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DRAFT STAFF REPORT

2020-2023 Investment Plan Update for the Clean Transportation Program

Gavin Newsom, Governor

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California Energy Commission

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ABSTRACT

The *2020-2023 Investment Plan Update for the Clean Transportation Program* (previously known as the Alternative and Renewable Fuel and Vehicle Technology Program) guides the allocation of program funding for Fiscal Years 2020-2023. This is the first time that the update proposes a multiyear allocation. The California Energy Commission will review the proposed allocations annually to make adjustments as needed.

This 2020-2023 investment plan covers the twelfth year of the program and reflects laws, executive orders, regulations, regulations, and other funding programs to reduce greenhouse gas emissions, petroleum dependence, and criteria pollution emissions. It details how the Energy Commission determines the goal-driven priorities of the program by incorporating input from stakeholders, the Disadvantaged Communities Advisory Group, and the newly revised Clean Transportation Program Advisory Committee and by analyzing project opportunities for funding. These priorities are consistent with the overall goal of the program "to develop and deploy innovative technologies that transform California's fuel and vehicle types to help attain the state's climate change policies."

This 2020-2023 investment plan establishes funding allocations based on identified needs and opportunities, including a near-term focus on zero-emission vehicles and infrastructure.

This draft staff report represents the first step in developing the *2020-2023 Investment Plan Update*. Before the adoption of the report at an Energy Commission business meeting, the Energy Commission expects to release a Lead Commissioner report in May 2020, as well as convene at least two advisory committee workshops.

Keywords: California Energy Commission, Clean Transportation Program, Alternative and Renewable Fuel and Vehicle Technology Program, AB 118, AB 8, funding program, alternative transportation fuels, investment plan, electric vehicles, hydrogen, biofuels, biomethane, biodiesel, renewable diesel, diesel substitutes, gasoline substitutes, renewable gasoline, ethanol, natural gas, federal cost-sharing, workforce training, sustainability, fueling stations, fuel production, alternative fuel infrastructure, manufacturing

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EXECUTIVE SUMMARY

Over the past decade, California has led the nation in combating climate change through aggressive greenhouse gas (GHG) emission reduction goals and innovative funding programs. The California Energy Commission's (CEC) Clean Transportation Program (formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program) was one of the first transportation-focused programs created by the California Legislature to help achieve the state's climate change policies. The program has successfully done so with steady investments designed to transform California's fuel and vehicle types. Now in the twelfth year, the Clean Transportation Program has provided more than $865 million to projects covering a broad spectrum of alternative fuels and technologies. In this time, California has experienced rapid growth in the sales of plug-in electric vehicles, the introduction of hydrogen fuel cell electric vehicles, and a notable increase in the in-state production and use of low-carbon alternative fuels. The Clean Transportation Program has supported this emerging revolution in the transportation sector with significant investments in alternative fuel vehicles and supporting infrastructure and will continue to do so with this *2020-2023 Investment Plan Update*.

Purpose of the Clean Transportation Program

Since 2006, California has set several pivotal goals to reduce GHG emissions and address the threat posed by global climate change. These goals require incremental progress that will ultimately lead to major emission reductions, including:

- Reducing GHG emissions to 1990 levels by 2020.
- Reducing GHG emissions to 40 percent below 1990 levels by 2030.
- Reducing short-lived climate pollutant emissions, such as methane, to 40 to 50 percent below 2013 levels by 2030.
- Achieving a carbon-neutral economy by 2045.
- Setting specific goals to boost the supply of zero-emission vehicles (ZEVs) and charging and refueling stations, including:
    - Putting at least 1.5 million ZEVs on the road by 2025.
    - Installing 200 hydrogen-fueling stations and 250,000 battery electric vehicle chargers, including 10,000 direct current fast chargers, by 2025.
    - Putting 5 million ZEVs on the road by 2030.

Achieving these goals will require significant technological and market changes within the transportation sector, which accounts for roughly 50 percent of state greenhouse gas emissions when accounting for "upstream emissions" from fuel production.

In addition to these greenhouse gas emission reduction goals, the state must comply with requirements under the federal Clean Air Act to reduce emissions of criteria air pollutants. Reducing air pollution is of particular importance from an equity context, given that air quality burdens fall disproportionately on vulnerable and disadvantaged communities within the state.

To help address these goals, the California Legislature passed Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007). This legislation created the Clean Transportation Program,

which is administered by the CEC. With funds collected from vehicle and vessel registration, vehicle identification plates, and smog-abatement fees, the Clean Transportation Program funds projects that will "transform California's fuel and vehicle types to help attain the state's climate change policies." Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) subsequently extended the collection of fees that support the Clean Transportation Program through January 1, 2024.

Investments to Date

Since the first Clean Transportation Program investment plan was released in 2009, the CEC has invested more than $865 million in projects that support the advancement and use of alternative fuels and advanced vehicle technologies. A detailed summary of all projects funded to date by the Clean Transportation Program can be found in Table ES-1.

Table ES-1: Clean Transportation Program Awards as of December 1, 2019

Funded Activity	Cumulative Awards to Date (in Millions)*	# of Projects or Units
Alternative Fuel Production		
Biomethane Production	$73.08	27 Projects
Gasoline Substitutes Production	$37.12	16 Projects
Diesel Substitutes Production	$63.94	26 Projects
Renewable Hydrogen Production	$7.93	2 Projects
Alternative Fuel Infrastructure		
Electric Vehicle Charging Infrastructure**	$145.23	10,924 Charging Connectors
Hydrogen Refueling Infrastructure	$138.70	64 Public Fueling Stations, plus Fleets
E85 Fueling Infrastructure	$3.61	57 Fueling Stations
Upstream Biodiesel Infrastructure	$3.98	4 Infrastructure Sites
Natural Gas Fueling Infrastructure	$24.14	70 Fueling Stations
Alternative Fuel and Advanced Technology Vehicles		
Natural Gas Vehicle Deployment***	$86.84	3,152+ Vehicles
Propane Vehicle Deployment	$5.98	514 Trucks
Hybrid and ZEV Deployment (Including CVRP, HVIP, and Low-Income Mobility Incentives)	$32.02	10,700 Cars and 150 Trucks
Advanced Technology Freight and Fleet Vehicles****	$125.45	54 Demonstrations
Related Needs and Opportunities		
Manufacturing	$52.46	24 Manufacturing Projects
Workforce Training and Development	$33.33	17,440 Trainees
Fuel Standards and Equipment Certification	$3.90	1 Project
Sustainability Studies	$2.04	2 Projects
Regional Alternative Fuel Readiness	$11.13	51 Regional Plans
Centers for Alternative Fuels	$5.41	5 Centers
Technical Assistance and Program Evaluation	$9.22	n/a
Total	**$865.51**	

Source: California Energy Commission. Totals may not match due to rounding. *Includes all agreements that have been approved at an Energy Commission business meeting or are expected for business meeting approval following a notice of proposed award. For canceled and completed projects, includes only funding received from the Clean Transportation Program, which may be smaller than initial award. Due to rounding, "total" may not match sum of rows. **Includes $75.97 million for the California Electric Vehicle Infrastructure Project to provide EV incentives throughout California, which will fund a yet-to-be-determined number of EV chargers. ***Funding includes both completed and pending vehicle incentives, as well as funds reserved for future incentives. ****Includes projects from the former Medium- and Heavy-Duty Vehicle Technology Demonstration category.

Commitment to Inclusion, Diversity, Equity, and Access

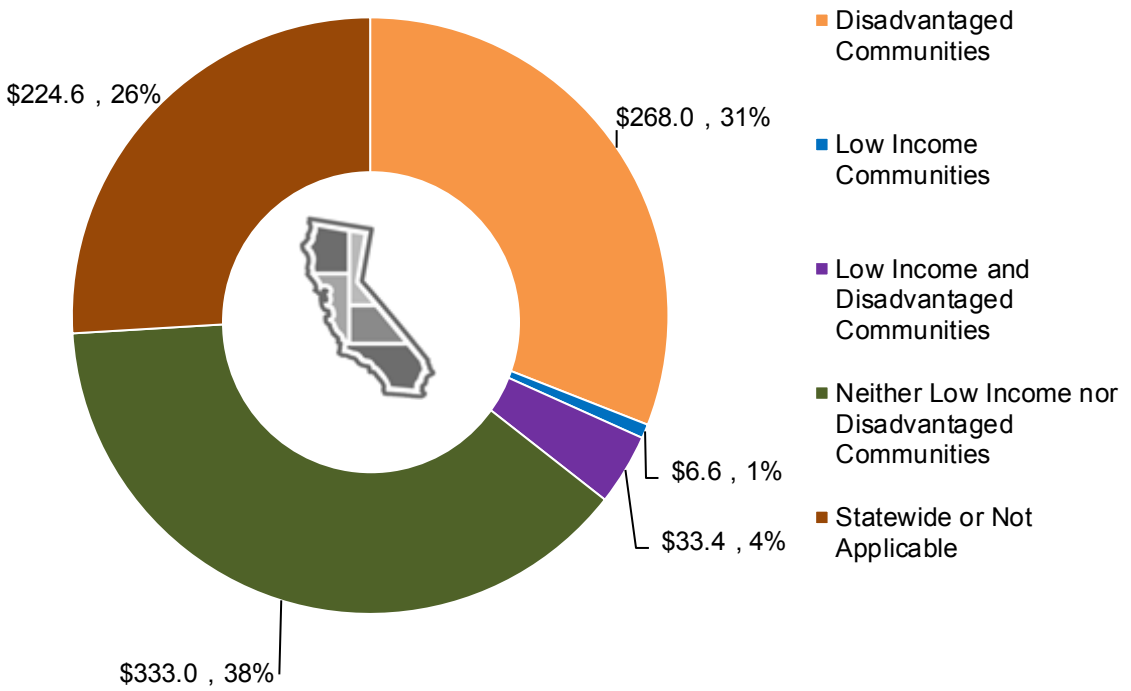
The CEC is committed to ensuring all Californians have an opportunity to participate in and benefit from programs and services. In 2015, the CEC adopted a resolution that committed the agency to improving fair and equal opportunities for economically disadvantaged and underserved communities to participate in and benefit from CEC programs. One important metric for evaluating impacts is the share of funding awarded to projects within disadvantaged or low-income communities. As depicted in Figure ES-1, roughly 36 percent of Clean Transportation Program project funds have been awarded to projects within disadvantaged or low-income communities or both. When excluding Clean Transportation Program projects that occur statewide or without an applicable site address, this funding share is closer to 50 percent.

The CEC recognizes project location is but one metric for evaluating the equity implications of specific projects. The Disadvantaged Communities Advisory Group (DACAG), which was established under Senate Bill 350 (De León, Chapter 547, Statutes of 2015), reviews and advises the CEC and the California Public Utilities Commission (CPUC) to determine whether proposed programs will be effective and useful in disadvantaged communities.

In its comment letter to the CEC on June 28, 2019, the DACAG included a recommendation to "Prioritize and Invest in Proper Community Outreach and Engagement." In its letter, the DACAG encourages investment into outreach to disadvantaged communities in partnership with local community-based organizations. This outreach is particularly true for smaller, tribal, or rural communities or a combination that may not have the resources to compete for funding opportunities. Improving such outreach has the potential to create more equitable opportunities to participate in the Clean Transportation Program's Advisory Committee, the identification of funding priorities (such as the program's Investment Plan Update), the development of funding solicitation criteria, and the funding application and award-making process.

Senate Bill 1000 (Lara, Chapter 368, Statutes of 2018) requires the CEC, in consultation with the California Air Resources Board (CARB), to assess whether electric vehicle charging station infrastructure is disproportionately deployed. If the infrastructure is found to be disproportionately deployed, or distributed, the CEC must use Clean Transportation Program funding to install more proportionately new charging station infrastructure. CEC staff is identifying, collecting, and analyzing the data that will inform this analysis. The results of this analysis may have an impact on the allocations of future investment plans as well as the CEC's approach toward implementing those allocations.

Figure ES-1: Proportion of Clean Transportation Program Funding Awarded to Projects Located in Disadvantaged or Low-Income Communities (in Millions)



Source: California Energy Commission. As of December 1, 2019. Totals may not match due to rounding. "Disadvantaged communities" are defined as communities within the top 25 percent scoring areas under CalEnviroScreen, as well as areas of high pollution and low population. "Low-income communities" are defined as communities that are at or below 80 percent of the statewide median income.

Context of the Investment Plan

Description of the Investment Plan

As part of the Clean Transportation Program, the CEC prepares and adopts an annual investment plan update that identifies the funding priorities for the coming fiscal year. Assembly Bill 1314 (Wieckowski, Chapter 487, Statutes of 2011) reduced the scope of the annual Clean Transportation Program investment plan to an update. The update builds on the work of previous investment plans while highlighting differences from those previous years. The resulting funding allocations are intended to reflect the unique technological and market conditions for each of these fuels and technologies, as well as state goals, policies, and directivesThe funding allocations reflect the potential for each alternative fuel and vehicle technology to contribute to the goals of the program; the anticipated barriers and opportunities associated with each fuel or technology; and the effect of other investments, policies, programs, and statutes.

The funding recommendations in this report are guided by, and complementary to, the state's energy policies, executive orders, regulations, and actions by other state agencies. The CEC is committed to ensuring that the Clean Transportation Program funding is complementary to policies and grant programs administered by other agencies, including CARB and the CPUC.

Electric Vehicle Charging Infrastructure Gap

Executive Order B-48-18 directs the state government to work with the private sector and other levels of government to deploy at least 5 million zero-emission vehicles in California by 2030. The executive order also calls for the installation and construction of 250,000 electric vehicle charging ports, including 10,000 direct-current-fast charging ports, and 200 hydrogen-refueling stations by 2025.

To date, the Clean Transportation Program has funded (or committed to funding) the installation of about 6,833 public and shared charging connectors for California's more than 600,000 plug-in electric vehicles on the road at the end of 2019. The state's electric utilities and Electrify America (a company established in the wake of the Volkswagen emissions scandal) are also investing in public charging station installations.

Despite these investments, Clean Transportation Program staff estimates that the sum of existing and expected future charging ports will not be sufficient to meet the state's goal of 250,000 charging connectors and 10,000 fast charging connectors by 2025. As depicted in Table ES-2, the currently identified investments still leave a gap of nearly 80,000 Level 2 charging connectors and 3,600 DC fast-charging connectors by 2025. Level 2 chargers use alternating current electricity to charge a PEV at 240 volts and can provide about 14 to 35 miles of range per hour of charging, while DC fast charging uses DC electricity at 480 volts to recharge a battery electric vehicle up to 100 miles in 30 minutes or less (depending on the size of the battery, the power level of the charger, and the charging capability of the vehicle). As a result of this continued shortfall, the *2020-2023 Investment Plan Update* will also reflect considerable investments in vehicle charging infrastructure to narrow the deployment gap.

Table ES-2: Progress Toward 250,000 Charging Connectors by 2025

	Level 2 Charging Connectors	DC Fast Charging Connectors
Existing Charging Connectors (Estimated)*	37,400	2,900
Allocated Funding for Chargers (includes anticipated funding from Clean Transportation Program)**	124,600	3,500
Total	162,000	6,400
2025 Goal (Executive Order B-48-18)	*240,000*	*10,000*
Gap From Goal	78,000	3,600

Source: California Energy Commission. Analysis as of December 1, 2019.*Existing charging ports estimated based on available data from U.S. Department of Energy's Alternative Fuels Data Center, as well as informal interviews with some (but not all) major charging infrastructure providers. **Estimate of ports from other state programs derived from public presentations and statements by utilities, CPUC, CARB, other entities, and Energy Commission. This analysis does not include the proposed $51 million one-time legislative appropriation from the Alternative and Renewable Fuel and Vehicle Technology Fund for FY 2020-2021 dedicated to electric vehicle charging infrastructure. Appropriations are contingent on legislative approval.

Proposed Funding Allocation for 2020-2023

For the first time, the CEC is proposing a multiyear funding plan to provide the public and stakeholders improved funding certainty and to convey long-term transformative goals of the Clean Transportation Program. There will be a modest annual update to evaluate whether adjustments should be made to the allocations.

Table ES-3 shows the proposed funding allocations for FY 2020-2021, as well as funding projections for the remainder of the Clean Transportation Program. For FY 2020-2021, a total of $146.2 million (including a proposed $51 million in one-time legislative expenditure) may be available for the purposes described in this investment plan update. The continued emphasis on zero-emission vehicles and infrastructure for FY 2020-2021 reflects the state's goals for zero-emission vehicles and fuels, near- and long-term carbon reduction, and air quality, with a focus on providing benefits for disadvantaged communities.

As shown in Table ES-3, the CEC is proposing significant investments in light-duty electric vehicle charging infrastructure for fiscal years 2020-2021 and 2021-2022 in order to narrow the charging gap as described in earlier analysis, with further depth later in this report. Additionally, it is vital to front load funding to ensure the public adoption of electric vehicles is not stymied by lack of charging infrastructure.

In fiscal years 2021-2022 and 2022-2023, the CEC will concentrate investments toward medium- and heavy- duty zero-emission vehicles and infrastructure. By this time, CEC staff will benefit from the inaugural charging infrastructure assessment required in Assembly Bill 2127 (Ting, Chapter 365, Statutes of 2018). Current charging assessments have only focused on light-duty vehicles; however, estimating the charging needs of medium- and heavy-duty vehicles will become a key area for additional analysis.

Table ES-3: Investment Plan Allocations for FY 2020-2021 and Subsequent Fiscal Years (in Millions)

Category	Funded Activity	2020-2021	2021-2022	2022-2023	2023	Total
Zero-Emission Vehicles and Infrastructure	Light-Duty Electric Vehicle Charging Infrastructure and eMobility	$92.7*	$30.2	$10	-	$132.9
Zero-Emission Vehicles and Infrastructure	Medium- and Heavy-Duty Zero-Emission Vehicles and Infrastructure	$20	$30	$52.2	$32.6	$134.8
Zero-Emission Vehicles and Infrastructure	Hydrogen Refueling Infrastructure	$20	$20	$20	$5	$65
Alternative Fuel Production and Supply	Zero- and Near Zero-Carbon Fuel Production and Supply	$10	$10	$10	$5	$35
Related Needs and Opportunities	Manufacturing	-	$5	-	$5	$10
Related Needs and Opportunities	Workforce Training and Development	$3.5	-	$3	-	$6.5
	Total	**$146.2**	**$95.2**	**$95.2**	**$47.6**	**$384.2**

Notes. *FY 2020-2021 includes a proposed one-time legislative appropriation from the Alternative and Renewable Fuel and Vehicle Technology Fund for $51 million to increase and accelerate electric vehicle charging infrastructure. Appropriations are contingent on legislative approval.

