

**California Air Resources Board**

**Quantification Methodology for  
California Air Resources Board  
Low Carbon Transportation Program  
Agricultural Worker Vanpools Pilot Project**

**Greenhouse Gas Reduction Fund  
Fiscal Year 2017-18**



**FINAL  
March 1, 2018**

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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 (CARB) is responsible for providing the quantification methodology to estimate the GHG emission reductions and co-benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). CARB 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>.

CARB staff periodically review each quantification methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified.

For the CARB Low Carbon Transportation (LCT) Agricultural Worker Vanpools Pilot Project, CARB staff developed this Quantification Methodology to provide methods for estimating the GHG emission reductions and air pollutant emission co-benefits (Section B), provide instructions for documenting and supporting the estimates (Section C), and outline the process for tracking and reporting GHG and other benefits once a project is funded (Section D).

The Agricultural Worker Vanpools Pilot Project is designed to expand access to cleaner, lower GHG-emitting transportation options for agricultural workers in the San Joaquin Valley's disadvantaged communities.

In an effort to enhance the analysis, provide greater transparency, and assist in project-level reporting, CARB also included guidance for calculating air pollutant emission estimates for select criteria and toxic air pollutants. Air pollutant emission estimates are calculated using the same methodology as GHG emissions estimates for the following criteria and toxic air pollutants: reactive organic gases (ROG), nitrogen oxide (NO<sub>x</sub>), and fine particulate matter less than 2.5 micrometers (PM<sub>2.5</sub>). CARB continues to develop methodologies to assess additional social, economic, and environmental co-benefits achieved by CCI.

## Methodology Development

CARB developed this Quantification Methodology consistent with the guiding implementation principles of CCI, including ensuring transparency and accountability.<sup>i</sup> This Quantification Methodology will be used to estimate the GHG emission reductions and co-benefits for implemented projects. The implementing principles ensure that the methodology will:

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

This methodology uses calculations to estimate the emission reductions of the technology conversion from a 2017 conventional van baseline vehicle to an advanced technology van (i.e., conventional hybrid, plug-in hybrid-electric (PHEV), battery-electric (BEV), and fuel-cell electric (FCEV)). The emission reduction calculations detailed in this Quantification Methodology are based on the methods described in the Draft Fiscal Year (FY) 2017-18 Funding Plan for Clean Transportation Incentives, Appendix A - Emission Reductions: Quantification Methodology,<sup>ii</sup> which CARB developed through a public process.

These estimates are calculated using equations listed in Section B and CARB-developed emission factors. CARB has established a single repository for emission factors used in quantification methodologies, referred to as the CCI Quantification Methodology Emission Factor Database (Database).<sup>iii</sup> The Database Documentation explains how emission factors used in CARB quantification methodologies are developed and updated.

## Updates

CARB staff periodically review each quantification methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified. CARB updated the Agricultural Worker Vanpools Pilot Project Quantification Methodology from the previous version<sup>iv</sup> to enhance the analysis and provide additional clarity. The changes include:

- Separation of Agricultural Worker Vanpools Pilot Project from other LCT consumer-based heavy-duty project types;
- Updates of GHG emission factors to reflect the model year of vehicles to be purchased or leased through Agricultural Worker Vanpools Pilot Project and the baseline conventional vehicle;
- Addition of guidance and emission factors to estimate air pollutant emission co-benefits using the same methodology used to estimate GHG emissions; and
- Additional language on reporting after funding.

## Program Assistance

CARB staff will ensure that the quantification methods described in this document are properly applied to estimate the GHG emission reductions and co-benefits for the Agricultural Worker Vanpools Pilot Project.

- Questions on this document should be sent to [GGRFProgram@arb.ca.gov](mailto:GGRFProgram@arb.ca.gov).
- For more information on CARB's efforts to support implementation of GGRF investments, see: <https://www.arb.ca.gov/auctionproceeds>.
- Questions pertaining to Agricultural Worker Vanpools Pilot Project should be sent to:

Kimya Lambert  
[Kimya.Lambert@arb.ca.gov](mailto:Kimya.Lambert@arb.ca.gov)  
(916) 323-2507

## Section B. Quantification Methodology for Implemented Projects

The purpose of this quantification methodology is to document the process used by CARB to estimate GHG emission reductions and air pollutant emission co-benefits from the Agricultural Worker Vanpools Pilot Project.

