Assistance**

Laura Zarembo-Schmidt
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- For more information on ARB's efforts to support implementation of GGRF investments, see: www.arb.ca.gov/auctionproceeds.

Section B. Greenhouse Gas Quantification Methodology for Awarded Funds

The quantification methodology in this section describes how ARB will estimate the GHG emission reductions based on funds allocated to the LCT Consumer-Based Light-Duty Projects. This methodology is to be used for each project type separately. Additionally, results for each project type are to be reported separately.

Step 1. Calculate the Annual GHG Emission Reductions for each Advanced Vehicle Technology Type

The annual GHG emission reductions are calculated for each advanced vehicle technology type (e.g., plug-in hybrid, battery-electric, fuel cell, conventional hybrid) using the emission factors and annual VMT assumptions included in Appendix A and Equation 1.

$$ER_{AV} = \frac{(EF_C - EF_{AV}) * (VMT)}{1,000,000} \quad (\text{Eq. 1})$$

Where,

ER_{AV}	is the annual GHG emission reductions from the use of one advanced technology vehicle in place of one conventional gasoline vehicle (MT CO ₂ e/year);
EF_C	is the emission factor for the baseline conventional gasoline vehicle ³ (g CO ₂ e/mile);
EF_{AV}	is the emission factor for the advanced vehicle technology type (g CO ₂ e/mile); and
VMT	is the annual VMT for the vehicle (miles/year).

Step 2. Calculate the Weighted Average Annual GHG Emission Reductions

A weighted average for the project (e.g., CVRP, Public Fleets, EFMP Plus-Up, Financing Assistance) is then calculated using the proportion of funding that each advanced vehicle technology type received historically (Appendix A) and Equation 2.

$$ER_{WtAvg} = \sum_{i=1}^n P_{AV,i} * ER_{AV,i} \quad (\text{Eq. 2})$$

Where,

ER_{WtAvg}	is the weighted average annual GHG emission reductions from
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³ The baseline conventional gasoline vehicle model year to be used for each project type is listed in Appendix A.

$P_{AV,i}$ is the historical proportion of the advanced vehicle technology type (percent); and
 $ER_{AV,i}$ is the annual GHG emission reduction from the use of one advanced technology vehicle in place of one conventional gasoline vehicle (MT CO₂e/year).

Step 3. Calculate the Number of Vehicles Funded

The number of vehicles funded is calculated for each project type using Equation 3.

$$N = \frac{\text{Project Allocation Amount (\$)} * (1 - A)}{\text{Weighted Average Project Rebate Amount (\$)}} \quad (\text{Eq. 3})$$

Where,

N is the number of vehicles funded; and
 A is the adjustment factor used to account for project administration costs (percent), which are based on project-specific data.

Step 4. Calculate the Total Project GHG Emission Reductions

The total GHG emission reductions for each project type (e.g., CVRP, Public Fleets, EFMP Plus-Up, Financing Assistance) is calculated using the weighted annual GHG emission reductions calculated in Step 2, project assumptions in Appendix A, and Equation 4.

$$ER_{PL} = ER_{WtAvg} * N * UL \quad (\text{Eq. 4})$$

Where,

ER_{PL} is the total project GHG emission reduction (MT CO₂e);
 ER_{WtAvg} is the result from Step 2;
 N is the result from Step 3; and
 UL is the average project life for a vehicle (years).

Section C. Greenhouse Gas Quantification Methodology for Implemented Projects

The quantification methodology in this section describes how ARB will refine the GHG emission reduction estimates from Section B as the grant administrator reports project-specific numbers for rebates issued. This methodology is to be used for each project type separately. Additionally, results for each project type are to be reported separately.

Step 1. Calculate the Total GHG Emission Reduction for each Advanced Vehicle Technology Type

The total GHG emission reductions is calculated for each advanced vehicle technology type (e.g., plug-in hybrid, battery-electric, fuel cell, conventional hybrid) using the emission factors and project assumptions in Appendix A, the number of rebates issued for each advanced vehicle technology type, and Equation 5.

$$ER_{AV_PL} = \frac{(EF_C - EF_{AV}) * (VMT) * R_{AV} * UL}{1,000,000} \quad (\text{Eq. 5})$$

Where,

ER_{AV_PL}	is the total GHG emission reductions from an advanced vehicle technology type (MT CO ₂ e);
EF_C	is the emission factor for the baseline conventional gasoline vehicle ⁴ (g CO ₂ e/mile);
EF_{AV}	is the emission factor for the advanced vehicle technology type (g CO ₂ e/mile);
VMT	is the annual VMT for the vehicle (miles/year);
R_{AV}	is the number of vehicle rebates given out for the advanced vehicle technology type; and
UL	is the project life for the vehicle (years).