CHAPTER 1: Introduction

California has been at the forefront of national efforts to combat climate change since the passage of the Global Warming Solutions Act of 2006, which established a goal of reducing statewide greenhouse gas (GHG) emissions to 1990 levels by 2020.[1] Senate Bill 32 established a goal of 40 percent below 1990 levels by 2030.[2] Executive Order B-55-18 established a goal to achieve carbon neutrality as soon as possible, and no later than 2045, and achieve and maintain net negative emissions thereafter.[3]

The state's efforts against global climate change have begun to show progress, and in 2016, California achieved its goal of reducing GHG emissions to 1990 levels, four years ahead of schedule. Despite the overall reduction in GHG emissions, emissions from the transportation sector have increased over the last several years, as Californians purchased more light trucks (sport utility vehicles, pickups, and vans) instead of cars and drove more miles.[4] When including upstream emissions, the transportation sector is the largest source of GHG emissions in California, with vehicles, oil extraction, and oil refining accounting for roughly 50 percent of in-state emissions.[5] California has made progress in implementing low-carbon transportation options, with sales of low-carbon alternative fuels and zero-emission vehicles steadily increasing and new transportation technologies becoming commercially available. Even with these advances, petroleum-based fuels still account for about 90 percent of California ground transportation fuel and result in significant GHG emissions.[6]

In addition to greenhouse gases, the transportation sector is also a major emitter of criteria pollutants, with mobile sources responsible for nearly 80 percent of nitrogen oxide emissions

1 Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006).

2 Senate Bill 32, Pavley (Chapter 249, Statutes of 2016).

3 Executive Order B-55-18. September 10, 2018. Available at https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf.

4 California Air Resources Board. 2019. *California Greenhouse Gas Inventory for 2000-2017.* Available at https://ww2.arb.ca.gov/ghg-inventory-data.

5 California Air Resources Board. July 11, 2018. *California Greenhouse Gas Emission Inventory*. Available at https://www.arb.ca.gov/cc/inventory/data/data.htm.

6 Based on analysis from California Energy Commission Energy Assessments Division.

and 90 percent of diesel particulate matter emissions statewide.[7] Protecting and improving public health in the state will require substantial reductions in criteria pollutant emissions. The CARB estimates that attaining federal air quality standards in 2023 and 2031 may require up to an 80 percent reduction of smog-forming emissions in parts of the state.[8]

To help address state climate change and air quality objectives, the California Legislature passed Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007). This legislation created the Clean Transportation Program (formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program). With funds collected from vehicle and vessel registration, vehicle identification plates, and smog abatement fees, the Clean Transportation Program funds projects that will "transform California's fuel and vehicle types to help attain the state's climate change policies." Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) extended the collection of fees that support the Clean Transportation Program through January 1, 2024.

As part of the Clean Transportation Program, the CEC prepares and adopts an annual investment plan update that identifies the funding priorities for the coming fiscal year. The funding allocations reflect the potential for each alternative fuel and vehicle technology to contribute to the goals of the program; the anticipated barriers and opportunities associated with each fuel or technology; and the effect of other investments, policies, programs, and statutes. The investment plan update also describes how the allocations will complement existing public and private efforts, including related state programs.

This *2020-2023 Investment Plan Update* is the twelfth investment plan in the history of the Clean Transportation Program and builds on the analyses and recommendations contained in prior documents. This is the first time in the history of the Clean Transportation Program that the investment plan proposes a multiyear funding plan. This draft staff report is the first version of the *2020-2023 Investment Plan Update*. In developing the *2020-2023 Investment Plan Update,* the CEC will hold two public meetings with the Clean Transportation Program Advisory Committee. The Advisory Committee was reconstituted in early 2020 to include a broader representation of interests and to better reflect California communities and provide increased representation of program beneficiaries, environmental justice communities, rural communities, tribes, and others. The first meeting is will take place at the CEC on March 3, 2020, with the second meeting in May or June. Representatives from the Advisory Committee,

7 California Air Resources Board. May 2016. *Mobile Source Strategy.* Available at https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf.

8 Ibid.

other stakeholders, and the public are encouraged to discuss and comment on drafts of this document during these meetings and through the CEC's docket system.[9]

Chapter 2 of this document provides the context for the current investment plan, including an update on the CEC's implementation of the Clean Transportation Program to date and a review of the most relevant federal and state laws, executive orders, state regulations and funding programs. Chapter 3 proposes funding allocations for 2020-2023 based upon the context setting in Chapter 2. The subsequent chapters are organized by specific investment areas. Chapter 4 focuses on zero-emission vehicles and the infrastructure necessary to support them. Chapter 5 addresses the types of opportunities for zero- and near-zero-emission fuel production and supply within California. Chapter 6 describes related opportunities to support the development and deployment of alternative fuels and advanced technology vehicles.

9 The Energy Commission's docket for the *2020-2021 Investment Plan Update for the Clean Transportation Program* (Docket #19-ALT-01) can be found at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-ALT-01.

CHAPTER 2:
Context of the 2020-2023 Investment Plan

Implementation of the Clean Transportation Program

Since the program's inception, the CEC has followed a consistent approach toward implementing the Clean Transportation Program. This year, for the first time, the investment plan proposes a multiyear funding approach. As summarized in Figure 1, the process begins with an annual investment plan that determines the coming fiscal-year funding allocation for categories of projects. CEC staff initially proposes funding allocations based on consideration of policy priorities such as air quality standards, environmental justice, and zero-emission vehicle deployment; evaluation of complementary funding or regulations; identification of the primary market and technological opportunities and barriers; and the greenhouse gas (GHG) emission reduction potential of alternative fuels and technologies (both near-term and long-term). Before official adoption by the CEC at a public business meeting, the investment plan update is proposed and revised across several drafts and incorporates stakeholder input from public Clean Transportation Program Advisory Committee meetings.

Each investment plan identifies funding allocations for particular segments of the supply chain for alternative fuel or vehicle technologies. The funding allocations typically do not determine the specific focus of future funding solicitations. Based on these funding allocations, the CEC subsequently issues a series of competitive solicitations, known as *grant funding opportunities* (GFOs). Each solicitation has a set of unique scoring criteria that reflect the selection preferences set by law.[10] Priority is also given to projects that will benefit economically disadvantaged areas or areas with poor air quality. Some funding opportunities are first-come, first-served and establish minimum requirements that must be achieved to be eligible for funding.

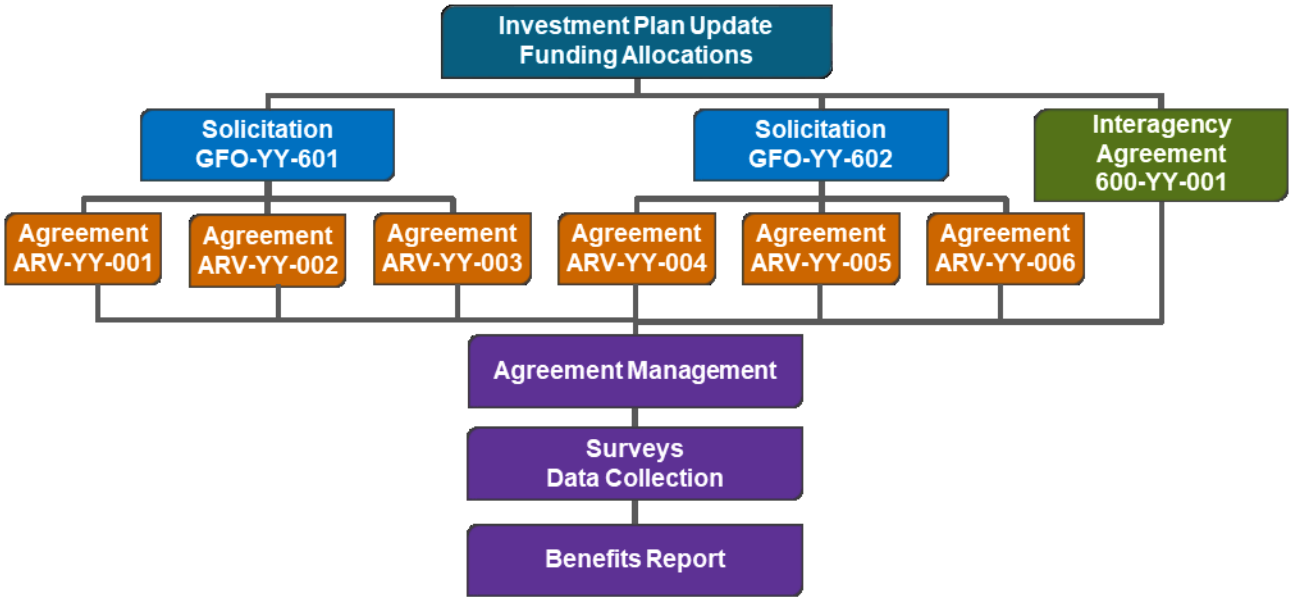
CEC staff reviews, scores, and ranks the proposals for each solicitation using the evaluation criteria developed for the particular solicitation. Other state agencies and contractors may also provide technical assessments of the proposals. Based on the total scores of each application, the CEC releases a notice of proposed awards (NOPA) for each solicitation. The NOPA ranks each application by score and provides a proposed funding amount for each proposal in order of score until available funding within the solicitation has been recommended for award. For specialized agreements with certain partner agencies, the CEC may develop interagency agreements without using the solicitation process.

10 These preference criteria are listed in Health and Safety Code Section 44272 (c) and (d) and are applied when ranking funding proposals under Clean Transportation Program solicitations.

Each funded application becomes a funding agreement once it has been approved and signed by the CEC and the applicant. CEC staff oversees completion of these agreements according to the respective schedules, budgets, scopes of work, and terms and conditions.

Data collection and project review are also key parts of the Clean Transportation Program implementation. The CEC surveys funding recipients on the anticipated results of their projects, with questions relating to alternative fuel use, petroleum displacement, GHG emission reductions, air quality benefits, and in-state economic benefits. The CEC also continues to collect data from funding recipients after completion of a project, typically for six months. Information from these efforts provide the Clean Transportation Program a method to measure, verify, and evaluate program effectiveness.

Figure 1: Schematic of the Clean Transportation Program Implementation



Source: California Energy Commission

Funding Disbursement Mechanisms

To date, the CEC has predominantly used grants to distribute funding, with awardees selected through competitive solicitations. As alternative fuels and technologies have advanced in the marketplace, the CEC has also implemented alternative funding and financing mechanisms, when appropriate. Each of these mechanisms has respective strengths and weaknesses, and the CEC weighs these options when developing the funding implementation strategy for each allocation. The most prominent funding mechanisms used for the Clean Transportation Program by the CEC are described below.

- **Competitive Solicitation for Grants**—This type of solicitation represents the most common funding mechanism for the Clean Transportation Program to date. It is flexible, as project requirements and scoring criteria can be adapted for a broad variety of commercial and technological maturity levels. Competitive scoring allows for increased scrutiny on key issues for each project type. However, it also requires

significant time and attention to review each application and oversee each subsequent funding agreement.

- **First-Come, First-Served**—This type of funding mechanism has been used by the Clean Transportation Program for vehicle and infrastructure incentives. Once eligibility requirements are established, the funding can be administered relatively quickly and can provide greater market certainty for a project type.
- **Production or Operation Incentives**—The CEC has used these types of incentives for in-state ethanol production and hydrogen refueling station operation and maintenance. The primary aim of these incentives is to provide greater market certainty, which allows further investment from nongovernment sources.
- **Loan Loss Reserve/Loan Guarantees**—These financing types are being tested by the Clean Transportation Program as a way to potentially increase opportunities to leverage private financing and transition alternative fuel and vehicle investments from public to private sources.
- **Block Grants**—The CEC has used this funding mechanism to distribute Clean Transportation Program funding through other organizations such as local and regional governments, academic institutions, or nonprofit groups. Block grants allow the CEC to select another organization to administer Clean Transportation Program funding while following set procedures for project and applicant eligibility.
- **Direct Agreements**—The CEC may make a single source award for applied research. The CEC may also establish contracts for, or through interagency agreements, to obtain technical, scientific, or administrative services to support the Clean Transportation Program.

In general, the most important factor in considering the appropriate funding mechanism for an activity has been the technological and market maturity of the fuel or technology. Public subsidies, most commonly in the form of grants, are vital to advance early stage technologies because private financiers are often unwilling to accept the high risks associated with these projects. As a technology or market matures, however, alternative financing mechanisms become a more effective method of support and can better leverage public funds with private financing.

Program Outreach and Inclusion

In 2015, the CEC adopted a resolution committing the agency to ensuring that a diverse range of applicants have the opportunity to participate in Clean Transportation Program projects, including small businesses, women, minorities, the LGBT community, and disabled veterans, and is similarly committed to increasing their Clean Transportation Program participation rates. The CEC also seeks to increase the participation of disadvantaged and underrepresented communities from a diverse range of geographical regions. The CEC, through the Clean Transportation Program's IDEA initiative, seeks to effectively reach and benefit communities disproportionately burdened by pollution and socioeconomic challenges, including rural and tribal communities. This effort includes:

- Diversifying the Clean Transportation Program Advisory Committee, as accomplished in December 2019, to better reflect California communities and provide increased

representation of program beneficiaries, environmental justice communities, rural communities, tribes, and others.

- Consulting with the Disadvantaged Communities Advisory Group[11] for guidance and recommendations on program effectiveness as it relates to disadvantaged communities and other vulnerable and underrepresented groups.
- Consulting with the CEC's Tribal Program and the Tribal Lead Commissioner for assistance with outreach and promoting transportation-related funding opportunities to tribes.
- Using technical support funding to develop outreach, education, and collaborative planning that will accelerate the adoption of alternative fuels and advanced technologies in California's Central Valley, with the goal of addressing greenhouse gas emissions, air-quality emission challenges, and equity issues.[12]
- Assessing whether electric vehicle charging station infrastructure is disproportionately distributed as a result of the SB 1000 analysis. If the infrastructure is found to be disproportionately distributed, the CEC will use Clean Transportation Program funding to install more new charging station infrastructure proportionately.

In addition to the above actions, the CEC has provided a scoring preference for projects located in or benefitting disadvantaged communities, as defined by the CalEnviroScreen tool.[13] These preferences have been used in most recent Clean Transportation Program solicitations, where appropriate, and nearly half of site-specific Clean Transportation Program funding is in or benefitting disadvantaged communities.

Summary of Program Funding to Date

As of December 2019, the CEC has more than $865 million in Clean Transportation Program funding. Table 1 shows a detailed listing of Clean Transportation Program awards to date. In many cases, projects are in progress, with ongoing siting, installation, construction, and demonstrations. Major highlights of the Clean Transportation Program funding portfolio through December 1, 2019, include:

Alternative Fuel Production

- 71 projects to promote the production of sustainable, low-carbon alternative fuels within California, with a cumulative annual production capacity equivalent to more than

11 More information available at https://ww2.energy.ca.gov/sb350/DCAG/.

12 For more information, see Solicitation Number GFO-18-603, "Outreach, Education, and Collaborative Planning for California's Central Valley." Available at https://www.energy.ca.gov/contracts/transportation.html#GFO-18-603.

13 The CalEnviroScreen 3.0 tool is available online from the California Office of Environmental Health Hazard Assessment at https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30.

158 million gallons of diesel fuel. Most will use waste-based feedstocks, which have some of the lowest carbon intensity pathways recognized under the Low Carbon Fuel Standard.

Electric Vehicles and Chargers

- 10,924 installed or planned charging connectors for plug-in electric vehicles, including 4,435 at multi- and single-family homes, 155 fleets, and 882 workplaces; 3,774 public Level 2 charging connectors; and 1,678 public direct-current (DC) fast-charging connectors along highway corridors and urban metropolitan areas.
- $24.5 million to fund incentives for all-electric and plug-in hybrid electric vehicles via the California Air Resources Board Clean Vehicle Rebate Project (CVRP)

Hydrogen Refueling

- 64 new or upgraded hydrogen-refueling stations that will help serve an emerging population of fuel cell electric vehicles, plus the development of retail fueling standards to enable hydrogen sales on a per-kilogram basis. Once built, these stations will represent two-thirds of the initial network of 100 hydrogen-refueling stations called for by AB 8.

Advanced Technology Freight and Fleet Vehicles

- 54 projects to demonstrate zero- and near-zero-emission advanced technologies and alternative fuels in a variety of medium- and heavy-duty vehicle applications. This number includes five projects at major California seaports to support Executive Order B-32-15 on sustainable freight, which will launch a variety of zero- and near-zero-emission freight vehicles.

Natural Gas Vehicles and Infrastructure

- More than 3,000 natural gas vehicles operating or soon to be operating in a variety of applications.
- 70 natural gas fueling stations to support a growing population of natural gas vehicles. These include at least six stations that will incorporate low-carbon biomethane into some, if not all, of the dispensed fuel. Thirty of these stations serve California school districts and will help provide air quality benefits to children and local communities.

In-state Manufacturing and Workforce Development

- 24 manufacturing projects that support in-state economic growth while reducing the supply-side barriers for alternative fuels and advanced technology vehicles, primarily in electric drive-related components and vehicles.
- Workforce training for 17,440 trainees and 277 businesses that translate clean technology investments into sustained employment opportunities.

Alternative Fuel Readiness Planning

- Five centers for alternative fuels and advanced vehicle technologies throughout the state that are dedicated to expanding the role of alternative fuels and advanced vehicle technologies in California.
- More than 50 alternative fuels readiness planning and implementation grants to help regions plan for alternative fuel vehicle deployment, new fueling infrastructure, and permit streamlining.

Table 1: Clean Transportation Program Awards as of December 1, 2019

Funded Activity	Cumulative Awards to Date (in Millions)*	# of Projects or Units
Alternative Fuel Production		
Biomethane Production	$73.08	27 Projects
Gasoline Substitutes Production	$37.12	16 Projects
Diesel Substitutes Production	$63.94	26 Projects
Renewable Hydrogen Production	$7.93	2 Projects
Alternative Fuel Infrastructure		
Electric Vehicle Charging Infrastructure**	$145.23	10,924 Charging Connectors
Hydrogen Refueling Infrastructure	$138.70	64 Public Fueling Stations, plus Fleets
E85 Fueling Infrastructure	$3.61	57 Fueling Stations
Upstream Biodiesel Infrastructure	$3.98	4 Infrastructure Sites
Natural Gas Fueling Infrastructure	$24.14	70 Fueling Stations
Alternative Fuel and Advanced Technology Vehicles		
Natural Gas Vehicle Deployment***	$86.84	3,152+ Vehicles
Propane Vehicle Deployment	$5.98	514 Trucks
Hybrid and ZEV Deployment (Including CVRP, HVIP, and Low-Income Mobility Incentives)	$32.02	10,700 Cars and 150 Trucks
Advanced Technology Freight and Fleet Vehicles****	$125.45	54 Demonstrations
Related Needs and Opportunities		
Manufacturing	$52.46	24 Manufacturing Projects
Workforce Training and Development	$33.33	17,440 Trainees
Fuel Standards and Equipment Certification	$3.90	1 Project
Sustainability Studies	$2.04	2 Projects
Regional Alternative Fuel Readiness	$11.13	51 Regional Plans
Centers for Alternative Fuels	$5.41	5 Centers
Technical Assistance and Program Evaluation	$9.22	n/a
Total	**$865.51**	

Source: California Energy Commission. Totals may not match due to rounding. *Includes all agreements that have been approved at an Energy Commission business meeting or are expected for business meeting approval following a notice of proposed award. For canceled and completed projects, includes only funding received from the Clean Transportation Program that may be smaller than initial award. Due to rounding, "total" may not match sum of rows. **Includes $75.97 million for the California Electric Vehicle Infrastructure Project to provide EV incentives throughout California, which will fund a yet-to-be-determined number of EV chargers. ***Funding includes both completed and pending vehicle incentives, as well as funds reserved for future incentives. ****Includes projects from the former Medium- and Heavy-Duty Vehicle Technology Demonstration category.