Emission factors used in calculations are contained in the Database available at: [www.arb.ca.gov/ccj-quantification](http://www.arb.ca.gov/ccj-quantification). Documentation on the sources and methods used to develop the emission factors is also provided.

In general, the emission reductions are calculated using the following approach:

$$\text{Annual Emission Reductions} = \text{Emissions}_{\text{Baseline Vehicle}} - \text{Emissions}_{\text{Advanced Technology Vehicle}}$$

### Step 1. Calculate the vehicle miles traveled (VMT)

The annual VMT for a van is calculated using Equation 1.

$$VMT = \frac{\text{Trips}}{\text{Day}} * \frac{\text{Miles}}{\text{Trip}} * \frac{\text{Days}}{\text{Year}} \quad (\text{Eq. 1})$$

Where,

VMT	is the annual VMT for a van (miles/year);
Trips/Day	is the average number of one-way trips driven per day per vehicle;
Miles/Trip	is the average number of miles traveled per trip; and
Days/Year	is the number of days per year that vehicles would be available for use (365 for daily service and 200 for weekday only service).

### Step 2. Calculate the emissions produced by a baseline vanpool

The emissions produced by the baseline vanpool are the emissions that would have been produced if a baseline conventional gasoline vans were used in lieu of advanced technology vans for trips. The emissions from a baseline vanpool are calculated using Equation 2.

$$E_{BV} = VMT * EF_{BV} * N \quad (\text{Eq. 2})$$

Where,

$E_{BV}$	is the emissions from baseline vanpool (grams (g)/year);
VMT	is the result from Equation 1;
$EF_{BV}$	is the emission factor for a baseline van (g/mile); and
N	is the number of vans.

### Step 3. Calculate the emissions produced by an advanced technology vanpool

The emissions for each advanced technology van type are calculated using Equations 3 through 6. The separate emissions for the advanced technology van types are then combined using Equation 7.

Step 3a. Calculate the emissions produced by conventional hybrid vans funded under the proposed project

$$E_{CH} = VMT * EF_{CH} * N_{CH} \quad (\text{Eq. 3})$$

Where,

$E_{CH}$  is the emissions from the conventional hybrid vans funded under the proposed project (g/year);  
 $VMT$  is the result from Equation 1;  
 $EF_{CH}$  is the emission factor for a conventional hybrid van (g/mile); and  
 $N_{CH}$  is the number of conventional hybrid vans funded under the proposed project.

Step 3b. Calculate the emissions produced by PHEV vans funded under the proposed project

$$E_{PHEV} = VMT * EF_{PHEV} * N_{PHEV} \quad (\text{Eq. 4})$$

Where,

$E_{PHEV}$  is the emissions from the PHEV vans funded under the proposed project (g/year);  
 $VMT$  is the result from Equation 1;  
 $EF_{PHEV}$  is the emission factor for a PHEV van (g/mile); and  
 $N_{PHEV}$  is the number of PHEV vans funded under the proposed project.

Step 3c. Calculate the emissions produced by BEV vans funded under the proposed project

$$E_{BEV} = VMT * EF_{BEV} * N_{BEV} \quad (\text{Eq. 5})$$

Where,

$E_{BEV}$  is the emissions from the BEV vans funded under the proposed project (g/year);  
 $VMT$  is the result from Equation 1;  
 $EF_{BEV}$  is the emission factor for a BEV van (g/mile); and  
 $N_{BEV}$  is the number of BEV vans funded under the proposed project.

Step 3d. Calculate the emissions produced by FCEV vans funded under the proposed project

$$E_{FCEV} = VMT * EF_{FCEV} * N_{FCEV} \quad (\text{Eq. 6})$$

Where,

- $E_{FCEV}$  is the emissions from the FCEV vans funded under the proposed project (g/year);
- VMT is the result from Equation 1;
- $EF_{FCEV}$  is the emission factor for a FCEV van (g/mile); and
- $N_{FCEV}$  is the number of FCEV vans funded under the proposed project.

