Appendix A: Emission Reductions Quantification Methodology

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Overview

In Fiscal Year (FY) 2022-23 the California Air Resources Board (CARB) received $746 million from the Greenhouse Gas Reduction Fund (GGRF), $710 million from the General Fund, $1.125 billion from Proposition 98 General Funds, and $28.64 million from the Air Quality Improvement Fund for incentive projects described in the Funding Plan for Clean Transportation Incentives (Funding Plan). This appendix describes the applied methodology and the assumptions used to generate conservative estimates of emission reductions for the Funding Plan's proposed projects. Assembly Bill (AB) 8 (Perea, Chapter 401, Statutes of 2013) and published GGRF quantification methodologies[1] guided this analysis.

It is important to note that these estimates are illustrative examples of potential emission reductions that can be achieved with the allocated funding to these projects. Refined emission reduction estimates will be quantified as projects are implemented and data becomes available.

Table A-1 summarizes the funding allocations for the projects proposed in the Funding Plan and the potential emission reductions over the project life.

[1] Cap-and-Trade auction proceeds quantification materials are available https://ww2.arb.ca.gov/resources/documents/cci-quantification-benefits-and-reporting-materials

Table A-1: Summary of Proposed Projects in FY 2022-23 Funding Plan and Total Potential Emission Reductions[2]

Project Category	Proposed FY 2022-23 Allocation (millions)	Vehicles, Equipment or Projects Funded	Total Potential Lifetime Emission Reductions (tons)			
			GHG	NOx	PM 2.5	ROG
Vehicle Purchasing Incentives						
Clean Vehicle Rebate Project Standard	N/A	N/A	N/A	N/A	N/A	N/A
Clean Vehicle Rebate Project Increased Rebate	N/A	N/A	N/A	N/A	N/A	N/A
Financing Assistance for Lower Income Consumer	$66	5,260	44,800	3.25	1.93	0.65
Clean Cars 4 All (Statewide)	$125	7,850	83,400	58.5	3.17	11.9
Clean Cars 4 All (Air Districts)	$120	8,040	85,400	59.9	3.25	12.2
Electric Bicycle Incentives	$3	TBD	TBD	TBD	TBD	TBD
Access Clean California	$1	N/A	N/A	N/A	N/A	N/A
California Integrated Transit Project (Cal-ITP)	$1	N/A	N/A	N/A	N/A	N/A
Clean Mobility Investments						
Clean Mobility Options	$20	767	6,280	1.11	0.22	0.28
Clean Mobility in Schools	$15	75	34,200	32	2.02	8.14
Sustainable Transportation Equity Project (STEP)	$15	6	1,930	0.25	0.08	0.06
Planning and Capacity Building	$5	N/A	N/A	N/A	N/A	N/A
Heavy-Duty and Off-Road Equipment						
HVIP – Standard	$265	2,310	115,000	129	4.34	3.32
HVIP – Transit Buses	$70	413	53,300	23.7	0.85	1.95
HVIP – School Buses	$135	291	17,200	108	2.40	1.10
HVIP – School Buses (Prop 98)	$1,125	3,300	187,000	1,180	21.9	11.9
HVIP – Drayage Trucks	$157	869	44,400	73.4	0.74	1.39
HVIP – Innovative Small e-Fleets	$35	175	7,560	10.00	0.17	0.23
Clean Off-Road Equipment Vouchers (CORE)	$273	1,770	306,000	192	8.28	119

[2] The total numbers may not add up due to rounding.

Project Category	Proposed FY 2022-23 Allocation (millions)	Vehicles, Equipment or Projects Funded	Total Potential Lifetime Emission Reductions (tons)			
			GHG	NOx	PM 2.5	ROG
Advanced Technology Demonstration and Pilot Projects	$75	246	7,550	10.1	0.14	0.22
Demonstration and Pilot Projects – Commercial Harbor Craft	$60	TBD	TBD	TBD	TBD	TBD
Truck Loan Assistance Program	$28.64	2,960	N/A	457	N/A	16.3
Zero-Emission Truck Loan Pilot	$5	84	3,940	5.44	0.08	0.12
Total	$2,599.64	34,400	998,000	2,340	49.6	189

Emission Factor Development

To support the emission reductions analysis from the proposed projects, staff developed emission factors for relevant vehicle classes. The emission factors and assumptions used in the analysis were derived from several sources. These sources include CARB's California-modified Greenhouse Gases (GHG), Regulated Emissions, and Energy Use in Transportation (CA-GREET 3.0) Model,[3] CARB's Emission Factor (EMFAC2017) Model,[4] information from CARB regulation staff reports and emissions inventories, publicly available technical reports, and staff assumptions. GHG emission factors were developed on a well-to-wheel (WTW) basis because GHG are global pollutants. Criteria pollutant and toxic emission factors were calculated based solely on tailpipe emissions because of their localized impact.

Staff developed emission factors for the following vehicle classes:

- Electric bicycles
- Light-duty vehicles (LDV)
- Light heavy-duty vehicles (LHD2)
- Medium heavy-duty vehicles (MHD)
- Heavy heavy-duty vehicles (HHD)
- Urban buses
- School buses
- Cargo-handling equipment (CHE)
- Transport refrigeration units (TRU)
- Off-road mobile agricultural equipment (tractors)

[3] *http://www.arb.ca.gov/fuels/lcfs/ca-greet/ca-greet.htm*
[4] *https://www.arb.ca.gov/emfac/2017/*

- Locomotives

GHG Emission Factors

Fuel economy is an important component of the GHG emission reduction analysis, as the value determines the GHG emissions generated based on the consumption of each unit of fuel for the miles traveled or in the case of off-road applications, unit of fuel consumed per hour of use. Fuel economy values were derived from EMFAC 2017[5] and CARB's off-road mobile source emissions inventories[6], specifically the 2011 Cargo Handling Equipment (CHE) Inventory, and the 2011 TRU Emissions Inventory models. Table A-2 provides a summary of the fuel economy values for baseline gasoline or diesel powered on-road vehicles, while Table A-3 provides a summary of fuel economy values for baseline diesel powered off-road vehicles. These values were used in the analysis for conventional vehicles. For instance, the Clean Vehicle Rebate Project (CVRP) is the only project to use model year 2023 vehicles, which is why the 2023 column only has one value – LDV Gasoline. Furthermore, Clean Mobility Options (CMO) and the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), among others, expect their projects to fund model year 2022 vehicles; since these projects span all vehicle classes listed, the model year 2022 column is complete.

Table A-2: On-Road Fuel Economy Values of Baseline Conventional Vehicles

Vehicle Class	Fuel Type	Fuel Economy Values (miles per gallon)						
		2000	2007	2018	2020	2021	2022	2023
LDV	Gasoline	23.9	-	33.3	35.6	36.7	38.1	39.6
LHD	Diesel	-	-	-	-	-	20.2	-
MHD	Diesel	-	-	-	-	10.8	11.7	-
HHD	Diesel	-	-	-	-	8.4	8.4	-
Urban Bus	Diesel	-	-	-	-	8.7	7.8	-
School Bus	Diesel	7.4	7.3	-	-	10.3	10.3	-

[5] https://www.arb.ca.gov/emfac/2017/

[6] https://www.arb.ca.gov/msei/msei.htm

Table A-3: Off-Road Fuel Economy Values of Baseline Diesel Vehicles

Vehicle Class	Horsepower Range	Tier 4 Final Fuel Economy Values (gal/hr)
Forklift	100-174	1.4
Yard Truck	175-299	3.5
TRU	23-25	0.7

As shown in Formula 1, a vehicle's fuel economy was paired with carbon intensity (CI) in units of CO2 weight per unit energy from the Low Carbon Fuel Standard (LCFS)[7] and the lower heating value (LHV) in units of energy per mass of the applicable fuel to calculate the WTW GHG emission factor for each project type. 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. For on-road vehicles, the GHG emission factor is in units of grams of carbon dioxide (CO2) equivalent per mile (gCO2e/mi), and for off-road vehicles, the GHG emission factor is in units of grams of CO2e per hour (gCO2e/hr).

Formula 1: GHG Emission Factors

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

For alternative-fueled vehicles, the baseline 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[8] or based on a study comparing efficiency of battery-electric vehicles and conventional diesel vehicles operating on the same duty cycle.[9]

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 adopted from the LCFS Program's carbon intensities

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[7] https://www.arb.ca.gov/fuels/lcfs/lcfs.htm

[8] https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf

[9] https://www.arb.ca.gov/msprog/actruck/mtg/170425eerdraftdocument.pdf

represent the average or typical production processes for each fuel used in California. Staff assumed the following pathways for the fuels analyzed:

- Gasoline: California reformulated gasoline (CaRFG) from the LCFS Lookup Table[10];
- 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 2020 from LCFS Reporting Tool (LRT)[11] data;
- Electricity: California grid average mix, which meets the Renewable Portfolio Standard (RPS) requirements, from the LCFS Lookup Table; and
- Hydrogen: SB 1505 compliant gaseous hydrogen reformed on-site at the refueling station from a mix of North American natural gas and 33 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 Toxics Emission Factors

To determine criteria pollutant emission factors for on-road vehicles, staff applied CARB's EMFAC 2017 model to calculate the tailpipe emissions of the supported vehicles or equipment and associated emissions, such as idling emissions and PM 2.5 emissions from brake and tire wear, when applicable. For off-road equipment, staff applied CARB's 2011 CHE Inventory and 2011 TRU Emissions Inventory to develop emission factors associated with the usage of the supported vehicles or equipment.

When available, staff incorporated deterioration factors for on-road and off-road vehicles, reflecting increased emissions from combustion engines as they age. Staff also applied a 50 percent reduction in brake wear emissions for on-road vehicles that implement regenerative braking.[12] The emission factors developed for advanced technology vehicles (e.g. BEVs, PHEVs, etc.) along with emission factors for baseline conventional vehicles are listed by the proposed projects when applicable. There are instances where emission factors cannot be developed because the projects are too new or not enough is known about the project – in those cases, those projects will report their emissions reductions during project implementation and will provide potential emissions reductions in future Funding Plans.

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[10] *https://www.arb.ca.gov/fuels/lcfs/fuelpathways/pathwaytable.htm*

[11] *https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm*

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

Quantification Methodology for Projects

To quantify the potential emission reductions for each project, staff must first determine the annual per-vehicle emission reductions for each technology weighted by the amount of each technology funded in the project. Staff then estimate the average project costs to determine the number of vehicles or equipment that may be funded by the allotted funding amounts. Finally, to determine the total potential emission reductions for each project, the average annual per-vehicle emission reductions is multiplied by the number of vehicles or equipment funded and the project life. As noted in the individual project write-ups, staff have quantified emission reductions based on projections, since the actual vehicle and equipment types that will be funded may not yet be known.

Annual Per-Vehicle Emission Reductions

Annual emission reductions are calculated for each eligible or representative technology in the project using the emission factors appropriate for each project. Annual emission reductions are in units of tons per year (tpy) 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 tpy for GHG emissions and tpy for criteria pollutants and toxic air contaminants.

For on-road projects, annual emission reductions are calculated using Formula 3, where emission factors ($EF_{baseline}$ meaning baseline emission factors and EF_{ATV} referring to alternate vehicle 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 off-road projects, annual emission reductions are also calculated using Formula 3, and emission factors are in terms of grams per hour (g/hr) and usage is in terms of hours per year. Additionally, the vehicle or equipment's load factor, which is an indicator of the nominal amount of work done by the engine for a particular application, and the horsepower rating of the engine are included when developing emission factors for off-road projects.

Formula 3: Annual Per-Vehicle Emission Reductions

$$Annual\ Per\ Vehicle\ Emission\ Reductions\ (tpy) = (EF_{baseline} - EF_{ATV}) * Usage$$

Once the annual per-vehicle emission reductions are calculated for the eligible technologies in each project, technology splits are factored in so that the emission reductions on a per-vehicle basis are representative of an average vehicle or equipment replaced under the project, as shown in Formula 4. The technology splits or mix for each project are determined based on historical project data or projected demand.

Formula 4: Average Annual Per-Vehicle Emission Reductions

$$Average\ Annual\ Per\ Vehicle\ Emission\ Reductions\ (tpy)$$
$$= \Sigma(annual\ emission\ reductions\ per\ vehicle\ type * fraction\ of\ vehicles\ funded)$$

Project Costs

Once staff have identified the incentive cost for each technology and potential technology split for a given project, staff calculate the average incentive amount for each project, using Formula 5.

Formula 5: Average Incentive Cost

$$Average\ Incentive\ Cost\ (\$) = \Sigma(cost\ per\ vehicle\ type * fraction\ of\ vehicles\ funded)$$

Once the average incentive amount is determined, the allotted funding for the project minus the administrative cost can be divided by the average incentive amount to estimate the number of vehicles or equipment likely to be funded, as shown in Formula 6. Staff evaluated the appropriate administrative cost for each project, which vary depending on the amount of oversight necessary to implement the project.

Formula 6: Number of Vehicles Funded

$$Number\ of\ Vehicles\ Funded = \frac{(Proposed\ Funding\ Allocation - Administrative\ Cost)}{Average\ Incentive\ Cost}$$

Total Lifetime Emission Reductions

Once the average per-vehicle emission reductions are determined, it is multiplied by the potential number of vehicles funded and the project life to determine the total potential lifetime emission reductions for a project, as shown in Formula 7.

Formula 7: Lifetime Emission Reductions

$$Lifetime\ Emission\ Reductions\ (tons) = average\ per\ vehicle\ emission\ reductions * number\ of\ vehicles * project\ life$$

Clean Transportation Equity and Light-Duty Investments

CARB’s clean transportation and light duty vehicle (LDV) and transportation equity investments are grouped into two broad project categories: Vehicle Purchase Incentives and Clean Mobility Investments. CVRP supports increasing the number of zero-emission vehicles (ZEV) on California’s roadways to meet the State’s ZEV deployment goals and achieve the large-scale transformation of the light-duty fleet. The transportation equity projects are designed to increase access to clean mobility in disadvantaged communities and lower-income households. The vehicle purchase incentives projects proposed in this year's Funding Plain include: Financing Assistance for Lower-Income Consumers, Clean Cars 4 All, Electric Bicycle Incentives Project, Access Clean California, and California Integrated Transit Project (Cal-ITP). The transportation equity projects proposed in this year's Funding Plan include: Clean Mobility Options, Clean Mobility in Schools, the Sustainable Transportation Equity Project (STEP), Planning and Capacity Building, and Workforce Training and Development.

All LDV and transportation equity investment projects use the light-duty automobile classification in EMFAC 2017 for the development of emission factors. Clean Mobility in Schools, Clean Mobility Options, and STEP are the exceptions since they can fund different types of vehicles, using heavy-duty emission factors as needed.

Quantification of the LDV and transportation equity investment projects proposed in this year's Funding Plan are described in more detail below.