Using funds from the Clean Transportation Program, the CEC has also leveraged the additional investment of nearly $880 million in private and other public funds. However, this amount represents only the minimal, contractually obligated amount of match funding provided toward

Clean Transportation Program projects; the actual amount of investment prompted by the Clean Transportation Program funding exceeds this amount.

The geographic distribution of Clean Transportation Program funding is shown in Table 2, sorted by air district.

Table 2: Clean Transportation Program Awards by Air District as of December 1, 2019

Air District	Cumulative Awards (in Millions)
San Joaquin	$125
Bay Area	$108
Sacramento	$33
Yolo-Solano	$11
Monterey	$14
Other Northern California Districts	$29
South Coast	$258
San Diego	$42
Other Southern California Districts	$20
Statewide	$157
Location not yet determined	$67
Total	**$865**

Source: California Energy Commission. Totals may not match due to rounding.

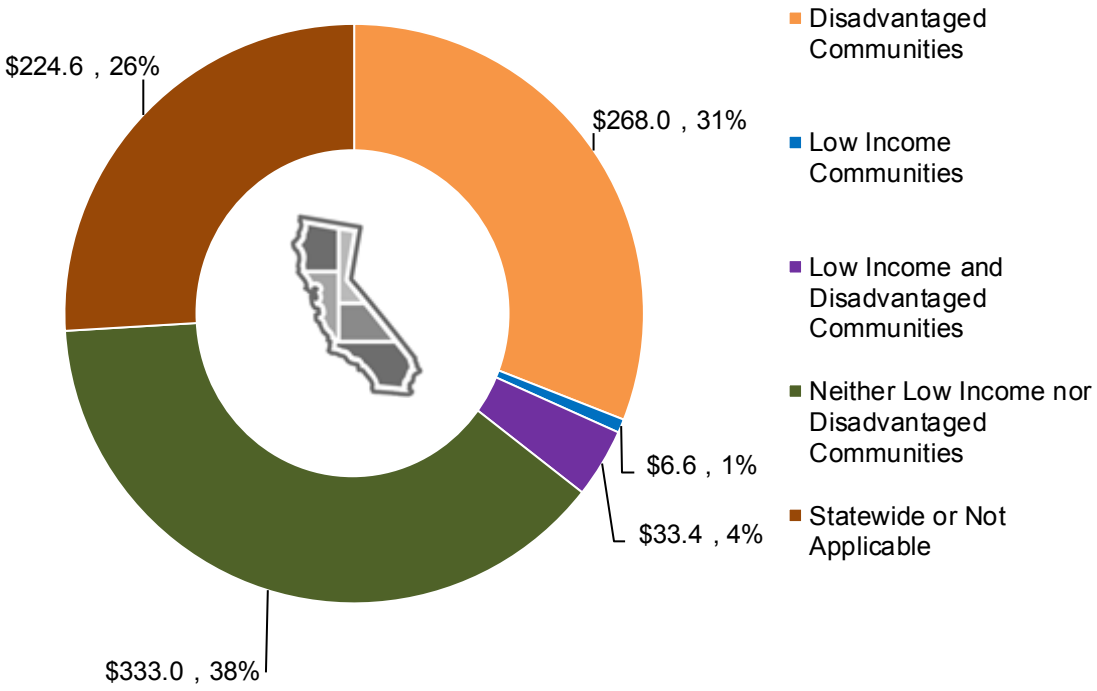
Summary of Program Funding for Disadvantaged Communities

The CEC also seeks to increase the participation of disadvantaged and underrepresented communities from a diverse range of regions in implementing the Clean Transportation Program. As depicted in Figure 2, roughly 36 percent of Clean Transportation Program project funding has gone into disadvantaged communities as defined by CalEnviroScreen. When excluding Clean Transportation Program projects that occur statewide or without an applicable site address, this funding share is closer to 50 percent.

However, the funding amounts of projects are not a complete metric for assessing the benefit of a project to disadvantaged communities. For instance, investments into large-scale fuel production or vehicle manufacturing plants might provide economic benefit to a region but may also risk increasing localized criteria emissions from fuel production or vehicle manufacturing. Similarly, investing in zero-emission refueling infrastructure within a disadvantaged community might reduce local tailpipe emissions but might overlook the mobility needs of local residents. Given these realities, the Disadvantaged Community Advisory Group recommended that the CEC revise the approach of the program toward defining,

measuring, and tracking the program benefits toward disadvantaged communities.[14] The CEC continues to explore new methods for advancing equity within the Clean Transportation Program, such as encouraging partnerships with community-based organizations and community organizers in grant applications, as well as identifying new metrics beyond project location to evaluate the effects of the program grants on local communities.

Figure 2: Clean Transportation Program Funding Toward Disadvantaged Communities (in Millions)



Source: California Energy Commission. Totals may not match due to rounding. As of December 1, 2019.

Related Policies and Goals

The CEC's implementation of the Clean Transportation Program reflects the effect of numerous policies and goals. Table 3 highlights examples of the significant policy goals and milestones that have been developed to address these issues, reduce emissions, and reduce petroleum use in California. CEC staff consulted with other state agencies and considered these policies when developing this investment plan update.

14 SB 350 Disadvantaged Communities Advisory Group, "SB 350 Disadvantaged Communities Advisory Group Comments on 2019-2020 Investment Plan Update," June 28, 2019. Submitted to Docket 18-ALT-01, TN# 228878. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=228878&DocumentContentId=60238.

Table 3: Greenhouse Gas, Fuel, and Air Quality Goals and Milestones

Policy Origin	Objectives	Goals and Milestones
Assembly Bill 32	GHG Reduction	Reduce GHG emissions to 1990 levels by 2020
Senate Bill 32	GHG Reduction	Reduce GHG emissions to 40 percent below 1990 levels by 2030
Executive Order B-55-18	GHG Reduction	Achieve carbon neutrality by 2045
Low Carbon Fuel Standard	GHG Reduction	Reduce carbon intensity of transportation fuels in California by 10 percent by 2020 and 20 percent by 2030 Increase zero-emission vehicle infrastructure
Clean Air Act; California State Implementation Plans	Air Quality	80 percent reduction in NOx by 2031
Senate Bill 1275; Executive Order B-16-2012; Executive Order B-48-18	Increase Zero-Emission Vehicles	Infrastructure to accommodate 1 million electric vehicles by 2020 1 million zero-emission and near-zero-emission vehicles by 2023 1.5 million electric vehicles by 2025 250,000 electric vehicle chargers, including 10,000 DC fast chargers, and 200 hydrogen refueling stations by 2025 5 million zero-emission vehicles by 2030
Zero-Emission Vehicle Regulation	Increase Zero-Emission Vehicles	Increase the deployment of plug-in hybrid, battery, and fuel cell electric vehicles
Innovative Clean Transit Regulation	Increase Zero-Emission Vehicles	100 percent of all new transit buses will be zero-emission by 2029; all operating buses will be zero-emission by 2040
Executive Order B-32-15 on Sustainable Freight	Air Quality GHG Reduction Petroleum Reduction	Improve freight efficiency and transition freight movement to zero-emission technologies

Source: California Energy Commission. *Senate Bill 1275 (De León, Chapter 530, Statutes of 2014) subsequently established a target of 1 million zero-emission and near-zero-emission vehicles in California by 2023, as well as increased access to such vehicles for disadvantaged, low-income, and moderate-income communities and consumers.

Federal Law: Clean Air Act, State Implementation Plans, and Mobile Source Strategy

The federal Clean Air Act of 1970 (42 U.S.C. 7401) authorizes the U.S. Environmental Protection Agency (U.S. EPA) to establish National Ambient Air Quality Standards (NAAQS) for criteria air pollutants that are harmful to public health. To achieve these standards, the Clean Air Act directs states to develop State Implementation Plans (SIPs) that describe how an area will attain the NAAQS.

The state SIP strategy is one of several planning elements based on the 2016 *Mobile Source Strategy*, which outlines an integrated strategy to meet air quality standards, achieve state greenhouse gas emission targets, minimize exposure to toxic air contaminants, reduce petroleum use by up to 50 percent by 2030, and increase energy efficiency and renewable electricity generation. Many actions recommended in the strategy, such as increasing the use

of ZEVs and renewably sourced alternative fuels, complement the activities of the Clean Transportation Program.

CARB reports that 12 million Californians live in communities that exceed the ozone and particulate matter standards set by the U.S. EPA, and that the South Coast and San Joaquin Valley are the only two areas in the nation in extreme nonattainment for the federal ozone standard.[15] The actions described in the state SIP strategy intend to resolve these problems and are expected to result in up to an 80 percent reduction in smog-forming emissions and a 45 percent reduction in diesel particulate emissions by 2031.[16] Since exposure to elevated levels of air pollutants causes significant health and economic impacts in the state, reducing emissions of criteria and toxic air pollutants will have corresponding benefits for Californians.

Clean Transportation Program investments frequently provide significant air quality benefits by replacing conventional gasoline- and diesel-fueled vehicles with near-zero- and ZEVs, as well as providing the fueling infrastructure required for these vehicles to operate. These Clean Transportation Program-funded vehicle and infrastructure projects complement and assist other California efforts in achieving the goals of the federal Clean Air Act.

State Laws

Assembly Bill 32, Senate Bill 32, and the Greenhouse Gas Reduction Fund

Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006), also known as the Global Warming Solutions Act of 2006, required CARB to adopt a statewide GHG emission limit for 2020 equivalent to the statewide GHG emission levels in 1990. Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016) amended the Global Warming Solutions Act of 2006 to extend the emission targets of AB 32. The amendment set a statewide GHG emission limit for 2030 equivalent to 40 percent below emission levels in 1990. AB 32 and SB 32 directed CARB to develop a climate change scoping plan to describe the approach that California will take to reduce GHG emissions and achieve the state's climate change goals. *California's 2017 Climate Change Scoping Plan*, published by CARB in November 2017, helped inform and guide the development of this investment plan update.[17]

As part of its regulation, CARB developed a Cap-and-Trade Program that set a limit on the amount of permissible GHG emissions from entities in regulated sectors. The Cap-and-Trade Program includes an auction system where tradable permits, or allowances, can be purchased

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15 California Air Resources Board. March 7, 2017. *Revised Proposed 2016 State Strategy for the State Implementation Plan*. Available at https://www.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf.

16 California Air Resources Board. May 2016. *Mobile Source Strategy*. Available at https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf.

17 California Air Resources Board. November 2017. *California's 2017 Climate Change Scoping Plan*. Available at https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

from the state at quarterly auctions. A portion of the proceeds from these auctions is deposited in the Greenhouse Gas Reduction Fund (GGRF). The Governor and Legislature enact GGRF appropriations for state agencies to implement a variety of programs that reduce greenhouse gases. Assembly Bill 398 (Garcia, Chapter 135, Statutes of 2017) extended California's Cap-and-Trade Program through 2030.

Senate Bill 1275

Senate Bill 1275 (De León, Chapter 530, Statutes of 2014) established the Charge Ahead California Initiative, administered by CARB in consultation with the CEC and related agencies. This statute establishes a goal of placing 1 million zero-emission and near-zero-emission vehicles in service by January 1, 2023, as well as increasing access to these vehicles for disadvantaged, low-income, and moderate-income communities and consumers. In implementing the initiative, CARB must include a three-year funding forecast for near-zero- and zero-emission vehicles. CARB released the first of these forecasts, the *Fiscal Year 2016-17 Funding Plan for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program,*[18] in 2016. CARB also adopted revisions to the Clean Vehicle Rebate Project to phase down rebate levels based on cumulative sales, limit eligibility based on income, and consider other methods of incentives.

Senate Bill 350 and the Disadvantaged Communities Advisory Group

SB 350, the Clean Energy and Pollution Reduction Act of 2015, requires that the CPUC and the CEC create a Disadvantaged Communities Advisory Group (DACAG) to advise on programs proposed to achieve clean energy and pollution reduction. In early 2018, the CPUC and the CEC jointly approved members of a new advisory group consisting of representatives of disadvantaged communities. As defined in Senate Bill 350, disadvantaged communities are the most burdened census tracts in California. Relative burden is determined by review of data on 20 pollution/health and socioeconomic factors. The DACAG will advise on programs related to renewable energy, energy efficiency, transportation electrification, distributed generation, and clean energy research and development and determine whether those proposed programs will be effective and useful in disadvantaged communities.

At a June 21, 2019, meeting of the DACAG, Clean Transportation Program staff solicited feedback on the March 27, 2019, draft of the *2019-2020 Investment Plan Update* from the DACAG members.[19] In response, the DACAG provided comments on the *2019-2020 Investment*

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18 California Air Resources Board. May 2016. *Fiscal Year 2016-2017 Funding Plan for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program*. Available at https://www.arb.ca.gov/msprog/aqip/fundplan/proposed_fy16-17_fundingplan_full.pdf.

19 DACAG meeting materials available at https://www.cpuc.ca.gov/DACAG/. The previous version of this investment plan update (Lead Commissioner Report version) is available at https://www.energy.ca.gov/altfuels/2018-ALT-01/documents/.

Plan Update on June 28, 2019.[20] These comments included recommendations on how the *2019-2020 Investment Plan Update* can effectively benefit communities disproportionately burdened by pollution and socioeconomic challenges. Recommendations from the DACAG included:

- Moving 100 percent of program funding toward zero-emission fuels.
- Funding projects exclusively in and benefiting disadvantaged communities.
- Expanding the definition of disadvantaged communities beyond the CalEnviroScreen definition.
- Increasing transparency and tracking expanded metrics to measure how projects "benefit" disadvantaged communities.
- Prioritizing and investing in community outreach and engagement.
- Expanding support for workforce development.
- Expanding the Clean Transportation Program Advisory Committee to increase representation of program beneficiaries, environmental justice communities, rural communities, tribes, and others.

The CEC will continue coordinating with the DACAG throughout the development of this and future Investment Plan Updates, as well as the Clean Transportation Program in general, to achieve equity and access for all Californians.

Executive Orders (EO)

EO B-55-18: Carbon Neutrality

EO B-55-18 established a goal to achieve carbon neutrality as soon as possible and no later than 2045. The executive order also requires the state to achieve and maintain net negative greenhouse gas emissions thereafter.

EO B-16-12 and B-48-18: Zero-Emission Vehicles

EO B-16-12 set a target of 1.5 million zero-emission vehicles on the road by 2025 and tasked various state agencies with specific actions needed to support this goal.[21] Subsequently, in January 2018, EO B-48-18 set an expanded target of 5 million zero-emission vehicles on the road by 2030, as well as a network of 200 hydrogen refueling stations and 250,000 electric vehicle charging stations, including 10,000 DC fast chargers, installed or constructed by

20 SB 350 Disadvantaged Communities Advisory Group, "SB 350 Disadvantaged Communities Advisory Group Comments on 2019-2020 Investment Plan Update," June 28, 2019. Submitted to Docket 18-ALT-01, TN# 228878. Available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=228878&DocumentContentId=60238.

21 Executive Order B-16-12 available at https://www.ca.gov/archive/gov39/2012/03/23/news17463/index.html.

2025.[22] These executive orders have guided the electric vehicle charging and hydrogen refueling infrastructure investments of the Clean Transportation Program to date.

The Governor's Interagency Working Group on Zero-Emission Vehicles (ZEVs) developed the *ZEV Action Plan*, issued in 2013 and subsequently updated in 2016 and 2018, to identify actions that support the state's ZEV goals.[23] Some actions in the *ZEV Action Plan* that are particularly relevant to the Clean Transportation Program include ensuring ZEVs are accessible to a broad range of Californians and making ZEV technologies commercially viable in the medium- and heavy-duty and freight sectors. Many recommendations in the *ZEV Action Plan* have been captured in the Clean Transportation Program since the inception of the program and continue to be program priorities.

EO B-32-15: Sustainable Freight

Issued in 2015, EO B-32-15 ordered the development of an integrated action plan to improve freight efficiency, transition to zero-emission technologies, and increase the competitiveness of California's freight system.[24] The resulting *California Sustainable Freight Action Plan,* released in 2016, identifies state policies, programs, and investments to achieve these targets. The California State Transportation, California Environmental Protection, and California Natural Resources Agencies, including the CEC, CARB, the California Department of Transportation, and the Governor's Office of Business and Economic Development, in partnership with the public and stakeholders, developed the plan as a joint effort. In addition, the executive order directs the CEC and other state agencies to initiate work on corridor-level freight pilot projects within the state primary trade corridors that integrate advanced technologies, alternative fuels, freight and fuel infrastructure, and local economic development opportunities.

Regulations by the California Air Resources Board

Low Carbon Fuel Standard

CARB adopted the Low Carbon Fuel Standard (LCFS) regulation in April 2009 with a goal of reducing the overall carbon intensity of fuel within the transportation sector by 10 percent by 2020. In September 2018, CARB set an additional goal of reducing carbon intensity by 20 percent by 2030. The LCFS sets a carbon intensity standard (or benchmark) that declines each year. Providers of low-carbon fuels earn credits under the LCFS by producing fuels with a carbon intensity below the annual carbon intensity standard. These credits can be used or sold to offset deficits caused by high-carbon fuels that exceed the annual carbon intensity

22 Executive Order B-48-18 available at https://www.ca.gov/archive/gov39/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/index.html.