Step 3e. Calculate the total emissions of the advanced technology vans funded under the proposed project

$$E_T = E_{CH} + E_{PHEV} + E_{BEV} + E_{FCEV} \quad (\text{Eq. 7})$$

Where,

- $E_T$  is the total emissions for all the advance technology vans funded under the proposed project (g/year);
- $E_{CH}$  is the result from Equation 3;
- $E_{PHEV}$  is the result from Equation 4;
- $E_{BEV}$  is the result from Equation 5; and
- $E_{FCEV}$  is the result from Equation 6.

#### Step 4. Calculate the total emissions reductions for the quantification period

The total emission reductions for the quantification period of the project is calculated using Equation 8.

$$ER_{Fleet} = \frac{E_{BV} - E_T}{CF} * QP \quad (\text{Eq. 8})$$

Where,

- $ER_{Fleet}$  is the annual emission reductions form (MT or lbs);
- $E_{BV}$  is the result from Equation 2;
- $E_T$  is the result from Equation 7;
- QP is the quantification period (6 years); and
- CF is the conversion factor (1,000,000g/MT for GHGs and 453.6 g/lb for air pollutants).

## Section C. Documentation

CARB reports Total Project GHG Emission Reductions for implemented projects. Total Project GHG Emission Reductions per dollar of GGRF funds can be calculated using Equation 7.

$$\frac{\text{Total Project GHG Emission Reductions (MTCO}_2\text{e)}}{\text{Total GGRF Funds (\$)}} \quad (\text{Eq. 9})$$

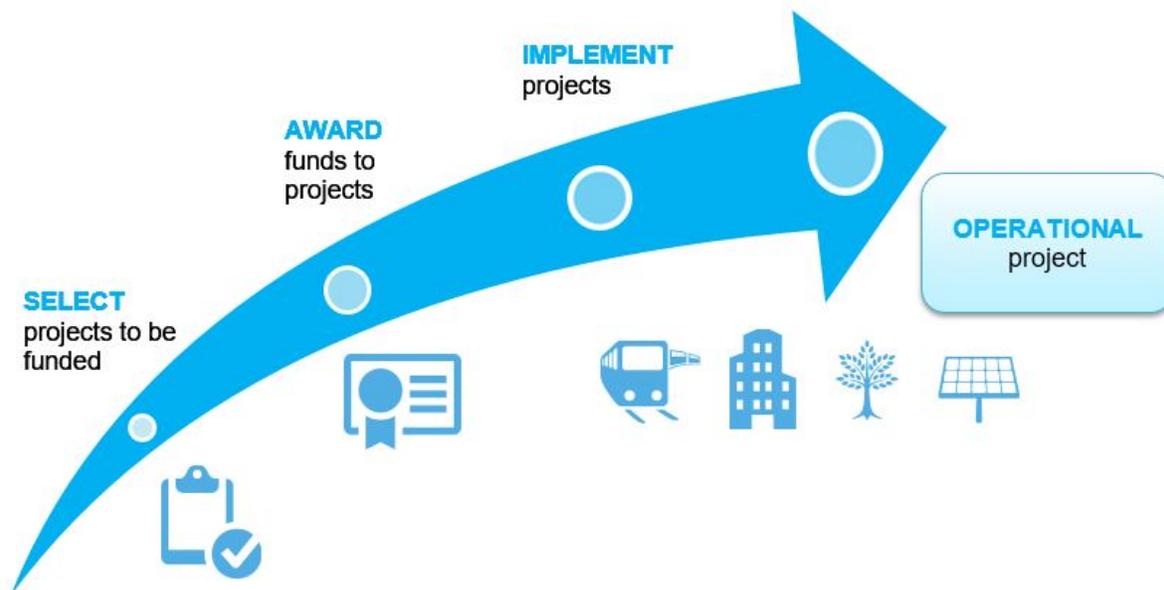
### Supporting Documentation

CARB is required to retain documentation that is sufficient to allow all quantification calculations to be reviewed and replicated. Refer to the FY 2016-17 and FY 2017-18 LCT Application for Agricultural Worker Vanpool Pilot Project for information on the required supporting documentation. Solicitation materials can be found at: <https://www.arb.ca.gov/msprog/aqip/solicitations.htm>