CVRP

CVRP achieves emission benefits by providing incentives for battery-electric vehicles (BEV), fuel cell vehicles (FCV), and plug-in hybrid electric vehicles (PHEV) to help motivate consumer purchasing decisions and support widespread adoption, especially among lower-income consumers. When estimating emission benefits for CVRP, staff assumed that the consumer was purchasing or leasing a new vehicle. As a result, emission reductions for CVRP are calculated as the difference between an average 2023 model year conventional LDV and an average 2023 model year CVRP-eligible vehicle.

In FY 2021-22, CVRP received a $525 million allocation that was intended to last three years[13]. The projected emission reductions were quantified in last year's Funding Plan Appendix A[14]; however, significant changes to the incentive amounts are being proposed for FY 2022-23. As a result, staff is re-quantifying these emissions reductions for the money that is not expected to be spent by February 2023 when most of the program changes go into effect, which is approximately $334 million.

Project data from December 2021 through May 2022 show that approximately 87 percent of standard CVRP rebates went to BEVs, 8 percent went to PHEVs, and 5 percent went to FCVs. Project data for low-income applicants for the same period show that 87 percent of rebates went to BEVs, 7 percent went to PHEVs, and 6 percent went to FCVs. For the increased rebate for low-income consumers, staff is recommending that the rebate amounts increase to $6,500 for PHEVs and $7,500 for

[13] CARB, "Proposed Fiscal Year 2021-22 Funding Plan for Clean Transportation Incentives", 2021. *https://ww2.arb.ca.gov/sites/default/files/2021-10/fy21-22_fundingplan.pdf*

[14] The full $525 million allocation quantification can be found at *https://ww2.arb.ca.gov/sites/default/files/2021-10/fy21-22_fundingplan_appendix_a.pdf*

BEVs and FCEVs. Additionally, staff is recommending that a $2,000 pre-paid charging card be provided to increased rebate recipients that purchase or lease a BEV or PHEV. There are no changes in rebate amounts to the standard rebate for FY 2022-23.

Table A-4 shows the emission factors for the selected baseline vehicle and PHEV, FCV, and BEV replacements. For more information on how these emission factors were developed, please see the Emission Factor Development section at the beginning of this appendix.

Table A-4: CVRP Emission Factors

Pollutant	2023 Gasoline (g/mi)	2023 Plug-in Hybrid Electric Vehicle (g/mi)	2023 Battery Electric Vehicle (g/mi)	2023 Fuel Cell Vehicle (g/mi)
NOx	0.0127	0.0055	0	0
PM 2.5	0.0187	0.0103	0.0099	0.0099
ROG	0.0023	0.0010	0	0
GHG	291	156	66	131

Staff estimated vehicle usage assumptions for CVRP through literature review for each of the vehicle types evaluated. The annual usage assumptions for CVRP are shown in the Table A-5 below.

Table A-5: CVRP Annual Usage Assumptions

Technology	Usage (mi/yr)
PHEV	14,855[15]
BEV	14,400[16]
FCV	12,445[17]

Using the emission factors, technology mix (i.e. the percent of BEVs, PHEVs, and FCVs over the data collection period), and the annual usage assumptions above, staff calculated the potential annual per-vehicle emission reductions for CVRP, as shown in Table A-6.

[15] Based on 40.7 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/*)

[16] Based on EMFAC 2017 Volume III- Technical Documentation, California Air Resources Board *https://ww3.arb.ca.gov/msei/downloads/emfac2017-volume-iii-technical-documentation.pdf*

[17] Hardman, S., Tal, G., 2019, Understanding the Early Adopters of Fuel Cell Vehicles, NCST (*https://escholarship.org/uc/item/866706mr*)

Table A-6: CVRP Annual Emission Benefits on a Per-Vehicle Basis

Pollutant	Supported Technologies	Per Vehicle Annual Emission Reductions (tpy)	
		Per Technology	Average
GHG	PHEV	2.01	3.08
	BEV	3.24	
	FCV	2.00	
NOx	PHEV	0.00012	0.00019
	BEV	0.00020	
	FCV	0.00017	
PM 2.5	PHEV	0.00014	0.00014
	BEV	0.00014	
	FCV	0.00012	
ROG	PHEV	0.00002	0.00003
	BEV	0.00004	
	FCV	0.00003	
	BEV	0.00004	
	FCV	0.00003	

Staff is allocating at least half of the $334 million to CVRP rebates for low-income applicants for FY 2022-23. Based on project data, staff anticipate the average rebate cost to be $9,310 for low-income applicants and $2,045 for standard rebates. For the standard rebate, the incentive amounts for BEVs, PHEVs, and FCVs are $2,000, $1,000, and $4,500, respectively. For the increased rebate, the incentive amounts for BEVs, PHEVs, and FCVs are $7,500, $6,500, and $7,500, respectively. Furthermore, for the increased rebate, the average rebate of $9,310 conservatively assumes that every participant purchasing or leasing a BEV or PHEV receives the $2,000 pre-paid charging card, thus receiving an additional $2,000 per incentive.

Based on the $167 million remaining from the FY 2021-22 allocation and the average cost discussed above, staff estimate that approximately 75,946 vehicles can be funded with the standard rebate, in addition to the 16,727 vehicles that can be funded with the $167 million allocation for CVRP rebates for low-income applicants. Staff assumed a 7 percent administration rate to process rebates for both the standard and increased programs. CVRP has a 30 month (2.5 years) ownership requirement; therefore, total potential emission reductions for the project are quantified over the course of 30 months and shown in Table A-7.

Table A-7: Total Potential Emission Reductions for CVRP

Type of Rebates	Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tons)
Standard Rebates	GHG	3.08	75,946	233,959	2.5	584,896
	NOx	0.00019		14.65		37
	PM 2.5	0.00014		10.50		26
	ROG	0.00003		2.62		7
Rebates for Low-Income Applicants	GHG	3.08	16,727	51,527	2.5	128,818
	NOx	0.00019		3.24		8
	PM 2.5	0.00014		2.31		6
	ROG	0.00003		0.58		1

Financing Assistance for Lower-Income Consumers

The Financing Assistance for Lower-Income Consumers project (Financing Assistance) achieves emission reduction benefits by assisting lower-income consumers in purchasing clean vehicles by improving access to more affordable financing options and providing down-payment assistance. For this year's quantification, staff quantified only the statewide program since the local program is not receiving additional funding. Based on grant data from June 2021- November 2021, before the program closed to new applications, the average model year purchased was 2020. Accordingly, the baseline replacement vehicle for these calculations is a 2020 conventional gasoline vehicle.

Clean Vehicle Assistance Program (CVAP) project data from June 2021 through November 2021 shows that approximately 86 percent of vehicle grants went to BEVs, 13 percent went to PHEVs, and 1 percent went to FCEVs; there were no conventional hybrid vehicles purchased through CVAP from June 2021 through November 2021. For this analysis, staff assumed that rebates for FY 2022-23 would continue to fund vehicles at a similar rate. Emission factors for CVAP are shown in Table A-8. For more information on how these emission factors were developed, please see the Emission Factor Development section at the beginning of this appendix.

Table A-8: Clean Vehicle Assistance Program Emission Factors

Pollutant	2020 Gasoline (g/mi)	2020 PHEV (g/mi)	2020 BEV (g/mi)	2020 FCEV (g/mi)
NOx	0.0165	0.0071	0	0
PM 2.5	0.0192	0.0105	0.0099	0.0099
ROG	0.0033	0.0014	0	0
GHG	324	174	73	145

Staff generated vehicle usage assumptions for Financing Assistance through literature review for each of the vehicle types evaluated, similar to CVRP. The annual usage assumptions for Financing Assistance are shown in Table A-9.

Table A-9: Financing Assistance Annual Usage Assumptions

Technology	Usage (mi/yr)
PHEV	14,855[18]
BEV	14,400[19]
FCEV	12,445[20]

Using the emission factors and technology mix mentioned above and the annual usage assumptions, staff calculated the potential annual per-vehicle emission reductions for Financing Assistance, as shown in Table A-10.

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[18] Based on 40.7 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/*)

[19] Based on EMFAC 2017 Volume III- Technical Documentation, California Air Resources Board *https://ww3.arb.ca.gov/msei/downloads/emfac2017-volume-iii-technical-documentation.pdf*

[20] Hardman, S., Tal, G., 2019, Understanding the Early Adopters of Fuel Cell Vehicles, NCST (*https://escholarship.org/uc/item/866706mr*)

Table A-10: Clean Vehicle Assistance Program Annual Emission Reductions on a Per-Vehicle Basis

Pollutant	Supported Technologies	Per Vehicle Annual Emission Reductions (tpy)	
		Per Technology	Average
GHG	BEV	3.60	3.41
	PHEV	2.23	
	FCEV	2.22	
NOx	BEV	0.00026	0.00025
	PHEV	0.00015	
	FCEV	0.00023	
PM 2.5	BEV	0.00015	0.00015
	PHEV	0.00014	
	FCEV	0.00013	
ROG	BEV	0.00005	0.00005
	PHEV	0.00003	
	FCEV	0.00005	

Based on proposed funding amounts and past project data, staff anticipates the average incentive amount to be $9,415 per vehicle. For this analysis, the incentive amounts for BEVs and FCVs are $7,500; for PHEVs, the incentive amount is $7,000. This conservatively assumes that every participant purchasing or leasing a BEV or PHEV receives either an EV charge card or at home charging, thus receiving an additional $2,000 per incentive.

Based on the proposed $66 million allocation for Financing Assistance, an estimated 25 percent administration fee for CVAP (based on historic implementation costs), and the average cost shown above, staff estimate that approximately 5,258 vehicles can be funded. Financing Assistance has a 30-month ownership requirement; therefore, total potential emission reductions for the project are quantified over the course of two and a half years, as shown in Table A-11.

Table A-11: Total Potential Emission Reductions for the Clean Vehicle Assistance Program

Pollutant	Per-Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tons)
GHG	3.41	5,258	17,936	2.5	44,839
NOx	0.00025		1.30		3.25
PM 2.5	0.00015		0.77		1.93
ROG	0.00005		0.26		0.65

Clean Cars 4 All

Clean Cars 4 All (CC4A) achieves emission reductions by incentivizing the scrap and replacement of old, high-emitting vehicles with cleaner advanced technology vehicles. To calculate the emission reductions for this project, staff used past project data to determine the model year of the baseline vehicle and the replacement vehicle. Based on project data through the 2021 calendar year, on average, a 2000 model year vehicle was being scrapped and replaced by an average 2018 model year advanced technology vehicle.

Project data for the 2021 calendar year shows that 61 percent went to PHEV purchases, 25 percent went to conventional hybrid vehicles, and the remaining 14 percent went to BEV purchases. For the purposes of this analysis, staff assumed that FY 2022-23 funding would continue to incentivize those technologies at similar rates. Table A-12 reflects the emission factors for the selected baseline conventional hybrid, PHEV 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.

Table A-12: Clean Cars 4 All Emission Factors

Pollutant	2000 Gasoline (g/mi)	2018 Conventional Hybrid (g/mi)	2018 PHEV (g/mi)	2018 BEV (g/mi)
NOx	0.1922	0.0161	0.0087	0
PM 2.5	0.0208	0.0116	0.0108	0.0099
ROG	0.0390	0.0034	0.0018	0
GHG	481	277	185	78

Staff generated vehicle usage assumptions for CC4A through literature review for each of the vehicle types evaluated, similar to CVRP. The annual usage assumptions for CC4A are shown in Table A-13.

Table A-13: Clean Cars 4 All Annual Usage Assumptions

Technology	Usage (mi/yr)
PHEV/Conventional Hybrid	14,855[21]
BEV	14,400[22]

Using the emission factors and technology mix mentioned above and the annual usage assumptions, staff calculated the potential annual per-vehicle emission reductions for CC4A, as shown in Table A-14.

Table A-14: Clean Cars 4 All Annual Emission Reductions on a Per-Vehicle Basis

Pollutant	Supported Technologies	Per-Vehicle Annual Emission Reductions (tpy)	
		Per Technology	Average
GHG	Conventional Hybrid	3.04	4.25
	PHEV	4.39	
	BEV	5.80	
NOx	Conventional Hybrid	0.00288	0.00298
	PHEV	0.00300	
	BEV	0.00305	
PM 2.5	Conventional Hybrid	0.00015	0.00016
	PHEV	0.00016	
	BEV	0.00017	
ROG	Conventional Hybrid	0.00058	0.00060
	PHEV	0.00061	
	BEV	0.00062	

The incentive amounts for BEVs, PHEVs, and Conventional Hybrids are $10,000, $9,500, and $7,000, respectively. Based on proposed funding amounts and past project data, staff anticipates the average incentive amount to be $11,945 per vehicle. This conservatively assumes that every BEV and PHEV is located in a disadvantaged community, thus receiving an additional $2,000 per incentive. In addition, this assumes that every participant purchasing or leasing a BEV or PHEV receives either an EV charge card or at home charging, thus receiving an additional $2,000 per incentive. Based on the proposed funding amount, $125 million will go to the statewide program and $120 million to the legacy district programs. With the proposed total of $245 million allocation for CC4A, staff estimates that approximately 15,885 vehicles can be funded between the statewide and district programs. To prevent overestimation of benefits, staff assumed a 20 percent administration rate would

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[21] Based on 40.7 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/*)

[22] Based on EMFAC 2017 Volume III- Technical Documentation, California Air Resources Board *https://ww3.arb.ca.gov/msei/downloads/emfac2017-volume-iii-technical-documentation.pdf*

support administering the district programs and 25 percent administration rate for the statewide program. These estimates are based on several factors. First, administrative costs have historically been 15 percent for district programs. Historic administrative costs for the Financing Assistance programs had been over 25 percent. CARB is evaluating implementation costs and considering increases where necessary to support the changes proposed for this fiscal year and changes authorized by Senate Bill 1382 (Gonzalez, Chapter 375). Further, with the needs-based approach and case management elements being adopted in the statewide program, staff assumes administrative costs could be as much as 25 percent. Finally, CC4A has a 30-month ownership requirement; therefore, total potential emission reductions for the project are quantified over the course of two and a half years. The potential emission reductions for CC4A statewide and district funding splits are shown in Table A-15 below.

Table A-15: Total Potential Emission Reductions for Clean Cars 4 All

Funding split	Pollutant	Per-Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emission Reductions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tons)
Statewide	GHG	4.25	7,848	33,350	2.5	83,374
	NOx	0.00298		23.39		58.5
	PM 2.5	0.00016		1.27		3.17
	ROG	0.00060		4.74		11.9
Districts	GHG	4.25	8,037	34,150	2.5	85,375
	NOx	0.00298		23.95		59.9
	PM 2.5	0.00016		1.30		3.25
	ROG	0.00060		4.86		12.2

Zero-Emission Assurance Project

The Zero-Emission Assurance Project (ZAP) will achieve GHG emission benefits by extending the life of ZEV through access to a rebate or vehicle service contract for the replacement battery or fuel cell component.

