BOARD MEETING DATE: March 7, 2025 AGENDA NO. 20

PROPOSAL: Approve and Adopt Technology Advancement Office Clean Fuels Program 2024 Annual Report and 2025 Plan Update, Resolution and Membership Changes for Clean Fuels Advisory Group

SYNOPSIS: Each year by March 31, South Coast AQMD must submit to the California Legislative Analyst an approved Annual Report for the past year and a Plan Update for the current calendar year for the Clean Fuels Program. These actions are to: 1) approve and adopt the Technology Advancement Clean Fuels Program Annual Report for 2024 and 2025 Plan Update; 2) adopt the Resolution finding that proposed projects do not duplicate any past or present programs; 3) approve and adopt membership changes to the SB 98 Clean Fuels Advisory Group; and 4) receive and file membership changes to the Technology Advancement Advisory Group.

COMMITTEE: Technology, February 21, 2025; Recommended for Approval

RECOMMENDED ACTIONS:

1. Approve and adopt the attached Technology Advancement Office Clean Fuels Program 2024 Clean Fuels Annual Report and 2025 Plan Update and include them in South Coast AQMD's Clean Fuels Program;
2. Adopt the attached Resolution finding that the Technology Advancement Office Clean Fuels Program Plan Update for 2025 and its proposed program and projects funded as part of the program will not duplicate any other past or present program or project funded by other specified organizations;
3. Approve and adopt membership changes to the Senate Bill (SB) 98 Clean Fuels Advisory Group; and
4. Receive and file membership changes to the Technology Advancement Advisory Group.

Wayne Nastri
Executive Officer

AK:MW:VP:MAW

Background
Emission reductions from mobile and stationary sources beyond those available from existing technologies will be needed to achieve state and federal ambient air quality standards. The 2022 AQMP projects an additional 83 percent NOx reduction by 2037 is required to achieve federal and state air quality standards, the majority of which must come from on- and off-road mobile sources. Achieving the needed NOx reductions will require widespread deployment of zero-emission technologies, wherever feasible, as well as further development and commercialization of advanced, cleaner technologies.

California Health and Safety Code (H&SC) 40448.5(e) requires the Clean Fuels Program to consider current and projected economic costs and availability of fuels, cost-effectiveness of emission reductions associated with clean fuels compared with other pollution control alternatives, use of new pollution control technologies in conjunction with traditional fuels as an alternative means of reducing emissions, potential effects on public health, ambient air quality, visibility within the region, and other factors determined to be relevant by South Coast AQMD. The Legislature recognized the need for flexibility, allowing focus on a broad range of technology areas, including cleaner fuels, which can help South Coast AQMD achieve federal and state air quality standards.

The South Coast AQMD Technology Advancement Office (TAO) Clean Fuels Program is an integral part of strategies to achieve the significant NOx reductions called for in the 2022 AQMP. In its first 36 years, from 1988 to 2024, the Clean Fuels Program leveraged $268.9 million into over $1.7 billion in projects, mainly through public-private partnerships in conjunction with private industry, technology developers, academic institutions, research institutions and government agencies. This public-private partnership approach has enabled South Coast AQMD to historically leverage public funds with outside investments in a ratio of about $4 of outside funding to every dollar of Clean Fuels funding. In 2024, South Coast AQMD leveraged $3 for every $1 in Clean Fuels funds. Incentive programs such as the Carl Moyer Program, Volkswagen Environmental Mitigation Trust for California, and Proposition 1B program provide a unique synergy to push market penetration of technologies developed and demonstrated by the Clean Fuels Program. This synergy maximizes resources to ensure continued progress in technology development and commercialization efforts of cleaner transportation technologies to further reduce criteria and toxic pollutant emissions.

H&SC Section 40448.5.1 requires that South Coast AQMD adopt a plan that describes the expected costs and benefits of proposed projects prior to any Clean Fuels Program expenditures and find that the proposed projects do not duplicate programs of other organizations specified in the H&SC provision. In 1999, SB 98 amended this provision by requiring annual updates to this Plan as well as a 30-day Public Notice to specified interested parties and the public prior to the annual public hearing at which the Board considers action on the Clean Fuels Program. SB 98 also requires the preparation of an

annual report that includes the prior year's accomplishments and other information. This annual report requires review by an advisory group and approval by the Board, prior to submittal to specified offices of the California Legislature.

This legislation also specifies the make-up of the 13-member SB 98 Clean Fuels Advisory Group and its primary responsibility, which is to make recommendations regarding the most cost-effective projects that advance and implement clean fuel technologies and improve public health. The membership of the SB 98 Clean Fuels Advisory Group was initially approved by the Board in September 1999. Changes to the composition are reviewed by the Technology Committee on an as-needed basis, subject to full Board approval as required by the charter. Prior to the formation of the SB 98 Clean Fuels Advisory Group, South Coast AQMD had formed the Technology Advancement Advisory Group (TAAG) to review and assess the Clean Fuels Program. The charter and membership of the TAAG were revised in 1999 with the formation of the SB 98 Clean Fuels Advisory Group so the functions of the two advisory groups would be complementary. The TAAG's charter specifies membership changes must be approved by the Technology Committee and membership changes to the Clean Fuels Advisory Group must be approved by the Board.

Finding of No Duplication of Technology Projects

These actions are for the Board to approve and adopt the TAO Clean Fuels Program 2024 Annual Report and 2025 Plan Update and, as part of the Board's consideration of the 2025 Plan Update, to make a finding that the Plan Update and ensure the proposed projects do not duplicate any past or present programs of specified organizations. The review process by the two advisory groups ensures that South Coast AQMD efforts do not duplicate projects. The advisory groups, and other invited technical experts, provide feedback to staff on the documents during biannual meetings and through subsequent correspondence. Staff monitors specific technologies through efforts at state and federal collaboratives, partnerships and industry coalitions. Through this effort, staff is confident there is no duplication of technology projects represented in the Annual Report and Plan Update, as required in the H&SC.

