California Air Resources Board

Greenhouse Gas Quantification Methodology for the
Air Resources Board
Low Carbon Transportation Program:
Hybrid and Zero Emission Truck and Bus Voucher Incentive (HVIP)
Zero-Emission Truck and Bus Pilot Projects in Disadvantaged Communities

Greenhouse Gas Reduction Fund
Fiscal Year 2014-15

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A. Introduction

The California Air Resources Board (ARB) is responsible for providing the quantification methodology to estimate greenhouse gas (GHG) emission reductions from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). ARB staff developed this GHG emission reductions quantification methodology for the Low Carbon Transportation medium and heavy-duty vehicle projects listed in Table 1 to estimate proposed project GHG emission reductions for Fiscal Year (FY) 2014-15 funds. The emission reduction estimates detailed in this quantification methodology are based on the methods described in the document titled "AB 8 Project Scoring Criteria: Methodology" (AB 8 Methodology) to estimate GHG emission reductions. The AB 8 Methodology is detailed in Appendix A of the Fiscal Year 2014-15 Funding Plan for the Air Quality Improvement Program and Low Carbon Transportation (LCT) Greenhouse Gas Reduction Fund Investments.[1]

Methodology Development

For FY 2014-15, ARB staff followed a set of principles to guide the development of the quantification methodology. These principles ensure that the methodology would:
- Apply at the project-level;
- Provide uniform methods among similar project types to be applied statewide;
- Use existing and proven methodologies where available; and
- Support the analysis of GHG emission reductions from the proposed projects.

ARB will continue to evaluate and update the GHG emission reductions quantification methodologies as necessary for future FY GGRF appropriations.

Medium and Heavy-Duty Vehicle Programs

LCT investments expand existing ARB clean transportation programs that provide incentives for advanced clean vehicles, such as zero-emission trucks and buses, to achieve GHG emission reductions along with criteria pollutant and air toxics co-benefits. LCT investments place an emphasis on projects that benefit disadvantaged communities. For the LCT projects listed in Table 1 and described below, GHG emission reductions estimates were performed by comparing advanced clean vehicles to conventional new vehicle baselines using GHG emission factors generated for each of the vehicle technology types. Staff analyzed the following projects with the corresponding supported advanced vehicle technologies:

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[1] http://www.arb.ca.gov/msprog/aqip/fundplan/final_fy1415_aqip_ggrf_fundingplan.pdf

Table 1: FY 2014-15 LCT Medium and Heavy-Duty Vehicle Projects and Advanced Vehicle Technology Types

LCT Projects	Supported Advanced Vehicle Technology Types	Estimated Percentage Split of Each Advanced Vehicle Technology Type[2]
Hybrid and Zero Emission Truck and Bus Voucher Incentive (HVIP)	Hybrid and battery-electric	50% hybrid and 50% battery-electric vehicle technology types based on HVIP data.
Zero-Emission Truck and Bus Pilot Projects in Disadvantaged Communities[3]	Fuel cell and battery-electric	50% fuel cell and 50% battery-electric vehicle technology types.

<u>Hybrid and Zero Emission Truck and Bus Voucher Incentive (HVIP)</u>
HVIP directly reduces the up-front cost of hybrid or zero-emission trucks and buses, with fleets able to secure a voucher through their local dealership as part of their vehicle purchase order.

<u>Zero-Emission Truck and Bus Pilot Projects in Disadvantaged Communities</u>
The Zero-Emission Truck and Bus Pilot Projects provide 100 percent of its funding to benefit disadvantaged communities. Project fleets operate within a concentrated, well-defined geographic area where commercial zero-emission vehicles, charging or refueling stations, energy storage devices, communications systems and support networks allow fleets to optimize the participation of zero-emission vehicles. This 'zero-emission ecosystem' facilitates the transition of other similar fleets to utilize zero-emission technologies by including an assessment of vehicle performance, infrastructure and maintenance costs, and other information of interest to other potential technology adopters.