CARB is proposing to allocate $10 million to establish ZAP. As this is a new project, not enough is known about how ZAP will be implemented to make assumptions needed to quantify benefits. Emission reductions and other benefits of funded projects will be quantified during project implementation. Staff will coordinate internally to develop GHG emission reduction methodologies for ZAP and provide reduction estimates when possible.

Electric Bicycle Incentives Project

CARB is proposing to allocate $3 million to support the Electric Bicycle Incentives Project for FY 2022-23. The Electric Bicycle Incentives Project will achieve GHG emission benefits by providing low- to moderate-income individuals incentives for electric bicycles (e-bikes) to help motivate consumer purchasing decisions, support active transportation, and displace VMT with bike trips.

At this time, there is not enough specific data about how the Electric Bicycle Incentives Project will be implemented to make assumptions needed to quantify benefits. Staff is in the process of determining incentive levels and other program parameters, such as an ownership duration requirement, without which makes reasonable quantification impossible. Emissions reductions and other benefits of funded projects will be quantified during project implementation.

While methodologies do exist to calculate GHG emission reduction estimates for e-bikes, this project is currently under development and as such, program parameters have not been established. Staff will develop GHG emission reduction methodologies for the Electric Bicycle Incentives Project and provide reduction estimates when possible.

Access Clean California for CARB's Equity ZEV Purchasing Incentives

CARB is proposing to allocate $1 million to support the Access Clean California program, a pilot project creating a single application tool for accessing incentive project funding and to coordinate outreach across all these projects in order to support ZEV adoption in disadvantaged communities, low-income communities, and low-income households. The goal of this project is to streamline and increase access to CARB's equity ZEV incentives and to expand participation by low-income households. Because this project enables ZEV adoption through other incentive projects, such as Financing Assistance and CC4A, staff is not quantifying any direct emission reductions for this project. Instead, this project is expected to help achieve the emission reductions projected for clean vehicle purchase incentives.

Cal-ITP Payment Issuance Strategy and Demonstrations

CARB is proposing to allocate $1 million to Cal-ITP. The Payment Issuance Strategy and Demonstrations being developed by Cal-ITP would support various projects across CARBs light-duty vehicle incentive projects. Specifically, this project seeks to ensure that any transit customer, and specifically underbanked and unbanked customers can easily pay for transit by accepting Euro Pay, Master Card, and Visa open-loop payments. Because this project supports consumer transit and micro-mobility options offered in CARB's other incentive projects, such as CC4A and Clean Mobility Options, staff is not quantifying any direct emission reductions for this project. Instead, this project is expected to help achieve the emission reductions projected for other light-duty vehicle incentives.

Clean Mobility Options

Clean Mobility Options projects achieve emission reduction benefits by implementing car share programs that use advanced technology vehicles instead of conventional LDV in disadvantaged communities. Clean Mobility Options projects also offer alternate modes of transportation that encourage the use of zero-emission and plug-in hybrid vehicles, vanpools, and other mobility options. For FY 2022-23 Clean Mobility Options is introducing micro-mobility options that include e-scooters, e-bikes, and e-mopeds. While a number of strategies can be employed, the use of advanced technology vehicles or micro-mobility options instead of conventional LDV in a car-sharing component provides the primary GHG reductions resulting from a project. For this analysis, staff estimates reductions from the emissions offset between a brand new, conventional light-duty vehicle, an advanced technology vehicle and micro-mobility projects.

The Clean Mobility Options project will award small mobility projects statewide using the proposed allocation of $20 million. Because future projects are unknown and each project is different, based on the most recent year's project statistics, staff assumes that the 32 percent of the funding will go towards micro-mobility projects and 68 percent towards light-duty vehicles. Of the LDV funded 90 percent are expected to be BEVs and 10 percent PHEVs.

Staff generated assumptions based on the proposed funding splits towards each project type and the average cost per vehicle from the previous year's projects funded. Staff used the following average costs for micro-mobility, BEVs, and PHEVs: $8,000, $65,000, and $40,000 respectively. Tables A-16 – A-18 show the assumptions for each project type in the Clean Mobility Options quantification. The tool and more information on quantification can be found on CARB's website: *https://ww2.arb.ca.gov/resources/documents/cci-quantification-benefits-and-reporting-materials*.

Table A-16: Clean Mobility Options Micro-mobility Assumptions

Field in Tool	Assumptions
Strategy Type	Mobility Project Voucher
Number of Components	1
Service Type	Bikeshare
Project Type	New or Expanded Service
Year 1	2022
Final Year	2026
Vehicle Type	Electric Bicycle
Primary Use of Service	Local Passenger Trip
Are Input Values for One-way Trips or Roundtrips?	One-way Trips
Average Occupancy in Year 1 & Final Year	1
Number of Vehicles in Year 1 & Final Year	600

Field in Tool	Assumptions
Average Number of Vehicle Trips in Year 1 & Final Year (per vehicle)	1,095
Length of Average Trip (miles)	1.5
Annual Average Number of Fares (quantity per year)	657,000
Average Fare Associated with Project ($ per fare)	1.75

Table A-17: Clean Mobility Options BEV Assumptions

Field in Tool	Assumptions
Strategy Type	Mobility Project Voucher
Number of Components	1
Service Type	Carshare
Project Type	New or Expanded Service
Year 1	2022
Final Year	2026
Vehicle Type	Sedan
New Vehicle Type	2022
Vehicle Fuel Type	Electricity
Primary Use of Service	Local Passenger Trip
Are Input Values for One-way Trips or Roundtrips?	One-way Trips
Average Occupancy in Year 1 & Final Year	2
Number of Vehicles in Year 1 & Final Year	141
Average Number of Vehicle Trips in Year 1 & Final Year (per vehicle)	5,595
Length of Average Trip (miles)	5
Annual Average Number of Fares (quantity per year)	790,186
Average Fare Associated with Project ($ per fare)	5.00

Table A-18: Clean Mobility Options PHEV Assumptions

Field in Tool	Assumptions
Strategy Type	Mobility Project Voucher
Number of Components	1
Service Type	Carshare
Project Type	New or Expanded Service
Year 1	2022
Final Year	2025
Vehicle Type	Sedan
New Vehicle Type	2022
Vehicle Fuel Type	Plug-In Hybrid
Primary Use of Service	Local Passenger Trip
Are Input Values for One-way Trips or Roundtrips?	One-way Trips
Average Occupancy in Year 1 & Final Year	2
Number of Vehicles in Year 1 & Final Year	26
Average Number of Vehicle Trips in Year 1 & Final Year (per vehicle)	5,595
Length of Average Trip (miles)	5
Annual Average Number of Fares (quantity per year)	142,673
Average Fare Associated with Project ($ per fare)	5.00

Based on the proposed $20 million allocation for Clean Mobility Options and 25 percent of the allocation going to grant administration and processing fees, staff estimates that up to 167 vehicles and 600 e-bikes can be funded.

For the purpose of this analysis, staff conservatively assumed that emission reductions will occur over the course of four years for both LDV and micro-mobility projects. The total potential emission reductions for Clean Mobility Options are shown in Table A-19.

Table A-19: Total Potential Emission Reductions for Clean Mobility Options

Mobility Option	Net GHG Emission Reductions (MTCO2e)	Diesel PM Reductions (tons)	NOx Reductions (tons)	PM2.5 Reductions (tons)	ROG Reductions (tons)
Micro-mobility	416	0	0.0975	0.0255	0.025
BEVs	5,221	0.001	0.8725	0.164	0.22
PHEVs	646	0	0.1360	0.028	0.0355
Total	**6,283**	**0.001**	**1.106**	**0.2175**	**0.2805**

Clean Mobility in Schools Pilot Project

The Clean Mobility in Schools Pilot Project (CMiS) achieves emission reduction benefits by funding deployment of synergistic GHG emission reduction technologies at schools located in disadvantaged communities. CMiS will open a new solicitation for applications for FY 2022-23 funds. The allocated FY 2022-23 funds will go to the highest ranked applications from the next solicitation. Staff estimates that $15 million will be used to fund new electric school buses, passenger EVs for ride-sharing, off-road utility vehicles, electric vanpool vans, lawn and garden equipment, solar photovoltaic installation, medium heavy-duty delivery van, and heavy-duty class 8 trucks, as shown below in Table A-29.

Staff is estimating reductions using the quantification tool provided by CARB's Climate Investments Branch. The tool can be found on CARB's website: *https://ww2.arb.ca.gov/resources/documents/cci-quantification-benefits-and-reporting-materials*.

The proposed FY 2022-23 $15 million allocation for CMiS is assumed to procure an estimated 33 vehicles, 30 pieces of lawn and garden equipment, and 12 solar photovoltaic installations.

For calculating the potential emission reductions, LDV were given a project life of 3 years, consistent with applicant assumptions for the light duty vehicles, and MHD were given a project life of 6 years. School buses were given a project life of 12 years. Heavy-duty trucks were given a project life of 15 years. Tables A-20 – A-27 provide the assumptions used in the quantification tools for each of the project components. Due to improved emissions estimation methodologies in the STEP quantification tool for

New Service types, the STEP tool was used for the All-Electric Car Share Service for District Employees (Table A-24) and the Zero-Emission Vanpool Program (Table A-25). The STEP tool can be found on CARB's website: *https://ww2.arb.ca.gov/resources/documents/cci-quantification-benefits-and-reporting-materials*.

The first of these tables, Table A-20, provides the assumptions for the new electric school bus (Type A). This table assumes 10 new school buses.

Table A-20: Clean Mobility in Schools Assumptions for New Electric School Buses (Type A)

Field in Tool	Assumptions
Vehicle/Equipment/Facility Type	School Bus
Project Type	New Service
Quantification Period (years)	12
Year 1	2022
Baseline Vehicle Model Year	2022
New/Replacement Vehicle Fuel Type	Electric (kWh)
Number of Riders per Vehicle in Year 1 and Final Year (respectively)	50 and 50
Number of Vehicles in Year 1 and Final Year (respectively)	10 and 10
Average Number of Annual Trips per Vehicle Expected in Year 1 and Final Year (respectively)	360 and 360
Length of Average Trip (miles)	50

The second table, Table A-21, provides the assumptions for a New Class 8 Electric Delivery Truck. This table assumes 5 new electric delivery trucks.

Table A-21: Clean Mobility in Schools Assumptions for New Electric Delivery Truck (Class 8)

Field in Tool	Assumptions
Vehicle/Equipment/Facility Type	Heavy Heavy-Duty Vehicle/Truck
Project Type	Vehicle Replacement
Quantification Period (years)	15
Year 1	2022
Baseline Vehicle Model Year	2022
Baseline Vehicle Fuel Type	Diesel (gal)
New/Replacement Vehicle Model Year	2022
New/Replacement Vehicle Fuel Type	Electric (kWh)
Expected VMT in Year 1	22,500

The third table, Table A-22, provides the assumptions for solar PV deployment.

Table A-22: Clean Mobility in Schools Assumptions for Solar PV Deployment

Field in Tool	Assumptions
Vehicle/Equipment/Facility Type	Solar Photovoltaic
Project Type	Solar PV Generation
Annual Solar PV Production (kWh/yr)	325,437
Electricity Pricing (Residential or Commercial)	Commercial

The fourth table, Table A-23, provides the assumptions for ZEV garden and lawn equipment.

Table A-23: Clean Mobility in Schools Assumptions for ZEV Garden & Lawn Equipment

Field in Tool	Assumptions
Vehicle/Equipment/Facility Type	Lawn and Garden
Project Type	Equipment Replacement
Number of Pieces of Lawn and Garden Equipment	30

The fifth table, Table A-24, provides the assumptions for an all-electric car share service for district employees using the STEP quantification tool.

Table A-24: Clean Mobility in Schools Assumptions for All-Electric Car Share Service for District Employees (using STEP quantification tool)

Field in Tool	Assumptions
Strategy Type	Shared Mobility
Project Type	New or Expanded Service
Year 1	2022
Final Year	2025
Vehicle Type	Sedan
Vehicle Model Year	2022
Vehicle Fuel Type	Electricity
Primary Use of Service	Local Passenger Trip
Ride-hailing Service?	No
Are Input Values for One-way Trips or Roundtrips?	Roundtrips
Number of Vehicles in Year 1 & Final Year	8 and 8
Average Occupancy in Year 1 & Final Year	1.15 and 1.15
Average Number of Vehicle Trips in Year 1 & Final Year	100 and 100
Length of Average Trip (miles)	10

The sixth table, Table A-25, provides the assumptions for a zero-emission vanpool program using the STEP quantification tool.

Table A-25: Clean Mobility in Schools Assumptions for the Zero-Emission Vanpool Program Component (using STEP quantification tool)

Field in Tool	Assumptions
Strategy Type	Shared Mobility
Project Type	New or Expanded Service
Year 1	2022
Final Year	2028
Vehicle Type	Van
Vehicle Model Year	2022
Vehicle Fuel Type	Electricity
Primary Use of Service	Local Passenger Trip
Ride-hailing Service?	No
Are Input Values for One-way Trips or Roundtrips?	Roundtrips
Number of Vehicles in Year 1 and Final Year	4 and 4
Average Occupancy in Year 1 and Final Year	8 and 8
Average Number of Vehicle Trips in Year 1 and Final Year	370 and 370
Length of Average Trip (miles)	30

The seventh table, Table A-26, provides the assumptions for the ZEV utility vehicle deployment component. This table assumes 4 school utility terrain vehicles.

Table A-26: Clean Mobility in Schools Assumptions for the ZEV Utility Vehicle Deployment Component

Field in Tool	Assumptions
Vehicle/Equipment/Facility Type	School Utility Terrain Vehicle (UTV)
Project Type	Vehicle Replacement
Quantification Period (years)	3
Year 1	2022
Baseline Vehicle Model Year	2022
Baseline Vehicle Fuel Type	Gasoline (gal)
New/Replacement Vehicle Model Year	2022
New/Replacement Vehicle Fuel Type	Electric (kWh)
Baseline Horsepower	48
Engine Standard	Controlled
Average Annual Hours of Operation	9,360

The eighth table, Table A-27, provides the assumptions for medium duty zero-emission van deployment. This table assumes 2 zero-emission medium duty vans.

Table A-27: Clean Mobility in Schools Assumptions for Zero-Emission Medium Duty Van Deployment

Field in Tool	Assumptions
Vehicle/Equipment/Facility Type	Medium Heavy-Duty Vehicle/Truck
Project Type	Vehicle Replacement
Quantification Period (years)	6
Year 1	2022
Baseline Vehicle Model Year	2007
Baseline Vehicle Fuel Type	Gasoline (gal)
New/Replacement Vehicle Model Year	2022
New/Replacement Vehicle Fuel Type	Electric (kWh)
Expected VMT in Year 1 & Final Year	10,000 and 10,000

It is important to note that the project presented in this appendix is a sample and that the solicitation for CMiS is under development. This sample is staff's best estimate of some of the types of components that might be funded with this allocation and is not an exhaustive list. Table A-28 provides the emissions reduction estimates for a sample project that may be funded through CMiS.