## Section D. Reporting after Funding Award

Accountability and transparency are essential elements for all CCI. All administering agencies are required to track project implementation and report on the benefits of those investments. CARB develops tracking and reporting guidance for CCI. The reporting process and requirements are found in Volume 3 of the Draft Funding Guidelines.<sup>1</sup> Draft Funding Guidelines Appendices 3.A and 3.B contain detailed reporting requirements that are specific to each project type or administering agency and cover all stages of reporting.

The specific data that need to be reported depend on the project type and the stage of project implementation at the time of reporting. Initially, administering agencies must report basic project information and expected benefits. As projects are implemented, administering agencies provide additional information on project status, benefits, and results. When projects are completed, administering agencies submit project closeout reports. A subset of projects, selected by CARB, will report on project outcomes upon reaching a specified milestone and being considered “operational.”



CARB is required to collect and compile project data from funding recipients, including the GHG emission reductions estimated using this Quantification Methodology, co-benefits, and information on benefits to AB 1550<sup>2</sup> Populations. Reported information will be used to demonstrate how the Administration is achieving or exceeding the

<sup>1</sup> CARB released updated Draft Funding Guidelines in August 2017. These Draft Funding Guidelines are subject to change based on public input and Board direction. While the draft provides an indication of what is currently required, administering agencies must incorporate all provisions reflected in the draft Funding Guidelines and subsequent Board approved Funding Guidelines.

<sup>2</sup> AB 1550, Gomez, Chapter 369, Statutes of 2016; amending Health and Safety Code Section 39713. Detailed information on AB 1550 requirements is provided in Volume 2 of the Draft Funding Guidelines.

statutory objectives for CCI. Funding recipients have the obligation to provide, or provide access to, data and information on project outcomes to CARB. Applicants should familiarize themselves with the requirements within the Agricultural Worker Vanpools Pilot Project solicitation materials and grant agreement, as well as the Draft Funding Guidelines.

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<sup>i</sup> California Air Resources Board (2017). Draft Funding Guidelines. Available at: [www.arb.ca.gov/cci-fundingguidelines](http://www.arb.ca.gov/cci-fundingguidelines)

<sup>ii</sup> California Air Resources Board (2017). Discussion Draft Funding Plan. Available at: [https://www.arb.ca.gov/msprog/aqip/fundplan/1718\\_draft\\_funding\\_plan\\_workshop\\_100417.pdf](https://www.arb.ca.gov/msprog/aqip/fundplan/1718_draft_funding_plan_workshop_100417.pdf)

<sup>iii</sup> California Air Resources Board (2017). California Climate Investments Quantification Methodology Emission Factor Database. Available at: [www.arb.ca.gov/cci-quantification](http://www.arb.ca.gov/cci-quantification).

<sup>iv</sup> California Air Resources Board Low Carbon Transportation Program Consumer-Based Heavy-Duty Projects Quantification Methodology for Fiscal Year 2016-2017 (2016). Available at: [https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/arb\\_cblid\\_finalqm\\_16-17.pdf](https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/arb_cblid_finalqm_16-17.pdf)

## Appendix A. Example Project

### Introduction

The following is a hypothetical project<sup>3</sup> to demonstrate how the FY 2017-18 Agricultural Worker Vanpools Pilot Project Quantification Methodology would be applied. This hypothetical project does not provide examples of the supporting documentation that is required of actual project applicants.

### Overview of the Proposed Project

The proposed pilot project includes the purchase of two convention hybrid vans, one PHEV van, and one FCEV van. All vans are classified as Light-Heavy-Duty Trucks (GVWR 8501-10000 lbs) (LDH1). Each vehicle is estimated to be used for 6 trips a day for weekday only service. The expected average trip length is 5.5 miles. The cost for the six vans is \$270,000

### Example Calculations using the Method in Section B

Emission factors used in example calculations were taken from the Database available at: [www.arb.ca.gov/cc-quantification](http://www.arb.ca.gov/cc-quantification).

