Appendix H: Cost Effectiveness of CARB's Incentive Programs

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Contents

Overview

This appendix provides the cost-effectiveness values for the suite of CARB's incentive programs including the Low Carbon Transportation Program, the Air Quality Improvement Program, The Carl Moyer Memorial Air Quality Standards Attainment Program (Moyer Program), the Community Air Protection Program, and the Funding Agricultural Replacement Measures for Emission Reductions (FARMER) program. Legislation that governs many of these programs includes additional goals that may not be reflected in criteria pollutant cost-effective metrics alone, such as greenhouse gas (GHG) emission reductions and directing funding to disadvantaged and low-income communities (e.g. AB 1550, SB 535, etc.). Many of these programs achieve co-benefits and other legislative directives, such as jobs creation and reduction in health risks from near-source exposure to toxic air contaminants. The cost-effectiveness results below are for the date ranges indicated in Table H-1.

Table H- 1: Project Data Analysis Time Periods

Program/Project Name	Data Start Date	Data as of Date
CVRP	July 2019	March 2021
CC4A	July 2018	March 2021
Financing Assistance for Low-Income Consumers	July 2019	March 2021
Clean Mobility Options	July 2019	March 2021
Clean Mobility in Schools	July 2019	March 2021
Agricultural Worker Vanpools	July 2018	March 2021
Rural School Bus Pilot	July 2019	March 2021
Heavy-Duty Demos and Pilots	July 2019	March 2021
HVIP	July 2020	March 2021
CORE	July 2019	March 2021
Truck Loan Assistance Program	July 2020	March 2021
Moyer Program	July 1998	June 2019
Community Air Protection Program	July 2017	May 2020
FARMER Program	July 2018	September 2020

The information and tables in this appendix display the cost-effectiveness of the respective incentive programs at reducing criteria pollutant emissions and greenhouse gases (GHGs). The criteria pollutants calculation methodology for all projects follows the Moyer Program Guidelines. The Moyer Program Guidelines do not explicitly provide a GHG cost-

effectiveness formula; however, the calculations for GHGs are similar to the criteria pollutant methodology, as described below.

Cost-effectiveness is the measure of dollars provided to a project for each weighted ton of covered emissions reduced. The calculation methods follow the Moyer Program Guidelines for criteria pollutants. To determine the project's air pollution (or criteria pollutant) cost-effectiveness, the annual particulate matter (PM) emission reductions is weighted by a factor of 20 to account for diesel PM toxicity and then added to the annual oxides of nitrogen (NOx) and reactive organic gas (ROG) reductions to calculate the weighted annual emission reduction for the project. The project's average incentive amount is multiplied by the capital recovery factor (CRF) and then divided by the annual weighted emission reductions.

Formula 1: Air Pollution Cost-Effectiveness

$$Air\ Pollution\ Cost\ Effectiveness = \frac{CRF * Average\ Incentive\ Cost}{NOx + ROG + (20 * PM2.5)}$$

Similar to the air pollution's cost-effectiveness, the GHG cost effectiveness is the CRF multiplied by the average incentive amount weighted by the project's GHG emissions reductions.

Formula 2: GHG Cost Effectiveness

$$GHG\ Cost\ Effectiveness = \frac{CRF * Average\ Incentive\ Cost}{GHG}$$

A project's capital recovery factor (CRF) is based on the project life and discount rate to account for inflation over time. The formula is provided below.

Formula 3: Capital Recovery Factor (CRF)

$$CRF = \left(1 + discount\ rate^{(a)}\right)^{project\ \ life} * \frac{discount\ rate}{(1 + discount\ rate)^{project\ \ life - 1}}$$

The average incentive cost is a function of the incentive cost for each technology and the potential technology split for a given project. The formula is provided below.