Table A-28: Estimated Benefits of an Average Sample Project from CMiS Funds

Project Component Name	GHG Emission Reductions (MTCO2e)	Diesel PM Reductions (tons)	NOx Reductions (tons)	PM 2.5 Reductions (tons)	ROG Reductions (tons)
New Electric School Buses (Type A)	19,112	0.003	12.52	1.13	0.52
New Electric Delivery Truck (Class 8)	448	0.001	0.84	0.01	0.02
ZEV Garden & Lawn Equipment	0.95	N/A	0.001	0.00	0.01
ZEV Utility Vehicle Deployment	650	0.000	6.71	0.05	4.76
Zero-Emission Medium Duty Van Deployment	79	0.000	0.62	0.00	0.02
All-Electric Car Share Service for District Employees	4	0.000	0.00	0.00	0.00
Zero-Emission Vanpool Program	379	0.000	0.06	0.02	0.01
Solar PV Deployment	2,155	N/A	0.60	0.14	0.09
All Project Elements	**22,828**	**0.004**	**21.35**	**1.35**	**5.43**

For calculating the potential emission reductions, each component was multiplied by 1.5 to bring the total amount of funding for the sample CMiS projects to the allocated $15 million. It is important to note that the project presented in this appendix is a sample and that the solicitation for CMiS is under development. This sample is staff's best estimate of some of the types of components that might be funded with this allocation and is not an exhaustive list. Table A-29 provides the emissions reduction estimates for the 1.5 sample projects that may be funded through CMiS.

Table A-29: Estimated Benefits of 1.5 Sample Projects from CMiS Funds

Project Component Name	GHG Emission Reductions (MTCO2e)	Diesel PM Reductions (tons)	NOx Reductions (tons)	PM 2.5 Reductions (tons)	ROG Reductions (tons)
New Electric School Buses (Type A)	28,667	0.004	18.78	1.69	0.78
New Electric Delivery Truck (Class 8)	672	0.001	1.26	0.02	0.03
ZEV Garden & Lawn Equipment	1.4	N/A	0.00	0.00	0.01
ZEV Utility Vehicle Deployment	976	0.00	10.07	0.07	7.13
Zero-Emission Medium Duty Van Deployment	118	0.00	0.93	0.00	0.03
All-Electric Car Share Service for District Employees	6	0.00	0.00	0.00	0.00
Zero-Emission Vanpool Program	569	0.00	0.08	0.03	0.02
Solar PV Deployment	3,232	N/A	0.89	0.21	0.14
All Project Elements	**34,241**	**0.01**	**32.0**	**2.02**	**8.14**

STEP

STEP projects achieve GHG emission reductions through implementing a wide variety of capital, infrastructure, operations, planning, policy, and outreach projects. For this year's quantification, staff designed a sample project, similar to past STEP projects. For FY 2022-23 Funds, STEP will be soliciting new applications with a proposed allocation of $15 million. Staff expect to fund approximately one to two projects with a mix of quantifiable and unquantifiable components. The quantifiable components of the STEP projects include, but are not limited to, new bike lanes, transit subsidies, new bus routes, and shuttle services. A project that includes all these quantifiable components may use approximately $8.9 million plus an additional $1.5 million for unquantifiable components, totaling approximately $10.4 million per project.

Staff made several assumptions to include as inputs for STEP quantification and then used the STEP benefits calculator to quantify potential emission reductions. The tool can be found on STEP's Solicitation website under Appendix I: *https://ww2.arb.ca.gov/sustainable-transportation-equity-project-step-solicitation*.

Tables A-30 through A-33 provide the assumptions staff used to build the components for the sample project. The first of these tables, Table A-30, provides the assumptions for the new bike lanes.

Table A-30: Assumptions for New Bike Lanes Component

Field in Tool	Assumptions
Year 1	2024
Existing Bikeway Class	None
New Bikeway Class	Class IV Cycle Track
One-Way Facility Length	2.4 miles
Average Daily Traffic	3,000
University Town with Population < 250,000?	No
Number of Key Destinations within ¼ Mile	10 destinations
Number of Key Destinations within ½ Mile	10 destinations

The second table, Table A-31, provides the assumptions used for the transit subsidies component of the sample project.

Table A-31: Assumptions for Transit Subsidies Component

Field in Tool	Assumptions
Year 1	2024
Final Year	2026
Vehicle Type	Transit Bus
Primary Use of Service	Local Passenger Trip
Are Input Values for One-way Trips or Roundtrips?	One-way Trips
Increase in Fixed-route Transit Ridership Associated with Project in Year 1 & Final Year	130,000 and 155,000 passengers (respectively)
Length of Average Passenger Trip on Fixed-route Transit	4.03 miles
Annual Number of Subsidies Associated with Project	1,000
Average Value of Each Subsidy Associated with Project (dollars per subsidy)	$2,000.00

The third table, Table A-32, provides the assumptions used for the new bus route component of the sample project.

Table A-32: Assumptions for New Bus Route Component

Field in Tool	Assumptions
Year 1	2024
Final Year	2030
Vehicle Type	Transit Bus
Vehicle Model Year	2023
Vehicle Fuel Type	Electricity
Primary Use of Service	Local Passenger Trips
Are Input Values for One-way Trips or Roundtrips?	One-Way Trips
Number of Vehicles in Year 1 & Final Year	2 and 2
Increase in Fixed-route Transit Ridership Associated with the Project in Year 1 & Final Year	90,000 and 170,000 passengers (respectively)
Length of Average Vehicle Trip	4.03
Average Expected VMT in Year 1 & Final Year	31,200 and 31,200
Percent Renewable Electricity Installed for Vehicle Charging	N/A
Percent Renewable Electricity Purchased for Vehicle Charging	50%
Annual Number of Fares Associated with Project	300,000
Average Fare Associated with Project ($ per passenger trip)	$2.00

The fourth table, Table A-33, provides the assumptions used for the shuttle services component of the sample project.

Table A-33: Assumptions for Shuttle Services Component

Field in Tool	Assumptions
Year 1	2024
Final Year	2027
Vehicle Type	Shuttle
Vehicle Model Year	2023
Vehicle Fuel Type	Electricity
Primary Use of Service	Local Passenger Trips
Are Input Values for One-way Trips or Roundtrips?	One-Way Trips
Number of Vehicles in Year 1 & Final Year	4 and 4
Average Occupancy per Vehicle in Year 1 & Final Year	4 and 6 occupants (respectively)
Average Number of Vehicle Trips per Vehicle Expected in Year 1 & Final Year	2,800 and 5,600 trips (respectively)
Length of Average Vehicle Trip	12
Percent Renewable Electricity Purchased for Vehicle Charging	50%
Annual Number of Fares Associated with Project	30,000
Average Fare Associated with Project ($ per passenger trip)	$0.00

It is important to note that the project presented in this appendix is a sample and that the solicitation for STEP is under development. This sample is staff's best estimate of some of the types of components that might be funded with this allocation and is not an exhaustive list. Table A-34 provides the emissions reduction estimates for a sample project that may be funded through STEP.

Table A-34: Estimated Benefits of an Average Sample Project from STEP Quantifiable Funds

Project Name	Net GHG Emission Reductions ($MTCO_2e$)	Diesel PM Reductions (tons)	NO_x Reductions (tons)	$PM_{2.5}$ Reductions (tons)	ROG Reductions (tons)	Net Passenger Auto VMT Reductions (miles)	Travel Cost Savings ($)	Net Fossil Fuel Use Reductions (GGE)
New Bike Lanes	51	0	0.0055	0.0030	0.0015	141,372	76,341	4,477
Transit Subsidies	226	0	0.0290	0.0120	0.0075	574,275	2,333,080	20,511
New Bus Route	529	0	0.0645	0.0225	0.0160	1,571,700	-888,414	45,883
Shuttle Services	531	0	0.0730	0.0200	0.0185	1,612,800	935,424	45,929
Total	**1,337**	**0**	**0.1720**	**0.0575**	**0.0435**	**3,900,147**	**2,456,431**	**116,800**

For calculating the potential emission reductions, each component was multiplied by 1.44 to bring the total amount of funding for the sample STEP projects to the allocated $15 million. Table A-35 shows the total potential benefits of the STEPs allocation.

Table A-35: Estimated Benefits of 1.44 Sample Projects from STEP Quantifiable Funds

Project Name	Net GHG Emission Reductions ($MTCO_2e$)	Diesel PM Reductions (tons)	NO_x Reductions (tons)	$PM_{2.5}$ Reductions (tons)	ROG Reductions (tons)	Net Passenger Auto VMT Reductions (miles)	Travel Cost Savings ($)	Net Fossil Fuel Use Reductions (GGE)
New Bike Lanes	73	0	0.0079	0.0043	0.0022	203,576	109,931	6,447
Transit Subsidies	325	0	0.0418	0.0173	0.0108	826,956	3,359,635	29,536
New Bus Route	762	0	0.0929	0.0324	0.0230	2,263,248	-1,279,316	66,072
Shuttle Services	765	0	0.1051	0.0288	0.0266	2,322,432	1,347,011	66,138
Total	**1,925**	**0**	**0.2477**	**0.0828**	**0.0626**	**5,616,212**	**3,537,261**	**168,192**

Planning and Capacity Building, Workforce Training and Development

CARB is proposing to allocate $5 million toward Planning and Capacity Building efforts to support communities through the design and development of community-driven projects that address a wide range of transportation barriers. Project types include community transportation needs and equity assessments, clean transportation project planning, school-based electrification planning, and workforce development programs. This funding category incorporates dedicated technical assistance that is focused on strengthening community capacity so that priority populations are prepared to access, apply for, and receive funding that advances their transportation and equity goals. In addition, this supports existing clean vehicle ownership investments by increasing community awareness and outreach and capacity building of CARB programs. Therefore, staff is not quantifying any direct emission reductions for this project. Instead, this project is expected to help achieve the emission reductions projected for CARB's clean vehicle ownership and clean mobility investments.

One critical focus of Planning and Capacity Building based on community-identified needs is to provide job assistance and workforce development in priority populations. CARB is not proposing to allocate separate funding for workforce training and development in FY 2022-23 and is focused on maximizing economic opportunities and benefits in existing clean mobility investments. These investments support zero-emission technology access, training and education, awareness, and development in the communities where CARB-incentivized ZEV deployment is occurring through existing clean transportation and mobility projects in the light-, medium-, and heavy-duty sector, such as through project selection criteria and provisions for local hiring.

Heavy-Duty Vehicle and Off-Road Equipment Investments

CARB continues to support a diverse portfolio of investments in heavy-duty and off-road technologies. This year's Funding Plan proposes investments in the deployment of commercialized on-road advanced technologies through the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), deployment of commercialized off-road advanced technology equipment in the Clean Off-Road Equipment Voucher Incentive Project (CORE), new Heavy Duty Advanced Technology Demonstration and Pilot Projects, and legacy vehicle improvements, including assistance for cleaner trucks through the Truck Loan Assistance Program, as well as the Zero-Emission Truck Loan Pilot Project.

Quantification of the emission reduction benefits for each of the heavy-duty vehicle and off-road equipment investment projects is described in more detail below.

Clean Truck, Bus, and Equipment Vouchers

Clean Truck, Bus and Equipment Vouchers are intended to encourage and accelerate the deployment of zero-emission trucks, buses, and off-road equipment in California. There is a total of $1.787 billion available for Clean Truck and Bus Vouchers or HVIP. HVIP provides vouchers for on-road battery-electric or fuel cell trucks and buses and CORE is the off-road corollary to HVIP. There is $273 million in vouchers available for CORE eligible off-road equipment.

HVIP

HVIP achieves emission reduction benefits by reducing the up-front cost of zero-emission trucks and buses, allowing fleet owners to secure a voucher through their local dealer as part of their vehicle purchase. For the purposes of this analysis, staff estimated reductions from the emissions offset between a new, 2022 model year conventional truck or bus, and an advanced technology vehicle.

For FY 2022-23 HVIP has been allocated $300 million from Low Carbon Transportation funding with $35 million set aside for the Innovative Small e-Fleet project. Additionally, HVIP is receiving $70 million for zero-emission transit buses, $135 million for zero-emission school buses, and $157 million for zero-emission drayage trucks from the General Fund. Furthermore, HVIP will include $1.125 billion of Proposition 98 General Funds for grants to local educational agencies to support the replacement of internal combustion school buses. For the standard HVIP program, based on project data available as of March 2022, staff estimates that this funding will split 5.9 percent LHD2 battery-electric trucks (Class 3 trucks), 20.4 percent for MHD battery-electric trucks, 33.1 percent for HHD battery-electric trucks, 12.7 percent battery-electric urban buses, 21.8 percent for battery-electric school buses, 4.4 percent for battery-electric shuttle buses, and 1.8 percent for electric power takeoff (ePTO) systems.

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 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 emission factors associated with ePTOs, staff utilized the emission factors found in EMFAC to quantify the 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 are shown in Table A-36 and emission factors used to quantify PTOs are shown in Table A-37. For more information on how these emission factors were developed, please see the Emission Factor Development section at the beginning of this appendix.

Table A-36: HVIP Emission Factors

Vehicle Class	Pollutant	2022 Diesel (g/mi)	2022 CNG (g/mi)	2022 BEV (g/mi)
LHD2	NOx	0.0509	-	0
	PM 2.5	0.0480	-	0.0221
	ROG	0.0681	-	0
	GHG	668	-	102
MHD	NOx	0.9950	-	0
	PM 2.5	0.0628	-	0.0309
	ROG	0.0090	-	0
	GHG	1,157	-	177
HHD	NOx	1.7503	-	0
	PM 2.5	0.0454	-	0.0222
	ROG	0.0409	-	0
	GHG	1,607	-	245
Urban Bus	NOx	0.6679	0.4909	0
	PM 2.5	0.0511	0.0432	0.0262
	ROG	0.0030	0.0921	0
	GHG	1,735	1,664	265
Shuttle Bus	NOx	1.0208	-	0
	PM 2.5	0.0622	-	0.0309
	ROG	0.0076	-	0
	GHG	1,160	-	177
School Bus	NOx	1.4190	-	0
	PM 2.5	0.3253	-	0.1626
	ROG	0.0148	-	0
	GHG	1,312	-	200

Note: MHD and HHD emission factors are based on population-weighted averages of the T6 and T7 diesel vehicle classes in EMFAC 2017, respectively, excluding out-of-state vehicles.