These actions are to adopt a Resolution finding that proposed projects do not duplicate any past or present programs (Attachment A); approve and adopt membership changes to the SB 98 Clean Fuels Advisory Group and receive and file membership changes to the Technology Advancement Advisory Group (Attachment B); and approve and adopt the combined TAO Clean Fuels Program 2024 Annual Report and 2025 Plan Update (Attachment C).

2024 Clean Fuels Program Annual Report

The Annual Report covers projects and progress of the Program for calendar year 2024 consistent with H&SC 40448.5.1(d).

In 2024, under the Clean Fuels Program, 25 new projects or studies were awarded to support research, development, demonstration and early deployment (RD^3) of the technology and conduct assessments. Executed contracts for alternative and clean fuel technologies through the Clean Fuels Program totaled over $8.5 million, with total project costs of over $25.8 million, which includes coordinated funding from other governmental agencies, the private sector, academia, and research institutions. These projects address a wide range of air quality issues with a diverse mix of advanced technologies. Figure 1 shows the distribution of funding committed from the Clean Fuels Program through executed agreements in 2024.

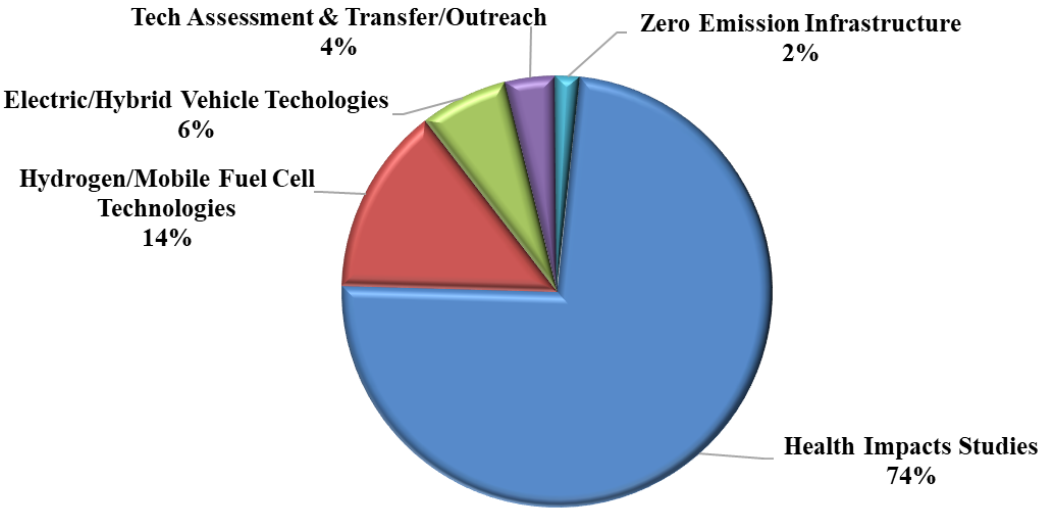


Figure 1: Distribution of Executed Clean Fuels Program Contracts in CY 2024 ($8.5M)

During 2024, South Coast AQMD supported a variety of projects and technologies, ranging from near-term to long-term RD^3 activities. This "technology portfolio" strategy provides South Coast AQMD the ability and flexibility to leverage state and federal funding while also addressing the specific needs of the Basin. Projects executed in 2024 included demonstration and evaluation of electric powered trailer for heavy-duty vehicles, development of portable liquid hydrogen fueling system, analysis of regional medium- and heavy-duty zero-emission vehicle infrastructure and support for the sixth multiple air toxics exposure study (MATES VI). Since 1987, South Coast AQMD has conducted five MATES to evaluate air toxics health risks in South Coast AQMD's jurisdiction. MATES VI measurements for a wide range of air toxics are anticipated to begin the first half of 2025. The collected data will be used to conduct air toxics modeling and quantify health impacts. The allocated Clean Fuels funds will be used to support a brake, road and tire wear emissions study, an ethylene oxide (EtO) source characterization and secondary EtO formation studies, purchase an array of air monitors to measure air pollutants of interest (e.g., particle number and mass concentrations, black carbon, VOCs, carbonyls and air toxics metals, ethylene oxide,

ammonia), laboratory and other field monitoring support equipment including monitoring shelters and vehicles to support field activities related to MATES VI.

In addition to new projects, 11 RD^3 and 20 technology assessments and transfer/outreach projects were completed in 2024. Summaries of technical projects completed in 2024 are provided in Appendix C of the combined Clean Fuels Program Annual Report and Plan Update.

The Clean Fuels Program in 2024 continued to leverage other outside opportunities with South Coast AQMD securing new awards of almost $8.3 million from federal, state and local funding. While this revenue may not be recognized into the Clean Fuels Fund, it is part of the overall RD^3 effort implemented under the Clean Fuels Program. Staff continue to aggressively pursue applicable funding opportunities that may focus on GHG reductions, energy efficiency and reductions in petroleum usage, while remaining committed to lead in the development of advanced technologies that lower criteria and toxic pollutants. Leveraging dollars and applying for funds is critical given the magnitude of required funding identified in the 2022 AQMP that is needed to achieve federal ozone air quality standards.

2025 Clean Fuels Program Plan Update

The attached Clean Fuels Program Draft Plan Update identifies potential projects to be considered for funding during 2025. The proposed projects reflect promising near-zero and zero-emissions technology and infrastructure applications such as the linear generator technology which has emerged as an alternative prime power generation technology to support and accelerate charging infrastructure deployments. This update includes several proposed projects, not all of which are expected to be funded in the current fiscal year given the available budget, limited grant funding opportunity, and/or fruition of the projects. Projects not funded in 2025 may be considered for funding in subsequent years.