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[2] This is the estimated percentage split of each technology type for the LCT project. See AB 8 Methodology Table A-7, available at: http://www.arb.ca.gov/msprog/aqip/fundplan/final_fy1415_aqip_ggrf_fundingplan.pdf
[3] Note that the 2014-15 pilot project focused solely on urban buses. Therefore, percentage of advanced vehicle types, annual mileage and emission factors for urban buses are used to calculate GHG emission reductions. Evaluation of heavy-duty trucks is not included.

GHG Emission Reductions

This methodology estimates the GHG emission reductions by comparing each supported advanced technology vehicle type against a conventional new vehicle baseline for each project. For the LCT projects listed in Table 1, the difference in the GHG emissions from the baseline conventional gasoline vehicle and the advanced technology vehicle is the quantified GHG emission reductions for one advanced technology vehicle.

The following sections describe the calculations needed to estimate the GHG emission reductions for FY 2014-15 medium and heavy-duty projects.

B.   Quantification Methodology

Estimated GHG emission reductions are based on the specific GHG emission factor for each vehicle type and default annual mileage assumptions (i.e., vehicle miles travelled or VMT).

Emission Factors

This quantification methodology uses a well-to-wheel (WTW) GHG emissions analysis to estimate the GHG emission reductions from the projects. WTW emission analysis allows staff to analyze the emissions resulting from the production, distribution and usage, including exhaust emissions, of the different fuel types such as gasoline, electricity and hydrogen. The methodology provides a uniform approach to estimate GHG emission reductions in metric tons (MT) of carbon dioxide equivalent (CO2e) for the projects.

Staff developed WTW emissions factors for medium (MDV) and heavy-duty vehicles (HDV) utilizing carbon intensity data from ARB's Low Carbon Fuel Standard (LCFS) Program; fuel energy density values from the California-modified Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model (CA GREET 2.0); and vehicle fuel economy values as listed in the AB 8 Methodology to estimate GHG emission factors in grams per mile.

Table 2. Vehicle Categories and WTW GHG Emission Factors for Medium-Duty Vehicles for HVIP[4]

Medium Duty Vehicle Type GHG Emission Factor	Diesel (2015)	Plug-in Hybrid (PHEV)	Battery-Electric Vehicle	Fuel Cell Vehicle	Hybrid (2015)	Hybrid (2025)
GHG (g/mi)	971	622	241	348	734	734

Table 3. Vehicle Categories and WTW GHG Emission Factors for Heavy-Duty Vehicles (Urban Buses)[5]

Urban Bus Vehicle Type GHG Emission Factor	Diesel (2015)	Plug-in Hybrid (PHEV)	Battery-Electric Vehicle	Fuel Cell Vehicle	Hybrid (2015)	Hybrid (2025)
GHG (g/mi)	4230	2748	1114	1606	3377	3377

As described in the AB 8 Methodology, staff developed vehicle usage assumptions (annual miles traveled) through literature review for each of the vehicle technology types evaluated, or actual usage data when available. Table 4 summarizes the annual mileage assumptions used for emission reductions analysis.

Table 4. Annual Usage Assumptions[6]

LCT Project	Annual VMT Assumptions (miles per year)
HVIP	22,000
Zero-Emission Truck and Bus Pilot Projects in Disadvantaged Communities	35,000

Use Steps 1, 2 and 3 to estimate the GHG emissions reductions for each project.

