APPENDIX C: QUANTIFICATION METHODOLOGIES

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Contents

Overview

This appendix provides additional details on the methodology and assumptions used for the light- and heavy-duty zero-emission and near-zero-emission vehicle categories quantified for CVRP, Clean Cars 4 All, HVIP, and Zero-Emission Truck and Bus Pilot Project presented in the "Assessment of CARB's Zero-Emission Vehicle Programs Per Senate Bill 498." This analysis is based on the methodologies presented in the Low Carbon Transportation Funding Plans[1] and published California Climate Investments quantification methodologies.[2] For CVRP, the analysis is further enhanced by using the method developed for the "Assembly Bill 615 Report to the Legislature on the Impact of the Clean Vehicle Rebate Project on California's Zero-Emission Vehicle Market,"[3] and work by the Center for Sustainable Energy (CSE).[4] The analyses done on behalf of the SB 498 report estimate the emission reductions that are achieved by the vehicles supported with funds from fiscal years (FY) 2014-2015 through 2017-2018 for the assumptions outlined below including the specific quantification period for each project. Because this analysis is backwards looking, staff was able to use project-specific data and updated assumptions as outlined below to refine the established methodologies.

Emission Factor Development

To support the analysis of emission reductions from the four projects quantified here, staff used emission factors (EF) for a variety of different vehicle classes. Emission factors are needed for the baseline vehicles and the advanced technology vehicles (ATV) incentivized through these projects. The emission factors and assumptions used in the analysis were derived from a number of sources such as CARB's California-modified Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (CA-GREET 2.0) Model,[5] CARB's Emission Factor (EMFAC2014) Model,[6] information from CARB regulation staff reports and emissions inventories, publically available technical reports, and staff assumptions. Greenhouse gas (GHG) emission factors were developed on a well-to-wheel (WTW) basis since greenhouse gases are global pollutants. In quantification methods prior to those from FY 2016-17, the criteria pollutant and toxic emission factors were calculated on a well-to-wheel basis. Starting in FY 2016-17, CARB staff decided to calculate criteria pollutant and toxic emission factors based solely on tailpipe emissions because of their localized impact. For the SB 498 analysis, criteria pollutants were also only analyzed based on their tailpipe emissions.

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[1] https://ww3.arb.ca.gov/msprog/aqip/fundplan/funding_plan_archive.htm.

[2] https://ww2.arb.ca.gov/resources/documents/cci-quantification-benefits-and-reporting-materials.

[3] https://ww3.arb.ca.gov/research/apr/reports/AB%20615-Clean%20Vehicle%20Rebate.pdf.

[4] Pallonetti and Williams, 2019. "Preliminary Estimation of Emission Reductions Associated with California's Clean Vehicle Rebate Project (CVRP)." July 2019 update to N. Pallonetti and B. Williams, "Exploratory Estimation of Greenhouse-Gas Emission Reductions Associated with California's Clean Vehicle Rebate Project," proceedings of the 2019 Annual Meeting of the Transportation Research Board, Washington, D.C., January 2018.

[5] https://ww3.arb.ca.gov/fuels/lcfs/ca-greet/ca-greet.htm.

[6] https://www.arb.ca.gov/emfac/2014/.

The analysis is based on the following vehicle categories:

- Light-duty vehicles (LDV)
- Medium heavy-duty vehicles (MHD)
- Heavy heavy-duty vehicles (HHD)
- Urban buses
- School buses
- Trucks equipped with electric power takeoff (ePTO) systems

GHG Emission Factors

Fuel economy is an important component of the emission reduction analysis, as the value determines the emissions generated based on the consumption of each unit of fuel for the miles traveled or unit of fuel consumed per hour of use for utility vehicles equipped with ePTO.

Different than in previous quantifications, the fuel economy values of the light-duty vehicles supported by CVRP and Clean Cars 4 All are based on reported values[7] from project-specific vehicles and are further described in the light-duty ZEV projects section. Previously, values derived from EMFAC2014 were used.

For both HVIP and Zero-Emission Truck and Bus Pilot Project, fuel economy values of the heavy-duty vehicles are still derived from EMFAC2014 due to limited performance data on project-specific vehicles.[8] For simplicity, staff assumed 2017 as the starting year of the vehicles supported by the heavy-duty vehicle incentive projects. The fuel economy values were based on the baseline fleet average in 2024, halfway through the assumed useful life of 15 years for advanced technology heavy-duty vehicles to account for vehicle deterioration, serving as the expected average fuel economy values over the assumed useful life.

The fuel economy was paired with carbon intensity (CI) values from the Low Carbon Fuel Standard (LCFS)[9] and the lower heating value (LHV) of the applicable fuels to calculate the WTW GHG emission factor for each project type, as shown in Formula 1. This was done so that the upstream (well-to-tank) emissions of the fuel were representative of the fuel used, paired with an illustrative potential technology. The GHG emission factor is in units of grams of carbon dioxide (CO2) equivalent per mile (gCO2e/mi). For ePTOs, the fuel economy is in units of grams CO2e per hour (gCO2e/hr).

Formula 1: GHG Emission Factors

$$GHG\ Emission\ Factor\ (\frac{gCO2e}{mi}\ or\ \frac{gCO2e}{hr}) = \frac{LCFS\ carbon\ intensity * LHV\ of\ fuel}{fuel\ economy\ of\ vehicle}$$

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[7] https://www.fueleconomy.gov/.

[8] https://www.arb.ca.gov/emfac/2014/.

[9] https://ww3.arb.ca.gov/fuels/lcfs/lcfs.htm.

For alternative-fueled heavy-duty vehicles, the respective fuel economy values were converted for a given alternative fuel, using LHVs of the baseline and alternative fuels and the energy economy ratio (EER) value, as shown in Formula 2. EER values were derived from the LCFS Regulation[10] or based on a study on the energy efficiency of battery-electric vehicles compared to conventional diesel vehicles operating on the same duty cycle.[11] For light-duty vehicles, the baseline fuel economy values were derived from project-specific data or the top selling vehicles in the State.

Formula 2: Alternative Fuel Vehicle Economy

$$Alt. Fuel\ Vehicle\ Economy\ \left(\frac{miles}{fuel\ unit}\ or\ \frac{hours}{fuel\ unit}\right) = fuel\ economy_{baseline} * \frac{LHV_{alt.\ fuel}}{LHV_{baseline\ fuel}} * EER$$

Lifecycle emission factors were adopted from the LCFS Program's carbon intensities, representing average or typical production processes for each fuel used in California. Staff assumed the following pathways for the fuels analyzed:

Lifecycle emission factors adopted from the LCFS Program's carbon intensities represent the average or typical production processes for each fuel used in California.