In addition to identifying proposed projects to be considered for funding, the Draft Plan Update confirms ten key technical areas of highest priority to South Coast AQMD. These high priority areas are listed below and shown in Figure 2:

- Hydrogen/Mobile Fuel Cell Technologies and Infrastructure;
- Engine Systems/Technologies (including alternative and renewable fuels for truck and rail applications);
- Electric/Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero-emission operations);
- Zero-Emission Infrastructure;
- Stationary Clean Fuel Technologies (including microgrids, renewables);

- Fueling Infrastructure and Deployment (NG and renewable fuels);
- Fuel and Emission Studies;
- Health Impact Studies;
- Emission Control Technologies; and
- Technology Assessment and Transfer / Outreach

These priorities represent areas where South Coast AQMD funding will have the greatest impact. In keeping with the diverse and flexible "technology portfolio" approach, these priorities may shift during the year to capture opportunities such as cost-sharing by state and federal government or other entities; or address specific technology issues which affect residents within South Coast AQMD's jurisdiction.

Figure 2 depicts the potential distribution of South Coast AQMD Clean Fuels funds, based on projected program costs of $31 million for the ten project areas discussed previously. The expected actual project expenditures for 2025 will be less than the total projected program cost since not all projects will materialize. The target allocations are based on balancing technology priorities, technical challenges and opportunities, and near-term versus long-term benefits within the constraints of available South Coast AQMD funding. Specific contract awards throughout 2025 will be based on this proposed allocation, quality of proposals received, evaluation of projects against standardized criteria, and Board approval. At that time, additional details will be provided about the technology, its application, specific scope of work, project team capabilities, and project cost-sharing. In addition, the Clean Fuel program has several projects co-funded with grants received from the U.S. EPA. These grants include projects supported by the California Clean Air Technology Initiative and Targeted Airshed Grant programs for a total of $43 million in grant awards and leveraged with $3.3 million in Clean Fuels funding.

Revenues from several sources support South Coast AQMD's technology advancement program. The principal revenue source is the Clean Fuels Program, which under H&SC Section 40448.5 and Vehicle Code Section 9250.11 establishes mechanisms to collect revenues from mobile and stationary sources to support the program's objectives, albeit with constraints on the use of the funds. Grants and cost-sharing revenue contracts from various government agencies, such as CARB, CEC, National Renewable Energy Laboratory, U.S. EPA and DOE, also support technology advancement efforts.

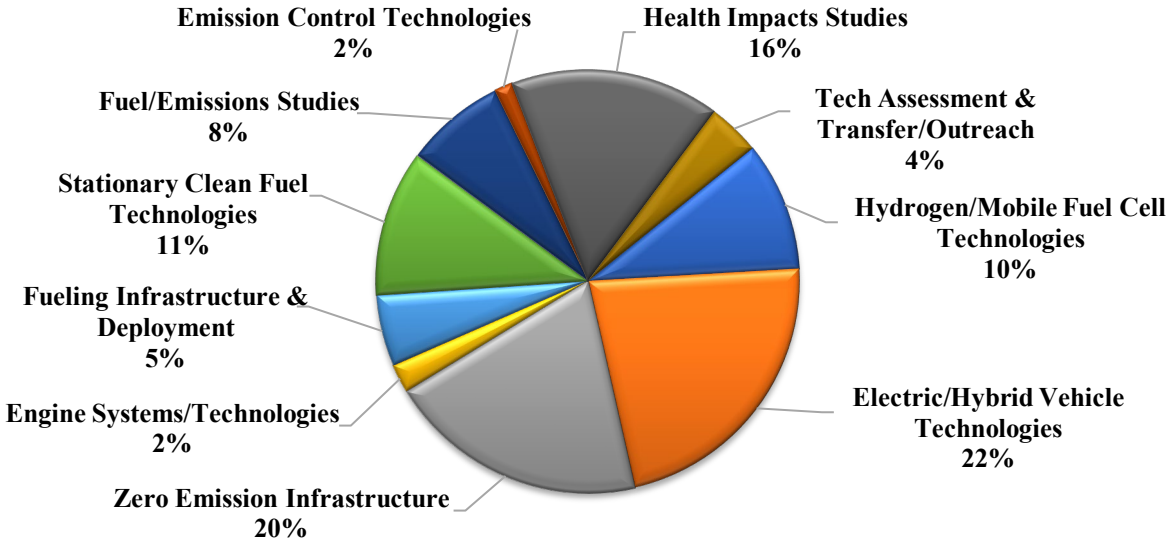


Figure 2: Projected Funding Distribution for Potential Projects in 2025 ($31M)

As required, the Annual Report and Plan Update have been reviewed by the SB 98 Clean Fuels Advisory Group. Staff recommends Board approval of the Clean Fuels Program Annual Report for 2024 and adoption of the Clean Fuels Program Plan Update for 2025 as well as finding that the proposed projects do not duplicate programs of other organizations specified in the H&SC provision.

Attachments

A. Resolution
B. Qualifications and Expertise of Proposed New Advisory Group Members
C. TAO Clean Fuels Program 2024 Annual Report and 2025 Plan Update
D. Presentation

ATTACHMENT A

RESOLUTION NO. 25-____

A Resolution of the Governing Board (the Board) of the South Coast Air Quality Management District (South Coast AQMD) approving the Technology Advancement Office Clean Fuels Program Annual Report for 2024 and adopting the Clean Fuels Program Plan Update for 2025.