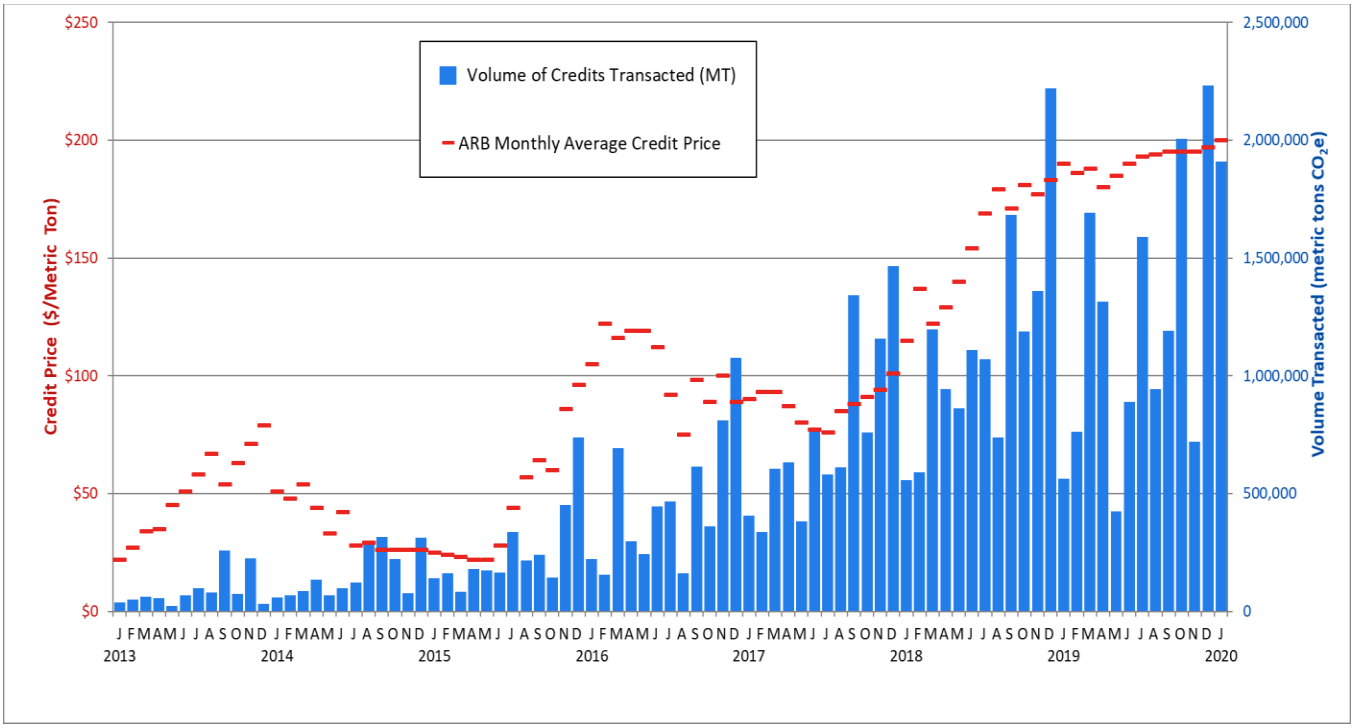
23 The ZEV Action Plan and updates are available at http://www.business.ca.gov/ZEV-Action-Plan.

24 California Air Resources Board. March 2017. Revised Proposed 2016 State Strategy for the State Implementation Plan. Available at https://www.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf.

standard. Through this mechanism, the LCFS allows the market to determine what mix of fuels will be used to achieve the program carbon intensity reduction goals.

LCFS credits and deficits are denominated in metric tons of CO_2e. Credit prices reached all-time highs in 2017 and 2018, as shown in Figure 3, ranging from a low of $22 in May 2015 to a high of $200 in January 2020.[25]

Figure 3: Average Monthly Low Carbon Fuel Standard Credit Prices



Source: California Energy Commission. Data from the LCFS Monthly Credit Price and Transaction Volumes February 12, 2020. Spreadsheet is available at https://www.arb.ca.gov/fuels/lcfs/dashboard/creditpriceserieswithoutargusopis.xlsx.

The LCFS has significance for the Clean Transportation Program in several ways. Most important, the CEC frequently relies on LCFS-derived carbon intensity numbers in numerous phases of Clean Transportation Program implementation. This reliance is due to the LCFS program life-cycle analysis of GHG emissions, the specificity of the analysis to California, and the consistent method of calculation across fuel pathways. The life-cycle GHG emission numbers are used in assessing the opportunities from different alternative fuels within the investment plan update, estimating the GHG reduction potential from applicants during solicitations, and analyzing Clean Transportation Program benefits.

25 California Air Resources Board. March 13, 2019. *LCFS Monthly Credit Price and Transaction Volumes July 2018 Spreadsheet.* Available at https://www.arb.ca.gov/fuels/lcfs/dashboard/creditpriceserieswithoutargusopis.xlsx.

The LCFS also provides a direct financial incentive per gallon, kilowatt-hour, therm, or kilogram to the producers and distributors of low-carbon alternative fuels. At the 2019 average price of about $192 per credit,[26] the LCFS value of an alternative fuel offering a 50 percent GHG emission reduction compared to gasoline would be about $0.96 per gasoline gallon equivalent (GGE).[27] This value complements the investments of the Clean Transportation Program by creating market incentives for near-term GHG reductions, allowing the Clean Transportation Program to focus more resources on longer-term market transformation goals.

In September 2018, CARB also adopted changes to the LCFS regulations that will benefit the launch of ZEVs and ZEV infrastructure. The amendments allow hydrogen refueling stations to earn hydrogen refueling infrastructure credits based on the capacity of the station. The amendments also provide credits for DC fast charging equipment based on the power rating of the equipment. On the vehicles side, the amendments also restructure the existing approach for providing PEV rebates through utilities to create a statewide rebate that would be offered at the dealership, funded through LCFS credit proceeds.

Zero Emission Vehicle Regulation

CARB's Advanced Clean Cars rulemaking consists of a suite of regulations for reducing emissions from the state's light-duty fleet. One element of the Advanced Clean Cars program is the ZEV Regulation, which requires auto manufacturers to offer for sale specific numbers of the cleanest cars available, including full battery-electric vehicles, hydrogen fuel cell electric vehicles, and plug-in hybrid electric vehicles. CARB is working on the update to the ZEV Regulation for the Advanced Clean Cars 2 program, which will look at regulations beyond 2025 and help ensure zero- and near-zero-emission technology options continue to grow in the market.

Innovative Clean Transit Regulation

CARB heavy-duty vehicle legacy programs have been focused on reducing vehicle tailpipe emissions. New heavy-duty zero-emission vehicle programs are complementary to these programs and focus on a long-term goal of full transition of the heavy-duty transportation sector to zero-emission technologies. They are part of California's holistic plan to address challenging mandates and needs for public health protection and to meet federal air quality standards and climate protection goals. The Innovative Clean Transit Regulation[28] is the first

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26 California Air Resources Board. January 11, 2020. Monthly LCFS Credit Transfer Activity Report for January 2020. Available at https://ww3.arb.ca.gov/fuels/lcfs/credit/Jan%202020%20-%20Monthly%20Credit%20Transfer%20Activity.pdf.

27 LCFS credit value derived from the CARB LCFS Credit Price Calculator Version 1.2, available at https://www.arb.ca.gov/fuels/lcfs/dashboard/creditpricecalculator.xlsx.

28 California Air Resources Board Innovative Clean Transit. Available at https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/about.

of its kind to support these programs. It was adopted in December 2018 to replace the Fleet Rule for Transit Agencies. The regulation requires all public transit agencies to transition gradually to a 100-percent zero-emission bus fleet and encourages them to provide innovative first- and last-mile connectivity and improved mobility for transit riders. This regulation also provides various exemptions and compliance options to provide safeguards and flexibility for transit agencies through this transition. The Zero-Emission Airport Shuttle Regulation will promote the development and use of zero-emission technologies in airport shuttles that operate on fixed routes at 13 California airports. This regulation requires airport shuttle operators to transition their vehicles to zero-emission technologies beginning in 2027, with a complete transition by the end of 2035. The regulation provides compliance extensions and other flexibilities to ensure service continuity as operators transition to zero-emission shuttles.

Complementary Funding Programs

California Energy Commission's School Bus Replacement Program

In the November 2012 California general election, voters approved Proposition 39 to improve energy efficiency and expand clean energy generation in schools and community colleges. This proposition provided up to $550 million annually for five fiscal years for these purposes, beginning with FY 2013-2014. Senate Bill 110 (Committee on Budget and Fiscal Review, Chapter 55, Statutes of 2017) allocated the available remaining funds from the implementation of Proposition 39 to improve energy efficiency at California schools. The energy efficiency measures in SB 110 include one-time funding of $75 million for the retrofit or replacement of school buses.

The CEC administers this funding, and priority is given to school districts operating the oldest and most polluting diesel school buses, as well as to school buses operating in disadvantaged and low-income communities. The $75 million in funding provided by SB 110 will be used exclusively for the purchase of battery-electric school buses, and this amount will be supplemented with up to $13 million in Clean Transportation Program funds to provide the necessary charging infrastructure to operate the buses. For circumstances in which battery-electric propulsion is not feasible, nearly $4 million in Clean Transportation Program natural gas vehicles funding and $2.1 million in Clean Transportation Program natural gas fueling infrastructure funds from previous fiscal years are being made available for natural gas-powered school buses and necessary fueling infrastructure.

California Air Resources Board Funding Programs

In addition to the CEC's Clean Transportation Program, AB 118 also created the Air Quality Improvement Program (AQIP), which the CARB administers. Since 2009, the AQIP has provided deployment incentives for light-duty electric vehicles through the CVRP, deployment incentives for alternative medium- and heavy-duty vehicles through the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), as well as funding for other advanced emission reduction technologies for vehicles. Before the availability of appropriations

from the GGRF, the Clean Transportation Program provided $49.1 million in funding[29] to backfill CVRP needs, as well as $4 million for HVIP incentives.

CARB also distributes GGRF funding through its Low Carbon Transportation Investments (LCTI) program. Projects that were originally funded by the AQIP, such as the CVRP, are now funded by the LCTI program because demand has exceeded available funding from the AQIP. The LCTI provides incentives for light-duty vehicle and transportation equity projects, as well as heavy-duty vehicle and off-road equipment projects.

In October 2019, CARB approved the *Proposed FY 2019-2020 Funding Plan for Clean Transportation Incentives* that includes funding totaling $533 million for LCTI and AQIP projects.[30] Table 4 summarizes the funding allocations. The Plan includes $182 million for clean trucks, buses and off-road freight equipment, including $142 million for the HVIP and $40 million for advanced technology demonstration and pilot projects in the heavy-duty sector. The plan also includes $48 million in Air Quality Improvement Program funding to clean up heavy-duty truck emissions. More than 90 percent of funding for the plan, or $485 million, comes from 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.

Senate Bill 1403 (Lara, Chapter 370, Statutes of 2018) requires CARB to develop a three-year investment strategy for zero-emission and near-zero-emission heavy-duty vehicles and equipment. This bill also requires CARB to provide information on milestones achieved by the state's school bus incentive programs and the projected need for funding. The CEC will closely follow the progress by CARB on these subjects.

29 Including budgetary transfers.

30 California Air Resources Board. October 24, 2019. *Fiscal Year 2019-20 Funding Plan for Clean Transportation Incentives*. Available at https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low-1.

Table 4: FY 2019-2020 CARB Clean Transportation Incentives Allocations

Project Category	Vehicle Purchase Incentives and Clean Mobility Projects (Allocation in Millions)	Heavy-Duty and Off-Road Equipment Investments (Allocation in Millions)	AQIP-Funded Heavy-Duty Investments (Allocation in Millions)
Clean Vehicle Rebate Project	$238		
Clean Transportation Equity Projects	$65		
Clean Truck and Bus Vouchers (HVIP)		$142	
Heavy-Duty Advanced Technology Demonstration and Pilot Projects		$40	
Truck Loan Assistance Program			$48
Total	**$303**	**$182**	**$48**

Source: California Air Resources Board

Many project categories listed above have particular importance to the goals and strategies of the Clean Transportation Program and are further discussed in subsequent chapters of this investment plan update.

Investor-Owned Utility Investments in Electric Vehicle Charging Infrastructure

In 2014, the California Public Utilities Commission (CPUC) adopted Decision 14-12-079 to allow consideration of utility ownership of electric vehicle charging stations and infrastructure on a case-specific basis. Subsequently, the CPUC approved infrastructure pilot programs for Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southern California Edison (SCE) to install 7,500, 3,500, and 1,500 charging stations, respectively.[31] The utility programs for light-duty infrastructure are described further in the Electric Vehicle Charging Infrastructure section in Chapter 4 of this report.

The CPUC is also working to implement provisions of SB 350 by directing the six investor-owned electric utilities under the CPUC's jurisdiction to propose portfolios of transportation electrification programs and investments that can be implemented over the next five years. The three major investor-owned utilities submitted more than $1 billion in applications to the CPUC for electric vehicle charging infrastructure projects, with $780 million of these projects approved in January and May 2018. These projects include roughly $592 million for medium- and heavy-duty vehicle infrastructure and $171 million for light-duty vehicle infrastructure. The projects for medium- and heavy-duty electric vehicle infrastructure are discussed further in the

31 California Public Utilities Commission, Decisions (D.)16-01-023, D.16-01-045, and D.16-12-065. Available at http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442454831.

Medium- and Heavy-Duty Zero-Emission Vehicles and Infrastructure section in Chapter 4 of this report.

Settlement Agreements

Volkswagen Diesel Emissions Settlement

Beginning with its 2009 model year, Volkswagen sold 2.0- and 3.0-liter diesel vehicles in the United States, including in California, violating federal and state law by using illegal devices to defeat emission tests. To remedy the harm caused by the use of these defeat devices, California entered into a series of settlement agreements with Volkswagen. From these agreements, California will receive about $423 million from a national Environmental Mitigation Trust for projects to reduce fully the lifetime excess NO_X emissions caused by the illegal devices. In May 2018, CARB approved a Beneficiary Mitigation Plan outlining how these funds will be spent.[32] In addition, Volkswagen will invest $800 million in ZEV-related projects in the state and must offer and sell additional battery-electric vehicle models in California between 2019 and 2025.

Volkswagen's ZEV investments will occur over a 10-year period, and eligible projects include fueling infrastructure for plug-in electric vehicles and hydrogen fuel cell electric vehicles, consumer awareness campaigns, and car-sharing programs. Volkswagen will submit four ZEV investment plans, each of which will cover 30 months and total $200 million, to CARB for approval. The first of these plans was approved in July 2017. In December 2018, CARB approved Electrify America's investment plan for the second 30-month cycle, which began July 1, 2019.[33] The ZEV infrastructure funding will complement Clean Transportation Program investments in electric vehicle charging infrastructure. In addition, CARB allocated $10 million from the Environmental Mitigation Trust for light-duty zero-emission vehicle infrastructure projects. The CEC will monitor the development of the Volkswagen settlement investment plans to ensure that investments are coordinated.[34]

Furthermore, California's Beneficiary Mitigation Plan for the Volkswagen Environmental Mitigation Trust will provide $130 million for school shuttle and transit buses, administered throughout San Joaquin County, of which, $65 million was released for the first installment. The second installment will be out in two years. The plan also includes $90 million for zero-

32 California Air Resources Board. June 2018. *Beneficiary Mitigation Plan for the Volkswagen Environmental Mitigation Trust.* Available at https://ww2.arb.ca.gov/resources/documents/californias-beneficiary-mitigation-plan.

33 Electrify America, October 3, 2018. *California ZEV Investment Plan: Cycle 2.* Available at https://www.arb.ca.gov/msprog/vw_info/vsi/vw-zevinvest/documents/c2zevplan_100318.pdf.

34 Information on CARB activities associated with the VW Environmental Mitigation Trust is available at https://www.arb.ca.gov/msprog/vw_info/vsi/vw-mititrust/vw-mititrust.htm.

emission Class 8[35] freight and port drayage trucks and $60 million for combustion freight and marine projects.[36]

CPUC/NRG Settlement Agreement

In 2012, the Federal Energy Regulatory Commission approved an agreement between NRG Energy and the CPUC to settle outstanding legal issues regarding the California energy crisis. The settlement required NRG to invest $102.5 million (original settlement amount) to install electric vehicle charging infrastructure across the state. The NRG settlement included project designs with four key components: public fast charging stations, electrical upgrades for electric vehicle charging stations at existing buildings, research and development on advanced charging technologies, and programs to increase electric vehicle access for underserved communities. The CPUC and NRG have agreed to amendments that have extended and increased the public benefits related to the settlement agreement.

35 Class 8 trucks include all trucks with weight limits more than 33,000 pounds.

36 California Air Resources Board. "California's Beneficiary Mitigation Plan for the Volkswagen Environmental Mitigation Trust." Available at https://ww2.arb.ca.gov/resources/documents/californias-beneficiary-mitigation-plan.

CHAPTER 3:
Proposed Funding Allocations for 2020-2023

The funding allocations for FY 2020-2021, and the projected funding allocations for subsequent fiscal years, are outlined in Table 5. In the event that a different amount of funding is available, the allocations in this document may be amended after final adoption.

For FY 2020-2021, a total of $146.2 million (including a proposed $51 million in one-time legislative expenditure) may be available for the purposes described in this investment plan update. The continued emphasis on zero-emission vehicles and infrastructure for FY 2020-2021 reflects the state's goals for zero-emission vehicles and fuels, near- and long-term carbon reduction, and air quality, with a focus on benefits for disadvantaged communities.

As shown in Table 5, the CEC is proposing significant investments in light-duty electric vehicle charging infrastructure for fiscal years 2020-2021 and 2021-2022 in order to narrow the charging gap as described in earlier analysis, with further depth later in this report. Additionally, it is vital to front load funding to ensure the public adoption of electric vehicles is not stymied by lack of charging infrastructure.

In fiscal years 2021-2022 and 2022-2023, the CEC will concentrate investments toward medium- and heavy- duty zero-emission vehicles and infrastructure. By this time, CEC staff will benefit from the inaugural charging infrastructure assessment required in Assembly Bill 2127 (Ting, Chapter 365, Statutes of 2018). Current charging assessments have only focused on light-duty vehicles; however, estimating the charging needs of medium- and heavy-duty vehicles will become a key area for additional analysis.

As the state's lead agency for ZEV infrastructure deployment, the CEC is making strategic investments in innovative solutions to fill anticipated gaps in charging infrastructure and to avoid a slow-down of light-duty electric vehicle adoption. The CEC is also proposing significant investments in medium- and heavy- duty zero-emission vehicles and infrastructure to meet this growing need, as well as to demonstrate the state's commitment to improving air quality.

The following chapters describe each funded activity in more depth.

Table 5: Investment Plan Allocations for FY 2020-2021 and Subsequent Fiscal Years (in Millions)

Category	Funded Activity	2020-2021	2021-2022	2022-2023	2023	Total
Zero-Emission Vehicles and Infrastructure	Light-Duty Electric Vehicle Charging Infrastructure and eMobility	$92.7*	$30.2	$10	-	$132.9
	Medium- and Heavy-Duty Zero-Emission Vehicles and Infrastructure	$20	$30	$52.2	$32.6	$134.8
	Hydrogen Refueling Infrastructure	$20	$20	$20	$5	$65
Alternative Fuel Production and Supply	Zero- and Near Zero-Carbon Fuel Production and Supply	$10	$10	$10	$5	$35
Related Needs and Opportunities	Manufacturing	-	$5	-	$5	$10
	Workforce Training and Development	$3.5	-	$3	-	$6.5
	Total	**$146.2**	**$95.2**	**$95.2**	**$47.6**	**$384.2**

Source: California Energy Commission. *FY 2020-2021 includes a one-time legislative expenditure authority from the Alternative and Renewable Fuel and Vehicle Technology Fund for $51 million to increase and accelerate electric vehicle charging infrastructure. Appropriations are contingent on legislative approval.

CHAPTER 4:
Zero-Emission Vehicles and Infrastructure

The mass adoption of zero-emission vehicles (ZEVs), including plug-in electric vehicles (PEVs) and fuel cell electric vehicles (FCEVs), is a critical to California's decarbonization goals, in addition to its air quality standards and petroleum reduction goals. This mass adoption has been recognized in several state laws and policies, including SB 1275, which established a target of 1 million ZEVs and near-ZEVs in California by 2023, and Executive Order B-16-12, which calls for 1.5 million ZEVs on California roads by 2025. Most recently, Executive Order B-48-18 set a goal of achieving 5 million ZEVs by 2030.