Table C - 1 Well-to-Wheels Carbon Intensity of the Fuels

Fuel	Carbon Intensity (gCO2e/gal for gasoline and diesel, gCO2e/kg for hydrogen and natural gas, or gCO2e/kWh for electricity)
Diesel: ultra-low sulfur diesel (ULSD)	13,718
Gasoline: California reformulated gasoline (CaRFG)	11,406
Hydrogen	10,598
Electricity	379
Natural Gas: compressed natural gas (CNG)	3,545

Staff assumed the following pathways for the fuels analyzed:

- Gasoline: California reformulated gasoline (CaRFG) from the LCFS Lookup Table.[12]

[10] https://ww3.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf.
[11] https://ww2.arb.ca.gov/sites/default/files/2018-10/170425eerdraftdocument.pdf.
[12] https://ww3.arb.ca.gov/fuels/lcfs/fuelpathways/pathwaytable.htm.

- Diesel: ultra-low sulfur diesel (ULSD), also from the LCFS Lookup Table.
- Compressed Natural Gas (CNG): volume-weighted average CI of CNG from North American natural gas consumed in California in 2016 from LCFS Reporting Tool (LRT)[13] data.
- Electricity: California grid average mix, which meets the Renewable Portfolio Standard (RPS) requirements, from the LCFS Lookup Table.
- Hydrogen: SB 1505 (Lowenthal, Chapter 877, Statutes of 2006) compliant gaseous hydrogen reformed on-site at the refueling station from a mix of North American natural gas and 33.3 percent biomethane from landfill gas, from the LCFS Lookup Table.

It should be noted that as more renewables are introduced into the transportation fuel mix, lowering the average CI of the fuel, additional GHG benefits may be achieved, which may lower the emission factors. As the fuel mix changes, staff will reflect those changes in future analyses.

Criteria Pollutant and Toxic Emission Factors

For the determination of tailpipe criteria pollutant emission factors for on-road vehicles, staff used CARB's EMFAC2014 model to calculate tailpipe emissions and emissions associated with the usage of the supported vehicles or equipment, such as idling emissions and PM 2.5 emissions from brake and tire wear, when applicable.

Staff incorporated deterioration, when available, for on-road vehicles. Staff also applied a 50 percent reduction in brake wear emissions for on-road electric vehicles because they implement regenerative braking capability.[14] Emission factors were developed for advanced technology vehicles supported by the projects when appropriate, along with emission factors for baseline conventional vehicles.

Quantification Methodology for Projects

Previously, to quantify the emission reductions achieved for each project given the specific assumptions, staff must first determine the annual per-vehicle emission reductions for each technology weighted by the amount of each technology incentivized in the project. Finally, to determine the total emission reductions for each project, the annual per-vehicle emission reductions for each technology is multiplied by the number of vehicles funded and the quantification period. As noted in the light-duty project descriptions, staff have quantified emission reductions based on project-specific data when possible using the best available assumptions. For example, CVRP did not use average emission factors by technology, but rather calculated emission

[13] https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm.

[14] NREL, BAE/Orion Hybrid Electric Buses at New York City Transit, http://www.afdc.energy.gov/pdfs/42217.pdf, March 2008.

reductions on a case-by-case basis specific to the model and model year of each rebated vehicle.

Annual Per-Vehicle Emission Reductions

Annual emission reductions are first calculated for each vehicle technology in the project using the emission factors that have been developed for each project. Annual emission reductions are in units of tons per year (tpy) for the emissions reduced and are calculated by taking the difference in emission rates between the baseline vehicle and advanced technology vehicle and then multiplying by usage. This value is then converted from grams per year to metric tons of carbon per year for GHG emissions (MTCO2e) and tons per year (tpy) for criteria pollutants and toxic air contaminants.

Per vehicle annual emission reductions are calculated using Formula 3, where emission factors are in terms of grams per mile (g/mi) and usage is based on annual vehicle miles traveled (VMT) or miles per year (mi/yr). For ePTOs, annual emission reductions are also calculated using Formula 3, however, emission factors are in terms of grams per hour (g/hr) and usage is in terms of hours per year.

Formula 3: Average Annual Per-Vehicle Emission Reductions per Technology

$$AER_{Vehicle} = (EF_{baseline} - EF_{ATV}) * Usage$$

Where:

- $AER_{Vehicle}$ = Average annual per vehicle emission reductions (tpy)
- $EF_{Baseline}$ = Emission factor for the baseline vehicle (g/mi or g/hr)
- EF_{ATV} = Emission factor for the advanced technology vehicle (g/mi or g/hr)
- Usage = Annual VMT or hours per year (mi/yr or hr/yr).

Total Lifetime Emission Reductions

Once the average per-vehicle emission reductions for each technology are determined, it is multiplied by the number of vehicles funded and the quantification period to determine the total achieved lifetime emission reductions for a project given the specific assumptions, as shown in Formula 4.

Formula 4: Lifetime Emission Reductions per Technology

$$\begin{aligned} &Lifetime\ Emission\ Reductions\ (tons) \\ &\quad = Average\ annual\ per\ vehicle\ emission\ reductions * \#\ vehicles\ funded \\ &\quad * Quantification\ period \end{aligned}$$

Light-Duty ZEV Projects

Although the quantification methodologies for CVRP and Clean Cars 4 All are based on the same framework, the emission factors are different because of the different structure and requirements for each project. For example, CVRP has no vehicle scrappage requirement while Clean Cars 4 All does. Additionally, Clean Cars 4 All incentivizes used and new eligible vehicles while CVRP only incentivizes new vehicles. Furthermore, Clean Cars 4 All is limited to low-income individuals while CVRP provides rebates to individuals and governmental, commercial, and nonprofit entities. There are four advanced technologies supported by CVRP and Clean Cars 4 All: battery electric vehicles (BEV), battery electric vehicles with a range extender (BEVx), plug-in hybrid electric vehicles (PHEV), and fuel cell electric vehicles (FCEV). The BEVx is treated like a PHEV with respect to having an eVMT percentage, but as a BEV otherwise. Before describing the quantification methodology for each project, the methodology for quantifying the percent electric vehicle miles traveled (eVMT) from PHEVs is presented since it the same method used for CVRP and Clean Cars 4 All.

Percent electric vehicle miles traveled (eVMT)

In previous methodologies, the percent of electric vehicle miles traveled (eVMT) for the average PHEV was assumed to be 40 percent based on reported data,[15] meaning that 60 percent of the miles driven by an average PHEV are powered by gasoline. Information on eVMT are not available from CVRP or Clean Cars 4 All. This analysis relies on the latest available assumptions when there is no project-specific data. The percent eVMT of a PHEV, which is a complex parameter to measure, depends on how it is driven, charged, and the specific vehicle model. For this report, staff calculated the weighted average percent eVMT based on the electric-range of PHEV models incentivized through the project. First, staff compiled percent eVMT values reported in literature[16, 17, 18, 19, 20] and averaged these per PHEV model, as presented in Table C - 2. Since the percent eVMT of all PHEV models has not been quantified, the rest were estimated based on the fit of the reported data of Table C - 2 as shown in Figure C - 1. In order to constrain the fitted function in Figure C - 1 to be as physically relevant (not go above 100 percent eVMT until very high values of electric range, staff included an artificial point at (200 mi, 95 percent) to help asymptote the function around 100 percent eVMT.