Table A-37: ePTO Emission Factors

Vehicle Class	Pollutant	2022 Diesel (g/hr)	2022 Battery Electric (g/hr)
ePTO	NOx	56.9673	0
	PM 2.5	0.0451	0
	ROG	0.3612	0
	GHG	37,795	5,831

For urban buses, 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.[23] Based on the information, staff assumed that a vehicle typically operates in PTO mode for four hours a day and 250 workdays a year. Additionally, staff assumed the fuel consumption rate of 2.825 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, Efficient and Advanced Truck Research Center (CalHEAT) Research Center's report on "Battery Electric Parcel Delivery Truck Testing and Demonstration."[24] The annual usage assumptions for HVIP are shown in Table A-38.

Table A-38: HVIP Annual Usage Assumptions

Vehicle Class	Technology	Usage (mi/yr)
LHD2	BEV	12,000
MHD	BEV	12,000
HHD	BEV	12,000
HHD	ePTO	1,000 (hrs/yr)
Urban Bus	BEV	30,000
School Bus	BEV	12,000
Shuttle Bus	BEV	12,000

HVIP – Standard

Using the emission factors, technology mix, and the annual usage assumptions above, staff calculated the potential annual per-vehicle emission reductions for the HVIP Clean Transportation Funds, as shown in Table A-39.

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[23] https://www.nrel.gov/transportation/assets/pdfs/67116.pdf

[24] Gallo, Jean-Baptiste, Jasna Tomić. (CalHEAT). 2013. Battery Electric Parcel Delivery Truck Testing and Demonstration. California Energy Commission.

Table A-39: HVIP Clean Transportation Funds Annual Emission Benefits on a Per-Vehicle Basis

Pollutant	EMFAC Vehicle Class	Supported Technologies	Per Vehicle Annual Emission Reductions (tpy)	
			Per Technology	Average
GHG (metric tons CO2e per year)	LHD2	BEV	6.79	17.803
	MHD	BEV	11.76	
	HHD	BEV	16.34	
	HHD	ePTO	32.34	
	Urban Bus	BEV	44.10	
	School Bus	BEV	13.33	
	Shuttle Bus	BEV	11.79	
NOx (tpy)	LHD2	BEV	0.00067	0.0186
	MHD	BEV	0.01316	
	HHD	BEV	0.02315	
	HHD	ePTO	0.06280	
	Urban Bus	BEV	0.01916	
	School Bus	BEV	0.01877	
	Shuttle Bus	BEV	0.01350	
PM 2.5 (tpy)	LHD2	BEV	0.00034	0.0008
	MHD	BEV	0.00042	
	HHD	BEV	0.00031	
	HHD	ePTO	0.00005	
	Urban Bus	BEV	0.00069	
	School Bus	BEV	0.00215	
	Shuttle Bus	BEV	0.00041	
ROG (tpy)	LHD2	BEV	0.00090	0.0005
	MHD	BEV	0.00012	
	HHD	BEV	0.00054	
	HHD	ePTO	0.00040	
	Urban Bus	BEV	0.00157	
	School Bus	BEV	0.00020	
	Shuttle Bus	BEV	0.00010	

Applying the proposed voucher amounts and the technology mix from the current HVIP data, staff calculated the average voucher cost for the HVIP as shown in Table A-40.

Table A-40: HVIP Average Incentive Cost

EMFAC Vehicle Class	Supported Technologies	Cost Per Technology	Average
LHD2	BEV	$47,128	$127,562
MHD	BEV	$83,560	
HHD	BEV	$147,216	
HHD	ePTO	$26,970	
Urban Bus	BEV	$157,720	
School Bus	BEV	$162,778	
Shuttle Bus	BEV	$69,424	

Next, the total emission reduction benefits were estimated over the useful life of each vehicle. While staff recognizes that trucks and buses can have a useful life of over 12-15 years[25,26], HVIP has a three-year ownership requirement. Therefore, staff assumed a conservative project life of three years and quantified HVIP's total potential emission reductions over the course of three years, as shown in Table A-41 below.

Table A-41: Total Potential Emission Reductions for HVIP Standard using Clean Transportation Funds

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tpy)
GHG	17.803	2,306	38,372	3	115,115
NOx	0.0186		43.648		129.2
PM 2.5	0.0008		1.473		4.34
ROG	0.0005		0.813		3.32

HVIP – Public Transit

The FY 2022-23 State budget includes $70 million for transit bus incentives, to be administered through HVIP. These funds will assist public transit fleets, including those who were initially on a diesel compliance pathway for the Innovative Clean Transit regulation, purchase zero-emission public transit buses. By providing these funds, HVIP reinforces its continued support for emission reductions of diesel particulate matter in communities disproportionately impacted by air pollution. Once this funding

[25] https://www.usf.edu/administrative-services/documents/asbc-resources-field-equipment-replacement.pdf

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

set-aside is depleted, HVIP will continue to allow standard HVIP applications for all public transit bus fleets.

Staff assumed a 7 percent administration rate would be incurred to administer the vouchers. Using an average incentive amount of $157,720 and accounting for administration costs, staff estimate that approximately 413 transit buses can be funded through the HVIP – Public Transit set-aside. Using the emission factors for urban buses from Table A-36, staff quantified the total potential emission reductions for the project over the course of three years, as shown in Table A-42.

Table A-42: Total Potential Emission Reductions for HVIP – Public Transit

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tpy)
GHG	43.03	413	17,771	3	53,314
NOx	0.01916		7.9131		23.74
PM 2.5	0.00069		0.2850		0.85
ROG	0.00157		0.6484		1.95

HVIP – School Bus

Moving forward, the Rural School Bus Pilot Project will be administered as an ongoing set-aside within HVIP. The FY 21-22 State Budget included the first installment to support incentives to the deployment of 1,000 zero-emission school buses in California over the next three years. For FY 2022-23, the HVIP school bus set aside allocated $135 million; however, $10 million of the $135 million will be used to fund the Proposition 98 School Bus administration. This leaves $125 million for the HVIP zero-emission school bus set aside. These funds are exclusively available to California public school bus fleets purchasing zero-emission school buses. Currently, purchasers can request funding for $350,000 to $400,000 each. Once depleted, HVIP will continue to allow standard HVIP applications for all school bus fleets following standard HVIP eligibility criteria and funding amounts. The HVIP school bus set aside also differs from the standard HVIP program by requiring scrappage of an existing internal combustion engine school bus within the first two years of the delivery of a new bus. From program data, 2007 is the average model year of a scrapped school bus. Table A-43 presents the emission factors of the baseline scrapped school buses and new 2022 BEV school.

Table A-43: HVIP – School Bus Emission Factors

Vehicle Class	Pollutant	2007 Diesel (g/mi)	2022 BEV (g/mi)
School Bus	NOx	9.3774	0
	PM 2.5	0.3705	0.1626
	ROG	0.0950	0
	GHG	1,846	200

Using an average incentive amount of $400,000 and an assumed 7 percent administration rate to administer the vouchers, staff conservatively estimate that approximately 291 school buses can be funded through the HVIP – School Bus set-aside. Using the emission factors for school buses from Table A-43, and the assumption of 12,000 mi/yr of usage, staff quantified the total potential emission reductions for the project over the course of three years, as shown in Table A-44.

Table A-44: Total Potential Emission Reductions for HVIP – School Bus

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tpy)
GHG	19.75	291	5,747.4	3	17,242
NOx	0.12404		36.096		108
PM 2.5	0.00275		0.8003		2.40
ROG	0.00126		0.3656		1.10

HVIP – Proposition 98 Funds School Bus

A new set aside within HVIP is the Local Education Agency School Bus Replacement Grants funded with $1.125 billion through Proposition 98. This program requires scrappage of an existing internal combustion engine school bus within the first two years of the delivery of a new bus. As with the HVIP School Bus set aside, staff assumed that 2007 is the average model year of the scrapped school bus. These grants prioritize zero-emission buses funding, but they can be used to fund renewable fuel buses in some cases. Unlike the standard HVIP program, this voucher will cover the entire school bus cost. According to program statistics the School Bus voucher will cover up to $400,000 per school bus and the renewable fueled school bus voucher will cover $165,000 per school bus. As a conservative estimate, staff estimates that 75 percent of these vouchers will be zero-emission and the remaining 25 percent will be for renewable fuel buses. The emission factors for the HVIP Proposition 98 Funds school bus set-aside are in Table A-45.

Table A-45: HVIP – Proposition 98 School Bus Emission Factors

Vehicle Class	Pollutant	2007 Diesel (g/mi)	2022 Renewable Diesel (g/mi)	2022 BEV (g/mi)
School Bus	NOx	9.3774	1.4190	0
	PM 2.5	0.3705	0.3253	0.1626
	ROG	0.0950	0.0148	0
	GHG	1,846	496	200

Using an average incentive amount of $400,000 for ZE school buses and $165,000 for renewable fuel school buses, staff estimate that approximately 2,472 ZE and 824 renewable fuel school buses can be funded with Proposition 98 funds. The estimated HVIP Proposition 98 School Bus Annual Emission Benefits are in Table A-46 below.

Table A-46: HVIP - Proposition 98 School Bus Annual Emission Benefits on a Per-Vehicle Basis

Pollutant	EMFAC Vehicle Class	Supported Technologies	Per Vehicle Annual Emission Reductions (tpy)	
			Per Technology	Average
GHG	SBUS	BEV	19.75	18.86
		Renewable Diesel	16.21	
NOx	SBUS	BEV	0.12404	0.11935
		Renewable Diesel	0.10527	
PM 2.5	SBUS	BEV	0.00275	0.00221
		Renewable Diesel	0.00060	
ROG	SBUS	BEV	0.00126	0.00121
		Renewable Diesel	0.00106	

Staff then quantified the total potential emission reductions for the HVIP – Proposition 98 School Bus funds over the course of three years, as shown in Table A-47.

Table A-47: Total Potential Emission Reductions for HVIP – Proposition 98 School Bus

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tons)
GHG	18.86	3,296	62,177	3	186,531
NOx	0.11935		393.374		1,180
PM 2.5	0.00221		7.2909		21.9
ROG	0.00121		3.9793		11.9

HVIP – Drayage

The FY 2022-23 State budget includes $157 million for zero-emission drayage truck incentives, which will be implemented through HVIP. This funding will provide the additional resources needed to build on the success of the Project 800 initiative to support the early adoption of zero-emission drayage trucks and continue supporting equitable access to zero-emission options for more fleets.

The base incentive amount is $150,000 but many would be eligible for higher incentive amounts if located within a disadvantaged community. With a conservative estimate an incentive amount of $168,000 and a 7 percent administration cost, staff estimate that approximately 869 drayage trucks can be funded through the HVIP – Drayage set-aside. Using the emission factors for HHD BEV trucks from Table A-36, staff quantified the total potential emission reductions for the project over the course of three years, as shown in Table A-48.

Table A-48: Total Potential Emission Reductions for HVIP – Drayage

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tons)
GHG	17.04	869	14,807.7	3	44,423
NOx	0.02815		24.464		73.39
PM 2.5	0.00028		0.2451		0.74
ROG	0.00053		0.4624		1.39

HVIP – Innovative Small e-Fleets Pilot

Innovative Small e-Fleets or ISEF is designed to support small fleets and individual owner/operators making the transition to zero-emission trucks. Innovative Small e-Fleets will pilot innovative mechanisms such as all-inclusive leases, peer-to-peer truck sharing, truck-as-a-service, assistance with infrastructure, individual owner planning assistance as well as other mechanisms. For the FY 2022-23, $35 million has been appropriated to ISEF. The exact details of the ISEF program have yet to be determined however only LHD2, MHD, ePTO, and HHD categories of vehicles will be eligible. Staff conservatively estimates that the voucher costs will be double that of the standard HVIP voucher costs. These vouchers costs are next in Table A-49.

Table A-49: HVIP – ISEF Voucher Costs

EMFAC Vehicle Class	Supported Technologies	Cost Per Technology	Average
LHD2	BEV	$94,256	$225,713
MHD	BEV	$167,120	
HHD	BEV	$294,432	
HHD	ePTO	$53,940	

With $35 million to fund ISEF, applying the standard HVIP vehicle mix without buses, and a 7 percent administration cost, staff estimates ISEF to fund 17 ePTO systems, 33 LD2 trucks, 65 MHD trucks and 60 HHD trucks. If the same standard HVIP emission factors and usage over three years are applied to these vehicle totals, staff estimated the total potential emission reductions for HVIP – ISEF in Table A-50.

Table A-50: Total Potential Emission Reductions for HVIP – ISEF

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tpy)
GHG	14.34	175	2,519	3	7,556
NOx	0.0188		3.334		10.0
PM 2.5	0.0003		0.0580		0.17
ROG	0.0004		0.0767		0.23

CORE

The CORE achieves emission reduction benefits by accelerating deployment of clean off-road technologies. It provides a streamlined way for fleets ready to purchase specific zero-emission equipment to receive funding. This project specifically targets zero-emission off-road freight equipment that is currently in the early stages of commercial deployment. Eligible project types include on and off-road terminal tractors (i.e., yard trucks), TRU's, mobile power units (MPUs), forklifts, container handling equipment, airport cargo loaders, wide-body aircraft tugs, railcar movers, rubber-tired gantry cranes, commercial harbor craft, switcher locomotives and construction and agricultural equipment. Because this project includes a variety of eligible types of vehicles and equipment, it is important to note that this analysis is an illustrative example of the potential emission reductions that may be achieved through this project. For FY 2022-23, CORE is allocating $273 million, and staff quantified the entirety of $273 million minus the administration costs which is 8 percent of the allocation.

For this analysis, staff estimated the potential reductions for four project types that have comprised the majority under this project, based on data from the start of the project to June 2021: yard trucks, forklifts, TRUs, and railcar movers. Emission factors for these project types are shown in Table A-51.

Table A-51: CORE Emission Factors

Vehicle Class	(g/hr)	Tier 4 Final Diesel	BEV
Forklift	NOx	0.781	0
	PM 2.5	0.281	0
	ROG	1.748	0
	GHG	19,304	3,880
Yard Truck	NOx	8.2376	0
	PM 2.5	0.4842	0
	ROG	4.2710	0
	GHG	47,150	6,549
TRU	NOx	47.261	0
	PM 2.5	1.699	0
	ROG	31.157	0
	GHG	8,863	1,231
Railcar Mover	NOx	8.00	0
	PM 2.5	0.552	0
	ROG	4.052	0
	GHG	51,200	9,380

Staff generated annual usage assumptions using CARB's CHE inventory model for forklifts and yard trucks as well as the TRU inventory model for TRUs as shown in Table A-52.

Table A-52: CORE Annual Usage Assumptions

Vehicle Class	Usage (hrs/yr)
Forklift	800
Yard Truck	2,400
TRU	1,300
Railcar Mover	800

Applying the emission factors and usage assumptions above, staff calculated the potential annual per-vehicle emission reductions for CORE as shown in Table A-53.