However, the expansion of ZEVs will depend on the availability of refueling infrastructure that meets consumers' needs and expectations. In recognizing this dependence, Executive Order B-48-18 also set goals for installing 250,000 electric vehicle chargers (including 10,000 DC fast chargers) and 200 hydrogen refueling stations by 2025.

Relative to most previous investment plan updates, the FY 2020-2021 funding allocations for zero-emission vehicle infrastructure represent a drastic increase in funding, specifically for electric vehicle charging infrastructure. The increase is due to a proposed one-time $51 million legislative appropriation from the Alternative and Renewable Fuel and Vehicle Technology Fund to increase and accelerate the installation of electric vehicle charging infrastructure which will support increased ZEV adoption and deployment in California. The increase reflects a near-term need to achieve the number of charging points needed to support the state's goals of 1.5 million zero-emission vehicles by 2025, as well as a long-term commitment to decarbonizing the transportation sector as a whole.

Light-Duty Electric Vehicle Charging Infrastructure

Cumulative sales of PEVs, which include battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), are growing rapidly in California, with more than 600,000 on the road at the end of 2019.[37] These sales account for about half of the vehicles sold in the United States. In the first half of 2019, the third-most purchased model vehicle in California was the Tesla Model 3, which indicates the rapid pace of electric vehicle adoption by consumers.[38] Furthermore, the CEC forecasts that between 1.5 million and 2.4 million ZEVs will be in the state by 2025, setting California on track to meet or exceed the state ZEV deployment goals

37 Based on CEC staff analysis of data from the California Department of Motor Vehicles. Cumulative PEV sales through end of 2019 (regardless of vehicle status) were estimated around 640,000.

38 Mulkern, Anne C. *E&E News*. August 2019. "Plug-Ins Are a Best-Seller in Calif. for the Time." Available at https://governorswindenergycoalition.org/plug-ins-are-a-best-seller-in-calif-for-the-first-time/.

for 2025. A convenient, reliable network of public electric vehicle charging stations (EVCS) will be critical to continuing support of the expansion of PEV ownership in California and ensuring state ZEV deployment goals are realized. (Most California ZEVs in the near term are expected to be PEVs, as CARB manufacturer surveys forecast 48,000 FCEVs on California roads in 2025.[39])

Technology Overview

Charging infrastructure is typically categorized into three power ratings: Level 1, Level 2, and direct current (DC) fast charging. Level 1 chargers use alternating current electricity at 120 volts to provide about 3.5-6.5 miles range per hour of charging. Level 2 chargers use alternating current electricity to charge a PEV at 240 volts and can provide about 14 to 35 miles of range per hour of charging. Finally, DC fast charging uses DC electricity at 480 volts to recharge a BEV up to 100 miles in 30 minutes or less (depending on the size of the battery, the power level of the charger, and the charging capability of the vehicle).[40]

In addition to varying by charging rate, charging infrastructure varies by location type. As at-home Level 2 chargers became readily available and affordable, the CEC discontinued funding for private-use residential charging stations. Shared-use residential charging stations, which are predominantly used in multifamily housing, still face barriers that impede PEV adoption. Projects at multifamily housing have been historically underrepresented by applicants despite efforts to target incentives toward electric vehicle charging station installations at these locations. However, increased DC fast charging could be one solution to help address the lack of residential charging at multiunit dwellings.

Workplace and public charging stations are another major component of the state's portfolio of charging stations. Public chargers include charging locations at stores, parking garages, universities, municipal governments, curbside locations, and other common, publicly accessible destinations. When residents of multifamily housing are unable to charge at home, having an available site to charge at work or access to other public locations can serve as an alternative. If located far from home, workplace and public charging can also help BEV owners extend their range and PHEV owners increase their electric miles driven.

When located along major interregional routes, DC fast chargers can enable long-distance travel by BEVs. Fast-charger plazas, which consist of two or more fast chargers at a location, can charge multiple PEVs quickly and simultaneously. These plazas can alleviate charger congestion in areas with large PEV populations. Fast chargers can also provide a quicker

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39 California Air Resources Board. *2019 Annual Evaluation of Fuel Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development*. July 2019. Available at https://ww2.arb.ca.gov/sites/default/files/2019-07/AB8_report_2019_Final.pdf.

40 Center for Sustainable Energy. *Electric Vehicle Charging Overview*. Accessed February 13, 2020. Available at https://cleanvehiclerebate.org/eng/ev/technology/fueling/electric.

alternative to charging at destinations. Next-generation BEVs with higher-capacity batteries will require higher-powered fast chargers than what is adequate for the current generation of BEVs.

Assessing Charging Infrastructure Needs for Light-Duty Vehicles

In an attempt to quantify the number of charging stations needed to service the growing number of PEVs in California, the CEC and the National Renewable Energy Laboratory (NREL) developed the Electric Vehicle Infrastructure Projections (EVI-Pro) tool. EVI-Pro estimates the number of charging connectors that will be needed at the local level while accounting for differing charger power levels, location types, and PEV adoption rates. This tool allows the CEC to estimate where local and regional gaps exist in charging station deployment, how many electric vehicle chargers will be needed to meet the goals of the *ZEV Action Plan*, how much this infrastructure will cost, and how differences in travel behavior and housing types will affect PEV charging demand. The EVI-Pro estimates of the amount of charging infrastructure needed to support 1.5 million ZEVs by 2025 helped inform Executive Order B-48-18, which calls for 250,000 charging points (including at least 10,000 DC fast chargers) by 2025.

To track progress toward this 2025 goal, CEC staff sought data and estimates regarding the number of public or shared charging connectors that exist within California, as well as the recent and proposed charging infrastructure investments of the Clean Transportation Program and other key state funding mechanisms.[41] Table 6 below provides estimates of the existing number of public or shared Level 2 and DC fast charging connectors or a combination within the state as of March 2019. The table also provides estimates of the number of connectors to be installed with previous years' and estimates of future years' of Clean Transportation Program funds and announced plans from other major funding programs. Finally, the table summarizes the estimated shortfall in charging infrastructure relative to the goals of Executive Order B-48-18.

41 The number of existing charging ports within California is difficult to measure and imprecise, as available data and reporting requirements vary widely. Notably, these estimates do not include private, nonshared charging ports, such as household garages or private (nonshared) fleets or workplaces.

Table 6: Progress Toward 250,000 Charging Connectors by 2025

	Level 2 Charging Connectors	DC Fast Charging Connectors
Existing Charging Connectors (Estimated)*	37,400	2,900
Allocated Funding for Chargers (includes anticipated funding from Clean Transportation Program)**	124,600	3,500
Total	162,000	6,400
2025 Goal (Executive Order B-48-18)	*240,000*	*10,000*
Gap From Goal	78,000	3,600

Source: California Energy Commission. Analysis as of March 8, 2019. *Existing charging ports estimated based on available data from U.S. Department of Energy's Alternative Fuels Data Center, as well as informal interviews with some (but not all) major charging infrastructure providers. **Estimate of ports from other state programs derived from public presentations and statements by utilities, California Public Utilities Commission, CARB, other entities, and the Energy Commission. This analysis does not include the proposed $51 million one-time legislative appropriation from the Alternative and Renewable Fuel and Vehicle Technology Fund for FY 2020-2021 dedicated to electric vehicle charging infrastructure.

As indicated in the final row of Table 6, CEC staff estimates that there is a sizable gap (more than 80,000) between the number of charging connectors needed in 2025 and the number of expected charging connectors available that year. Electric vehicle infrastructure investments are growing at a slower pace compared to trajectories of PEV adoption. It is also possible that California will exceed the goal of 1.5 million zero-emission vehicles on the road by 2025, and the state will need more chargers to meet the expanded market. In that case, it is likely that the gap under-estimates the short fall of charging needed for PEV's in 2025.

In September 2018, Governor Edmund G. Brown Jr. signed Assembly Bill 2127 (Ting, Chapter 365, Statutes of 2018). The legislation requires the CEC, working with CARB and the CPUC, to prepare and biennially update a statewide assessment of the electric vehicle charging infrastructure. The assessment will focus on the number and types of charging infrastructure needed to support levels of electric vehicle adoption required for the state to meet its goals of at least 5 million vehicles on California roads by 2030 and of reducing emissions of GHGs to 40 percent below 1990 levels by 2030. Under a recent amendment to the CEC's contract with NREL, NREL will revise and extend EVI-Pro to look further ahead to the state's goal of 5 million ZEVs by 2030. These findings will significantly inform the CEC's charging infrastructure assessment required under AB 2127.

The CEC expects that additional (and significant) public funding is still appropriate and necessary toward meeting the needs of prospective PEV buyers through 2025. In recognition of this need, the funding allocation for this activity in *2020-2023 Investment Plan Update* is notably higher than in most previous investment plan updates to meet the growing needs of PEV charging.

In September 2018, Governor Brown signed Senate Bill 1000 (Lara, Chapter 368, Statutes of 2018). The legislation requires the CEC, in consultation with CARB, to assess whether electric vehicle charging station infrastructure is disproportionately deployed. As used in the legislation, "disproportionate" refers to population density, geographical area, or income level. If the infrastructure is found to be disproportionately deployed, the Commission must use Clean Transportation Program funding to install more proportionately new charging station

infrastructure, unless the CEC finds the disproportionate deployment reasonable and in furtherance of state energy or environmental policy goals.[42] CEC staff is beginning to identify and collect the requisite data that will inform this analysis (and other transportation electrification analysis).

Clean Transportation Program Funding to Date

The CEC has supported the rollout of PEVs by awarding nearly $145 million in Clean Transportation Program funding for electric vehicle charging infrastructure. Partly because of these investments, California has the largest network of publicly accessible electric vehicle chargers in the nation.

Clean Transportation Program investments have funded EVCS at many types of locations, as detailed in Table 7. The "Private Access" connectors include residential chargers that are generally dedicated to serving only one vehicle; the CEC has moved away from providing incentives for these chargers over the life of the Clean Transportation Program. The "Shared Access" connectors include fleets, workplaces, and multifamily housing chargers that may serve multiple vehicles, but are not necessarily open to the public. Finally, the "Public Access" connectors include public Level 2 chargers as well as corridor and urban metropolitan DC fast chargers.

Table 7: Charging Connectors Funded by the Clean Transportation Program as of December 1, 2019

Status	Private Access	Shared Access	Shared Access	Shared Access	Public Access	Public Access	Total
	Residential (Single & Multifamily)	Fleets	Workplaces	Residential (Multifamily)	Public	Corridor/ Urban Metro	
Installed	3,936	155	411	341	3,111	385	**8,339**
Planned	0	0	471	158	663	1,293	**2,585**
Total	**3,936**	**155**	**882**	**499**	**3,774**	**1,678**	**10,924**

Source: California Energy Commission. Does not include connectors that have yet to be approved at an Energy Commission business meeting or connectors that have yet to be funded under CALeVIP.

California Electric Vehicle Infrastructure Project (CALeVIP)

In December 2017, the CEC introduced the California Electric Vehicle Infrastructure Project (CALeVIP) to provide streamlined Clean Transportation Program incentives for light-duty electric vehicle charging infrastructure. The incentives provided through CALeVIP simplify the funding process and accelerate charger deployment compared to the previously used grant solicitations. Each CALeVIP project provides incentives for the purchase and installation of electric vehicle infrastructure in specific regions throughout the state, with funding targeted at

42 Senate Bill 1000 (Lara, Chapter 368, Statutes of 2018).

regions that have low rates of infrastructure installation or lack adequate incentives from utilities and other sources.

Through 2019, the CEC has allocated $71 million for charger rebates through CALeVIP, and the Commission may make up to $200 million available through this funding mechanism depending on demand, project performance, and funding availability. CALeVIP incentives for both Level 2 and DC fast chargers have been made available in Sacramento, Humboldt, Shasta, Tehama, Santa Cruz, Monterey, San Benito, Fresno, San Joaquin, and Kern Counties. In 2020, additional CALeVIP incentive projects will include those in Santa Clara, San Mateo, San Diego, Sonoma, and Mendocino Counties. Incentives for DC fast chargers have been made available for businesses and public agencies in Los Angeles, Orange, Riverside, and San Bernardino Counties. Dedicated funding amounts or higher incentive amounts or both are also available under CALeVIP for project sites within disadvantaged communities and multi-family residents. Energy Commission staff continues to coordinate closely with local councils of governments, local governments, and municipalities to leverage other funding opportunities to increase chargers in focused locations to maximize the effectiveness of limited Clean Transportation Program funds. To this end, there are no plans to make CALeVIP a statewide program; however, incentives may end up covering each county in the state.

Innovations in Charging Technology and Business Strategies

Most charging at workplaces is expected to occur during the daytime, which is likely to create opportunities for electricity demand management at these sites. Electric vehicle charging with demand-side management can increase charging during times of excess electricity and decrease use during peak times. As more intermittent renewable energy is available to the electricity grid, such as solar and wind, the electricity supply available during the day will increase and possibly result in overgeneration. Vehicle-to-grid technologies and daytime PEV charging, especially at workplace and fleet-use stations, have the opportunity to reduce the negative effects of overgeneration.

The CEC is seeking ways to advance innovative and transformative technologies and transportation trends that can increase the efficiency and the effectiveness of zero-emission charging infrastructure. Newer recharging technologies, such as robotic charging (which can initiate charging sessions without human involvement), pantograph charging (which can provide electricity to vehicles while in motion via contact), and wireless charging (which can recharge vehicles without direct contact) have shown great potential to improve upon the speed and cost-effectiveness of charging infrastructure. Mobile charging that is supported with energy storage can also be deployed quickly and replaced during emergencies or during peak travel demand. Such advancements could greatly increase use of existing equipment and enable new private investments. Supporting innovative technologies and emerging transportation trends, such as TNCs and autonomous vehicles, can have a real effect in accelerating zero-emission vehicles toward broader commercialization. The CEC is also committed to enabling "smart" charging and vehicle-grid integration, which help reduce costs for PEV drivers and all electricity customers.

As the market for PEVs becomes more developed, financing for electric vehicle charging stations will eventually need to shift from government incentives to private sector lending. Electric vehicle chargers, however, may require innovative business models because of

uncertain long-term payoff and risk, and these uncertainties may reduce the willingness of lenders to fund EVCS with competitive financing terms. To validate the profitability and feasibility of financing charging stations, the Clean Transportation Program funded the Electric Vehicle Charging Station Financing Program, which is administered by the California Pollution Control Financing Authority. Because potential borrowers have shown limited interest in this demonstration-scale financing program, CEC staff expects to reevaluate and modify this program to best meet the needs for charging infrastructure development in the state. Other advanced financing mechanisms may also be considered as EVCS markets continue to mature.

eMobility

New mobility services, including car and ridesharing and autonomous and connected vehicles, present other opportunities to expand the use of ZEVs. Thus far, ZEV use has been limited largely to those who have the means to purchase a new vehicle. Dedicated ZEV car and ridesharing services, however, can provide zero-emission transportation options for drivers and passengers who would otherwise have no alternatives to conventional automobiles. To advance ZEV adoption and provide equity, the CEC is researching grant opportunities to fund innovative electric mobility projects, focusing on partnerships with communitycentric organizations. This could include partnering with community services in rural locations; churches; community centers; tribal communities and rancherias; and locations identified using indices such as California Healthy Places Index or communities with a high-number of subsidized school lunches.[43] The funding would be directed toward projects that provide clean shared light- and medium-duty vehicle mobility options for three types of disadvantaged populations within six specified California areas to provide needed charging infrastructure. These demonstrations may be targeted in disadvantaged and rural communities to provide further benefits to Californians who lack adequate transportation options. The $65 million CARB is investing in car and ridesharing in disadvantaged communities with its Low Carbon Transportation funding would further complement Clean Transportation Program investments in this area.

Planning and Readiness

The CEC has provided funding to other project types that can indirectly achieve the goals of the Clean Transportation Program, including regional alternative fuel readiness plans. The Regional Alternative Fuel Readiness Planning allocation provided a funding source for planning that prepares for and expedites the launch of alternative fuel infrastructure and vehicles.

The CEC has conducted six grant solicitations for regional readiness planning, providing $11.13 million for 51 agreements to prepare for and expedite the deployment of alternative fuel infrastructure and vehicles. Since the first regional readiness planning projects were approved in 2011, the zero-emission vehicle sector has matured significantly. Most regions in California

43 Healthy Places. Healthy Places Index. Available at https://healthyplacesindex.org/map/.

have developed regional readiness plans because of this funding, and the plans have aided the launch of the first generation of zero-emission vehicles and the continued installation of charging and refueling infrastructure.

Most recently, the CEC released Solicitation GFO-17-604 to provide grant funding for the EV Ready Communities Challenge competition. GFO-17-604 is the first phase of a two-phase effort that provided funds to develop replicable planning blueprints that identify the actions needed to accelerate implementation of electrified transportation at the regional level. Twenty organizations applied for funding under GFO-17-604, and the CEC provided a total of $2 million in grants to nine recipients. All organizations successfully completed Phase I blueprints and will be eligible to apply for blueprint implementation funding under the second phase of the EV Ready Communities Challenge solicitation with planned release in the second quarter of 2020.

Other Sources of Funding for PEV Infrastructure

As referenced in Chapter 2, CEC staff will continue to monitor and coordinate with other EVCS deployment projects, such as CPUC transportation electrification activities and the Volkswagen diesel emissions settlement to ensure the strategic placement of electric vehicle infrastructure and avoid duplication of efforts. As more funding sources become available, all agencies, utilities, and companies providing EVCS funding will need to coordinate to expedite expansion of the charging network and avoid duplication.

Summary

Issued in January 2018, Executive Order B-48-18 set a directive to install 250,000 zero-emission vehicle charging ports, including 10,000 DC fast charging ports, in California by 2025. CEC staff, using NREL's EVI-Pro modeling, estimates that the sum of existing charging ports and charging ports funding across all state funding programs will result in 162,000 Level 2 charging ports and 6,400 DC fast charging ports by 2025, leaving gaps of nearly 78,000 Level 2 charging ports and 3,600 DC fast charging ports by 2025. Staff recommends an aggressive near-term funding solution to help close this gap. To help achieve this adoption, the CEC proposes allocating $92.7 million (includes the proposed $51 million one-time legislative appropriation) for light-duty electric vehicle charging infrastructure for FY 2020-2021.

Medium- and Heavy-Duty Zero-Emission Vehicles and Infrastructure

Freight and transit vehicles serve as a pillar to the California economy, providing indispensable functions for domestic goods movement, international trade, mass transportation, and other essential services. Clean Transportation Program funding in this sector has historically focused on medium- and heavy-duty vehicles, defined here as vehicles with a gross vehicle weight rating above 10,000 pounds. These vehicles represent a small share of California registered vehicle stock, accounting for about 1 million out of 31 million vehicles, or 3 percent; however, this small number of vehicles is responsible for about 23 percent of on-road GHG emissions in the state because of comparatively low fuel efficiency and high number of miles traveled per

year.[44] Medium- and heavy-duty vehicles additionally account for nearly 60 percent of NO_X and 52 percent of $PM_{2.5}$ emissions from on-road transportation in California.[45] For these reasons, medium- and heavy-duty vehicles represent a significant opportunity to reduce GHG emissions and criteria emissions while focusing on a small number of vehicles. Non-road freight vehicles, such as forklifts and other cargo handlers, have similar or supporting purposes and potential for emission reductions.