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[15] https://ww3.arb.ca.gov/msprog/aqip/fundplan/proposed_1819_funding_plan.pdf. Appendix A

[16] CARB, 2017. January 2017. "Advanced Clean Cars Midterm Review Appendix G." https://ww3.arb.ca.gov/msprog/acc/mtr/appendix_g.pdf.

[17] Gil, et al., 2019. Final Research Report. "Advanced Plug-in Electric Vehicle Travel and Charging Behavior Final Report." https://ww3.arb.ca.gov/research/single-project.php?row_id=65206.

[18] Francfort, et al., 2015. "Plug-in Electric Vehicle and Infrastructure Analysis." September 2015. Idaho National Laboratory. INL/EXT-15-35708. https://inldigitallibrary.inl.gov/sites/sti/sti/6799570.pdf.

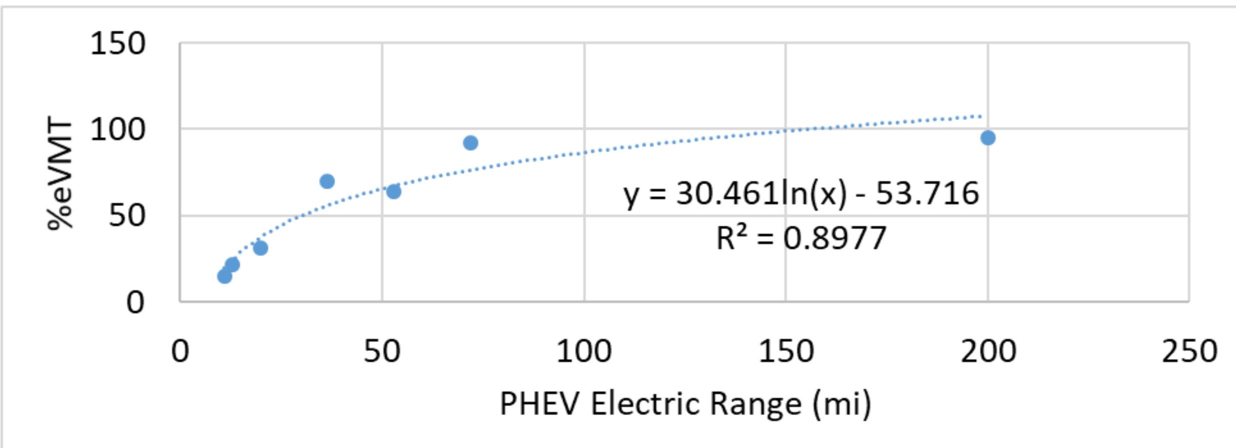
[19] Carlson, 2015, "Electric Vehicle Mile Traveled (eVMT): on-road results and analysis." DOE Vehicle Technologies Program Annual Merit Review 2015. http://energy.gov/sites/prod/files/2015/07/f24/vss171_carlson_2015_p.pdf.

[20] Duhon, et al., 2015. "Chevrolet Volt Electric Utilization." SAE International Journal of Alternative Powertrains, 2015. 4(2): p. 269-276. https://saemobilus.sae.org/content/2015-01-1164/.

Table C - 2 Percent eVMT Based on Reported Values[18, 19, 20, 21, 22]

PHEV Model	EPA Reported Electric Range (mi)	Average eVMT Reported
BMW i3REx	72	92.2
Chevrolet Volt[21]	36.5	69.6
Chevrolet Volt[22]	53	64.0
Ford CMax Energi and Fusion Energi	20	31.5
Honda Accord Plug-in	13	21.8
Toyota Prius Plug-in	11	14.5

Figure C - 1 Function Used to Calculate Project Percent eVMT



Though model-specific eVMT values were used in the CVRP emission calculations, for reference, the weighted average percent eVMT was calculated for both projects based on the average reported values (for PHEV models with reported values) and estimated values (for PHEV models without reported values) for the specific PHEVs supported by each project. The resulting weighted average percent eVMT for Clean Cars 4 All and CVRP for individuals based on the PHEV models incentivized for these fiscal years was 49 percent. The percent eVMT for CVRP rebates provided to fleets was 44 percent based on the PHEV models rebated. For BEVx, the eVMT value used in this analysis is the one for BMW i3REx reported in Table C - 2.[23]

CVRP

The emission reductions for CVRP are calculated as the difference between the rebated

[21] Model years 2011-2015.
[22] Model year 2016 and newer.
[23] The BMW i3REx has been the only commercially available BEVx.

new advanced technology vehicle that was purchased or leased and an average new light-duty conventional gasoline vehicle of the same model year that would have otherwise been purchased or leased. Table C - 3 shows the number of light-duty vehicles rebated by CVRP for individuals, split between standard rebate and increased rebate for low-income participants, and fleet[24] rebates. Because vehicles used by individuals and fleets have different usage patterns, the emission reductions attributed to vehicles rebated to individuals and fleets will be different. Thus, here they are treated and presented separately. There is no known difference in emission factors or usage for the advanced technology vehicles supported through the increased rebate for low-income participants compared to the standard rebate, so these are treated the same. The CVRP quantification was done by CSE in collaboration with CARB staff.

Table C - 3 Number of Rebated Vehicles through CVRP (FY 2014-15 - FY 2017-18)[25]

Advanced Technology Vehicle Class	Standard Rebates Given to Individuals	Increased Rebate for Low-Income Participants	Rebates Given to Fleets
BEV	108,472	4,967	4,468
BEVx	6,003	248	219
PHEV	66,220	4,419	1,729
FCEV	4,154	225	173
Overall	**184,849**	**9,859**	**6,589**

Previous quantifications derived the baseline vehicle emission factors from the LCFS carbon intensity of CaRFG and the average new model year gasoline vehicle fuel economy per EMFAC. The advanced technology vehicle information was derived from converting the gasoline EMFAC vehicle through an energy-equivalent calculation. Instead of using these derived values from EMFAC for the SB 498 report analysis, the average baseline vehicle fuel economy was derived from the top 30 California sales-weighted average values[26] for each model year. Table C - 4 provides a summary of the fuel economy values used for the light-duty vehicles in miles per gallon (MPG) of gasoline. The overall average fuel economy for the baseline vehicle is presented for reference, but the yearly values were used in the calculations.

[24] Here fleet refers to a local, state, or federal government as well as to a commercial or non-profit entity regardless of whether they participated in the increased rebates for public fleets.