Formula 4: Average Incentive Cost

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

Low Carbon Transportation Program and Air Quality Improvement Program

The Low Carbon Transportation program is part of California Climate Investments, a statewide program that puts billions of Cap-and-Trade dollars to work reducing greenhouse gas emissions, strengthening the economy and improving public health and the environment, particularly in disadvantaged communities. These investments accelerate the transition to low carbon freight and passenger transportation with a priority on providing health and economic benefits to California's most disadvantaged communities. The Air Quality Improvement Program (AQIP) is a voluntary, mobile source incentive program that focuses on reducing criteria pollutant and diesel particulate emissions with concurrent reductions in greenhouse gas emissions. AB 8 (Perea, Chapter 401, Statutes of 2013) refined the evaluation criteria for projects funded by fees that support AQIP.

Table H-2 presents the GHG cost-effectiveness and the air pollutant cost-effectiveness estimates for the entire suite of Low Carbon Transportation and AQIP programs. To calculate the average cost-effectiveness values shown in the table below, the cost-effectiveness for each individual project within a project category is added together and then divided by the total number of projects in that category.

The projects in the following table are grouped by project type: vehicle purchase incentives, clean mobility investments, heavy duty vehicle and off-road equipment incentives, and AQIP. Vehicle purchase incentives include the Clean Vehicle Rebate Project (CVRP), the Financing Assistance Project for Lower Income Consumers (Financing Assistance), and the Clean Cars 4 All programs. CVRP supports increasing the number of ZEVs on California's roadways to meet deployment goals and achieve large scale transformation of the fleet while also providing support to increase ZEV adoption in low-income communities. Clean Cars 4 All and Financing Assistance are designed to increase access to cleaner vehicles in disadvantaged communities and lower-income households as prescribed by SB 1275 and supported by SB 350, as well as provide support to the secondary ZEV market. Clean mobility incentive projects include: Clean Mobility Options, Clean Mobility in Schools, Agricultural Worker Vanpools, the Rural School Bus Pilot, and the Sustainable Transportation Equity Project. Clean mobility incentives projects support transportation needs of low-income residents and those living in disadvantaged and low-income communities. Mobility needs are not the same in all communities and it is important to provide various options in order to be flexible and responsive to the transportation needs of specific communities. The heavy-duty vehicle and off-road equipment incentive programs include: Clean Truck and Bus Vouchers (HVIP), heavy-duty demonstration and pilot projects, the Clean Off-Road Equipment Project (CORE), and the Truck Loan Assistance Program. For more detailed information about each of the projects described in Table H-2, please refer to the Fiscal Year 2021-22 Low Carbon Transportation Program Funding Plan – the exception being the Agricultural Worker Vanpools. CARB has paused funding for the Agricultural Worker Vanpools project because there are currently no technologies on the market that meet the

specifications required for the project. The application period for the Sustainable Transportation Equity Project closed on August 31, 2020. At the time of publishing, there was not enough known about the types of projects being funded to provide average cost-effectiveness values. Next year's funding plan will provide updated numbers and include cost-effectiveness values for the Sustainable Transportation Equity Project.

The cost-effectiveness values presented in Table H-2 were calculated based on program parameters for the Fiscal Year 2019-2020 with the exception of HVIP, whose calculations were done based on FY 2020-2021 program changes.

Table H- 2: Low Carbon Transportation Program

Proposed Project	Average GHG Cost-Effectiveness per Project ($/weighted ton GHG)	Average Cost-Effectiveness per Project ($/weighted ton)	Total Funding Invested (millions)
Vehicle Purchase Incentives			
CVRP (Standard)	$711	$258,705	$991
CVRP (Increased)	$1,739	$581,936	$100
CC4A	$2,000	$463,187	$104
Financing Assistance for Low-Income Consumers	$2,700	$912,243	$9
Clean Mobility Incentives			
Clean Mobility Options	$6,000	$6,043,789	$10
Clean Mobility in Schools	$698	$1,283,000	$25
Agricultural Worker Vanpools	$1,164	$714,020	$6
Rural School Bus Pilot	$1,202	$78,234	$62
Heavy-Duty Vehicle and Off-Road Equipment Incentives			
Heavy-Duty Demos and Pilots	$2,997	$760,000	$149
HVIP	$277	$213,776	$385
CORE	$1,472	$222,458	$19
Truck Loan Assistance Program	Not applicable	$16,093	$108