Step 2. Calculate the Total Project GHG Emission Reductions

The total project (e.g., CVRP, Public Fleets, EFMP Plus-Up, Financing Assistance) GHG emission reductions is calculated by summing the emission reductions from each advanced vehicle technology type funded by the project.

$$ER_{PL} = \sum ER_{AV_PL} \quad (\text{Eq. 6})$$

Where,

ER_{PL}	is the total project GHG emission reductions (MT CO ₂ e).
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⁴ The baseline conventional gasoline vehicle model year to be used for each project type is listed in Appendix A.

Section D. Documentation

ARB reports Total Project GHG Emission Reductions by project type for both awarded funds and implemented projects. Total Project GHG Emission Reductions per dollar of GGRF funds can be calculated using Equation 7.

$$\frac{\text{Total Project GHG Emission Reduction (MTCO}_2\text{e)}}{\text{Total GGRF Funds (\$)}} \quad (\text{Eq. 7})$$

Supporting Documentation

ARB is required to retain documentation that is sufficient to allow all quantification calculations to be reviewed and replicated.

Documentation collected with issuance of rebates includes:

- Contact information for the person who can answer project specific questions from staff reviewers on the quantification calculations;
- Project specific equipment specifications and certifications; and
- Summary page with, at a minimum, the following information:
 - Number of advanced vehicles by technology type;
 - GHG emission reduction estimates for awarded funds and implemented projects;
 - GGRF funds requested for the project; and
 - Total Project GHG emission reductions per GGRF dollar.

Section E. Reporting after Funding Award

Accountability and transparency are essential elements for all GGRF CCI projects. As described in Volume 3 of ARB’s Funding Guidelines², each administering agency is required to track and report on the benefits of the CCI funded under their program(s). Each project funded by the GGRF is expected to provide quantifiable GHG emission reductions. The previous sections of this document provide the methods used to estimate the GHG emission reductions from the purchase or lease of conventional hybrid, plug-in hybrid, battery-electric, or fuel cell light-duty vehicles. This section explains ARB’s reporting requirements for awarded funds and implemented projects.

LCT Consumer-Based Light-Duty Based Project grant administrators have the obligation to provide, or provide access to, data and information on project outcomes to ARB.

It is the responsibility of ARB to collect and compile data from the grant administrators, including information needed to refine GHG emission reduction estimates and information on benefits to disadvantaged communities.

Table 1: Quantification and Reporting by Project Phase

	Timeframe	Quantification Methods
Funding Allocation	Upon allocation of funding from the legislature, when ARB can estimate the number of vehicles that can be funded from funding allocation.	ARB uses methods in Section B to estimate GHG reductions based on funding allocations and historical project data.
Phase 1	Period from funding allocation through implementation of all allocated project funds, when the grant administrator has provided project-specific information.	ARB uses methods in Section C to calculate GHG reductions based on the actual number of rebates issued.

During the funding allocation phase, ARB estimates the GHG emission reductions anticipated by allocated funds and reports these estimates in the funding plan for the Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program. The GHG emission reductions from the alternative transportation mobility component the EFMP Plus-Up project are not currently quantified for the funding plan as no historical data is available due to it being a new project component.

During Phase 1, ARB will collect information characterizing the vehicle rebates issued. Refined emission reduction estimates will be quantified as projects are implemented and data becomes available. The GHG emission reductions from the alternative transportation mobility component of the EFMP Plus-Up project are not currently included in the quantification methodology.

Appendix A. Emission Factors and Project Data Assumptions

ARB developed a set of emissions factors using fuel consumption rates from the ARB Mobile Source Emission Factor Model (EMFAC 2014⁵) and carbon intensity values for different fuel types from the ARB Low Carbon Fuel Standards (LCFS⁶) Program. Table A-1 and Table A-2 provide an overview of the emission factors for GHG emissions for 2016 advanced technology vehicles and conventional gasoline vehicles respectively.