In October 2019, CEC staff conducted a workshop to explore various solicitation concepts that will prioritize infrastructure to support deployment of zero-emission medium- and heavy-duty advanced vehicle technologies within the California freight system, transit bus fleets, and other sectors in need.[46] The five concepts introduced at the workshop will be developed into solicitations over the next year and will provide a wide range of support for medium- and heavy-duty zero-emission vehicle infrastructure. These concepts could draw upon nearly $47.5 million available from prior investment plans. Concepts proposed at the workshop include:

- Freight, Zero-Emission Vehicle Infrastructure Deployment for Vehicle Demonstrations.
- Transit Fleets, Capital Expenses Assistance for Zero-Emission Infrastructure Deployment.
- ZEV Blueprints for Medium- and Heavy-Duty Vehicles Infrastructure (including small seaports and disadvantaged communities).
- Hydrogen Rail and Marine Applications.
- Innovative Charging and Refueling Solutions.

Clean Transportation Program Funding to Date

The CEC has provided more than $125 million in Clean Transportation Program funding for a wide variety of alternative fuel and advanced technology powertrains that can be incorporated into California trucks and buses. Table 8 summarizes the portfolio of the advanced technology freight and fleet vehicle projects supported through the Clean Transportation Program.

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44 Based on analysis from California Energy Commission Energy Assessments Division, with data from the California Department of Motor Vehicles. California Air Resources Board. June 22, 2018. "California Greenhouse Gas Inventory for 2000-2016." Available at https://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_sum_2000-16.pdf.

45 California Air Resources Board. "Almanac Emission Projection Data." Accessed August 17, 2018. https://www.arb.ca.gov/app/emsinv/2017/emssumcat_query.php?F_YR=2012&F_DIV=-4&F_SEASON=A&SP=SIP105ADJ&F_AREA=CA#7.

46 California Energy Commission. October 25, 2019. Staff workshop for Medium and Heavy-Duty Zero-Emission Vehicles. Available at https://www.youtube.com/watch?v=fbL3VfUsC_0&feature=youtu.be.

Table 8: Advanced Freight and Fleet Vehicle Projects Supported by the Clean Transportation Program as of December 1, 2019

Medium- and Heavy-Duty Vehicle Demonstrations	# of Demonstration Projects
Medium-Duty BEVs	5
Medium-Duty PHEVs	2
Medium-Duty Hybrids	1
Heavy-Duty BEVs	10
Heavy-Duty PHEVs	7
Heavy-Duty Hybrids	4
Electric Buses	4
Natural Gas Trucks	7
Fuel Cell Trucks	2
Fuel Cell Buses	5
Off-Road Hybrids	1
E85 Hybrids	1
Vehicle-to-Grid	3
Intelligent Transportation Systems	2
Total	**54**

Source: California Energy Commission

Other Sources of Funding

As referenced in Chapter 2, CEC staff will continue to monitor and coordinate with other freight and fleet deployment projects, such as CARB's Clean Transportation Incentives and the SB 1403 investment strategy for zero-emission and near-zero emission heavy-duty vehicles and equipment, along with the planning efforts associated with the California's Beneficiary Mitigation Plan for the Volkswagen Mitigation Trust. As more funding sources become available, all agencies and companies providing freight and fleet funding will need to coordinate to avoid duplication.

Charging for Medium- and Heavy-Duty Vehicles

Medium- and heavy-duty vehicles with electric powertrains may have charging infrastructure requirements that are incompatible with those of light-duty vehicles. These vehicles may require charging infrastructure with specialized connectors or higher voltage and power levels than what are typically provided for light-duty PEVs. In addition, heavy-duty vehicle operators may need to locate chargers in areas that are inaccessible to the public for security and safety reasons. CEC staff is developing a set of guidelines specific to medium- and heavy-duty vehicles and expects that a portion of the funding from this allocation may be used to support the installment of charging infrastructure specifically for medium- and heavy-duty PEVs.

Many alternative-fueled freight and fleet vehicles also require specialized refueling infrastructure. While light-duty PEVs use standard Level 1, Level 2, or DC fast chargers,

medium- and heavy-duty electric vehicles can require charging systems that provide significantly higher voltage and power levels. Medium- and heavy-duty PEV manufacturers have not yet agreed to standardize electric vehicle chargers, and some use specialized charging systems that can be significantly more expensive than light-duty counterparts. This specialized and dedicated electric charging refueling infrastructure can add significant cost and affect the financial viability of alternatively fueled vehicle projects.

The CEC is seeking ways to assist transit agencies with their transition to zero-emission buses. The objective would be to provide targeted capital assistance to install transit zero-emission fueling infrastructure (in other words, "make-ready" equipment and infrastructure for battery charging systems and hydrogen fueling equipment) throughout the state where transit buses operate. By providing funding assistance for fueling infrastructure and grid infrastructure improvements needed to support zero-emission transit buses and equipment, the CEC would accelerate the modernization of California's public transport system, support compliance with CARB's Innovative Clean Transit bus regulation for transit operators, and spread the benefits of transportation electrification to diverse communities.

As mentioned in the previous section, the CEC has used the EVI-Pro tool to estimate charging infrastructure needs for the light-duty sector. However, the EVI-Pro tool is not configured to provide similar estimates for medium- and heavy-duty vehicles because of comparative lack of information regarding travel patterns and preferred approaches for recharging. As the CEC prepares to conduct its inaugural charging infrastructure assessment as part of Assembly Bill 2127 (Ting, Chapter 365, Statutes of 2018), estimating the charging needs of medium- and heavy-duty vehicles will be one of the key areas of analysis. The analysis will also involve the development of the Heavy Electric Vehicle Infrastructure Projection tool, or "HEVI-Pro" for short. HEVI-Pro will assist with analyzing smart charging load profiles and providing a framework for potential grid upgrades. The analysis is expected by the late summer of 2020, in alignment with the requirement to complete the first biennial AB 2127 infrastructure assessment by the end of 2020.

CEC staff is exploring the option for developing a streamlined, continuous incentive project for medium- and heavy-duty charging infrastructure. If pursued, this funding mechanism could be structured as a block grant, with similarities to CALeVIP (which promotes charging infrastructure aimed at the light-duty sector).

Hydrogen Refueling Infrastructure for Medium- and Heavy-Duty Vehicles

Fuel cell electric vehicles using hydrogen fuel offer another zero-emission transportation option for California's medium- and heavy-duty sectors and short-range and long-range applications. The CEC has funded projects that use hydrogen infrastructure for freight vehicles at California seaports and inland warehouses and distribution centers, and the Commission continues to explore new options for advancing this technology.

Companies are also producing or are planning to produce heavy-duty vehicles with hydrogen fuel cell electric powertrains, including transit buses and tractor-trailer trucks. These vehicles, and the fleets that operate them, may require dedicated refueling infrastructure to ensure the safety, security, and fuel supply of the vehicles. CEC staff expects that some portion of Clean

Transportation Program funding will be used to support the construction and installation of hydrogen refueling infrastructure specifically for medium- and heavy-duty FCEVs.

Planning and Readiness for Medium- and Heavy-Duty Vehicle Infrastructure

The CEC is seeking ways to assist commercial and bus fleet operators with transitioning to zero-emission medium- and heavy-duty vehicles by providing funding for ZEV readiness blueprints. Funding can promote planning efforts that prepare for and expedite the deployment of ZEVs and infrastructure that are integrated smartly into the grid to reduce charging costs, provide grid benefits, and reduce costs for all electricity users. Commercial and bus fleets throughout the state are facing significant barriers with infrastructure installation as they prepare to incorporate electrification or fuel cell technology or both. Guidance is critical, and CEC staff is working on ways to provide a mechanism for planning, as well as outreach and education to help achieve this transition.

Summary

To meet state GHG and air quality goals, this sector will need to transition to zero-emission technologies, and the resources required for this transition far exceed available funding. CEC staff expects an increasing demand for dedicated charging and refueling infrastructure for medium- and heavy-duty ZEVs funded through the Clean Transportation Program and by other state incentives programs. As the state's lead agency for ZEV infrastructure deployment, the CEC will focus on the infrastructure needs of medium- and heavy-duty ZEVs; however, the option to fund medium- and heavy-duty ZEV demonstrations will remain eligible. In addition to vehicle and infrastructure investments, the CEC will seek ways to include grid integration, integrated storage solutions, and charging management as complementary technologies.

For FY 2020-2021, the CEC allocates $20 million for this category dedicated to medium- and heavy-duty ZEV and infrastructure. However, looking beyond the timeframe in which CEC staff will implement the five previously proposed concepts, the CEC expects the need for medium- and heavy-duty ZEV infrastructure to ramp up drastically. For this reason, the funding allocation for this activity will increase dramatically in subsequent fiscal years to meet the growing needs of medium- and heavy-duty ZEVs and charging infrastructure, as well as demonstrate the state's commitment to improving air quality.

Hydrogen Refueling Infrastructure

Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) directs the CEC to allocate $20 million annually, not to exceed 20 percent of the funds appropriated by the Legislature, from the Alternative and Renewable Fuel and Vehicle Technology Fund for planning, developing, and building hydrogen-refueling stations until there are at least 100 publicly available stations in California. The Clean Transportation Program funds the development of hydrogen refueling stations to support the early fuel cell electric vehicle (FCEV) market and the increasing population of on-road FCEVs. These annual allocations also support the goal of having 200 hydrogen refueling stations by 2025, which was established by Governor Edmond G. Brown Jr. Executive Order B-48-18.

Technology Overview

FCEVs using hydrogen fuel offer another zero-emission transportation option for Californians. Like electricity, hydrogen can be produced from a variety of pathways, including renewable sources of energy. FCEVs can also travel farther and be refueled more quickly than BEVs. Fuel cells enable electrification of a broad range of vehicles, including passenger cars, light-duty trucks and SUVs, transit buses, and heavy-duty trucks and can complement BEVs by offering zero-emission vehicles to drivers who need more range or faster refueling.

FCEVs are available in California for lease or sale from Toyota, Honda, and Hyundai. In July 2018, Mercedes-Benz announced a concept hydrogen fuel cell Sprinter F-Cell. In October 2019, Toyota announced the next generation Mirai, "Mirai Concept," with a targeted 30 percent increase in range, scheduled for launch in late 2020.

The CEC, through the Clean Transportation Program, has supported the development of hydrogen refueling regulations and test procedures, hydrogen refueling infrastructure test equipment, and regional readiness plans for FCEV and refueling station development. The CEC also provides data on Clean Transportation Program-funded hydrogen refueling infrastructure to the NREL Technology Validation Program. NREL combines these data with other nationally sourced data to assess hydrogen refueling systems and components under real-world conditions; analyze the availability and performance of existing hydrogen fueling stations; and provide feedback regarding capacity, use, station build time, maintenance, fueling, and geographic coverage. The technology validation analyses help inform state and national hydrogen refueling infrastructure installation.

Clean Transportation Program Funding to Date

Through the Clean Transportation Program, the CEC has provided nearly $120 million of funding to install or upgrade 64 publicly available hydrogen stations capable of light-duty vehicle refueling. As of February 2020, 44 hydrogen refueling stations were open retail in California, with 43 funded by the Clean Transportation Program.

Furthermore, the Clean Transportation Program recently issued a solicitation, GFO-19-602, announcing the availability of up to $115.7 million in grant funds (subject to future appropriations and Clean Transportation Program Investment Plan funding allocations). The solicitation is to fund hydrogen refueling infrastructure projects that will expand California's early commercial light-duty hydrogen refueling and FCEV markets and accommodate the projected FCEV rollout in 2021-2024. The solicitation was designed to help station developers achieve economies of scale and reduce equipment costs by offering the remaining funding allocations for hydrogen refueling infrastructure. The CEC anticipates that the $115.7 million in grant funding available in GFO-19-602 could result in at least 60 additional stations.

GFO-19-602 allows projects to include refueling for commercial fuel cell vehicles and buses with light-duty vehicle refueling without diminishing the light-duty customer experience. This approach has the potential to aid in the transition of California's commercial vehicle and bus fleets to a zero-emission alternative while strengthening the business case for light-duty hydrogen refueling through increased station throughput and stations with common designs and fuel supply. This strategy also reduces costs of hydrogen production and distribution as hydrogen-powered commercial fleet and bus vehicles are launched in greater numbers.

Overall, stations funded by the Clean Transportation Program so far are expected to dispense fuel with an average of 39 percent renewable hydrogen content. Any stations resulting from GFO-19-602 are required to meet requirements for the LCFS Hydrogen Refueling Infrastructure (HRI) credit, which requires at least 40 percent of the hydrogen from renewable sources. The renewable hydrogen from these agreements is typically derived from either renewable electricity via electrolysis or biomethane via steam methane reformation at central production plants.

In addition to funding for infrastructure development, the CEC offered operations and maintenance (O&M) funding for the initial network of hydrogen refueling stations in the past. This funding provided ongoing support to station developers who build and operate stations before the mass introduction of FCEVs and was meant to sustain the stations until enough vehicles are on the roads to be profitable. With the introduction of the LCFS HRI program in 2019, the Clean Transportation Program decided not to offer O&M funding in GFO-19-602 to maximize the number of hydrogen refueling stations the CEC can fund.

Other Sources of Project Support

The HRI credit provision of the LCFS became effective in January 2019. This provision allows eligible hydrogen refueling station operators to earn HRI credits based on the capacity of the hydrogen station, in addition to credits earned for the fuel dispensed.[47] The expected value of these HRI credits and the duration of the incentive exceed the O&M funding that was offered through the Clean Transportation Program in the past, and the value and duration should reduce investment risk and provide a stable source of operating capital. The CEC will continue discussions with CARB and stakeholders to ensure that all available funding for hydrogen refueling is used in the most effective manner for encouraging early FCEV adoption.

In 2018, CARB selected Bay Area Air Quality Management District (BAAQMD) to administer $10 million of the Volkswagen Mitigation Trust funds for light duty zero-emission infrastructure projects, evenly allocated between electric vehicle charging stations and hydrogen refueling stations. In 2019, CARB and BAAQMD executed an agreement confirming BAAQMD as the project administrator. CEC will receive and utilize Mitigation Trust funds from BAAQMD to augment the CEC's competitive hydrogen refueling station solicitation that will allow CEC to fund additional stations.

Use of the $5 million Mitigation Trust funds will accelerate the Clean Transportation Program's development of at least 100 publicly available hydrogen refueling stations in California, as specified in Assembly Bill 8. The use of the $5 million Mitigation Trust funds and cooperation

47 California Air Resources Board Resolution 18-34 information is available at https://www.arb.ca.gov/fuels/lcfs/rulemakingdocs.htm. This modification to the LCFS provides credits to hydrogen refueling station owners for 15 years, with the credits being calculated based on the nameplate capacity of the station not to exceed 1,200 kilograms of hydrogen per day, and the availability (or uptime) of the station relative to the permitted hours of operation. The amount of dispensed hydrogen is subtracted from the calculation of HRI credits so that credits are not double earned.

among CARB, BAAQMD, and the CEC will ensure that hydrogen refueling infrastructure funding decisions are optimized and reduce the amount of time and funding required to reach the goal of 100 publicly available hydrogen refueling stations in California

Evaluating the Deployment of FCEVs and Hydrogen Refueling Stations

Assembly Bill 8 requires CARB to evaluate the need annually for additional publicly available hydrogen fueling stations. This evaluation includes the quantity of fuel needed for the actual and projected number of hydrogen-fueled vehicles (based on DMV registrations and automaker projections), geographic areas where fuel will be needed, and station coverage. Based on this evaluation, CARB reports to the CEC the number of stations; areas where additional stations will be needed; and minimum operating standards, such as number of dispensers, filling protocols, and pressure. CARB determines station and fuel cell electric vehicle projections for up to six years in the future, based on mandatory survey information provided by vehicle manufacturers for the next three model years and voluntary information for an additional three following model years.

CARB released the *2019 Annual Evaluation of Fuel Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Deployment* report in July 2019 to comply with the requirements of Assembly Bill 8.[48] In this assessment, CARB determined that today's network of open retail hydrogen refueling stations has established the early fueling market that enabled the launch of the FCEV consumer market in California. CARB also determined that the Clean Transportation Program funding and CARB's LCFS HRI program are major steps that should provide certainty to the market for the 200 station goal. Manufacturer surveys project 48,000 FCEVs will be on California roads by the end of 2025.

In December 2019, the CEC and CARB released the *Joint Agency Staff Report on Assembly Bill 8: 2019 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California*.[49] This annual joint report evaluates progress in establishing a network of 100 publicly available hydrogen refueling stations, the factors affecting timely station development, the time and public funding needed to reach the goal of 100 publicly available stations by 2024, and the ability of the hydrogen refueling network to serve the anticipated 48,000 FCEVs projected by the end of 2025. Among the key findings of the joint report:

- California needs more hydrogen fueling capacity to support the anticipated numbers of FCEVs in the years to come. The network capacity of the 44 open retail stations is more

48 California Air Resources Board. *2019 Annual Evaluation of Fuel Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development.* July 2019. Available at https://ww2.arb.ca.gov/sites/default/files/2019-07/AB8_report_2019_Final.pdf.

49 Baronas, Jean, Gerhard Achtelik, et al. 2019. *Joint Agency Staff Report on Assembly Bill 8: 2019 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California.* California Energy Commission and California Air Resources Board. Publication Number: CEC-600-2019-039. Available at https://ww2.energy.ca.gov/2019publications/CEC-600-2019-039/CEC-600-2019-039.pdf.

than 12,300 kilograms per day. Considering the entire funded network of 64 stations that are either open or under development, the capacity is nearly 24,500 kilograms per day. The vehicle projections from the auto manufacturer survey will require another 10,000 kilograms of daily capacity by 2025 at minimum.

- GFO-19-602 stands to fund the installation of the necessary hydrogen refueling infrastructure to allow for the acceleration of FCEV deployment such that these vehicles can provide significant emissions reductions and help achieve the goal of having 5 million zero-emission vehicles in California by 2030.
- CARB has approved 48 stations to participate in the HRI program thus far. The program encouraged several hydrogen refueling station operators to increase the renewable hydrogen content of their fuel to increase the potential to earn more credits.
- The hydrogen station network experienced a hydrogen supply disruption that affected most of Northern California stations for more than six months. To develop a more resilient system, the CEC included more comprehensive requirements for hydrogen supply agreements under GFO-19-602.
- Both the cost per kilogram of station capacity and development time are decreasing.

Summary

As the market for hydrogen fuel matures, station developers become more experienced, and with the funding structure set up in GFO-19-602, hydrogen station capital expenses are expected to decrease.

For FY 2020-2021, the CEC allocates $20 million for hydrogen refueling infrastructure, which is the maximum allocation allowable under current law.[50] With this funding restriction, CEC staff analysis predicts that the Clean Transportation Program will be able to fund a statewide network exceeding 100 publicly available hydrogen refueling stations that will be open retail by the end of 2024. These stations are expected to have larger refueling capacities than most of the stations that the CEC funded early in the program, and to be able to provide fueling adequate to support the number of FCEVs that CARB predicts will be on the roads in 2025.