Carl Moyer Memorial Air Quality Standards Attainment (Moyer) Program

The Carl Moyer Memorial Air Quality Standards Attainment Program (Moyer Program) provides incentive grants to fund the incremental cost of cleaner than-required engines, equipment and other technology. The core principle of the Moyer Program is to achieve cost-effective criteria pollutant emission reductions that are surplus, quantifiable, enforceable, and creditable to the State Implementation Plan. The Moyer Program is implemented as a partnership between CARB and local air districts. Air districts administer Moyer Program grants and select the projects to fund while CARB establishes the Guidelines and provides oversight.

The Moyer Program has invested a total of $1.2 billion since its inception in 1998. For the purposes of this request, CARB staff evaluated the cost-effectiveness for the most recent 5 years of project data to reflect recent program performance. Source category projects are grouped based on similarity for illustrative purposes. The off-road agricultural category includes stationary and potable agricultural pump projects. The off-road other category includes construction, airport ground support, cargo handling, and lawn and garden equipment replacement projects.

The cost-effectiveness value is in terms of dollars per weighted ton of criteria pollutant emission reductions. To calculate the average cost-effectiveness values shown in Table H-3, the cost-effectiveness for each implemented project within a source category is added together and then divided by the total number of projects in that category. Infrastructure projects are treated differently; while they enable emissions reductions, they do not directly reduce emissions themselves. Thus, no cost-effectiveness value can be calculated.

Table H- 3: Carl Moyer Memorial Air Quality Standards Attainment Program

Project/Source Category	Average GHG Cost-Effectiveness per Project ($/weighted ton GHG)	Average Cost-Effectiveness per Project ($/weighted ton (NOx+ROG+20*PM))	Total Funding Invested (in millions)
Infrastructure	Not applicable	Not applicable	$23
Locomotives	Not applicable	$12,000	$84
Marine Vessels	Not applicable	$14,000	$160
Off-Road Agricultural	Not applicable	$12,000	$375
Off-Road Other	Not applicable	$18,000	$264
On-Road	Not applicable	$39,000	$210
Car Scrap	Not applicable	$12,000	$33

Reporting GHG emission reductions associated with Moyer Program projects risks misrepresenting what Moyer incentives actually pay for and confound attempts to co-fund with other programs that do pay for and track GHG reductions. The cost-effectiveness calculation for the Carl Moyer Program used the most recent 5 years of data rather than the 2019 statistics. Calculation methodologies remain unchanged from what was used to derive the 2019 statistics. On-Road projects in the Carl Moyer Program include school buses, which are not as cost-effective from mass reduction standpoint; however, funding cleaner school buses is a high priority to reduce children's exposure to pollutants. This is reflected in the school bus only cost-effectiveness limit of $276,230/weighted ton. On-Road without school buses has an average cost-effectiveness of $21,00/weighted ton, which is consistent with the other categories.

Community Air Protection Program

The Community Air Protection (CAP) incentives focus on projects in Assembly Bill (AB) 617 selected communities Statewide[1]. The air districts work closely with local community groups to prioritize and select projects. This program emphasizes cleaner vehicles and equipment with priority on community-guided zero-emission projects. Mobile source projects are funded pursuant to the Moyer Program and the Proposition 1B Goods Movement Emission Reduction Program (Proposition 1B). The 2017 CAP Incentives Guidelines provide additional funding opportunities for stationary sources and community-identified projects.

Source category projects are grouped based on similarity for illustrative purposes. On-road projects include Proposition 1B trucks that are not subject to cost-effectiveness limits. The off-road agricultural category includes stationary and potable agricultural pump projects. The off-road other category includes construction, airport ground support, cargo handling, and lawn and garden equipment replacement projects. Infrastructure projects include air filtration projects.

The cost-effectiveness value is in terms of dollars per weighted ton of criteria pollutant emission reductions. To calculate the average cost-effectiveness values shown in Table H-4, the cost-effectiveness for each implemented project within a source category is added together and then divided by the total number of projects in that category. As with the Moyer program, infrastructure projects are treated differently; while they enable emissisons reductions, they do not directly reduce emisssions themselves. Thus, no cost-effectiveness value can be calculated.