### GHG Calculations

#### Step 1. Calculate the VMT

$$VMT = \frac{Trips}{Day} * \frac{Miles}{Trip} * \frac{Days}{Year} = 6 \frac{trips}{day} * 5.5 \frac{miles}{trip} * 200 \frac{days}{year} = 6,600 \frac{miles}{year}$$

#### Step 2. Calculate the emissions produced by a baseline vanpool

$$E_{BV} = VMT * EF_{BV} * N = 6,600 \frac{miles}{year} * 1,038 \frac{gCO_2e}{mile} * 4 = 27,403,200 \frac{gCO_2e}{year}$$

<sup>3</sup> The hypothetical project has not undergone verification of any LCT Agricultural Worker Vanpool Pilot Project requirements; all assumptions about location type and features are for quantification methodology demonstration purposes only.

**Step 3. Calculate the emissions produced by an advanced technology vanpool**

Step 3a. Calculate the emissions produced by conventional hybrid vans funded under the proposed project

$$E_{CH} = VMT * EF_{CH} * N_{CH} = 6,600 \frac{\text{miles}}{\text{year}} * 830 \frac{\text{gCO}_2\text{e}}{\text{mile}} * 2 = 10,956,000 \frac{\text{gCO}_2\text{e}}{\text{year}}$$

Step 3b. Calculate the emissions produced by PHEV vans funded under the proposed project

$$E_{PHEV} = VMT * EF_{PHEV} * N_{PHEV} = 6,600 \frac{\text{miles}}{\text{year}} * 629 \frac{\text{gCO}_2\text{e}}{\text{mile}} * 1 = 4,151,400 \frac{\text{gCO}_2\text{e}}{\text{year}}$$

Step 3c. Calculate the emissions produced by BEV vans funded under the proposed project

$$E_{BEV} = VMT * EF_{BEV} * N_{BEV} = 0 \frac{\text{gCO}_2\text{e}}{\text{year}}$$

Step 3d. Calculate the emissions produced by FCEV vans funded under the proposed project

$$E_{FCEV} = VMT * EF_{FCEV} * N_{FCEV} = 6,600 \frac{\text{miles}}{\text{year}} * 372 \frac{\text{gCO}_2\text{e}}{\text{mile}} * 1 = 2,455,200 \frac{\text{gCO}_2\text{e}}{\text{year}}$$

Step 3e. Calculate the total emissions of the advanced technology vans funded under the proposed project

$$\begin{aligned} E_T &= E_{CH} + E_{PHEV} + E_{BEV} + E_{FCEV} \\ &= 10,956,000 \frac{\text{gCO}_2\text{e}}{\text{year}} + 4,151,400 \frac{\text{gCO}_2\text{e}}{\text{year}} + 0 \frac{\text{gCO}_2\text{e}}{\text{year}} + 2,455,200 \frac{\text{gCO}_2\text{e}}{\text{year}} \\ &= 17,562,600 \frac{\text{gCO}_2\text{e}}{\text{year}} \end{aligned}$$

**Step 4. Calculate the total emissions reductions for the quantification period**

$$\begin{aligned} ER_{Fleet} &= \frac{E_{BV} - E_T}{CF} * QP = \frac{27,403,200 \frac{\text{gCO}_2\text{e}}{\text{year}} - 17,562,600 \frac{\text{gCO}_2\text{e}}{\text{year}}}{1,000,000 \frac{\text{g}}{\text{MT}}} * 6 \text{ years} \\ &= 59 \text{ MTCO}_2\text{e} \end{aligned}$$

Calculate the Total Project GHG Emission Reductions per dollar of GGRF funds.

$$\frac{\text{Total Project GHG Emission Reduction (MTCO}_2\text{e)}}{\text{Total GGRF Funds (\$)}} = \frac{59 \text{ MTCO}_2\text{e}}{\$270,000}$$

$$= 0.00022 \frac{\text{MTCO}_2\text{e}}{\text{GGRF Dollar}}$$

The same calculations are done for ROG, NO<sub>x</sub>, and PM<sub>2.5</sub> using the corresponding emission factors from the Database.