Table A-53: Clean Off-Road Equipment Voucher Incentive Project Annual Emission Reduction Benefits on a Per-Vehicle Basis

Pollutant	Vehicle Class	Supported Technologies	Per Vehicle Annual Emission Reductions (tpy)	Average Vehicle Annual Emission Reductions (tpy)
GHG	Forklift	BEV	12.34	68.28
	Yard Truck	BEV	97.44	
	TRU	BEV	9.92	
	Railcar Mover	BEV	33.46	
NOx	Forklift	BEV	0.0006	0.026
	Yard Truck	BEV	0.0198	
	TRU	BEV	0.0614	
	Railcar Mover	BEV	0.0064	
PM 2.5	Forklift	BEV	0.0002	0.001
	Yard Truck	BEV	0.0012	
	TRU	BEV	0.0022	
	Railcar Mover	BEV	0.0004	
ROG	Forklift	BEV	0.0014	0.016
	Yard Truck	BEV	0.0103	
	TRU	BEV	0.0405	
	Railcar Mover	BEV	0.0032	

From the most recent vouchers requested, TRUs received 21.3 percent, large forklifts 7.8 percent, railcar mover's 6.1 percent, and yard trucks 64.8 percent. The expected cost per technology for the four project types are shown in Table A-54.

Table A-54: CORE Average Incentive Cost

Vehicle Class	Supported Technologies	Cost Per Technology
Forklift	BEV	$220,591
Yard Truck	BEV	$174,512
TRU	BEV	$73,525
Railcar Mover	BEV	$313,475

CORE has a three year ownership requirement. Based on the expected cost per technology and the aforementioned funding portions for each vehicle class, staff expect to fund about 90 forklifts, 943 yard trucks, 49 railcar movers, and 734 TRUs resulting in the total emission reductions outlined in Table A-55.

Table A-55: Total Potential Emission Reductions for CORE

Pollutant	Vehicle Class	Per Vehicle Annual Emission Reductions (tpy)	Number of Vehicles	Annual Emission Reductions (tpy)	Project Life (years)	Lifetime Emission Reductions Per Vehicle Class (tons)	Project Total Lifetime Emission Reductions (tons)
GHG	Forklift	12.34	90	1,113	3	3,339	305,842
	Yard Truck	97.44	943	91,905		275,716	
	TRUs	9.92	743	7,283		21,848	
	Railcar Mover	33.46	49	1,646		4,939	
NOx	Forklift	0.0006	90	0		0	192
	Yard Truck	0.0198	943	19		56	
	TRUs	0.0614	743	45		135	
	Railcar Mover	0.0064	49	0		1	
PM 2.5	Forklift	0.0002	90	0		0	8.28
	Yard Truck	0.0012	943	1		3	
	TRUs	0.0022	743	2		5	
	Railcar Mover	0.0004	49	0		0	
ROG	Forklift	0.0014	90	0		0	119
	Yard Truck	0.0103	943	10		29	
	TRUs	0.0405	743	30		89	
	Railcar Mover	0.0032	49	0		0	

Advanced Technology Demonstration and Pilot Projects

Demonstration and pilot projects are geared towards accelerating the introduction of advanced technologies, feeding the innovation pipeline, as well as helping to cover the costs of technology development. The Funding Plan proposes several eligible equipment and project types that would be eligible for funding through a competitive solicitation, including, but not limited to, green zones, zero-emission rail, port vehicles and equipment, zero-emission aviation and ground support equipment, and off-road construction and agriculture equipment. Because a variety of vehicles, equipment, and technology could be funded, the analysis of potential emission reductions in this section is based on drayage trucks as an illustrative example, given that they continue to be a priority and would be eligible for funding. More robust emission quantification will be provided as specific projects are selected and operational data becomes available.

For this illustrative scenario, staff conservatively estimates $60 million will fund BEV drayage trucks and the remaining $15 million will fund FCEV drayage trucks. If staff conservatively assumes the same vehicle costs as last year's quantification ($261,469 per BEV Truck and $500,000 per FCEV Truck), that equates to 218 BEV trucks and 29 FCEV trucks. Staff also conservatively estimated 12,000 mi/yr of use for both vehicle types and a two-year project life. Drayage truck emission factors for diesel baseline, FCEV, and BEV trucks are shown in Table A-56.

Table A-56: ZEV Drayage Truck Emission Factors

Vehicle Class	Pollutant	2022 Diesel (g/mi)	2022 FCEV (g/mi)	2022 BEV (g/mi)
HHD	NOx	1.5510	0	0
	PM 2.5	0.0429	0.0222	0.0222
	ROG	0.0337	0	0
	GHG	1,601	936	245

Note: HHD emission factors are based on population-weighted average of the T7 diesel vehicle class in EMFAC 2017, respectively, excluding out-of-state vehicles.

Using the emission factors, technology mix, and the annual usage assumptions above, staff calculated the potential annual per-vehicle emission reductions for the Advanced Technology Demonstration and Pilot Projects, as shown in Table A-57.

Table A-57: Demonstration and Pilot Projects Annual Emission Benefits on a Per-Vehicle Basis

Pollutant	EMFAC Vehicle Class	Supported Technologies	Per Vehicle Annual Emission Reductions (tpy)	
			Per Technology	Average
GHG (metric tons CO2e per year)	HHD	BEV	16.28	15.32
		FCEV	7.98	
NOx (tpy)	HHD	BEV	0.02052	0.02052
		FCEV	0.02052	
PM 2.5 (tpy)	HHD	BEV	0.00027	0.00027
		FCEV	0.00027	
ROG (tpy)	HHD	BEV	0.00045	0.00045
		FCEV	0.00045	

Next, the total emission reduction benefits of the $75 million Clean Transportation Funds for Demonstration and Pilot Projects were estimated over the two-year project life of each vehicle. These total potential emission reductions are shown in Table A-58 below.

Table A-58: Total Potential Emission Reductions for Demonstration and Pilot Projects

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tons)
GHG	15.32	246	3,776.3	2	7,553
NOx	0.02052		5.057		10.1
PM 2.5	0.00027		0.0675		0.14
ROG	0.00045		0.1100		0.22

Demonstration and Pilot Projects – Commercial Harbor Craft

This year, staff is proposing that the Advanced Demonstration and Pilot Projects support commercial harbor craft (CHC) projects, consistent with legislative direction. These projects will achieve GHG, criteria pollutant, and toxic emission benefits by providing funding to showcase commercial harbor craft regulation compliant technologies which include zero-emission, zero-emission capable and commercially available tier 4 and tier 3 engines as required by the regulation.

For FY 2022-23, staff propose $60 million to support CHC regulation compliance. While methodologies do exist to calculate GHG emission reduction estimates for CHC projects, this project is currently under development and as such, program parameters have not been established. Staff will develop GHG emission reduction methodologies. Emissions reductions and other benefits of funded projects will be quantified during project implementation.

Truck Loan Assistance Program

The Truck Loan Assistance Program aids small business truckers affected by CARB's In-Use Truck and Bus Regulation[27] by providing financing assistance for fleet owners to upgrade their fleets with newer trucks or with diesel exhaust retrofits. Staff quantified the allocated $28.64 million for the standard Truck Loan Assistance Program. For the standard Truck Loan Assistance Program, data from January 2021 through February 2022 shows that, on average, funds were directed toward the replacement of 2009 model year diesel trucks in both the MHD and HHD vehicle classifications.

Only used and new trucks with 2010 or newer model year engines can now be purchased through the Truck Loan Assistance Program. From the 2020 calendar year through February 2022, 9 percent of purchases went towards MHD vehicles, and 91

[27] https://www.arb.ca.gov/msprog/onrdiesel/onrdiesel.htm

percent towards the purchase of HHD vehicles. On average, fleet owners purchased trucks with 2017 model year engine trucks.

Staff used these engine model years to develop the emission factors as shown in Table A-59. For more information on how these emission factors were developed, please see the Emission Factor Development section at the beginning of this appendix.

Table A-59: Truck Loan Assistance Program Emission Factors

Vehicle Class	Pollutant	2009 Diesel (g/mi)	2017 Diesel (g/mi)
MHD	NOx	5.3788	1.3004
MHD	ROG	0.1727	0.0104
HHD	NOx	9.2353	2.1418
HHD	ROG	0.3005	0.0491

Note: MHD and HHD emission factors are based on population-weighted averages of the T6 and T7 vehicle classes in EMFAC 2017, respectively, excluding out-of-state vehicles.

Staff generated annual usage assumptions based on the average use of a 2009 model year, conventional MHD and HHD diesel truck in EMFAC 2017. The annual usage assumptions for the Truck Loan Assistance Program are shown in Table A-60.

Table A-60: Truck Loan Assistance Program Annual Usage Assumptions

Truck Category	VMT (mi/yr)
MHD	13,000
HHD	21,000

Using the emission factors and annual usage assumptions above, staff calculated the potential annual per-vehicle emission reductions for the Truck Loan Assistance Program, as shown in Table A-61. Please note that PM reductions for the Truck Loan Assistance Program are not quantified because PM reductions are required by the Truck and Bus Regulation through the use of diesel particulate filters. Additionally, GHG emission reductions are not quantified because this program is funded through AQIP, which focuses on criteria pollutant and toxics emission reductions, and the trucks do not achieve a significant fuel economy improvement.

Table A-61: Truck Loan Assistance Program Annual Emission Reduction Benefits on a Per-Vehicle Basis

Pollutant	Vehicle Class	Supported Technologies	Per Vehicle Annual Emission Reductions (tpy)	
			Per Technology	Average
NOx	MHD	2017 MY	0.05884	0.15468
	HHD	2017 MY	0.1642	
ROG	MHD	2017 MY	0.00233	0.00550
	HHD	2017 MY	0.00582	

In the Truck Loan Assistance Program, staff found the average loan contribution amount per loan since the contribution rates were increased in March 2020 had risen to approximately $9,000 as of the first quarter 2022. With the proposed $28.64 million allocation for the Truck Loan Assistance Program, including administration costs of 7 percent, staff estimate that approximately 2,959 vehicles can be funded. Emissions reductions from the Truck Loan Assistance program will be surplus to the Truck and Bus Regulation only until January 1, 2023, but staff assumed a one-year project life in order perform the calculations. Historically, the project life for the Truck Loan Assistance Program has been based on the surplus period ahead of the regulation dates for the Truck and Bus Regulation. As we enter the final year of the Truck and Bus regulation implementation, we assume only one year of surplus project life. The total potential emission reductions for the Truck Loan Assistance Program are shown in Table A-62.

Table A-62: Total Potential Emission Reductions for the Truck Loan Assistance Program

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emission Reductions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tons)
NOx	0.15468	2,959	457.71	1	457
ROG	0.00550		16.29		16.3

Zero-Emission Truck Loan Pilot Project

The Zero-Emission Truck Loan Pilot Project currently under development is being designed to combine financing for both heavy-duty ZEVs and charging or fueling infrastructure. Staff is proposing $5 million for the new Zero-Emission Truck Loan Pilot Project for the FY 2022-2023 funding cycle. Using the standard truck loan HHD and MHD split of 91 percent and 9 percent respectively, based on recent data from the Truck Loan Assistance program, the $5 million Zero-Emission Truck Loan Pilot would fund approximately 71 HHD zero-emission trucks and 13 MHD zero-emission trucks. This also assumes a $300,000 average cost per HHD zero-emission truck and $165,000 MHD zero-emission truck with both having a 20 percent contribution rate. Emission

Factors for these zero-emission HHD and MHD vehicles would be the same as the HVIP's Table A-36 Emission Factors. The mileage usage assumptions from HVIP's Table A-38 are 12,000 mi/yr for both vehicle categories.

Using the emission factors, technology mix, and the annual usage assumptions above, staff calculated the potential annual per-vehicle emission reductions for the Zero-Emission Truck Loan Pilot Project, as shown in Table A-63.

Table A-63: Zero-Emission Truck Loan Pilot Project Annual Emission Benefits on a Per-Vehicle Basis

Pollutant	Vehicle Class	Supported Technologies	Per Vehicle Annual Emission Reductions (tpy)	
			Per Technology	Average
GHG	MHD	BEV	11.76	15.92
	HHD	BEV	16.34	
NOx	MHD	BEV	0.01316	0.02225
	HHD	BEV	0.02315	
PM 2.5	MHD	BEV	0.00042	0.00032
	HHD	BEV	0.00031	
ROG	MHD	BEV	0.00012	0.00050
	HHD	BEV	0.00054	

Based on the proposed $5 million allocation for the Zero-Emission Truck Loan Assistance Project with a 7 percent administration fee, staff estimates that 84 vehicles can be funded. The total emission reduction benefits of the $5 million Zero-Emission Truck Loan Assistance Project were estimated over a three-year project life of each vehicle. These total potential emission reductions are shown in Table A-64 below.

Table A-64: Total Potential Emission Reductions for Zero-Emission Truck Loan Pilot Project

Pollutant	Per Vehicle Average Annual Emission Reductions (tpy)	Number of Vehicles	Average Annual Emissions (tpy)	Project Life (years)	Lifetime Annual Emission Reductions (tons)
GHG	15.92	84	1,313	3	3,938
NOx	0.02225		1.82		5.44
PM 2.5	0.00032		0.03		0.08
ROG	0.00050		0.04		0.12

AB 8

AB 8 extended the funding for AQIP through 2023, refined the evaluation criteria for projects supported by AQIP, and introduced the following requirements that staff followed to develop the project scoring criteria:

- The state board shall provide preference in awarding funding to those projects with higher benefit-cost scores that maximize the purposes and goals of the Air Quality Improvement Program.[28]
- "Benefit-cost score" means the reasonably expected or potential criteria pollutant emission reductions achieved per dollar awarded by the Board for the project.[29]
- The state board also may give additional preference based on the following criteria, as applicable, in funding awards to projects:[30]

  1. Proposed or potential reduction of criteria or toxic air pollutants.
  2. Contribution to regional air quality improvement.
  3. Ability to promote the use of clean alternative fuels and vehicle technologies as determined by the state board, in coordination with the Energy Commission.
  4. Ability to achieve climate change benefits in addition to criteria pollutant or air toxic emission reductions.
  5. Ability to support market transformation of California's vehicle or equipment fleet to utilize low carbon or zero-emission technologies.
  6. Ability to leverage private capital investments.

Statute directs CARB to annually evaluate potential project categories to assign preference for AQIP funding, based upon the specific criteria identified above. The analysis and methodology in this section of the appendix describes the implementation of the provisions that require CARB to assign preference to projects with a higher benefit-cost score. The AB 8 analysis is fully executed for the project that will be funded through AQIP: the Truck Loan Assistance Program.

Overview

Conservative estimates for criteria pollutant and toxic air contaminants were developed using guidance provided in AB 8. Because criteria pollutant and toxic air contaminant emissions are geographically localized, criteria pollutant and toxic air contaminant emissions reductions reported in this appendix are estimated at the tailpipe. The Truck Loan Assistance Program does generate GHG reductions, so these

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[28] Health & Safety Code Section 44274(b)
[29] Health & Safety Code Section 44270.3(e)(1)
[30] Health & Safety Code Section 44274(b)

were not tabulated. Building upon the emission reductions and cost information from the Project Quantification section, this section of the appendix provides information on the following:

- Benefit-Cost Score Analysis;
- Additional Preference Criteria Scores; and
- Total Benefit Index (TBI) Scores.