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[4] See AB 8 Methodology Table A-3, available at:
http://www.arb.ca.gov/msprog/aqip/fundplan/final_fy1415_aqip_ggrf_fundingplan.pdf
[5] See AB 8 Methodology, Table A-5, available at:
http://www.arb.ca.gov/msprog/aqip/fundplan/final_fy1415_aqip_ggrf_fundingplan.pdf
[6] See AB 8 Methodology, Table A-9, available at:
http://www.arb.ca.gov/msprog/aqip/fundplan/final_fy1415_aqip_ggrf_fundingplan.pdf

Step 1: Calculate annual GHG emission reductions: Use the GHG emission factors from Table 2 or Table 3, in conjunction with annual VMT assumptions from Table 4, to calculate the GHG emission reductions from the use of one advanced technology vehicle in place of a conventional new diesel vehicle.

$$(Eq. 1) \qquad \mathbf{GHG\_AR_{Advanced\ Vehicle\ Type}} = \frac{[(\mathbf{C\_EF} - \mathbf{AV\_EF}) * (\mathbf{VMT\_AV})]}{1,000,000}$$

Repeat Eq. 1 for each advanced vehicle type included in the program.
Where:
- C_EF = conventional new vehicle baseline (diesel, 2015) GHG emission factor For HVIP, use emission factors from Table 2 (grams/mile). For the Zero-Emission Truck and Bus Pilot, use emission factors from Table 3 (grams/mile)
- AV_EF = advanced vehicle technology type GHG emission factor. For HVIP, use emission factors from Table 2 (grams/mile). For the Zero-Emission Truck and Bus Pilot Projects, use emission factors from Table 3 (grams/mile)
- VMT_AV = annual VMT for the advanced vehicle type from Table 4 (miles/yr)
- GHG_AR $_{Advanced\ Vehicle\ Type}$ = annual GHG reductions from the use of one advanced technology vehicle in place of a conventional new diesel vehicle (MT CO_2e)

Step 2: Calculate the average (or weighted) annual GHG emissions reduction:
Sum the product of GHG emission reductions for each vehicle type (e.g., battery electric or plug-in hybrid) by the percentage of that vehicle type.

$$(Eq. 2) \qquad \mathbf{W\_GHG\_AR} = \sum [\% \mathbf{VT} * \mathbf{GHG\_AR_{Advanced\ Vehicle\ Type}}]$$

Where:
- %VT=percentage split (in decimal format) of vehicle type from Table 1
- W_GHG_AR = weighted annual GHG emission reductions for one advanced vehicle (MTCO$_2$e/year)

Step 3: Calculate the GHG Reductions over the project life: Calculate the GHG emission reductions for all advanced vehicles for one year and over the project life[7] (i.e., 15 years).

$$(Eq. 3) \qquad \mathbf{GHG\_A} = \mathbf{\#\ of\ vehicles\ replaced} * \mathbf{W\_GHG\_AR}$$

$$(Eq. 4) \qquad \mathbf{MT\ CO2e\ over\ the\ project\ life} = \mathbf{GHG\_A} * \mathbf{15}$$

Where:

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[7] The project life for all project types included in this methodology is based on a 15 year vehicle life as listed in the AB 8 Methodology, Table A-24, available at:
http://www.arb.ca.gov/msprog/aqip/fundplan/final_fy1415_aqip_ggrf_fundingplan.pdf

- GHG_A=annual GHG emission reductions total for all advanced vehicles

The estimated total lifetime GHG emission reductions per dollar of GGRF funds requested is reported as:

(Eq. 5) $$\frac{\text{MT CO}_2\text{e over the project life}}{\text{GGRF Funds Requested (\$)}}$$

C.   Reporting and Documentation

ARB is required to capture and retain documentation that is complete, and sufficient enough to allow the quantification calculations to be reviewed and replicated.

Documentation will include:
- Contact information for the person who can answer project specific questions; from staff reviewers on the quantification calculations;
- Project specific equipment specifications and certifications;
- Summary page with, at a minimum, the following information;
  - Number of advanced vehicles by vehicle type;
  - GHG emission reduction estimates for year 1 and project life total;
  - GGRF funds requested for the project;
  - Total Project GHG emission reductions per GGRF dollar; and
- Each project may have specific reporting requirements that can be found at the following: http://www.arb.ca.gov/msprog/aqip/solicitations.htm