WHEREAS, the Board initiated a Clean Fuels Program in 1988 to expedite the demonstration and commercialization of advanced low emission and zero emission technologies and clean fuels;

WHEREAS, Health and Safety Code Sections 40404 and 40448.5 require the South Coast AQMD to coordinate and manage a Clean Fuels Program to accelerate the utilization of clean-burning fuels within the South Coast Air Basin;

WHEREAS, Health and Safety Code Section 40512 and Vehicle Code Section 9250.11 authorize funding for the South Coast AQMD Clean Fuels Program;

WHEREAS, SB 98 (Alarcon), chaptered into state law on June 8, 1999, extended the funding authority for the Clean Fuels Program and added administrative provisions under Health and Safety Code Section 40448.5.1 regarding program planning and reporting, including:

- Providing notice to interested parties and the public at least 30 days prior to the annual public hearing at which the Board or a committee of the Board takes action to approve the clean-burning fuels program.
- Consulting with the SB 98 Clean Fuels Advisory Group regarding approval of the required annual report. The results of that consultation shall be provided to the Board prior to its approval of the report.
- Submitting the Clean Fuels Program annual report to the office of the Legislative Analyst and to the committees of the Legislature responsible for improving air quality on or before March 31 of each year that the clean-burning fuels program is in operation;

WHEREAS, SB 1646 (Padilla), chaptered into state law on September 30, 2008, reauthorized the funding authority for the Clean Fuels Program, removed the sunset of January 1, 2010, and reinstated the five percent administrative cap;

WHEREAS, the Technology Advancement Office Clean Fuels Program Plan Update has been reviewed and commented on by both the Technology Advancement Advisory Group and the SB 98 Clean Fuels Advisory Group;

WHEREAS, Health and Safety Code Section 40448.5.1 requires that the South Coast AQMD coordinate and ensure non-duplication of clean fuels-related projects with specified organizations, including the: CARB, CEC, California air quality management districts or air pollution control districts, a public transit district or authority within the geographic jurisdiction of the South Coast AQMD, San Diego Transit Corporation, North County Transit District, Sacramento Regional Transit District, Alameda-Contra Costa Transit District, San Francisco Bay Area Rapid Transit District, Santa Barbara Metropolitan Transit District, Los Angeles Department of Water and Power, Sacramento Municipal Utility District, Pacific Gas and Electric Company, Southern California Gas Company, Southern California Edison Company, San Diego Gas and Electric Company, or the Office of Mobile Sources within the U.S. Environmental Protection Agency;

WHEREAS, based on communications with the organizations specified in Health and Safety Code Section 40448.5.1 and review of their programs, the proposed program and projects included in the Technology Advancement Office Clean Fuels Program Plan Update do not duplicate any other past or present program or project funded by those organizations;

WHEREAS, notice has been provided to interested parties and the public at least 30 days prior to the public hearing at which the Board is to consider approving the clean-burning fuels program; and

WHEREAS, the SB 98 Clean Fuels Advisory Group has reviewed the Technology Advancement Office Annual Report;

NOW, THEREFORE, BE IT RESOLVED that the Board finds the Technology Advancement Office Clean Fuels Program Plan Update does not duplicate any past or present programs or projects funded by the above-specified organizations;

BE IT FURTHER RESOLVED that the Board approves the Technology Advancement Office Clean Fuels Program Annual Report for 2024;

BE IT FURTHER RESOLVED that the Board approves the Technology Advancement Office Clean Fuels Program Plan Update for 2025; and

BE IT FURTHER RESOLVED that the Board hereby directs staff to forward the Technology Advancement Office Clean Fuels Program Annual Report 2024 and Plan Update 2025 to the California Legislature and the Legislative Analyst.

_____ _____

Dated: Faye Thomas, Clerk of the Boards

Approve and Adopt Technology Advancement Office Clean Fuels Program 2024 Annual Report and 2025 Plan Update, Resolution and Membership Changes for Clean Fuels Advisory Group

ATTACHMENT B
Qualifications and Expertise of Proposed New Advisory Group Members

SB 98 Clean Fuels Advisory Group*

Gordon Abas Goodarzi Magmotor Technologies, Inc.	Dr. Gordon Abas Goodarzi is President and CEO of Magmotor Technologies, Inc., driving innovation in technology and product development, while also contributing to strategic policy and clean energy advancements. In his Research Affiliate role with the B. John Garrick Institute for the Risk Sciences at UCLA, Dr. Goodarzi has been involved in innovative research, including wildfire risk mitigation for utilities like PG&E/CPUC and renewable energy initiatives. His industry contributions include founding US Hybrid Corporation, where he pioneered the design and production of fuel cell engines for medium-duty municipal and heavy-duty vehicles and developed the first electric helicopter for Sikorsky. Dr. Goodarzi has created zero-emission solutions for drayage trucks and port equipment, reflecting his deep expertise in sustainable transport. Earlier in his career, as Technical Direct at Hughes Power Control System, he spearheaded the development of General Motors' EV1 powertrain and inductive charging infrastructure, laying the groundwork for modern EV technology. His efforts in manufacturing, service deployment, and commercialization of EVs were instrumental in advancing electric mobility. Dr. Goodarzi earned his Bachelor's degree from California State University, Sacramento, and Master's and Ph.D. degrees from University of Missouri-Columbia. He has been a registered professional engineer since 1985. Dr. Goodarzi also previously was faculty at the California State University, San Francisco.
Yassamin Kavezade Sierra Club	Ms. Yassamin Kavezade has advocated for economic and environmental justice for over 10 years across California. She began her professional career as a utility ratepayer advocate at the Utility Reform Network, protecting affordable rates for customers across the electric and telecommunication sectors. She followed her passion for environmental justice and community organizing by joining the Sierra Club staff in 2017. At the Sierra Club, she organized communities in the Inland Empire to support clean energy and zero emission mitigation projects at warehouses, closing down one of California's oldest power plants, and successfully led efforts to pass legislation like Senate Bill 100, guaranteeing 100% renewable energy in California by 2045. As she pivoted to regional and national strategy as a Senior Advisor for the Sierra Club she supported the passage of the Warehouse Indirect Source Rule at South Coast, Advance Clean Truck Rules, Trucking Refrigeration Rules, Innovative Clean Transit, At-Berth, and Harbor Craft rules at the California Air Resources Board on behalf of the Sierra Club. During her eight-year tenure at Sierra Club, she has grown her role to support clean air and energy campaigns in the country's western region. Yassi has recently left Sierra Club National for a new opportunity to lead policy and campaign efforts at the California Building Decarbonization Coalition. She will be the Policy

	and Campaigns Director leading communications and outreach strategies across these states. She believes in building trust, community organizing, and creating public policy across several regulatory agencies and governments for clean air and environmental justice. She has experience winning campaigns and policies for zero-emission transportation and clean transportation. For fun, she likes to bike and hike with her dog in Inland Valley in her free time.