[25] Totals contain partial data for FY 2017–2018 because of the time delay between receiving applications, processing, verifying, approving and mailing the rebate check.

[26] Based on registration data licensed from IHS Markit, fuel economy data from http://www.fueleconomy.gov, and still using the LCFS carbon intensity of CaRFG

Table C - 4 Fuel Economy Values Used for Baseline Conventional Vehicles for CVRP

Fuel Type	Model Year	MPG
Gasoline	2014	28.2
	2015	28.4
	2016	28.7
	2017	28.0
	2018	28.8
	2019[27]	28.8
	Overall Average[28]	**28.4**

CSE obtained the individual fuel economy values[29] for each advanced technology vehicle rebated by CVRP during this period and used those model-specific values in the calculations. For reference, a weighted average value per rebate technology and rebate recipient type are presented in Table C - 5. This high-detailed data analysis can be done because the emission reductions are quantified for vehicles already funded and CSE tracks the rebate vehicle and recipient type.

Table C - 5 Average Fuel Economy Values Used for the Advanced Technology Vehicles for CVRP

Advanced Vehicle Technology	Fuel Type	Fuel Economy of Vehicles Rebated to Individuals[30]	Fuel Economy of Vehicles Rebated to Fleets
BEV	Electricity	3.23 mi/kWh	3.00 mi/kWh
BEVx	Electricity	3.40 mi/kWh	3.40 mi/kWh
	Gasoline	37.6 mpg	37.6 mpg
PHEV	Electricity	3.12 mi/kWh	2.97 mi/kWh
	Gasoline	42.1 mpg	40.6 mpg
FCEV	Hydrogen	65.8 mi/kg	63.6 mi/kg

Table C - 6 shows the weighted average emission factors for the baseline vehicle, though, as stated above, the analysis was done with model-year-specific baseline vehicle data. The emission factors are different between individual and fleet vehicles

[27] Using same value as 2018 due to limited 2019 data availability at the time of the analysis.
[28] This combines the fuel economy values of baseline vehicles for both individuals and fleets.
[29] From http://www.fueleconomy.gov.
[30] This combines the fuel economy values of the vehicles supported through the standard rebate and the increased rebate for low-income participants.

because they are calculated based on model-year-specific fuel economy values and the model year mix is not the same between individual and fleet groups.

Table C - 6 Average CVRP Baseline Vehicle Emission Factors

Pollutant	Individuals (g/mi)	Fleets (g/mi)
NOx	0.0332	0.0337
PM 2.5	0.0196	0.0196
ROG	0.0067	0.0068
GHG	402	402

For reference, Table C - 7 and Table C - 8 show the weighted average emission factors for the advanced technology vehicles for the rebates provided to individuals and fleets, respectively. The emission factors are different between individual and fleet rebated vehicles because they are calculated based on the fuel economy values of the actual rebated vehicles. For PHEVs, the emission factors also depend on the percent eVMT. Although these tables are showing the overall weighted average vehicle emission factors across years, the values were calculated per year and used for each set of yearly data. For more information on how these emission factors were developed, please see the Emission Factor Development section at the beginning of this appendix.

Table C - 7 CVRP Average Advanced Technology Vehicle Emission Factors for Individual Rebates

Pollutant	BEV (g/mi)	BEVx (g/mi)	PHEV (g/mi)	FCEV (g/mi)
NOx	0	0.0013	0.0158	0
PM 2.5	0.0099	0.0099	0.0108	0.0099
ROG	0	0.0003	0.0032	0
GHG	119	126	202	183

Table C - 8 CVRP Average Advanced Technology Vehicle Emission Factors for Fleet Rebates

Pollutant	BEV (g/mi)	BEVx (g/mi)	PHEV (g/mi)	FCEV (g/mi)
NOx	0	0.0013	0.0160	0
PM 2.5	0.0099	0.0099	0.0108	0.0099
ROG	0	0.0003	0.0032	0
GHG	128	127	216	190

CARB staff previously[31] generated vehicle usage assumptions for CVRP through a literature review for each of the vehicle types evaluated. Here, there is a separate set of vehicle usage assumptions for advanced technology vehicles, per CSE,[32] that were rebated to fleets. The annual usage assumptions for CVRP are shown in Table C - 9. The assumed annual mileage for fleet vehicles is lower than for individuals, but CARB staff expect that as fleets gain experience with these vehicles, the vehicle range increases as the ZEV market develops, and refueling infrastructure becomes more widespread that these fleet vehicles will be driven more.

Table C - 9 CVRP Annual Usage Assumptions

Technology	Usage by Individuals (mi/yr)	Usage by Fleets (mi/yr)
PHEV	14,855[33]	9,207[34]
BEV	11,059[35]	6,854[36]
BEVx	11,059[37]	6,854[38]
FCEV	11,059[39]	6,854[40]

Using the emission factors, the model and model year mix of the rebated vehicles, and the annual usage assumptions from Table C - 9, CSE calculated the average annual per-vehicle emission reductions as shown in Table C - 10 for vehicles rebated to individuals and fleets.

[31] https://ww3.arb.ca.gov/msprog/aqip/fundplan/funding_plan_archive.htm.

[32] Pallonetti and Williams, 2019. “Preliminary Estimation of Emission Reductions Associated with California’s Clean Vehicle Rebate Project (CVRP).” July 2019 update to N. Pallonetti and B. Williams, "Exploratory Estimation of Greenhouse-Gas Emission Reductions Associated with California’s Clean Vehicle Rebate Project," proceedings of the 2019 Annual Meeting of the Transportation Research Board, Washington, D.C., January 2018.

[33] Based on 40.7 miles per day. Smart, et al., 2013. "Extended Range Electric Vehicle Driving and Charging Behavior Observed Early in the EV Project," SAE Technical Paper 2013-01-1441, 2013, https://doi.org/10.4271/2013-01-1441.

[34] Based on average of FY 2013–2017 federal fleet passenger vehicle values from FY 2017 Federal Fleet Report https://www.gsa.gov/policy-regulations/policy/vehicle-management-policy/federal-fleet-report.

[35] Based on 30.3 miles per day. Smart and Schey, 2012. "Battery Electric Vehicle Driving and Charging Behavior Observed Early in The EV Project," *SAE Int. J. Alt. Power.* 1(1):27-33, 2012, https://doi.org/10.4271/2012-01-0199.

[36] Based on scaling the PHEV fleet values down at the rate observed for individuals: 9,207 x (11,059/14,855).

[37] Assumption based on similarity between BEV and BEVx.

[38] Assumption based on similarity between BEV and BEVx.

[39] Assumption that usage is similar to BEV based on limited data.

[40] Assumption that usage is similar to BEV based on limited data.