[1] CAP also has projects in AB 1550 disadvantaged and low-income communities Statewide.

Table H- 4: Community Air Protection Incentives

Project/Source Category	Average GHG Cost-Effectiveness per Project ($/weighted ton GHG)	Average Cost-Effectiveness per Project ($/weighted ton (NOx+ROG+20*PM))	Total Funding Invested (in millions)
Infrastructure	Not applicable	Not applicable	$30
Locomotives	$6,402	$18,000	$25
Marine Vessels	Not applicable	$23,000	$38
Off-Road Agricultural	$2,050	$8,000	$71
Off-Road Other	$1,520	$24,358	$58
On-Road	$783	$101,000	$55

CAP projects are selected according to community needs. Some projects may result in no GHG reduction, or even slight increases. The projects funded for marine vessels resulted in a slight increase in GHG when looked at separately, so reporting a cost effectiveness number would be misleading. That is because they are primarily diesel to diesel engine replacements and the new engine may have a slightly higher horsepower than the old engine. On a per horsepower basis, there would be GHG emission reductions from the old diesel engine to the new one; but, in most cases newer diesel engines have higher horsepower than the old and with the way the calculations are configured, even though the two engines do the same work, they quantify a slight increase in GHGs. California Climate Investments considers total GHG emissions for the entire program, rather than per vehicle/equipment/engine and overall the CAP incentives generate a significant decrease in emissions Statewide. The program on the whole has so far provided net total GHG reductions of $165,000/ton.

Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program

The Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program provides funding to replace high-emitting diesel agricultural vehicles and equipment with the cleanest, commercially available to achieve cost-effective emission reductions. Consistent with Legislative direction, the FARMER Program also provides funding to replace heavy-duty trucks used in agriculture – vehicles that are not covered under other incentive programs. Additionally, the FARMER Program provides opportunities to support market transformation in the agricultural sector by providing funding for zero-emission equipment used in agriculture, such as zero-emission UTVs. The FARMER Program has been appropriated $322.6 million over the past 3 fiscal years (fiscal years 2017-18 through 2019-20). All FARMER funding appropriated to date is under executed grants with local air districts to implement.

Currently, over $295 million (or 92%) in FARMER funding has been disbursed to air districts for selected projects and the demand in many districts significantly exceeds the available funding.

As of June 30, 2020, the FARMER Program had implemented $171.5 million in funding over 3,800 projects statewide. The FARMER Program uses project-specific data to calculate NOx, ROG, and PM emission reductions benefits and Moyer Program methodology to evaluate cost-effectiveness for each implemented project. To calculate the estimated emission reductions, staff calculates the NOx, ROG, and PM benefits individually using established emission factors for the baseline and replacement engine from the Moyer Program and CARB's publicly available emission inventories and accounts for the deterioration rate of engines over the project life, when available.

To calculate the average cost-effectiveness values shown in Table H-5, the cost-effectiveness for each implemented project within a source category is added together and then divided by the total number of projects in that category.

Table H- 5: FARMER Program

Project/Source Category	Average GHG Cost-Effectiveness per Project ($/weighted ton GHG)	Average Cost-Effectiveness per Project ($/weighted ton)	Total Funding Invested (in millions)
Off-Road Agriculture	$2,500	$12,900	$131
On-Road Trucks	$4,800	$946,000	$22
Zero-Emission Agricultural Utility-Terrain Vehicles (UTV)	$400	$129,000	$18

More Information

This document provides the cost-effectiveness calculations for the suite of CARB's incentive programs. These calculations are based on program parameters imposed by each project. To learn more about the Low Carbon Transportation Funding Plan, please visit the *Low Carbon Transportation Investments and AQIP Funding Plans page*. To learn more about the Carl Moyer Program and their annual reports, visit the *Carl Moyer Memorial Air Quality Standards Attainment* page. To learn more about CAP, visit the *Community Air Protection Program* page. To learn more about FARMER, visit the *FARMER Program* page.