**The charter of the CFAG requires membership changes to be approved by the full South Coast AQMD Board.*

Technology Advancement Advisory Group**

Leela Rao Port of Long Beach (POLB)	Dr. Leela Rao is an Air Quality Officer at the Port of Long Beach. In this capacity, she manages a team that is implementing the Port's Clean Air Action Plan, a joint effort with the Port of Los Angeles to reduce emissions from all freight transportation sources operating at the ports. Dr. Rao is the environmental staff lead on the Clean Truck Program, which aims to achieve zero emission drayage operation by 2035. In this capacity she administers the Clean Truck Fund Rate incentive programs, which invests in zero emission drayage trucks and infrastructure. Dr. Rao also manages several of the Port's zero emission demonstration grants in which terminal, harbor craft, and fleet partners are deploying zero emission terminal equipment, vessels, and drayage trucks. Her team also manages the Port's harbor craft, air monitoring, and emissions inventory programs. Prior to her work at the Port of Long Beach, Dr. Rao was a manager with the California Air Resources Board On-Board Diagnostics Branch and a staffer with the Environmental Protection Agency Office of Research and Development. Dr. Rao holds a Master of Environmental Management in Resource Ecology from Duke University and a Ph.D. in Environmental Science from University of California, Riverside.

***The charter of the TAAG requires membership changes to be approved by the Board's Technology Committee.*

ATTACHMENT C
TECHNOLOGY ADVANCEMENT OFFICE
CLEAN FUELS PROGRAM DRAFT 2024
ANNUAL REPORT & 2025 PLAN UPDATE

South Coast Air Quality Management District

Governing Board

Chair:	VANESSA DELGADO Senator (Ret.) Senate Rules Committee Appointee
Vice Chair:	MICHAEL A. CACCIOTTI Councilmember, South Pasadena Cities of Los Angeles County/Eastern Region
Members:	CURT HAGMAN* Supervisor, Fourth District County of San Bernardino
	GIDEON KRACOV Governor's Appointee
	PATRICIA LOCK DAWSON* Mayor, Riverside Cities of Riverside County Representative
	LARRY MCCALLON* Mayor Pro Tem, Highland Cities of San Bernardino County
	HOLLY J. MITCHELL Supervisor, Second District County of Los Angeles
	JANET NGUYEN Supervisor, First District County of Orange
	BRENDA OLMOS Councilmember, City of Paramount Cities of Los Angeles County/Western Region
	VERONICA PADILLA-CAMPOS* Speaker of the Assembly Appointee
	V. MANUEL PEREZ Supervisor, Fourth District County of Riverside
	NITHYA RAMAN Councilmember, Fourth District City of Los Angeles Representative
	CARLOS RODRIGUEZ** Mayor Pro Tem, Yorba Linda Cities of Orange County
Executive Officer:	WAYNE NASTRI

[This Page Intentionally Left Blank]

South Coast Air Quality Management District

Technology Advancement Office

Aaron Katzenstein, Ph.D., Deputy Executive Officer
Mei Wang, Assistant Deputy Executive Officer

Daniel Garcia, Community Programs & Special Incentives Manager
Tom Lee, On-Road Incentives, Contracts & Outreach Manager
Vasileios Papapostolou, Sc.D., Technology Demonstration Manager
Vacant, Off-Road Incentives, Inspections & Special Projects Manager

Sam Cao, Ph.D., Program Supervisor
Ping Gui, Program Supervisor
Maryam Hajbabaei, Ph.D., Program Supervisor
Victor Juan, Program Supervisor
Joseph Lopat, Program Supervisor
Krystle Martinez, Program Supervisor
Nicole Silva, Program Supervisor
Yuh Jiun Tan, Program Supervisor
Kelly Trainor Gamino, Program Supervisor
Fan Xu, Ph.D., Program Supervisor
Alyssa Yan, Program Supervisor

Christina Kusnandar, Sr. Staff Specialist
Ash Nikravan, Sr. Staff Specialist
Jessie Conaway, Staff Specialist

David Chen, Air Quality Specialist
Berj Der Boghossian, Air Quality Specialist
Liliana Garcia, Air Quality Specialist
Darren Ha, Air Quality Specialist
Justin Joe, Air Quality Specialist
Charlize Li, Air Quality Specialist
Hay Lo, Air Quality Specialist
Alicia Ibarra Martinez, Air Quality Specialist
Frances Maes, Air Quality Specialist
Mariel Maranan, Air Quality Specialist
Kevin Perozo, Air Quality Specialist
Annie Shin, Air Quality Specialist
Veronica Tejada, Air Quality Specialist
Greg Ushijima, Air Quality Specialist
Nick Volpone, Air Quality Specialist
Kristina Voorhees, Air Quality Specialist
Alan Wang, Air Quality Specialist
George Wu, Air Quality Specialist
Andrew Yoon, Air Quality Specialist

Justin Chuang, Air Quality Inspector II
Kenny Heralal, Air Quality Inspector II
Charles Hewitt, Air Quality Inspector II
Jonathan Rocha, Air Quality Inspector II