Table C - 10 CVRP Annual Per-Vehicle Emission Reductions

Pollutant	Vehicle Tech	Per Vehicle Annual Emission Reductions for Rebates Given to Individuals	Per Vehicle Annual Emission Reductions for Rebates Given to Fleets
GHG (metric tons CO2e per year)	PHEV	2.98	1.71
	BEV	3.12	1.87
	BEVx	3.05	1.89
	FCEV	2.45	1.45
NOx (tpy)	PHEV	0.00028	0.00018
	BEV	0.00041	0.00026
	BEVx	0.00040	0.00025
	FCEV	0.00038	0.00024
PM 2.5 (tpy)	PHEV	0.00014	0.00009
	BEV	0.00012	0.00007
	BEVx	0.00012	0.00007
	FCEV	0.00012	0.00007
ROG (tpy)	PHEV	0.00006	0.00004
	BEV	0.00008	0.00005
	BEVx	0.00008	0.00005
	FCEV	0.00008	0.00005

CSE then calculated the total annual emission reductions based on the number and type of advanced technology vehicles supported from Table C - 3 and the annual per vehicle emission reduction values from Table C - 10.

Table C - 11 CVRP First-Year Emission Reductions

Pollutant	Vehicle Tech	First-Year Emission Reductions for Standard Rebates Given to Individuals	First-Year Emission Reductions for Increased Rebate for Low-Income Participants	First-Year Emission Reductions for Rebates Given to Fleets
GHG (metric tons CO2e per year)	PHEV	197	13	3
	BEV	338	15	8
	BEVx	18	1	<1
	FCEV	10	1	<1
NOx (tpy)	PHEV	19	1	<1
	BEV	44	2	1
	BEVx	2	<1	<1
	FCEV	2	<1	<1
PM 2.5 (tpy)	PHEV	10	1	<1
	BEV	13	1	<1
	BEVx	1	<1	<1
	FCEV	1	<1	<1
ROG (tpy)	PHEV	4	<1	<1
	BEV	9	<1	<1
	BEVx	1	<1	<1
	FCEV	<1	<1	<1

Finally, the first-year emission reductions from Table C - 11 are multiplied by the quantification period to get total emission reductions achieved by CVRP. The quantification period for CVRP individual rebates was changed from 15 years (typical vehicle usage life) to 2.5 years (CVRP vehicle ownership requirement) in fiscal year 2017-2018[41] because staff wanted the emission quantification to be conservative. To be conservative and consistent within this CVRP analysis, these calculations are using 2.5 years as the quantification periods across all years. The quantification period used for CVRP fleet rebates is based on the same 2.5-year ownership requirement, but a small number of fleet vehicles (4 percent) did have a shorter ownership requirement of 1 year. Therefore, those vehicles were analyzed with this shorter quantification period to be conservative.

[41] The quantification period for CVRP was 2.5 years in the Proposed Funding Plan FY 2017-2018 (https://ww3.arb.ca.gov/msprog/aqip/fundplan/proposed_1718_funding_plan_final.pdf. Appendix A.) and 15 years in the FY 2016-2017 Proposed Funding Plan Appendix A (https://ww3.arb.ca.gov/msprog/aqip/fundplan/proposed_fy16-17_fundingplan_appa.pdf).

Table C - 12 Total Emission Reductions for CVRP by Rebate Recipient Type and Technology Type (2.5-Year Quantification Period)[42]

Pollutant	Vehicle Tech	Total Emission Reductions for Standard Rebates Given to Individuals	Total Emission Reductions for Increased Rebate for Low-Income Participants	Total Emission Reductions for Rebates Given to Fleets	Overall
GHG (1,000 metric tons CO2e)	PHEV	492	35	7	**534**
	BEV	845	40	20	**905**
	BEVx	46	2	1	**49**
	FCEV	25	1	1	**27**
	Overall	**1,409**	**77**	**29**	**1,515**
NOx (tons)	PHEV	46	3	1	**50**
	BEV	111	5	3	**118**
	BEVx	6	<1	<1	**6**
	FCEV	4	<1	<1	**4**
	Overall	**167**	**8**	**4**	**179**
PM 2.5 (tons)	PHEV	24	2	<1	**26**
	BEV	32	1	1	**34**
	BEVx	2	<1	<1	**2**
	FCEV	1	<1	<1	**1**
	Overall	**59**	**3**	**1**	**64**
ROG (tons)	PHEV	9	1	<1	**10**
	BEV	22	1	1	**24**
	BEVx	1	<1	<1	**1**
	FCEV	1	<1	<1	**1**
	Overall	**34**	**2**	**1**	**36**

Based on actual vehicles incentivized and the assumptions outlined in this appendix, the total emission reductions achieved for CVRP for vehicles funded during FY 2014-2015 through FY 2017-2018 using a quantification period of 2.5 years are shown in Table C - 12.

The overall GHG emission reductions quantified of 1,500,000 MTCO2e is significantly lower than the ~5,500,000 MTCO2e that was reported in the 2019 California Climate Investments (CCI) Annual Report.[43] This difference is mostly due to the CCI change in the quantification period from 15 years in the FY 2014-2015 and FY 2015-2016 quantification methodologies and 2.5 years in the FY 2016-2017 and FY 2017-2018 methodologies, whereas this analysis for the SB 498 report is using 2.5 years throughout as previously mentioned. Additionally, this SB 498 analysis is only

[42] Totals may not add up due to rounding.
[43] https://ww3.arb.ca.gov/cc/capandtrade/auctionproceeds/2019_cci_annual_report.pdf.

quantifying a portion of CVRP's supported vehicles by focusing on the last four fiscal years with complete data. Furthermore, the CCI reported value only considers the fraction of emission benefits of CVRP that were funded by Cap-and-Trade dollars. However, in FY 2014-15 and FY2015-16, CVRP also received a total of $13 million funding through AQIP.[44] For CVRP's total emission reductions achieved thus far, including for different quantification periods, please see "Assembly Bill AB 615 Report to the Legislature on the Impact of the Clean Vehicle Rebate Project on California's Zero-Emission Vehicle Market."[45]

For simplicity, in the SB 498 report the BEVx vehicles are included in the BEV category although they were calculated separately, as shown in this appendix.

[44] https://ww3.arb.ca.gov/msprog/aqip/fundplan/proposed_1819_funding_plan.pdf.

[45] https://ww3.arb.ca.gov/research/apr/reports/AB%20615-Clean%20Vehicle%20Rebate.pdf.

Clean Cars 4 All

Clean Cars 4 All achieves emission reductions by incentivizing the scrappage of old, high-emitting vehicles and replacement with clean advanced technology vehicles. Clean Cars 4 All incentivizes the replacement of both new and used vehicles. To calculate the emission reductions for this report, staff used project-specific data from the beginning of the project in FY2015-2016 through FY2017-2018, which include 518 BEVs and 1,396 PHEVs as shown in Table C - 13. The project also funds conventional hybrid vehicles but because those are outside the scope of the SB 498 report, they were not included in this analysis.