Benefit-Cost Score Analysis

Staff analyzed the expected costs and developed cost-effectiveness values for the AQIP-funded project using well-established cost-effectiveness calculation methodology for incentives, consistent with that used in the Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer Program). In addition, to calculate cost-effectiveness, staff also applied an appropriate discount rate and utilized a capital recovery factor (CRF) in the analysis based on 2017 Carl Moyer Program Guidelines.[31] The one percent discount rate was used and the corresponding CRF was determined based on the assumed usage life of the vehicles or equipment supported by a given project.

For the proposed project funded by AQIP, a cost-effectiveness value was calculated. The cost-effectiveness of a project is determined using Formula 8 below.

Formula 8: Cost-Effectiveness

$$Cost\ Effectiveness\ (\frac{\$}{ton}) = \frac{Incentive\ Amount\ per\ Vehicle\ or\ Equipment * CRF}{Annual\ Per\ Vehicle\ Weighted\ Emission\ Reductions}$$

Weighted emission reductions are calculated using Formula 9, consistent with Carl Moyer Program Guidelines:

Formula 9: Annual Weighted Emission Reductions

$$Annual\ Weighted\ Emission\ Reductions (\frac{weighted\ tons}{year}) = NOx\ reductions + ROG\ reductions + (20 * PM\ reductions)$$

Table A-65 provides the inputs and the resulting weighted criteria pollutant and toxic air contaminant cost-effectiveness, in terms of dollars per ton of weighted emission reductions.

[31] https://www.arb.ca.gov/msprog/moyer/guidelines/2017gl/2017_cmp_gl_volume_1.pdf

Table A-65: AB 8 Analysis – Weighted Criteria Pollutant and Toxic Air Contaminant Cost-Effectiveness

Proposed Project	Project Life	CRF	Average Annual Per-Vehicle Weighted Emission Reductions (tpy)	Average Incentive Cost	Cost-Effectiveness ($/ton)
Truck Loan Assistance	1	1.010	0.160	$9,000	$56,813

The cost-effectiveness values for the project was given points based on a scale of one to five points. The bins were determined by taking the high and low resulting benefits and scaled to develop an equal distribution of scores. Those projects with a cost-effectiveness of less than $5,000 per ton of weighted emission reductions received a high of five points. The remaining bins were increased by $5,000 increments with the least cost-effective projects, those projects that cost over $20,000 per weighted ton of emissions reduced, receiving the lowest points possible. The cost-effectiveness of each proposed project was scored based on the following scale:

5: Less than $5,000 per ton

4: $5,000 to $9,999 per ton

3: $10,000 to $14,999 per ton

2: $15,000 to $19,999 per ton

1: $20,000 per ton or more

The resulting scores from the scale shown above were then used in the "Total Benefit Index" for AB 8 project selection. Finally, per AB 8, the cost-effectiveness values were converted to benefit-cost values based on pound of weighted emission reductions per dollar spent. The cost-effectiveness, benefit-cost value, and resulting score of the proposed project is shown in Table A-66.

Table A-66: AB 8 Analysis – Benefit-Cost Value and Score for Total Benefit Index

Proposed Project	Cost-Effectiveness ($/ton)	Benefit-Cost Value (lbs/$)	Benefit-Cost Score
Truck Loan Assistance	$56,813	0.035	1

Additional Preference Criteria

Per AB 8, additional preference criteria may be used to provide additional funding preference in conjunction with the benefit-cost scores summarized in Table A-66. The additional preference criteria includes:

- Proposed or potential reduction of criteria and toxic air pollutants;
- Contribution to regional air quality improvement;

- Ability to promote the use of clean alternative fuels and vehicle technologies;
- Ability to achieve GHG reductions;
- Ability to support market transformation of California's vehicle or equipment fleet to utilize low carbon or zero-emission technologies; and
- Ability to leverage private capital investments.

Staff analyzed the associated data and equally divided the results into scores between 0 and 5 for quantitative preference criteria. The quantitative preference criteria includes the proposed or potential reduction of criteria and toxic air pollutants, contribution to regional air quality, and the ability to achieve GHG reductions. Staff used the following steps to develop scoring scales and final scores for the quantitative preference criteria:

1. Quantify the results for each additional preference criteria for the proposed projects;
2. Establish scoring scale increments to generate an equal distribution in points for the proposed project; and
3. Rank the proposed projects based on the established scoring scale, which is then used in the "Total Benefit Index."

Staff anticipate that the scales for the quantitative additional preference criteria may change each year depending on the mix of project(s) proposed, due to differences in the range of expected benefits or when additional information becomes available to refine the evaluation. The data and rationale used to establish each of the criteria weighting factors for the associated scores are described below.

Proposed or Potential Reduction of Criteria or Toxic Air Pollutants

This analysis considered the magnitude of emission reductions by quantifying the direct criteria pollutant and toxic air contaminant emission reductions expected per average vehicle or equipment.

For this additional preference criterion, staff analyzed the emission benefits on a per-vehicle basis to account for the differences in vehicle sales volumes and statewide populations of the various vehicles supported by AQIP. Resulting total lifetime emission reductions ranged from less than one ton to almost three tons of lifetime criteria pollutant and toxic air contaminant emission reductions per-vehicle. The scoring scale for this criterion was established by evaluating the range of lifetime tons of emission reductions between the highest and lowest value to try to have an equal distribution of scores. As a result, the bins were scaled in half ton increments. Project(s) with less than or equal to one ton of criteria pollutant and toxic air contaminant emission reductions receive one point, while those projects with greater than two and a half tons of criteria pollutant and toxic air contaminant emission reductions receive a score of five points. The resulting scale for criteria pollutant and toxic air contaminant emission reductions on a per-vehicle basis is shown below.

5: Greater than 2.5 tons of criteria and toxic emission reductions per vehicle

4: 2 to 2.49 tons of criteria and toxic emission reductions per vehicle

3: 1.5 to 1.99 tons of criteria and toxic emission reductions per vehicle

2: 1 to 1.49 tons of criteria and toxic emission reductions per vehicle

1: Less than 1 ton of criteria and toxic emission reductions per vehicle

Based on the information described above, Table A-67 summarizes the results and the corresponding score for this additional preference criterion.

Table A-67: AB 8 Analysis – Potential Reduction of Criteria or Toxic Air Pollutants

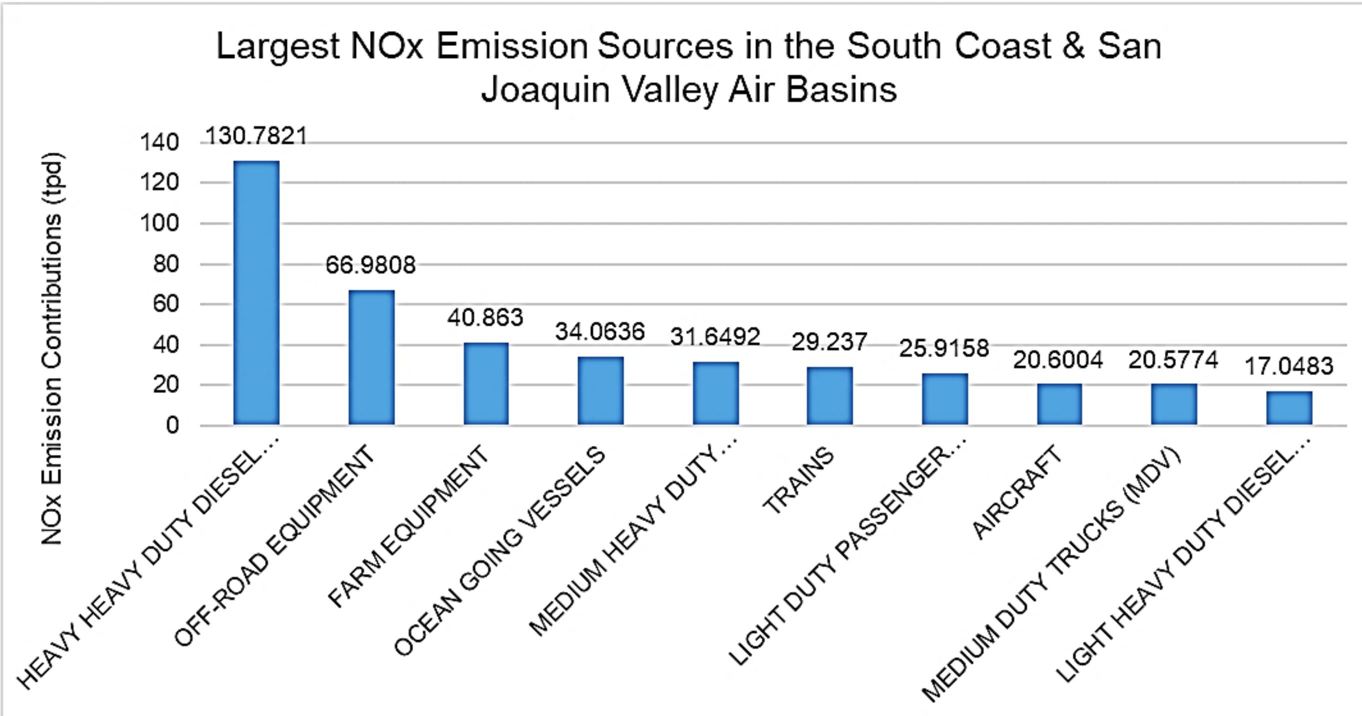
Proposed Project	Annual Per-Vehicle Emission Reductions (tpy)	Project Life (years)	Per-Vehicle Lifetime Emission Reductions (tons)	Score
Truck Loan Assistance	0.169	1	0.17	1

Contribution to Regional Air Quality Improvement

Staff developed a scoring scale based on CARB's emissions inventory for the South Coast and San Joaquin Valley air basins, two of the state's extreme nonattainment regions, and ranked project(s) based on their corresponding emissions contributions from highest to lowest. Specifically, staff used the NOx emissions inventory in tons per day from the 2016 State Implementation Plan (SIP) emission projection data for the South Coast and San Joaquin Valley air basins.[32] The ranking scale is based on the emissions inventory shown in Figure A-1.

[32] *https://www.arb.ca.gov/ei/maps/2017statemap/abmap.htm*

Figure A-1: Largest NOx Emission Sources in the South Coast & San Joaquin Valley Air Basins



The top ten NOx emission sources were ranked in tons per day for various vehicle and equipment types, ranging from heavy heavy-duty diesel trucks, at 131 tons per day, to light heavy duty diesel trucks, at 17 tons per day. Because the HHD diesel truck category is the largest emission source by far, the scoring scale for this criterion was established for the range of NOx emissions between the second highest and lowest value. As a result, the bins were rounded and scaled in 25-ton per day increments. Projects corresponding to inventory sources with less than or equal to 25 tons of NOx per day receive one point, while those projects with greater than 100 tons of NOx per day receive five points. Potential contribution to regional air quality improvement is ranked based on the scale below.

5: Category contributes more than 100 tons of NOx per day

4: Category contributes 75 to 99 tons of NOx per day

3: Category contributes 50 to 74 tons of NOx per day

2: Category contributes 25 to 49 tons of NOx per day

1: Category contributes less than 25 tons of NOx per day

Based on the information described above, Table A-68 summarizes the results and the corresponding score for this additional preference criterion.

Table A-68: AB 8 Analysis – Contribution to Regional Air Quality Improvement

Proposed Project	Annual Per-Vehicle Emission Reductions (tpy)	Project Life (years)	Per-Vehicle Lifetime Emission Reductions (tons)	Score
Truck Loan Assistance	0.169	1	0.17	1

Ability to Promote the Use of Clean Alternative Fuels and Vehicle Technologies

Clean alternative fuels are fuels that have lower WTW emissions compared to conventional fuels, such as electricity, hydrogen, and renewable fuels. Clean vehicle technologies are technologies that emit zero tailpipe emissions, such as battery-electric and fuel cell vehicles, or enabling technologies, such as vehicles that utilize conventional hybrid or plug-in hybrid systems. This qualitative analysis ranked project(s) by whether or not they used a clean low carbon alternative or renewable fuel or utilized clean vehicle technologies. Staff scored this additional preference criterion on the scale below.

> 5: Projects that use low carbon alternative fuels <u>and</u> clean vehicle technologies
>
> 3: Projects that use low carbon alternative fuels <u>or</u> clean vehicle technologies
>
> 1: Projects that do not use low carbon alternative fuels nor clean vehicle technologies

Based on the information described above, Table A-69 summarizes the results and the corresponding score for this additional preference criterion.

Table A-69: AB 8 Analysis – Ability to Promote the Use of Cleaner Alternative Fuels and Vehicle Technologies

Proposed Project	Annual Per-Vehicle Emission Reductions (tpy)	Project Life (years)	Per-Vehicle Lifetime Emission Reductions (tons)	Score
Truck Loan Assistance	0.169	1	0.17	1

Ability to Achieve GHG Reductions

Similar to the methodology established in the first preference criterion for criteria pollutant and toxic air contaminant emission reductions, staff conducted a full WTW GHG emissions analysis for the vehicles and equipment supported by the proposed project(s). Staff determined expected lifetime GHG emission reductions achieved for each vehicle or equipment and found that there were no GHG emission reductions. The scoring scale for GHG emission reductions is shown below.

5: Greater than 200 metric tons of CO2e per vehicle

4: 150 to 199 metric tons of CO2e per vehicle

3: 100 to 149 metric tons of CO2e per vehicle

2: 50 to 99 metric tons of CO2e per vehicle

1: Less than 50 metric tons of CO2e per vehicle

Based on the information described above, Table A-70 summarizes the results and the corresponding score for this additional preference criterion.

Table A-70: AB 8 Analysis – Ability to Achieve GHG Emission Reductions

Proposed Project	Annual Per-Vehicle GHG Emission Reductions (tpy)	Project Life (years)	Per-Vehicle Lifetime GHG Emission Reductions (tons)	Score
Truck Loan Assistance	N/A	1	N/A	1

Ability to Support Market Transformation of California's Vehicle or Equipment Fleet to Utilize Low Carbon or Zero-Emission Technologies

This qualitative analysis ranked project(s) by whether or not technologies with the potential for market transformation are supported by the proposed projects. Staff used CARB's Three-Year Investment Strategy for Heavy-Duty Vehicles and Off-Road Equipment from Low Carbon Transportation and Air Quality Improvement Program Investments as a key reference in scoring technologies used for this evaluation. Zero-emission, including battery-electric and fuel cell electric vehicle technologies, for example, are considered transformative technologies that will help the State meet its air quality goals. Staff scored this preference criterion based on the scale below.