50 California Health and Safety Code Section 43018.9.

Summary of Zero-Emission Vehicles and Infrastructure Allocations

Table 9: Multiyear Funding for Zero-Emission Vehicles and Infrastructure

	FY 2020-2021	FY 2021-2022	FY 2022-2023	FY 2023
Light-Duty Electric Vehicle Charging Infrastructure and eMobility Relevant Policy Goals: – GHG Reduction – Petroleum Reduction – Low Carbon Fuel Standard – Air Quality – ZEV Regulations – Environmental Equity	$92.7* Million	$30.2 Million	$10 Million	-
Medium- and Heavy-Duty Zero-Emission Vehicles and Infrastructure Relevant Policy Goals: – GHG Reduction – Air Quality – Petroleum Reduction – Low Carbon Fuel Standard – Sustainable Freight Action Plan	$20 Million	$30 Million	$52.2 Million	$32.6 Million
Hydrogen Refueling Infrastructure Relevant Policy Goals: – GHG Reduction – Petroleum Reduction – Low Carbon Fuel Standard – Air Quality – ZEV Regulations	$20 Million	$20 Million	$20 Million	$5 Million
Totals	**$132.7 Million**	**$80.2 Million**	**$82.2 Million**	**$37.6 Million**

Source: California Energy Commission. *For FY 2020-2021 the Light-Duty Vehicle Charging Infrastructure and eMobility funding category received a $51 million one-time legislative expenditure authority from the Alternative and Renewable Fuel and Vehicle Technology Fund to increase and accelerate electric vehicle charging infrastructure which will support increased zero-emission vehicle adoption and deployment in California.

CHAPTER 5:
Alternative Fuel Production and Supply

Zero- and Near-Zero-Carbon Fuel Production and Supply

The California transportation sector depends largely on petroleum, which accounts for 89 percent of ground transportation fuel used in the state.[51] Any low-carbon substitute fuel that can displace the roughly 14 billion gallons of petroleum-based gasoline and 3.3 billion gallons of petroleum-based diesel used per year in California can provide an immediate and long-term opportunity to reduce GHG emissions and criteria air pollution.[52] Biofuels—defined in this document as nonpetroleum diesel substitutes, gasoline substitutes, and biomethane—represent the largest existing stock of alternative fuel in the California transportation sector.[53] In addition, production of and demand for renewable hydrogen are expected to increase in the coming years as more hydrogen fuel cell electric vehicles are sold.

The carbon intensity of renewable fuels can vary significantly depending on the pathway, which accounts for the specific feedstock and production process of the fuel. CARB provides carbon intensity values for most transportation fuels as part of the LCFS. The carbon intensity value accounts for the life-cycle GHG emissions of the fuel, including production, transportation, and consumption, and is reported in grams of carbon dioxide equivalent greenhouse gases per megajoule (gCO_2e/MJ).[54] Maximizing renewable fuel production from the lowest carbon pathways represents a key opportunity to reduce near-term GHG emissions in combustion engines and fuel cell electric vehicles. Biofuels derived from waste-based feedstocks typically have the lowest carbon intensity of all transportation fuels. Clean Transportation Program funding uniquely drives innovative biofuel production plants to California, which may otherwise come from out of state through other funding mechanisms.

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51 Based on analysis from California Energy Commission Energy Assessments Division, with data from the California Department of Motor Vehicles.

52 Ibid.

53 The term *gasoline substitutes* refers to any liquid fuel that can directly displace gasoline in internal combustion engines, including ethanol and renewable drop-in gasoline substitutes. The term *diesel substitutes* refers to any liquid fuel that can significantly displace diesel fuel, including biodiesel and renewable diesel. These definitions differ from similar terms used by CARB under the LCFS, which are broader and include fuels such as electricity, natural gas, and hydrogen.

54 Consult the glossary for the definition of *megajoule*.

Past Clean Transportation Program fuel production awards have been disproportionately located in disadvantaged communities. The projects were funded because of the various possible economic benefits associated with the installation, expansion and operation of the plants. Such anticipated benefits included increases of tax bases and job creation. However, local pollution costs and benefits are less certain. The CEC will seek to further ensure that alternative fuel production projects provide economic and environmental benefits within disadvantaged communities.

Fuel Type Overview

Renewable Diesel and Biodiesel

In 2018, renewable diesel was the most common diesel substitute in California with 384 million gallons used.[55] Renewable diesel that meets the fuel specification requirements of ASTM International Standard D975 is fungible, or interchangeable, with conventional diesel fuel and can be used in existing diesel engines and fuel infrastructure.

Biodiesel is another diesel substitute; however, unlike renewable diesel, it is not fully fungible with conventional diesel fuel. Many modern diesel vehicles can use biodiesel in concentrations ranging from 5 to 20 percent, depending on the requirements and limitations of the engine and blend robustness, without special modifications to the vehicle. Renewable diesel and biodiesel have carbon intensities up to 92 percent lower than diesel fuel, depending on the pathway used.[56] Together, renewable diesel and biodiesel accounted for about 50 percent of LCFS credits in 2018, increasing from 9 percent of LCFS credits in 2011.[57]

Within California, there are limited distribution methods for the different types of low carbon fuels. As LCFS continues to incentivize increased production and supply of low carbon fuels in California, the infrastructure to distribute low carbon fuels will have to be in place to meet California's low-carbon fuel production potential and consumption needs, as well as to accomplish California's greenhouse gas emission goals.

Ethanol and Renewable Gasoline

Ethanol is the only widely available gasoline substitute and is used primarily as a fuel additive with gasoline. California limits ethanol blends in conventional gasoline to 10 percent, although the U.S. Environmental Protection Agency permits blends of up to 15

55 California Air Resources Board. April 30, 2019."LCFS Quarterly Data Spreadsheet." Available at http://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm.

56 Compared to California diesel (102.01 gCO2e/MJ), with biodiesel carbon intensity as low as 8.63 gCO2e/MJ and renewable diesel carbon intensity as low as 16.89 gCO2e/MJ. Based on data from the LCFS Fuel Pathway Table (April 16, 2019), available at https://www.arb.ca.gov/fuels/lcfs/fuelpathways/current-pathways_all.xlsx.

57 California Air Resources Board. April 30, 2019. "LCFS Quarterly Data Spreadsheet." Available at http://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm.

percent for a conventional engine, and 85 percent for a flex fuel engine. Though ethanol continues to be the largest volume alternative fuel used in California, in-state ethanol use has not substantially changed since 2011.

Renewable gasoline is a potential gasoline substitute, although it is undergoing research and development and is not commercially available. Similar to renewable diesel, it will need to conform to relevant ASTM International standard specifications to operate in unmodified spark ignition (for example, gasoline) engines. Renewable crude oil products can serve as a fully fungible substitute for petroleum crude oil at refineries. Renewable crude oil is in the research and development phase and, if developed into a commercially viable product, may contribute significantly to California's environmental and energy goals.

Biomethane

Biomethane is a commercially mature biofuel that serves as a low- or negative-carbon substitute for conventional natural gas. Biomethane from anaerobic digestion of wastewater sludge can reduce GHG emissions by as much as 92 percent below diesel. Biomethane derived from high-solids anaerobic digestion of prelandfill food and green wastes has a carbon intensity around *negative* 23 grams of carbon dioxide equivalent greenhouse gases per megajoule (gCO_2e/MJ) (or roughly 125 percent below diesel), indicating that the pathway contributes a net GHG emission reduction. Biomethane derived from dairy biogas has the lowest carbon intensity approved under the LCFS—about negative 255 gCO_2e/MJ.[58]

The potential of low-carbon biomethane to replace natural gas in the transportation sector is based on the availability of waste-based feedstocks, and estimates vary on technical and economical availability. Based on a 2013 study from the National Renewable Energy Laboratory (NREL), the Union of Concerned Scientists suggests that capturing biomethane from all potential sources of organic waste in California could represent up to 450 million diesel gallon equivalents (DGE), or roughly, 15 percent of diesel fuel use in California.[59] The University of California, Davis, Institute of Transportation Studies, indicated in 2016 a slightly higher economically feasible potential of roughly 623 million DGE. However, based on other studies provided by NREL, the technical availability (under preferable market conditions) could be four times higher.[60] Regardless, given the limited availability, the carbon reduction benefits

58 California Air Resources Board. October 31, 2018. "LCFS Pathway Certified Carbon Intensities." Available at https://www.arb.ca.gov/fuels/lcfs/fuelpathways/pathwaytable.htm.

59 Union of Concerned Scientists. May 2017. "The Promises and Limits of Biomethane as a Transportation Fuel." Available at https://www.ucsusa.org/sites/default/files/attach/2017/05/Promises-and-limits-of-Biomethane-factsheet.pdf.

60 California Energy Commission staff. 2017. *2017 Integrated Energy Policy Report.* California Energy Commission. Publication Number: CEC-100-2017-001-CMF. Available at https://www.energy.ca.gov/2017_energypolicy/.

from biomethane need to be prioritized for specific transportation applications (as well as other purposes) in which no zero-emission alternative is available.

The Legislature passed SB 1383 with the intent to, among other things, support policies that improve the cost-effectiveness and environmentally beneficial uses of biomethane derived from solid waste. As part of this legislation, the CPUC is directing natural gas utilities to undertake at least five pilot projects to demonstrate pipeline injection of biomethane at California dairies. These pilot projects are expected to demonstrate the feasibility of these project types and provide a model to increase the use of biomethane fuel in California.

Renewable Hydrogen

Senate Bill 1505 (Lowenthal, Chapter 877, Statutes of 2006) requires that 33 percent of hydrogen used for transportation come from renewable sources. As part of the Low Carbon Fuel Standard credits for ZEV infrastructure that took effect in January 2019, qualifying stations must have a renewable content of 40 percent or higher. Renewable hydrogen is a relatively new transportation fuel, as hydrogen fuel cell electric vehicles (FCEVs) have only recently become commercially available. The production methods, however, are commercially mature; renewable hydrogen can be produced through steam reformation of biomethane, or through electrolysis using water and renewable electricity.

According to the California Independent System Operator, increasing amounts of renewable power generation may result in electricity oversupply as California renewable power requirements grow from 33 percent to 50 percent.[61] Renewable hydrogen production is being investigated as a viable technology for beneficial use of this surplus renewable energy. Several Clean Transportation Program projects already use electrolysis to generate modest volumes of hydrogen at fueling stations. Potential renewable hydrogen production projects may include using renewable energy to produce large volumes of renewable hydrogen through electrolysis, or commercial-scale steam reformation plants that exclusively use biomethane as a feedstock.

Clean Transportation Program Funding to Date

To date, the CEC has awarded nearly $200 million to 71 low-carbon fuel production projects. These awards are summarized by fuel type in Table 10.

61 California Independent System Operator. April 29, 2016. *"Flexible Resources to Help Renewables - Fast Facts."* Available at http://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf.

Table 10: Summary of Low-Carbon Fuel Production Awards to as of December 1, 2019

Fuel Type	Qualifying Proposals* Submitted	Funds Requested by Qualifying Proposals* (in Millions)	Awards Made	Funds Awarded (in Millions)
Gasoline Substitutes	27	$68.8	16	$39.5
Diesel Substitutes	60	$177.1	26	$74.2
Biomethane	62	$191.9	27	$76.8
Renewable Hydrogen	3	$11.9	2	$7.9
Total	**152**	**$449.7**	**71**	**$198.4**

Source: California Energy Commission. Does not yet include results from GFO-19-601. *Qualifying proposals refers to proposals that received at least a passing score.

The Clean Transportation Program investments into low-carbon fuel production are typically focused on either smaller precommercial projects or large community- or commercial-scale projects. The smaller, precommercial projects have typically focused on transformative technology solutions that have the potential to increase yields, productivity, or cost-effectiveness of low-carbon fuel production. The CEC funds these pilot and demonstration projects with the expectation that, after successful operations at this scale, the technology will be suitable for commercial use. These precommercial projects are focused on advanced new technologies and approaches that can subsequently be expanded into wider markets.

In August 2019, the CEC released GFO-19-601 titled "Low-Carbon Fuel Production Program." The solicitation was an offer to fund ultra-low-carbon transportation fuel production at new and existing advanced fuel production plants. The solicitation provided $12.5 million from the Greenhouse Gas Reduction Fund, and on January 21, 2020, the CEC issued a notice of proposed awards of four grants. The solicitation produced $53 million in requested funds, indicating a strong interest in the sector.

Other Sources of Funding

Other state and federal programs also provide support and incentives to low-carbon fuel producers. The California Department of Resources Recycling and Recovery (CalRecycle) Organics Grant Program conducted three grant cycles in 2014, 2017, and 2018, which awarded $32.9 million to nine biomethane-producing projects. For Fiscal Year 2018-2019, slightly more than $25 million is available for waste diversion using greenhouse gas reduction funds.

The California Department of Food and Agriculture awarded $35.2 million in October 2017 for anaerobic digesters at dairies through the Dairy Digester Research and Development Program and awarded $72.4 million for additional dairy digester projects in 2018. For 2019, the California Department of Food and Agriculture anticipates making between $61 million and $75 million available for these activities. The CEC will work with these agencies to ensure future funding awards are complementary rather than duplicative.

In addition, the LCFS and RFS requirements can support low-carbon fuel producers by creating markets for carbon credits and renewable fuels. The incentives earned through the LCFS provide steady financial support to low-carbon fuel producers, distributors, and blenders in California. In 2018, 88 percent of LCFS credits were granted for biofuels including biomethane, ethanol, biodiesel, and renewable diesel.[62] These credits equate to an incentive of more than $1.1 billion for biofuel producers and retailers, if sold at the average credit price of $154 for 2018.[63] CARB and CEC staff expects that the LCFS will serve as the state's primary source of financial support for low-carbon fuel production and distribution.

Summary

Given the near-term petroleum and GHG emission reduction potential of any low-carbon, drop-in gasoline or petroleum replacement, future solicitations under this category may emphasize renewable gasoline, renewable crude oil, and similar products in an attempt to accelerate development. There may also be opportunities to expand or otherwise improve the limited distribution of liquid biofuels (whether for drop-in substitutes or blending), which impedes the state's supply of low-carbon transportation fuel.

Some fuel types and pathways have shown minimal improvement in carbon intensity or cost-effectiveness in recent funding solicitations, which may indicate that the technology or process has fully matured. The CEC may evaluate renewable fuel types and production pathways to determine when state incentives are no longer necessary. As the market for low-carbon fuels continues to develop, the CEC may also consider alternative funding mechanisms, such as revolving loan or loan guarantee programs, which may be more suitable for large projects and developed industries.

For FY 2020-2021, the CEC allocates $10 million Clean Transportation Program funding for Zero- and Near-Zero Carbon Supply Production and Supply. Funding priorities for this allocation may include increasing the in-state production of low-carbon fuels from waste-based feedstocks, supporting upstream blending infrastructure, and improving the state's supply of renewable hydrogen from renewable electricity overgeneration or biomethane.

62 California Air Resources Board. April 30, 2019. "LCFS Quarterly Data Spreadsheet." Available at http://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm.

63 California Air Resources Board. April 10, 2019. "LCFS Monthly Credit Price and Transaction Volumes April 2019 Spreadsheet." Available at https://www.arb.ca.gov/fuels/lcfs/dashboard/creditpriceserieswithoutargusopis.xlsx.

Summary of Alternative Fuel Production and Supply Allocations

Table 11: Multiyear Funding for Alternative Fuel Production and Supply

	FY 2020-2021	FY 2021-2022	FY 2022-2023	FY 2023
Zero- and Near Zero-Carbon Fuel Production and Supply Relevant Policy Goals: – GHG Reduction – Short-Lived Climate Pollutant Reduction – Petroleum Reduction – In-State Low-Carbon Fuel Production – Low Carbon Fuel Standard	$10 million	$10 Million	$10 Million	$5 Million
Totals	**$10 million**	**$10 Million**	**$10 Million**	**$5 Million**

Source: California Energy Commission

CHAPTER 6:
Related Opportunities

Manufacturing

Providing funding for manufacturing and scale-production of ZEV and ZEV infrastructure technologies is a hallmark of the Clean Transportation Program. California's emerging ZEV supply chain leverages the state's innovations and investments. Companies that produce clean transportation technologies employ workers and have an economic impact in regions of the state from disadvantaged communities and low-income communities to the Silicon Valley. In the absence of private capital for companies to scale production of their clean transportation technologies, companies encounter technology and commercialization risk. Some of this risk can be reduced through state incentives and technology advancement programs.

California is home to nearly 40 PEV and charging infrastructure manufacturing companies.[64] The range of technologies includes light-, medium, and heavy-duty, on- and off-road vehicles. Some of the companies are completely vertically integrated such as Tesla and Proterra (a Clean Transportation Program-funded company). Others produce components such as powertrains and control systems. California is also home to EV charging manufacturers that provide a range of products over global distribution markets.

Since the inception of the Clean Transportation Program, five solicitations have been issued under the manufacturing category for a total of $52 million over 24 projects. The range of products includes ZEV powertrains; fully integrated ZE buses, trucks, and motorcycles, and EV chargers. Recent new additions to the Clean Transportation Program manufacturing portfolio include Enel X North America and FreeWire Technologies. Consistently oversubscribed to these solicitations, Clean Transportation Program investments into manufacturing help companies bridge the investment gap as capital needs grow with scale.

In California, technology-driven transportation electrification regulations are drivers of clean transportation innovation and product commercialization. Air quality goals also drives the need to scale manufacturing of these clean transportation technologies. This need is evidenced, most recently, by the CARB's adoption of the Innovative Clean Transit Regulation (ICT).[65] Proterra, Inc., through a Clean Transportation Program grant, will scale production of its all-electric bus manufacturing in California in 2020. Furthermore, ChargePoint, Inc., through a Clean Transportation Program grant, will also scale DC fast-charger manufacturing to meet the

64 Based on CEC staff research.

65 California Air Resources Board, 2018. Innovative Clean Transit Regulations. Available at: https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit.

needs of the ICT for buses and for other nonlight-duty ZEV markets domestically and abroad by 2020. In addition to benefits that accrue to product manufacturing, economic and workforce benefits accrue to communities where these supply chains reside. In some communities, manufacturing jobs are critical to disadvantaged communities, low-income communities, and to small businesses. More than 700 manufacturing jobs have been created or retained or both under the Clean Transportation Program manufacturing portfolio.

Summary

For FY 2020-2021, the CEC is not allocating Clean Transportation Program funding for manufacturing because of the emphasis on zero-emission vehicle infrastructure deployment. However, manufacturing funding is being recommended for future years.

Workforce Training and Development

Central to the advancement of clean transportation technologies in commercial markets are investments made by the program into various workforce training and development projects. More than $31 million has been invested in workforce projects for more than 17,400 trainees. Since the inception of the program, the delivery of workforce investments have been through state entities as the CEC relied on these entities for workforce knowledge and partnerships. The state agencies then distributed those funds through municipalities, community colleges, and private businesses.