Table C - 13 Number of Supported Light-Duty Vehicles through Clean Cars 4 All (FY 2015-2016 - FY 2017-2018)

Advanced Technology **Vehicle**	**Clean Cars 4 All**
BEV	518
PHEV	1,396
FCEV	0
Overall	**1,914**

Similarly as quantified in the past, the baseline vehicle emission factors were derived from the scrapped vehicles, while the advanced technology vehicle information was derived from the incentivized vehicle. The difference from previous quantification methodologies is that the fuel economy used for the analysis for this report is not based on an average model year EMFAC data but rather the vehicles funded through the program itself. Instead, staff used project-specific data to calculate the weighted average fuel economy of the actual scrapped and incentivized vehicles shown in Table C - 14. The fuel economy of the average baseline vehicle was derived from the individual fuel economy[46] per vehicle model and model year of the reported scrapped vehicles that were replaced by BEVs and PHEVs. Similarly, the average fuel economy values of the advanced technology vehicles were derived from the individual values of the incentivized vehicles. For PHEVs, both the average gasoline and electric fuel economies were calculated separately.

[46] Per https://www.fueleconomy.gov/ using city and highway combined values. Vehicles with model year older than 1983 were excluded because they are not included in the fueleconomy.org database.

Table C - 14 Average Fuel Economy Values Used for Clean Cars 4 All

Vehicle Technology	Fuel Type	MPG
Baseline	Gasoline	21.7 mpg
BEV	Electricity	3.24 mi/kWh
PHEV	Electricity	3.09 mi/kWh
	Gasoline	41.8 mpg

Table C - 15 presents the emission factors for the baseline vehicle, PHEVs, and BEVs. For more information on how these emission factors were developed, please see the Emission Factor Development section at the beginning of this appendix. In previous quantification methodologies, the average model year of the scrapped vehicle was used to derive the emission factors for the criteria and toxic pollutant emissions based on EMFAC2014. For this analysis, the emission factors were derived from EMFAC for each model year of the vehicles scrapped and replaced. From these, the weighted average emission factors were calculated, as shown in Table C - 15. For reference, the weighted average model year of the scrapped vehicles is 1997, with 41 percent of the scrapped vehicles being a model year between 1965 and 1996. The weighted average model year of the incentivized PHEVs and BEVs is 2013. The calendar year used for analysis is 2017.

Table C - 15 Clean Cars 4 All Emission Factors

Pollutant	Baseline Gasoline Vehicle (g/mi)	PHEV (g/mi)	BEV (g/mi)
NOx	0.4371	0.0136	0
PM 2.5	0.0241	0.0103	0.0099
ROG	0.1321	0.0028	0
GHG	527	199	117

CARB staff previously generated conservative usage assumptions for Clean Cars 4 All. According to EMFAC2014, a 1997 model year vehicle operates approximately 7,500 miles per year in calendar year 2017.

Using the emission factors and technology mix mentioned above and the annual usage of 7,500 miles per year, staff calculated the annual per-vehicle emission reductions for PHEVs and BEVs for Clean Cars 4 All, as shown in Table C - 16.

Table C - 16 Clean Cars 4 All Annual Per-Vehicle Emission Reductions

Pollutant	Vehicle Technology	Per Vehicle Annual Emission Reductions
GHG (metric tons CO2e per year)	PHEV	2.45
	BEV	3.06
NOx (tpy)	PHEV	0.0035
	BEV	0.0036
PM 2.5 (tpy)	PHEV	0.0001
	BEV	0.0001
ROG (tpy)	PHEV	0.0011
	BEV	0.0011

Table C - 17 shows the calculated total annual emission reductions based on the number and type of advanced technology vehicles supported from Table C - 13 and the per vehicle annual emission reduction values from Table C - 16.

Table C - 17 Clean Cars 4 All Annual Emission Reductions

Pollutant	Vehicle Technology	Annual Emission Reductions
GHG (metric tons CO2e per year)	PHEV	3.4
	BEV	1.6
NOx (tpy)	PHEV	5
	BEV	2
PM 2.5 (tpy)	PHEV	<1
	BEV	<1
ROG (tpy)	PHEV	2
	BEV	1

Staff previously estimated that the remaining useful life of the baseline 1996 model year vehicle is 3 years,[47] therefore, the quantification period for Clean Cars 4 All used in this analysis is 3 years (the ownership requirement for EFMP Plus-Up is 2.5 years). The emission reductions were then calculated by multiplying the annual emission reductions from Table C - 17 by the quantification period. Based on actual vehicles scrapped and incentivized and the assumptions outlined in this appendix, the total

[47] https://ww3.arb.ca.gov/msprog/aqip/fundplan/proposed_1819_funding_plan.pdf. Appendix A.

emission reductions achieved for Clean Cars 4 All through FY 2017-2018 using a quantification period of 2.5 years are shown in Table C - 18.

Table C - 18 Total Emission Reductions for Clean Cars 4 All (3-Year Quantification Period)[48]

Pollutant	Vehicle Technology	Emission Reductions
GHG (1,000 metric tons CO2e)	PHEV	10
	BEV	5
	Overall	**15**
NOx (tons)	PHEV	15
	BEV	6
	Overall	**20**
PM 2.5 (tons)	PHEV	<1
	BEV	<1
	Overall	**1**
ROG (tons)	PHEV	5
	BEV	2
	Overall	**6**

For Clean Cars 4 All, the 2019 California Climate Investments Annual Report[49] reports a GHG emission reduction of 19,000 MTCO2e. Similar in magnitude, this analysis for the SB 498 report shows an emission reduction of 15,000 MTCO2e. The discrepancy between the numbers is due to the CCI value including the conventional hybrid vehicles funded by the project, which are not included in this SB 498 analysis.

[48] Totals may not add up due to rounding.

[49] https://ww3.arb.ca.gov/cc/capandtrade/auctionproceeds/2019_cci_annual_report.pdf.

Heavy-Duty ZEV Projects

The quantification methodologies for HVIP and the Zero-Emission Truck and Bus Pilot Projects are presented together because they are the same. For the purposes of this analysis, staff estimated reductions from the emissions offset between a new, 2018 model year conventional truck or bus, and an advanced technology vehicle (i.e., zero-emission trucks and buses and vehicles equipped with ePTO). Table C - 19 shows the number of vehicles supported by vehicle class for each heavy-duty project. For HVIP these numbers include vehicles from vouchers that have been redeemed and requested.