Penny Shaw Cedillo, Sr. Administrative Assistant
Kristin Remy, Sr. Administrative Assistant
Maria Allen, Administrative Assistant I
Marjorie Eaton, Administrative Assistant I
Sinde Enriquez, Administrative Assistant I
Donna Vernon, Administrative Assistant I

Alejandra Vega, Sr. Public Affairs Specialist
Michelle White, Sr. Public Affairs Specialist
Lauren Henninger, Staff Assistant
Ana Ambriz, Staff Assistant
Karen Ayala, Contracts Assistant
Tribrina Brown, Contracts Assistant
Stacy Brzozowski, Contracts Assistant
Margarita Cabral, Contracts Assistant
Emmanuel Del Rosario, Contracts Assistant
Priscilla Pineda, Contracts Assistant
Christine Sakata, Contracts Assistant
Cynthia Snyder, Contracts Assistant
David Tam, Contracts Assistant
Benigna Taylor, Contracts Assistant
Cruz Hernandez, Sr. Office Assistant
Jessica Sosa, Office Assistant
Edwin Talledo, Office Assistant

[This Page Intentionally Left Blank]

Table of Contents

List of Figures

List of Tables

List of Appendices

[This Page Intentionally Left Blank]

EXECUTIVE SUMMARY

I. Introduction

South Coast Air Quality Management District (South Coast AQMD) is the air pollution control agency for Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties. This region, which encompasses the South Coast Air Basin (SCAB) as well as small portions of the Mojave Desert and Salton Sea Air Basins, historically experiences the worst air quality in the nation due to its natural geographic and atmospheric conditions, coupled with its high population density and associated mobile and stationary source emissions.

In 1988, Senate Bill (SB) 2297 (Rosenthal) was signed into law (Chapter 1546). It initially established a five-year program to increase the use of clean fuels, but subsequent legislation extended and removed the sunset clause for the Program. That legislation also reaffirmed the existence of the Technology Advancement Office (TAO) to administer the Clean Fuels Program. The Clean Fuels Program is an integral part of South Coast AQMD's effort to achieve the significant nitrogen oxide (NOx) emission reductions called for in the 2022 Air Quality Management Plan (AQMP) because it affords South Coast AQMD the ability to fund research, development, demonstration and accelerated deployment of clean fuels and transformative transportation technologies.

Using funding from a $1 motor vehicle registration fee, the Clean Fuels Program encourages, fosters, and supports clean fuels and transportation technologies, such as battery electric vehicles, plug-in hybrid electric vehicles and related charging infrastructure, hydrogen fuel cells and related fueling infrastructure, advanced natural gas (NG) technologies, alternative fuel engines, and renewable fuels. A key strategy of the Program is its public-private partnerships with private industry, technology developers, academic institutions, research institutions, and government agencies. Since 1988, the Clean Fuels Program leveraged nearly $268.7 million into over $1.7 billion in clean technology projects. Leveraging of the Clean Fuels Fund is based on executed contracts and total project costs from the prior year's Clean Fuels Annual Report and Plan Update. The Mobile Source Air Pollution Reduction Review Committee (MSRC) discretionary fund, established under Assembly Bill 2766, is another funding source for mobile source emission reduction projects. The MSRC develops an annual Work Program to define the categories of projects for funding. Each year, approximately $14 million, collected from motor vehicle registration fees, is allocated to the discretionary fund and is an important source of funding to supplement the Clean Fuels Program.

As technologies are commercialized (battery electric trucks or BETs) or move towards commercialization (fuel cell trucks or FCTs), the Clean Fuels Program partners with large original equipment manufacturers (OEMs), such as Daimler, Volvo, Hyundai, and Peterbilt to deploy these vehicles at scale. These OEM partnerships allow the Program to leverage their research, product development, customer relationships, and financial resources needed to move advanced technologies from the laboratories to the field and into customers' hands. The OEMs have the resources and capabilities to design, engineer, test, manufacture, market, distribute, and service quality products under trusted brand names. This scale is needed to reduce emissions and attain national ambient air quality standards (NAAQS).

South Coast AQMD and its partners play a leadership role in technology development and commercialization to accelerate criteria for reductions in pollutant and greenhouse gas (GHG) emissions. The Clean Fuels Program has traditionally supported a portfolio of technologies at different technology

readiness levels. This helps develop new technologies across many mobile sectors needing new technologies that provide emission and GHG reductions and health benefits. This approach enhances the region's chances of achieving the NAAQS.

California Health and Safety Code (H&SC) 40448.5(e) calls for the Clean Fuels Program to consider factors such as current and projected economic costs and availability of fuels, cost-effectiveness of emission reductions associated with clean fuels compared with other pollution control alternatives, use of new pollution control technologies in conjunction with traditional fuels as an alternative means of reducing emissions; potential effects on public health, ambient air quality, visibility within the region; and other factors. The Legislature recognized the need for flexibility, allowing focus on a broad range of technology areas, including cleaner fuels, vehicles, equipment, emission control technologies, and supporting infrastructure, which helps South Coast AQMD make progress toward achieving its clean air goals.

California H&SC 40448.5.1 requires South Coast AQMD to prepare and submit a Clean Fuels Annual Report and Plan Update annually to the Legislative Analyst by March 31. The Clean Fuels Annual Report looks at Program accomplishments in the prior calendar year (CY), and the Clean Fuels Plan Update looks ahead at proposed projects for the next CY, re-calibrating the program's technical emphasis.