In addition to workforce training and development of advanced vehicle technology maintenance and service sectors, the CEC also supports upstream workforce support for clean transportation technology innovation, demonstration, deployment, and manufacturing. The entire clean transportation supply chain in California is the beneficiary of Clean Transportation Program investments, as well as other CEC investments.

In addition to investments into manufacturing workforce projects, other key workforce investments include transit workforce development, ZEV curricula at California community colleges, and sustainable freight workforce assessments.

The California Community Colleges Chancellor's Office, in partnership with the California Workforce Development Board and Mission College, developed the Energy Transit Apprenticeship Program (ETAP). The apprenticeship program was funded by the Clean Transportation Program. The ETAP was institutionalized by the California Division of Apprenticeship Standards (DAS) for the Santa Clara Valley Transportation Authority with Mission College as the lead educational agency. The project established the DAS registered apprenticeships for coach operator and service mechanic. The project supported an initial enrollment of more than 200 apprentices, established the Mission College Department of Transportation Studies, and created 29 transit career pathway courses and two certificates. The project included ongoing collaboration with the transit districts of San Mateo, Alameda County, Golden Gate Bridge Highway and Transportation, City of Fresno, and the City of Stockton. The ETAP is a transferable model available to regional Workforce Development Boards. The ETAP is designed to meet the projected growth in zero-emission bus procurement and accompanying demand for transit workers that can service and operate these electric bus fleets throughout the state.

The CEC has a long-standing partnership with the community colleges through their Advanced Transportation and Logistics Initiative (ATL; formerly the Advanced Transportation and Technology Centers). This partnership includes:

- ZEV Curriculum–-College faculty developed ZEV curricula for degrees, credit, and certificates at their college for zero-emission vehicle technology for light-duty and truck/bus platforms. A new training project focuses on ZEV curricula in community colleges in communities that serve students in disadvantaged communities and low-income populations.
- Electric School Bus Training–-The CEC awarded funding to school districts to replace diesel school buses with electric school buses in 2019. School districts will receive customized training from nearby community college faculty on these buses for maintenance/service staff and bus operators.
- Clean Fuels Transportation Pilot Career Opportunity Project–-In 2018, ATL, led by Cerritos Community College, developed a pilot training project. The project would build on existing high school automotive programs and increase awareness for the state's high school students in clean transportation. Twenty-seven high schools have been awarded funds to establish credit technical training programs that have a career pathway to clean automotive programs at the community colleges.

As zero-emission vehicle technology has spread to the freight sector, workforce training and development are critical. Workers at port facilities throughout the state are exposed to significant pollution. The use of zero-emission freight technology and the freight workforce is noted in the state's California Sustainable Freight Action Plan (CSFAP)[66] and in the work of the CEC's Ports Energy Collaborative.[67] The CEC recognizes the importance of a sustainable freight workforce and funded two projects:

- Zero-Emission Port Equipment: Workforce Assessment–-The Port of Long Beach was awarded Clean Transportation Program funds to demonstrate 25 zero-emission freight vehicles. Long Beach City College was hired by the Port of Long Beach to perform a workforce gap analysis. The Freight Workforce Assessment addresses issues regarding the deployment of these pieces of equipment, equipment/vehicle adoption projections, potential job growth, and job competencies.
- Sustainable Freight Foundations Certificate–-The CSFAP identified as a priority action, the analysis of key freight workforce skills needed for a sustainable freight system. The CEC, in partnership with California State University, Long Beach, and the University of Southern California, are establishing a pilot project for a sustainable

66 California Sustainable Freight Strategy. Available at: https://californiaports.org/project/california-sustainable-freight-strategy/.

67 California Energy Commission. 2016. Ports Energy Collaborative. Available at: https://ww2.energy.ca.gov/commission/documents/ports_energy_collaborative.pdf.

freight foundations certificate. The pilot project will inform the most critical issues for workforce development in the freight industry.

In a March 2019 "*Integrated Energy Policy Report* Staff Workshop on the Electric Vehicle Charging Infrastructure Assessment AB 2127," CARB provided a presentation on the effect and growth of state policies/regulations for zero-emission vehicle/equipment technologies.[68] In addition to the ICT regulation noted above, CARB noted that at least eight other regulations are in development. The procurement horizons for these ZEV technologies is now. These regulations will require an immediately transformed workforce across all job classifications and industries of public and private employers.

The CEC may consider leveraging its historical investments into the clean transportation sector. New thinking, approaches, and public-private partnerships to workforce training and development should be explored and leveraged as capital. Clean Transportation Program investments should track the level and intensity of zero-emission regulations with respect to required vehicle/equipment procurement schedules.

Summary

Based on the state's development of zero-emission transportation regulations in the near term and needed funds in FY 2021-2022, the CEC allocates $3.5 million for workforce training and development projects. The CEC will continue to explore public-private partnerships and leverage limited capital to determine how Clean Transportation Program funding can best be invested to maximize the benefits of this funding. Workforce training and development investments will prioritize disadvantaged communities, low-income communities, priority populations, and economically disadvantaged high schools to ensure equitable participation in the clean transportation economy.

School Bus Replacement Program

As mentioned in Chapter 2, the School Bus Replacement Program is helping schools throughout the state transition from old, polluting diesel school buses to zero- or low-emissions vehicles, improving children's health by limiting their exposure to transportation-related air pollution and building the green economy. School districts applied for grants to replace over 1,600 diesel school buses, but the program only had sufficient funding for 233 zero-emission buses and charging infrastructure. Given the harmful impacts to children from exposure to toxic diesel exhaust, the state should prioritize replacing older diesel school buses with clean new electric buses, particularly in disadvantaged communities.

SB 110 (Committee on Budget and Fiscal Review, Chapter 55, Statutes of 2017), appropriated the available remaining funds from the implementation of the Proposition 39 K-12 Program to

68 California Air Resources Board. 2019 Presentation–The Need for EV Charging Infrastructure Assessments available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=227307&DocumentContentId=58166.

establish the School Bus Replacement Program at the CEC. SB 110 provided one-time funding of $75 million for the replacement of old diesel school buses with battery electric school buses in disadvantaged and low-income communities throughout California.

The $75 million from Proposition 39 funding is being used exclusively for the purchase of battery-electric school buses. In addition, approximately $14 million in Clean Transportation Program funds is available to provide the necessary charging infrastructure to operate the buses. Finally, the CEC is providing $1 million in Clean Transportation Program funds for workforce training and development, collaborating with local community colleges to develop curriculum for school districts that were awarded electric school buses.

Solicitations and Awards

The School Bus Replacement Program used a two-phased approach to select buses for funding. During the first phase, staff released a solicitation allowing all school districts, County Offices of Education, and Joint Power Authorities in California to apply for up to 10 buses for replacement. The CEC received over 200 applications with over 1,600 diesel school buses requested for replacement; the oldest of which was a 1978 diesel school bus. Individual school buses were evaluated based on three factors: age of bus, applicant's percentage of free and reduced-price meals recipients, and applicant's disadvantaged community score from CalEnviroScreen 3.0.

The second phase of the program also kicked off in November 2018, with a solicitation to select an electric school bus manufacturer(s) or dealer to design, construct, and deliver the electric school buses. The purpose of this solicitation was to establish a bulk purchase price for school districts, COEs and JPAs to utilize. Applications passing a technical evaluation competed in the bus bid evaluation, where the lowest cost bid was selected for each bus type.

From the initial rank list of buses, the CEC was able to fund 233 electric school buses, with an additional $60,000 in infrastructure funding per bus. Table 12 shows a breakdown of the number of awardees, number of buses awarded, total number of seats available on the electric buses in each region, and the total bus and infrastructure awards in each of the four regions. With almost $75 million in funding for school buses, the CEC is able to fund 12,185 seats for students. Approximately 90% of the awardees are located in disadvantaged communities.

Table 12: School Bus Replacement Program Awardees

Region	Number of Awardees	Number of Buses Awarded*	Total Number of Seats Funded**	Total Bus Award	Total Infrastructure Award
North	18	59	3,183	$18,581,444	$3,540,000
Central	23	58	3,662	$18,974,613	$3,480,000
Los Angeles	12	59	2,250	$18,638,763	$3,540,000
South	11	57	3,090	$18,719,024	$3,420,000
Total	**64**	**233**	**12,185**	**$74,913,844**	**$13,980,000**

Source: California Energy Commission.

In July 2019, the CEC approved the majority of the electric school bus replacement and manufacturing agreements. Recipients with fully executed agreements are currently placing orders with manufacturers for new battery electric school buses, and working with their local utilities to install the necessary electric infrastructure. All buses are expected to be delivered by October 2022.

Further Opportunities

There remain over 1,300 buses that could not be funded under the CEC's School Bus Replacement Program due to insufficient funding. Fully funding the remaining buses would require an additional $422 million, as well as $79 million in needed infrastructure.

Summary of Related Opportunities Allocations

Table 13: Multiyear Funding for Related Opportunities

	FY 2020-2021	FY 2021-2022	FY 2022-2023	FY 2023
Manufacturing Relevant Policy Goals: – GHG Reduction – Petroleum Reduction – Air Quality – Equitable Economic Development	-	$5 Million	-	$5 Million
Workforce Training and Development Relevant Policy Goals: – GHG Reduction – Petroleum Reduction – Air Quality – Equitable Economic Development	$3.5 Million	-	$3 Million	-
Totals	**$3.5 Million**	**$5 Million**	**$3 Million**	**$5 Million**

Source: California Energy Commission

GLOSSARY

AIR POLLUTANT – Amounts of foreign or natural substances occurring in the atmosphere that may result in adverse effects to humans, animals, vegetation, or materials or any combination thereof.

ANAEROBIC DIGESTION – A biological process in which biodegradable organic matter is broken down by bacteria into biogas, which consists of methane (CH_4), carbon dioxide (CO_2), and trace amounts of other gases. The biogas can be further processed into a transportation fuel or combusted to generate heat or electricity.

BATTERY-ELECTRIC VEHICLE – A type of electric vehicle that derives power solely from the chemical energy stored in rechargeable batteries.

BIODIESEL – A transportation fuel for use in diesel engines that is produced through the transesterification of organically derived oils or fats. Transesterification is a chemical reaction between oil and alcohol that forms esters (in this case, biodiesel) and glycerol.

BIOMETHANE – A pipeline-quality gas that is fully interchangeable with conventional natural gas and can be used as a transportation fuel to power natural gas engines. Biomethane is most commonly produced through anaerobic digestion or gasification using various biomass sources. Also known as renewable natural gas (RNG).

BRITISH THERMAL UNIT (Btu) – A unit of heat energy. One Btu is equal to the amount of energy required to raise the temperature of 1 pound of water by 1 degree Fahrenheit at sea level. One Btu is equivalent to 252 calories, 778 foot-pounds, 1,055 joules, or 0.293 watt-hours.

CARBON DIOXIDE EQUIVALENT – A measure used to compare emissions from various greenhouse gases based upon the related global warming potential. The carbon dioxide equivalent for a gas is derived by multiplying the mass of the gas by the associated global warming potential.

CARBON INTENSITY – A measure of greenhouse gas emissions by weight per unit of energy. A common measure of carbon intensity is grams of carbon dioxide equivalent greenhouse gases per megajoule of energy (gCO_2e/MJ).

CRITERIA AIR POLLUTANT – An air pollutant for which acceptable levels of exposure can be determined and for which the U.S. Environmental Protection Agency has set an ambient air quality standard. Examples include ozone (O_3), carbon monoxide (CO), nitrogen oxides (NO_X), sulfur oxides (SO_X), and particulate matter (PM_{10} and $PM_{2.5}$).

DIRECT-CURRENT FAST CHARGER – Equipment that provides charging through a direct-current plug, typically at a rate of 50 kilowatts or higher.

ELECTRIC VEHICLE – A vehicle that uses an electric propulsion system. Examples include battery-electric vehicles, hybrid electric vehicles, and fuel cell electric vehicles.

ELECTROLYSIS – A process by which a chemical compound is broken down into associated elements by passing a direct current through it. Electrolysis of water, for example, produces hydrogen and oxygen.

ETHANOL – A liquid that is produced chemically from ethylene or biologically from the fermentation of various sugars from carbohydrates found in agricultural crops and cellulosic residues. Used in the United States as a gasoline octane enhancer and oxygenate, or in higher concentration (E85) in flex-fuel vehicles.

FEEDSTOCK – Any material used directly as a fuel or converted into fuel. Biofuel feedstocks are the original sources of biomass. Examples of biofuel feedstocks include corn, crop residue, and waste food oils.

FLEX-FUEL VEHICLE – A vehicle that uses an internal combustion engine that can operate on alcohol fuels (methanol or ethanol), regular unleaded gasoline, or any combination of the two from the same fuel tank.

FUEL CELL – A device capable of generating an electrical current by converting the chemical energy of a fuel (for example, hydrogen) directly into electrical energy.

FUEL CELL ELECTRIC VEHICLE – A type of electric vehicle that derives power from an onboard fuel cell.

GREENHOUSE GAS – Any gas that absorbs infrared radiation in the atmosphere. Common examples of greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated fluorocarbons (HCFCs), ozone (O_3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

HIGH-SOLIDS ANAEROBIC DIGESTION – High solids anaerobic digestion process is one in which the percentage of total solids of the feedstock is greater than 15 percent, and little or no water is added to the digester.

HYBRID VEHICLE – A vehicle that uses two or more types of power, most commonly using a combustion engine together with an electric propulsion system. Hybrid technologies typically expand the usable range of electric vehicles beyond what an electric vehicle can achieve with batteries alone, and increase fuel efficiency beyond what an internal combustion engine can achieve alone.

INTELLIGENT TRANSPORTATION SYSTEM – The application of advanced information and communications technology to surface transportation to achieve enhanced safety, efficiency, and mobility while reducing environmental impact.

INVESTOR-OWNED UTILITY – A private company that provides a utility, such as water, natural gas, or electricity, to a specific service area. The California Public Utilities Commission regulates investor-owned utilities that operate in California.

LANDFILL GAS – Gas generated by the natural degradation and decomposition of municipal solid waste by anaerobic microorganisms in sanitary landfills. The gases produced, carbon dioxide and methane, can be collected by a series of low-level pressure wells and can be processed into a medium Btu gas that can be further processed into a transportation fuel or combusted to generate heat or electricity.

LEVEL 1 CHARGER – Equipment that provides charging through a 120 volt alternative-current plug.

LEVEL 2 CHARGER – Equipment that provides charging through a 240 volt (typical in residential applications) or 208 volt (typical in commercial applications) alternative-current plug. This equipment requires a dedicated 40-amp circuit.

MEGAJOULE – One million joules. A joule is a unit of work or energy equal to the amount of work done when the point of application of force of 1 newton is displaced 1 meter in the direction of the force. One British thermal unit is equal to 1,055 joules.

METHANE – A light hydrocarbon that is the main component of natural gas. It is the product of the anaerobic decomposition of organic matter or enteric fermentation in animals and is a greenhouse gas. The chemical formula is CH_4.

MICROMETER – One millionth of a meter, equal to roughly 0.00004 inches.

NATIONAL AMBIENT AIR QUALITY STANDARDS – A set of standards established by the U.S. EPA for six criteria air pollutants, measured by the amount of each pollutant for a specified period.

NATURAL GAS – A hydrocarbon gas found in the earth composed of methane, ethane, butane, propane, and other gases.

NO_X – Oxides of nitrogen, a chief component of air pollution that is commonly produced by the burning of fossil fuels.

OVERGENERATION – A condition that occurs when total electricity supply exceeds total electricity demand. This condition may negatively affect the reliable operation of the regional, state, or interstate electrical grid.

PARTICULATE MATTER – Any material, except pure water, that exists in a solid or liquid state in the atmosphere. The size of particulate matter can vary from coarse, wind-blown dust particles to fine particle combustion products.

PATHWAY – A descriptive combination of three components including feedstock, production process, and fuel type.

PLUG-IN ELECTRIC VEHICLE – A type of vehicle that is equipped with a battery than can be recharged from an external source of electricity. It may or may not also have an internal combustion engine.

PLUG-IN HYBRID ELECTRIC VEHICLE – A type of hybrid vehicle that is equipped with a larger, more advanced battery that can be recharged from an external source of electricity. This larger battery allows the vehicle to be driven on battery power alone, gasoline fuel alone, or a combination of electricity and gasoline.

ZERO-EMISSION VEHICLE – A vehicle that produces no pollutant emissions from the onboard source of power.

APPENDIX A:
LIST OF ACRONYMS

AB	Assembly Bill
AQIP	Air Quality Improvement Program
ARPA-E	Advanced Research Projects Agency – Energy
ATL	Initiative Advanced Transportation and Logistics Initiative
BEV	battery-electric vehicle
CaFCP	California Fuel Cell Partnership
CA-GREET	California Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model
CALeVIP	California Electric Vehicle Infrastructure Project
CalRecycle	California Department of Resources Recycling and Recovery
CARB	California Air Resources Board
CEC	California Energy Commission
CHIT	California Hydrogen Infrastructure Tool
CNG	compressed natural gas
CO_2e	carbon dioxide-equivalent greenhouse gases
COE	County Office of Education
CPUC	California Public Utilities Commission
CSFAP	California Sustainable Freight Action Plan
CVRP	Clean Vehicle Rebate Project
DAS	Division of Apprenticeship Standards
DC	direct current
DGE	diesel gallon-equivalent
EPIC	Electric Program Investment Charge
ETAP	Energy Transit Apprenticeship Program
EVs	electric vehicles
EVCS	electric vehicle charging station
EVI-Pro	Electric Vehicle Infrastructure Projections
FCEV	fuel cell electric vehicle
FRPM	free and reduced-price meals recipient
FY	fiscal year
GFO	grant funding opportunity
GGE	gasoline gallon-equivalent
GGRF	Greenhouse Gas Reduction Fund
gCO_2e/MJ	grams of carbon dioxide-equivalent greenhouse gases per megajoule
GVW	gross vehicle weight
GHG	greenhouse gas
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
HRI	hydrogen refueling infrastructure
ICT	Innovative Clean Transit
JPA	Joint Power Authorities
LCFS	Low Carbon Fuel Standard

LCTI	Low Carbon Transportation Investments
MJ	megajoule
$MMTCO_2e$	million metric tons of carbon dioxide-equivalent greenhouse gases
NAAQS	National Ambient Air Quality Standards
NO_X	oxides of nitrogen
NOPA	notice of proposed award
NREL	National Renewable Energy Laboratory
O&M	operations and maintenance
$PM_{2.5}$	particulate matter, 2.5 micrometers and smaller
PEV	plug-in electric vehicle
PG&E	Pacific Gas and Electric Company
PHEV	plug-in hybrid electric vehicle
PON	program opportunity notice
RFS	Renewable Fuel Standard
RIN	renewable identification number
SB	Senate Bill
SCE	Southern California Edison
SDG&E	San Diego Gas & Electric Company
SIP	State Implementation Plan
SoCal Gas	Southern California Gas Company
U.S. EPA	United States Environmental Protection Agency
WDB	Workforce Development Board
ZEV	zero-emission vehicle