5: Technologies that support market transformation

0: Technologies that do not support market transformation

Based on the information described above, Table A-71 summarizes the results and the corresponding score for this additional preference criterion.

Table A-71: AB 8 Analysis – Ability to Support Market Transformation of California's Vehicle or Equipment Fleet to Utilize Low Carbon or Zero-Emission Technologies

Proposed Project	Annual Per-Vehicle Emission Reductions (tpy)	Project Life (years)	Per-Vehicle Lifetime Emission Reductions (tons)	Score
Truck Loan Assistance	0.169	1	0.17	0

Ability to Leverage Private Capital Investments

Staff is proposing not to include this criterion for FY 2022-23 as staff works on developing methodologies to analyze the private capital investments leveraged by projects. Staff intends to identify information sources and may include this preference criterion in future years.

Total Benefit Index

Staff utilized the benefit-cost/cost-effectiveness scores of the proposed project and the additional preference criteria in the consideration of the projects to be funded under AB 8. Staff developed the TBI score that preferentially weights the benefit-cost score (at 75 percent of the total score) with additional preference scores (at 25 percent of the total score). Staff weighted the benefit-cost/cost-effectiveness scores in this manner because AB 8 identified the benefit-cost score as the primary metric to assign funding preference.

Table A-72 summarizes the individual scores and the TBI scores for the AQIP project proposed in the FY 2022-23 Funding Plan.

Table A-72: AB 8 Analysis – Project Scores and TBI Score of Proposed Projects

Truck Loan Assistance	Additional Preference Criteria of Potential Reduction of Criteria or Toxic Air Pollutants
Potential Reduction of Criteria or Toxic Air Pollutants	1
Contribution to Regional Air Quality Improvement	1
Ability to Promote Use of Clean Fuels and Technologies	3
Ability to Achieve GHG Emission Reductions	1
Ability to Support Market Transformation	0
Average of Additional Preference Criteria (25% of TBI)	1.2
Benefit-Cost Score (75% of TBI)	1
TBI Score	**1.05**

Jobs Co-Benefits

CARB's Low Carbon Transportation Investments yield a whole host of co-benefits including an impact on jobs – directly and indirectly. Quantifying direct, indirect, and induced jobs at the start and during a project allows stakeholders to take a much more holistic and robust approach while assessing the positive impacts from these projects. Furthermore, job quantification could help shape programmatic changes. Job co-benefits refer to California jobs supported. A job is defined as one full-time equivalent (FTE) employee position over one year, equal to approximately 2,080 hours of work. Jobs supported include direct, indirect, and induced employment:

- Directly supported jobs refer to labor to complete projects, through direct employment or contracted work paid with Low Carbon Transportation investment dollars (e.g., housing construction, ecosystem restoration, or technical assistance) and labor to produce equipment or materials purchased with Low Carbon Transportation investment dollars (e.g., manufacturing ZEV or anaerobic digesters).
- Indirectly supported jobs exist in the supply chains supporting Low Carbon Transportation investment projects. Funding a project generates demand for intermediate inputs of materials and equipment needed to complete the project, leading to expanded production and employment in the relevant upstream industries (e.g., manufacturing construction equipment, zero-emission vehicle parts, or solar panel components).
- Induced jobs are linked to the spending of income from directly and indirectly supported jobs. The personal consumption expenditures of workers in jobs directly and indirectly supported by Low Carbon Transportation investment

projects (i.e., increased household spending) stimulate demand for goods and services in the wider California economy.

The methodology for assessing the number of jobs supported was developed by CARB in consultation with the Center for Resource Efficient Communities at the University of California, Berkeley (UC Berkeley). CARB first released the Job Co-benefit Assessment Methodology and Modeling Tool in January 2019 and has since updated this tool. Detailed documentation of the methodology itself and the comprehensive steps that went into its development can be found on CARB's California Climate Investments (CCI) Co-benefit Assessment Methodologies page: *https://www.arb.ca.gov/resources/documents/cci-methodologies*.

Based on inputs such as proposed funding allocation, allocation fraction going to the actual vehicle and/or equipment procurement, allocation fraction going to implementation and administrative expenses, among other inputs, staff determined the number of jobs supported for each of the Low Carbon Transportation project categories using the aforementioned jobs assessment methodology. For projects where there was not a methodology to quantify emissions reductions, the number of supported jobs was not assessed. The job estimate results for FY 2022-23 Low Carbon Transportation Investments are shown in Table A-73 and the total jobs from General Fund, AQIP, and Proposition 98 funding sources are shown in Table A-74.

Table A-73: Estimate of Number of Jobs Supported by FY 2022-23 Low Carbon Transportation Investments (GGRF)

Project Category	Directly Supported Jobs	Indirectly Supported Jobs	Induced Jobs	Total Supported Jobs
Financing Assistance for Lower Income Consumers	51.0	31.3	143.9	226.1
Clean Cars 4 All (statewide)	N/A	N/A	N/A	N/A
Clean Cars 4 All (districts)	32.8	20.1	74.9	127.9
Zero-Emission Assurance Project	N/A	N/A	N/A	N/A
Electric Bicycle Incentives Project	2.2	1.3	7.5	11.0
ACCess Clean California	6.8	1.7	5.7	14.3
Cal-ITP	7.3	1.9	5.6	14.7
Clean Mobility Options	N/A	N/A	N/A	N/A
Clean Mobility in Schools	N/A	N/A	N/A	N/A
STEP	292.4	83.6	130.6	506.8
Planning and Capacity Building and Workforce Training	N/A	N/A	N/A	N/A
HVIP - Standard	55	418	723	300
HVIP - Set Asides	N/A	N/A	N/A	N/A
HVIP - ISEF	73.6	39.9	41.2	186.4
Advanced Technology Demonstrations & Pilot Projects	47.2	25.6	43.5	116.4
Commercial Harbor Craft Demonstrations & Pilot Projects	86.8	41.2	72.4	200.4
CORE	695.8	351.8	527.9	1575.5
ZEV Truck Loan Pilot	10.5	5.7	10.4	26.6
Total	**1,863.6**	**905.9**	**1,648.1**	**4,417.7**

Table A-74: Estimate of Number of Jobs Supported by FY 2022-23 General Fund, AQIP, and Proposition 98 funding sources

Project Category	Directly Supported Jobs	Indirectly Supported Jobs	Induced Jobs	Total Supported Jobs
Financing Assistance for Lower Income Consumers	N/A	N/A	N/A	N/A
Clean Cars 4 All (statewide)	96.5	59.2	272.5	428.3
Clean Cars 4 All (districts)	65.6	40.3	149.8	255.7
Zero-Emission Assurance Project	68.2	17.4	56.9	142.5
Electric Bicycle Incentives Project	N/A	N/A	N/A	N/A
ACCess Clean California	N/A	N/A	N/A	N/A
Cal-ITP	N/A	N/A	N/A	N/A
Clean Mobility Options	17.4	10.7	31.3	59.3
Clean Mobility in Schools	31.4	18.9	43.4	93.7
STEP	N/A	N/A	N/A	N/A
Planning and Capacity Building and Workforce Training	36.4	9.3	28.0	73.7
HVIP – Standard	N/A	N/A	N/A	N/A
HVIP – Set Asides	761.1	412.3	755.0	1928.4
HVIP – ISEF	N/A	N/A	N/A	N/A
HVIP – Prop 98 School Bus	2543.3	1377.6	1921.7	5842.6
Advanced Technology Demonstrations & Pilot Projects	113.8	61.7	104.8	280.3
Commercial Harbor Craft Demonstrations & Pilot Projects	173.6	82.5	144.8	400.8
CORE	N/A	N/A	N/A	N/A
AQIP Truck Loans	60.2	32.6	59.7	152.6
Total	**3,967.5**	**2,122.5**	**3,567.9**	**9,657.9**

Californians have begun to see the economic benefits of these Clean Transportation Incentives by the thousands number of jobs created as California has become a hub for the manufacture and deployment of clean technologies and associated green jobs.

CARB staff shall continue to keep a cumulative job creation total moving forward and direct job data will continue to be collected through the project reports.

AB 1550: Disadvantaged Community, Low-Income Community, Low-Income Household Investment Targets

In the proposed Funding Plan, staff proposes that at least 60 percent of CARB's Low Carbon Transportation appropriation be invested in projects meeting one of the AB 1550 criteria with the following targets:

- At least 45 percent of funds for projects located within and benefiting disadvantaged communities.
- At least 15 percent of funds for projects within and benefiting low-income communities or benefiting low-income households. The subset of these funds meeting the additional AB 1550 requirement for low-income community/ household investments that are <u>within ½ mile of a disadvantaged community</u> would be determined based on program implementation and reported in future Annual Reports to the Legislature on California Climate Investments.

Staff considers the investment targets to be a floor and expects to exceed them. This section provides additional detail showing how CARB will meet, and very likely exceed these targets, based on the historical performance of Low Carbon Transportation funded projects and the project criteria established in this Funding Plan.

AB 1550 only statutorily applies to projects funded from GGRF; however, CARB is committed to focusing all these projects on priority populations as defined in AB 1550 and SB 535. Even though these projects are funded through a mix of GGRF and Non-GGRF investments, we are estimating the priority population benefits for all allocated funds. If interested in GGRF spent funds, please visit the *CCI Cap-and-Trade Dollars at Work* page.

This minimum CARB commitment of at least 60 percent would exceed the overall target set in AB 1550 for the State's collective CCI in disadvantaged communities, low-income communities, and low-income households. AB 1550 does not set targets for individual agencies, but requires that the State, overall, invest at least 25 percent in project located in and benefiting disadvantaged communities, at least 5 percent in and benefiting low-income communities or benefiting low-income households, and at least 5 percent low-income communities located within one-half mile of a disadvantaged community for a total AB 1550 investment of at least 45 percent of California Climate investment funds.

Table A-75 shows staff estimates of the minimum percent of funds for each project expected to be spent within and benefiting disadvantaged community census tracts as well as the nonoverlapping minimum percent of funds expected to be spent within and benefiting low-income communities. Staff only counted an investment as being in a low-income community if it had not already been counted as being spent in disadvantaged communities because AB 1550 does not allow funds to be counted twice for reporting purposes. Staff used several different methods for these estimates.

For ongoing projects with several years of implementation data such as CC4A and HVIP, staff used the historical percent of funds spent in disadvantaged communities as reported in the *2021 Annual Report on CCI* to project future performance.

As shown in Table A-75 several project categories are limited to disadvantaged and low-income communities, so staff can say with certainty 100 percent of these funds will be spent in these communities. These include Clean Mobility in Schools, Clean Mobility Options, STEP, and Advanced Vehicle Technology Demonstration Projects.

There are also a number of proposed projects that lack sufficient historical data upon which to make an informed estimate of the percent of funds that will be spent in disadvantaged and low-income communities, such as the Electric Bicycle Incentives Project. In this case, staff took the most conservative approach and left the estimates as "to be determined" even though staff expects an appreciable amount of this funding will meet one of the AB 1550 criteria. For example, the Electric Bicycle Incentives Project will be designed to support individuals in disadvantaged and low-income communities, but it has yet to launch. Staff expects 75 percent of this funding will be spent in disadvantaged communities, in low-income communities, or for consumers meeting the AB 1550 low-income household definition.

Even with these conservative estimates, staff estimates that over 75 percent of the proposed Low Carbon Transportation funds would be spent in disadvantaged communities and approximately 8 percent in non-overlapping low-income communities for a total of over 80 percent meeting one of the AB 1550 criteria as shown in Table A-75. When data are included for all the projects based on actual performance including those for which no AB 1550 is estimated at this time, staff expects CARB will exceed its AB 1550 targets by a considerable margin. CARB will report on these projects' performance in future Annual Reports to the Legislature on CCI as funds are awarded and spent.

Table A-75: Estimate of the Minimum Proposed FY 2021-22 Low Carbon Transportation Investments in Disadvantaged Communities, Low-Income Communities, and Low-Income Households

Project Category	Allocation (millions)	% in DC	$ in DC (millions)	% in LIC (non-overlap)	$ in LIC (non-overlap) (millions)	%DC/LIC Combined	$DC/LIC Combined (millions)	Data Source for Disadvantaged Community (DC)/Low-Income Community or Household (LIC) Estimates
Light-Duty Equity Projects								
Financing Assistance for Lower-Income Consumers	$66.00	67%	$44.22	17%	$11.22	84%	$55.44	67% spent in DCs and 17% spent in LICs and LIC households from the 2022 Annual Report of California Climate Investments, https://www.caclimateinvestments.ca.gov/financing-assistance-for-lower-income-consumers
Clean Cars 4 All	$40.00	51%	$20.40	47%	$18.80	98%	$39.20	51% spent in DCs and 47% spent in LICs and LIC households from the 2022 Annual Report of California Climate Investments, https://www.caclimateinvestments.ca.gov/clean-cars-4-all
Electric Bicycle Incentive Project	$3.00	TBD	$-	TBD	$-	-	$-	This project is designed to support DACs and LICs but has not launched.
Access Clean California	$1.00	50%	$0.50	25%	$0.25	75%	$0.75	This project is designed to support DCs and LICS.
Cal-ITP	$1.00	TBD	$-	TBD	$-	-	$-	This project has not launched.
Sustainable Transportation Equity Projects	$15.00	98%	$14.70	2%	$0.30	100%	$15.00	98% spent in DCs and 2% spent in LICs and LIC households from the 2022 Annual Report of California Climate Investments, https://www.caclimateinvestments.ca.gov/sustainable-transportation-equity-project
Heavy-Duty, Freight, Off-Road Projects								
Clean Truck and Bus Vouchers (HVIP)	$300	63%	$189.00	10%	$30.00	73%	$219.00	63% spent in DCs and 10% spent in LICs in 2020 from 2021 Annual Report of California Climate Investments, page 49.
Clean Off-Road Equipment Voucher Incentive Project	$273	94%	$256.62	0%	$0.00	94%	$256.62	94% spent in DCs and 0% spent in LICs and LIC households from the 2022 Annual Report of California Climate Investments,

								https://www.caclimateinvestments.ca.gov/clean-off-road-equipment-vouchers
Advanced Technology Demonstration and Pilot Projects (including commercial harbor craft)	$42	100%	$42.00	0%	$0.00	100%	$42.00	This project is designed to support DCs. Staff estimates that 100% of funding will go to DCs.
Zero-Emission Truck Loan Pilot	$5	50%	$2.50	25%	$1.30	75%	$3.80	This project is designed to support DCs and LICS but has not launched.
Total	**$746**	**76.40 %**	**$570**	**8.12%**	**$62**	**84.52%**	**$632**	

DC *means disadvantaged community as described in Health and Safety Code Section 39711.*
LIC *means low-income community (or low-income household in the case of CC4A) as defined in Health and Safety Code Section 39713. "% in LIC" shown in this table means the percent of funds spent in low-income communities that have not already been counted as being spent in disadvantaged communities because AB 1550 does not allow funds to be counted twice for reporting purposes.*