II. Setting the Stage

The overall strategy of the Clean Fuels Program is largely based on emission reduction technologies identified in the 2022 AQMP and South Coast AQMD Board directives to protect the health of almost 18 million residents (nearly half the population of California) in SCAB. The 2022 AQMP is the long-term regional blueprint that identifies the fair-share emission reductions from all jurisdictional levels (e.g., federal, state, and local). The 2022 AQMP is composed of stationary and mobile source emission reductions from traditional regulatory control measures, incentive-based programs, projected co-benefits from climate change programs, mobile source strategies, and other innovative approaches, including indirect source measures and incentive programs, to reduce emissions from federally regulated sources (e.g., aircraft, locomotives, and ocean-going vessels). California Air Resources Board's (CARB) 2022 State Implementation Plan (SIP) Strategy included a revised mobile source strategy required for SCAB to meet the 2015 8-hour ozone standard of 70 ppb by 2037. The CARB 2022 SIP Strategy for mobile and stationary sources requires rapid deployment of zero emission technologies to achieve air quality targets.

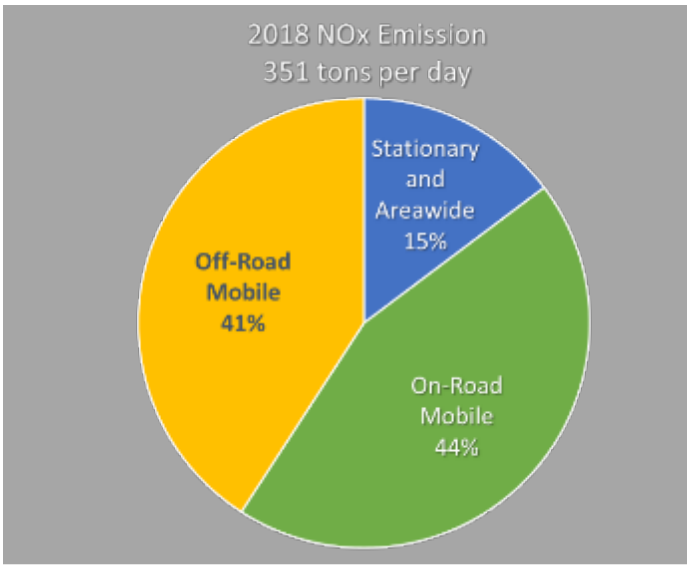


Figure 1: NOx Emissions by Source Category in South Coast Air Basin for 2018

Ground-level ozone (a key component of photochemical smog) is formed by a chemical reaction between NOx and volatile organic compound (VOC) emissions in the presence of sunlight. NOx emission reduction is the key to improving ozone air quality and attaining the ozone NAAQS in SCAB. In 2018, approximately 85 percent of NOx emissions were from mobile sources, as shown in Figure 1.[1] Furthermore, NOx and VOC emissions also lead to the secondary formation of PM2.5 in the atmosphere (particulate matter measuring 2.5 micrometers or less in size).

The emission reductions and control measures in the 2022 AQMP rely on the commercial adoption of a mix of currently available technologies and the expedited development and commercialization of clean fuel mobile and stationary advanced technologies in SCAB to achieve air quality standards. The 2022 AQMP identifies that 83 percent NOx emission reductions from the 2018 level and 67 percent additional reductions in 2037 beyond already adopted regulations and programs are necessary to meet the 2015 8-hour ozone standard by 2037. Figure 2 illustrates the needed NOx reductions in SCAB by source category. Most NOx emission reductions must come from mobile sources, both on- and off-road categories. Notably, South Coast AQMD is one of only two regions in the nation designated as an extreme nonattainment area of the 2015 8-hour ozone NAAQS (the other region is California's San Joaquin Valley).

[1] 2022 South Coast AQMD Air Quality Management Plan, http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan

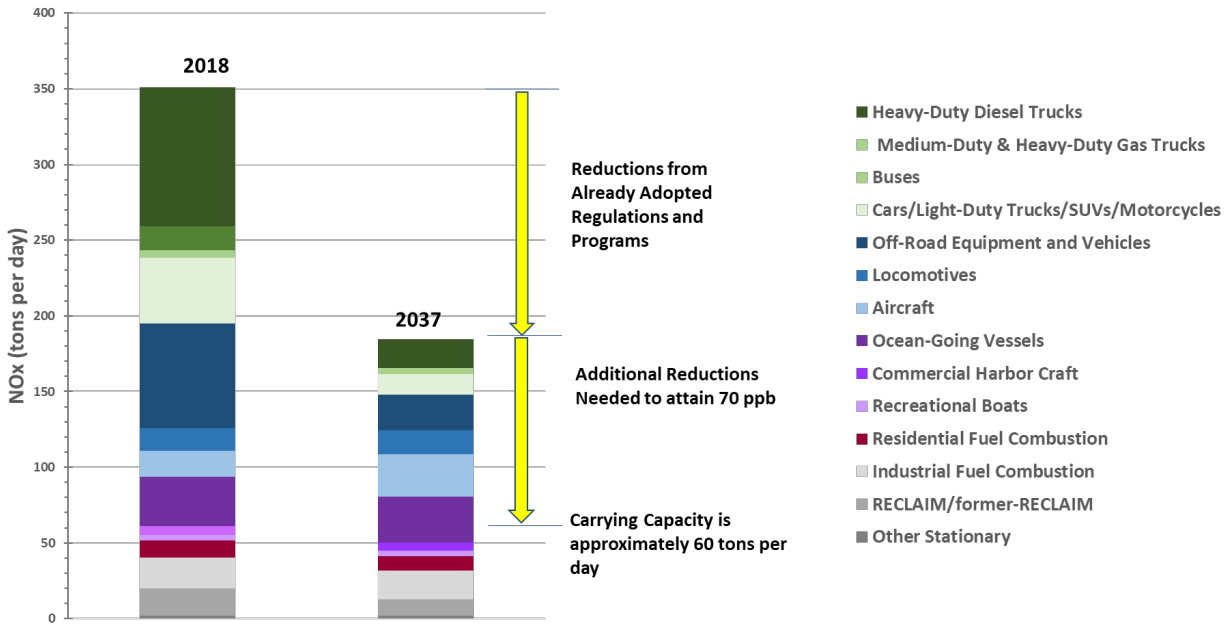


Figure 2: NOx Emissions and Reductions Required to Attain 2015 Ozone Standard in 2037[2]

The 2022 AQMP shows the need for an economy-wide transition to zero emission technologies where feasible, along with the CARB 2020 Mobile Source Strategy and low NOx technologies in other applications. New mobile source technologies must be developed, commercialized, and implemented widely to achieve these targets.