Table C - 19 Number of Supported Heavy-Duty Vehicles (FY 2014-2015 - FY 2017-2018)

Vehicle Class	HVIP	Zero-Emission Truck and Bus Pilot Projects
MHD BEV	1,193	45
HHD BEV	75	1
Urban bus BEV	483	25
Urban bus FCEV	5	25
School bus BEV	60	29
ePTO	189	0
Totals	2,005	125

For both HVIP and Zero-Emission Truck and Bus Pilot Project, fuel economy values of the heavy-duty vehicles were derived from EMFAC2014.[50] For simplicity, staff assumed 2017 as the starting year of all the vehicles supported by the heavy-duty vehicle incentive projects. The fuel economy values were based on the baseline fleet average in 2024, halfway through the assumed useful life of 15 years, to account for vehicle deterioration, serving as the expected average fuel economy values of the baseline vehicles. Besides this simplification change, the methodology remains the same to previous ones.[51]

Table C - 20 provides a summary of the fuel economy values for baseline vehicles in miles per gallon (MPG), miles per kilogram (m/kg) for compressed natural gas (CNG) urban buses, and gallons per hour (gal/hr) for vehicles equipped with ePTO.

[50] https://www.arb.ca.gov/emfac/2014/.

[51] https://ww3.arb.ca.gov/msprog/aqip/fundplan/proposed_1819_funding_plan.pdf Appendix A.

Table C - 20 Fuel Economy Values Used for Baseline Conventional Vehicles for HVIP and Zero-Emission Truck and Bus Pilot Project

Vehicle Class	Fuel Type	MPG
MHD	Diesel	8.9
HHD	Diesel	6.2
Urban Bus	Diesel	5.4
Urban Bus	CNG	1.7 (m/kg)
School Bus	Diesel	7.7
ePTO	Diesel	3.2 (gal/hr)

It should be noted that for baseline urban bus emission factors, staff used an average of diesel and CNG urban bus emission rates since the current California fleet utilizes a mix of the two fuel types. Only limited data is available for heavy-duty CNG-fueled vehicles, therefore, staff assumed CNG vehicles have similar criteria pollutant and toxics emission rates as diesel-fueled vehicles because they are certified to the same emission standard.

Based on discussions with manufacturers, ePTO systems automatically prevent engine idle by shutting the engine off while in park or neutral, preventing unnecessary engine usage during PTO operation. For criteria pollutant and toxics emission factors associated with ePTOs, staff utilized the emission factors found in EMFAC to quantify the criteria pollutant and toxics emissions reduction associated with ePTO systems that are currently eligible in HVIP. The emission factor used is associated with the excess emissions due to the usage of PTOs powered by a diesel engine. Emission factors for HVIP and the Zero-Emission Truck and Bus Pilot Projects are shown in Table C - 21 and emission factors used to quantify PTOs are shown in Table C - 22. For more information on how these emission factors were developed, please see the Emission Factor Development section at the beginning of this appendix.

Table C - 21 Heavy-Duty Vehicle Emission Factors (WTW for GHG and TTW for CP/Toxics)

Vehicle Class	Pollutant	2018 Diesel (g/mi)	2018 CNG (g/mi)	2018 BEV (g/mi)	2018 FCEV (g/mi)
MHD	NOx	0.8536	NA	0	NA
	PM 2.5	0.0616	NA	0.0309	NA
	ROG	0.0368	NA	0	NA
	GHG	1,540	NA	289	NA
HHD	NOx	1.4041	NA	0	NA
	PM 2.5	0.0404	NA	0.0222	NA
	ROG	0.0766	NA	0	NA
	GHG	2,223	NA	417	NA
Urban Bus	NOx	0.8140	0.8140	0	0
	PM 2.5	0.3669	0.3669	0.1834	0.1834
	ROG	0.0228	0.0228	0	0
	GHG	2,539	2,451	476	1,157
School Bus	NOx	1.4076	NA	0	NA
	PM 2.5	0.3249	NA	0.1626	NA
	ROG	0.0549	NA	0	NA
	GHG	1,786	NA	335	NA

Note: MHD and HHD emission factors are based on population-weighted averages of the T6 and T7 diesel vehicle classes in EMFAC 2014, respectively, excluding out-of-State vehicles.

Table C - 22 ePTO Emission Factors

Vehicle Class	Pollutant	2018 Diesel (g/hr)	2018 Battery Electric (g/hr)
ePTO	NOx	72.84	NA
	PM 2.5	0.0724	NA
	ROG	0.4171	NA
	GHG	44,144	8,273

For HVIP, the usage assumptions from previous methodologies are used here. For urban buses, CARB staff used data provided by previous HVIP voucher recipients to determine the average annual usage. Data for ePTO systems were obtained from NREL's Fleet Test and Evaluation Team.[52] Based on the information, staff assumed that a vehicle typically operates in PTO mode for 4 hours a day and 250 workdays a year. Additionally, staff assumed the fuel consumption rate of 3.2 gallons per hour for ePTO systems based on data from EMFAC. For all other battery-electric vehicle classifications, the annual usage assumption was based on the California Hybrid,

[52] https://www.nrel.gov/transportation/assets/pdfs/67116.pdf (accessed June 26, 2018).

Efficient and Advanced Truck Research Center (CalHEAT) Research Center's report on "Battery Electric Parcel Delivery Truck Testing and Demonstration."[53] The annual usage assumptions for both projects are shown in Table C - 23.

Table C - 23 Heavy-Duty Vehicle Annual Usage Assumptions

Vehicle Class	Vehicle Technology	Usage (mi/yr)
MHD	BEV	12,000
HHD	BEV	12,000
	ePTO	1,000 hours/yr
Urban Bus	BEV and FCEV	30,000
School Bus	BEV	12,000

For the Zero-Emission Truck and Bus Pilot Projects, the emission benefit quantification of this program in the 2019 (and previous) California Climate Investments Annual Report (CCI report)[54] used annual usage assumptions based on applicant projections. The range of these values is shown in Table C - 24. There is a large range on the projected usage assumptions as these values represent individual projects at different sites. For example, the usage assumption for the urban buses depends on the detailed route information and frequency. Some transit bus applicants indicated expected high vehicle usage by placement on long-distance routes with high frequency, while others operate in dense urban areas with fewer miles and more stops. Since these values are still being validated based on actual vehicle usage and to be conservative, CARB staff used the same assumptions as for the HVIP vehicle categories from Table C - 23 since these are based on published reports and literature.

Table C - 24 Zero-Emission Truck and Bus Pilot Projects Annual Usage Assumptions per Applicant Projections

Vehicle Class	Vehicle Technology	Projected Usage (mi/yr)
MHD	BEV	9,100-15,000
HHD	BEV	23,000
Urban Bus	BEV and FCEV	16,698-123,881
School Bus	BEV	6,993-14,302

[53] Gallo, Jean-Baptiste, Jasna Tomić. (CalHEAT). 2013. Battery Electric Parcel Delivery Truck Testing and Demonstration. California Energy Commission. https://calstart.org/wp-content/uploads/2018/10/Battery-Electric-Parcel-Delivery-Truck-Testing-and-Demonstration.pdf.