Table A- 1. Well-to-Wheel GHG Emission Factors for 2016 Model Year Advanced Technology Light-Duty Vehicles⁷

	Conventional Hybrid	Plug-in Hybrid (PHEV)	Battery-Electric (BEV)	Fuel Cell (FCV)
GHG (gCO ₂ e/mi)	326	243	120	137

Note: PHEV values assume operation in all-electric mode 40 percent of the time with additional fuel economy improvements provided by the use of the hybrid drivetrain.⁸

Table A- 2. Well-to-Wheel GHG Emission Factors for Conventional Gasoline Light-Duty Vehicles⁷

	2016 Gasoline	2013 Gasoline	1995 Gasoline
GHG (gCO ₂ e/mi)	382	495	495

The baseline conventional gasoline vehicle model year to be used for each project type is dependent on the model year of the conventional gasoline vehicle that is typically replaced by the advanced technology vehicle.

- CVRP and Public Fleets in Disadvantaged Communities utilize a 2016 conventional gasoline vehicle as the baseline;
- EFMP Plus-Up utilizes a 1995 model year conventional gasoline vehicle as the baseline; and
- Light-Duty Financing Assistance utilizes a 2013 model year conventional gasoline vehicle the baseline.

Vehicle usage assumptions (annual VMT) were generated through a literature review for each of the vehicle technology types. Table A-3 and Table A-4 summarize the annual mileage assumptions used for GHG emission reductions analysis.

⁵ <http://www.arb.ca.gov/emfac/2014/>

⁶ <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm>

⁷ https://www.arb.ca.gov/msprog/aqip/fundplan/proposed_fy16-17_fundingplan_full.pdf

⁸ Consistent with assumptions used in 2012 Proposed Amendments to the California Zero-Emission Vehicle Program Regulations Staff Report: Initial Statement of Reasons. <http://www.arb.ca.gov/regact/2012/zev2012/zevisor.pdf>

Table A- 3. Annual Usage Assumptions for CVRP and Financing Assistance⁹

Supported Advanced Vehicle Technology Type	Annual VMT Assumptions (miles per year)
Conventional Hybrid	14,855 ¹⁰
Plug-in Hybrid (PHEV)	14,855 ¹¹
Battery-Electric (BEV)	11,059 ¹¹
Fuel Cell (FCV)	14,855 ¹¹

Table A- 4. Annual Usage Assumptions for Public Fleets in Disadvantaged Communities and EFMP Plus-Up⁹

	Annual VMT Assumptions (miles per year)
Public Fleets in Disadvantaged Communities	10,647 ¹¹
EFMP Plus-Up	7,500 ¹¹

The proportion of each advanced vehicle technology type funded for each project type is based on historical project data. While CVRP funds fuel cell vehicles, staff found that fuel cell vehicles historically account for less than 1 percent of CVRP rebates; therefore when determining the potential GHG emission reductions for awarded funds, staff only used BEV and PHEV for the analysis. Table A-5 shows the proportion of each advanced vehicle technology type funded by project type. Table A-6 show the average rebate amount and the administration cost adjustment factors by project type.

Table A- 5. Proportion of Advanced Vehicle Technology Types Funded and Project Life by Project Type⁹

	Conventional Hybrid	Plug-in Hybrid (PHEV)	Battery-Electric (BEV)	Fuel Cell (FCV)	Project Life (years)
CVRP	0%	40%	60%	0%	15
Public Fleets in Disadvantaged Communities	0%	50%	50%	0%	15
EFMP Plus-up	55%	25%	20%	0%	3
Financing Assistance	55%	25%	20%	0%	3

⁹ https://www.arb.ca.gov/msprog/aqip/fundplan/proposed_fy16-17_fundingplan_full.pdf

¹⁰ PHEV annual VMT based on 40.7 miles per day and BEV annual VMT based on 30.3 miles per day. Smart, J., Powell, W., and Schey, S., "Extended Range Electric Vehicle Driving and Charging Behavior Observed Early in the EV Project," SAE Technical Paper 2013-01-1441, 2013, doi:10.4271/2013-01-1441. (<http://papers.sae.org/2013-01-1441/>)

¹¹ Consistent with assumptions used in 2012 Proposed Amendments to the California Zero-Emission Vehicle Program Regulations Staff Report: Initial Statement of Reasons. <http://www.arb.ca.gov/regact/2012/zev2012/zevisor.pdf>

Table A- 6. Average Rebate Amount and Administration Cost Adjustment Factors by Project Type ¹²

	Average Rebate Amount	Adjustment Factor for Admin. Costs (A)
CVRP	\$2,250	4.16%
Public Fleets in Disadvantaged Communities	\$7,625	15%
EFMP Plus-Up	\$6,125	Not Available
Financing Assistance	\$10,500	Not Available

¹² https://www.arb.ca.gov/msprog/aqip/fundplan/proposed_fy16-17_fundingplan_full.pdf