[54] https://ww3.arb.ca.gov/cc/capandtrade/auctionproceeds/2019_cci_annual_report.pdf.

Using the emission factors, technology mix, and the annual usage assumptions from Table C - 23, staff calculated the estimated annual per-vehicle emission reductions for the heavy-duty vehicles, as shown in Table C - 25.

Table C - 25 Heavy-Duty Vehicle Annual Emission Benefits on a Per-Vehicle Basis

Pollutant	EMFAC Vehicle Class	Supported Technologies	Per Vehicle Annual Emission Reductions
GHG (metric tons CO2e per year)	MHD	BEV	15.02
	HHD	BEV	21.68
	HHD	ePTO	35.87
	Urban Bus	BEV	60.57
	Urban Bus	FCEV	40.14
	School Bus	BEV	17.41
NOx (tpy)	MHD	BEV	0.0113
	HHD	BEV	0.0186
	HHD	ePTO	0.0803
	Urban Bus	BEV	0.0269
	Urban Bus	FCEV	0.0269
	School Bus	BEV	0.0186
PM 2.5 (tpy)	MHD	BEV	0.0004
	HHD	BEV	0.0002
	HHD	ePTO	0.0001
	Urban Bus	BEV	0.0061
	Urban Bus	FCEV	0.0061
	School Bus	BEV	0.0021
ROG (tpy)	MHD	BEV	0.0005
	HHD	BEV	0.0010
	HHD	ePTO	0.0005
	Urban Bus	BEV	0.0008
	Urban Bus	FCEV	0.0008
	School Bus	BEV	0.0007

As presented in previous methodologies,[55] staff assumed a useful life of 15 years for heavy-duty trucks and the average school bus has a useful life of 15 years.[56] Staff multiplied the annual per vehicle emission reductions from Table C - 25 by the quantification period to derive the per vehicle total reductions. This value was then multiplied by the number and type of vehicles supported by each project from Table C

[55] https://ww3.arb.ca.gov/msprog/aqip/fundplan/proposed_1819_funding_plan.pdf. Appendix A.

[56] https://www.afdc.energy.gov/uploads/publication/case-study-propane-school-bus-fleets.pdf.

- 19. Table C - 26 summarizes the total reduction per vehicle over the quantification period and the total emission reductions for all of the supported vehicles.

Table C - 26 Per Vehicle and Total Emission Reductions per Heavy-Duty Vehicle Class and Project (15-Year Quantification Period)[57]

Pollutant	EMFAC Vehicle Class	Supported Tech	Per Vehicle Total Reductions	HVIP Emission Reductions	Zero-Emission Truck and Bus Pilot Projects Emission Reductions
GHG (1,000 metric tons CO2e per year)	MHD	BEV	0.2253	269	10
	HHD	BEV	0.3252	24	<1
	HHD	ePTO	0.5381	102	N.A.
	Urban Bus	BEV	0.9085	439	23
	Urban Bus	FCEV	0.6022	3	15
	School Bus	BEV	0.2612	16	8
	Overall			**852**	**56**
NOx (tpy)	MHD	BEV	0.1694	202	8
	HHD	BEV	0.2786	21	<1
	HHD	ePTO	1.204	228	N.A.
	Urban Bus	BEV	0.4038	195	10
	Urban Bus	FCEV	0.4038	2	10
	School Bus	BEV	0.2793	17	8
	Overall			**664**	**36**
PM 2.5 (tpy)	MHD	BEV	0.0061	7.28	<1
	HHD	BEV	0.0036	0.27	<1
	HHD	ePTO	0.0012	0.23	N.A.
	Urban Bus	BEV	0.0910	43.95	2
	Urban Bus	FCEV	0.0910	0.46	2
	School Bus	BEV	0.0322	1.93	1
	Overall			**54**	**6**
ROG (tpy)	MHD	BEV	0.0073	9	<1
	HHD	BEV	0.0152	1	<1
	HHD	ePTO	0.0069	1	N.A.
	Urban Bus	BEV	0.0113	6	<1
	Urban Bus	FCEV	0.0113	<1	<1
	School Bus	BEV	0.0109	1	<1
	Overall			**17**	**1**

57 Totals may not add up due to rounding.

Table C - 27 shows the combined emission reductions to provide the overall reductions for each pollutant for the vehicles supported by HVIP and Zero-Emission Truck and Bus Pilot Projects during FY 2014-2015 through FY 2017-2018 over the 15-year quantification period.

Table C - 27 Total Emission Reductions for HVIP and Zero-Emission Truck and Bus Pilot Projects (FY 2014-2015 - FY 2017-2018 Supported Vehicles, 15-Year Quantification Period)

Pollutant	HVIP - Total	Zero-Emission Truck and Bus Pilot Projects- Total
GHG (1,000 metric tons CO2e)	852	56
NOx (tons)	664	36
PM 2.5 (tons)	54	6
ROG (tons)	17	1

These calculated GHG emission reductions are different than those of the 2019 California Climate Investments Annual Report (CCI report)[58] due to differences in each methodology. The CCI report quantifies project lifetime benefits attributed only from Cap-and-Trade Proceeds. In contrast, this SB 498 analysis quantifies the project benefits regardless of the funding source, but only for four fiscal years and only for zero-emission vehicles.

For HVIP, the GHG emission reductions are relatively similar with 879,000 MTCO2e for the CCI report versus 852,000 for this SB 498 report. Despite HVIP first receiving AQIP funding from FY 2009-10, it did not receive Cap-and-Trade Funds until FY 2013-14. In FY 2013-14 and FY 2014-15 HVIP received funding from both AQIP and Cap-and-Trade Funds. Beginning in FY 2015-16, zero-emission vehicles in HVIP were fully funded via Cap-and-Trade Proceeds. Overall, through FY 2017-18, HVIP has received $228 million from Cap-and-Trade Proceeds and $64 million from AQIP. The SB 498 analysis does not include HVIP's emission benefits from the conventional hybrid or low-NOx vehicles funded.

For the Zero-Emission Truck and Bus Pilot Projects, the GHG emission reductions are very different with 107,000 MTCO2e for the CCI report versus 56,000 MTCO2e for this SB 498 report. The quantification period and total vehicles quantified[59] are the same for both reports. The main reason for this large discrepancy has to do with the different usage assumptions since the CCI report was calculated based on the

[58] https://ww3.arb.ca.gov/cc/capandtrade/auctionproceeds/2019_cci_annual_report.pdf.

[59] Since only zero-emission trucks and buses were funded.

applicant usage projections and this SB 498 analysis is based on conservative estimates.

For simplicity, in the SB 498 report the MHD and HHD vehicle classes are combined although they were calculated separately in this appendix.