III. Clean Fuels Program

The Clean Fuels Program, established in California H&SC 40448.5, is an important mechanism to encourage and accelerate the advancement and commercialization of clean fuels in stationary and mobile source technologies.

Figure 3 provides a conceptual design of the wide scope of the Clean Fuels Program and its relationship with incentive programs. Various stages of technology projects are funded to provide a portfolio of technologies and achieve near-term and long-term emission and GHG reductions. The Clean Fuels Program typically funds projects in the Technology Readiness Level (TRL) ranging between 3-8.

[2] South Coast AQMD 2022 AQMP. Chapter 4, p. 4-2, Figure 4-1. https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/final-2022-aqmp/07-ch4.pdf?sfvrsn=6

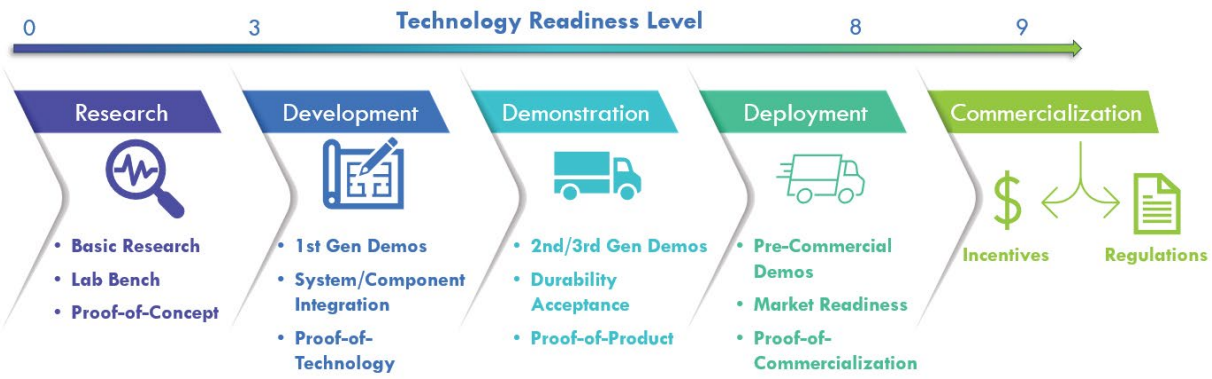


Figure 3: Technology Readiness Stages 3-8 of Clean Fuels Program

Below is a summary of the 2024 Annual Report and 2025 Plan Update. Every Annual Report and Plan Update is reviewed by two advisory groups–the Clean Fuels Advisory Group, legislatively mandated by SB 98 (chaptered, 1999), and the Technology Advancement Advisory Group, created by the South Coast AQMD Governing Board in 1990. These stakeholder groups review and assess the overall direction of the Clean Fuels Program. The two groups meet approximately every six months to provide expert analysis and feedback on potential projects and areas of focus. Key technical experts in the Program's core technology areas also attend and provide feedback. South Coast AQMD's Governing Board and other interested parties and stakeholders also offer preliminary reviews and comments. In 2024, the advisory groups met on January 23 and September 12.

IIIa. 2024 Annual Report

In CY 2024, the South Coast AQMD Clean Fuels Program executed 25 new contracts. Table 2 shows major funding partners in CY 2024. Table 3 lists the 5 projects and 20 technology transfer and outreach contracts, which are further described in this report. The Clean Fuels Program contributed over $8.5 million in partnership with other governmental organizations, private industry, academia and research institutes, and interested parties, with total project costs of over $25.8 million. Additionally, in CY 2024, the Clean Fuels Program continued to leverage outside funding opportunities, securing new awards totaling almost $8.3 million from federal, state and local funding opportunities. Table 4 provides a comprehensive summary of these federal, state and local revenues awarded to South Coast AQMD during CY 2024. Typical historical leveraging is $4 for every $1 in Clean Fuels funding. In 2024, South Coast AQMD leveraged $3 for every $1 in Clean Fuels funds. Leveraging dollars and aggressively pursuing federal, state and local funding opportunities is critical, given the magnitude of needed funding identified in the 2022 AQMP to achieve NAAQS.

The projects or studies executed in 2024 included a diverse mix of advanced technologies and are included in the following core areas of technology advancement:

1. Hydrogen / Mobile Fuel Cell Technologies;
2. Electric / Hybrid Vehicle Technologies (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations);
3. Zero Emission Infrastructure;
4. Health Impacts Studies; and

5. Technology Assessment and Transfer / Outreach.

Figure 11 on page 30 shows the distribution by percentage of executed agreements in 2024 across these core technologies.

During CY 2024, South Coast AQMD supported a variety of projects and technologies, ranging from near-term to long-term research, development, demonstration and deployment activities. This "technology portfolio" strategy provides South Coast AQMD the ability and flexibility to leverage state and federal funding while also addressing the specific needs of SCAB. Projects included significant battery electric and hybrid electric technologies and infrastructure to develop and demonstrate medium-duty (MD) and HD vehicles in support of transitioning to near-zero and zero emission goods movement; development, demonstration and deployment of large displacement ultra-low NOx engines; and demonstration of hydrogen fuel cell MD and HD vehicles and infrastructure.

In addition to the 25 executed contracts and projects, 11 research, development, demonstration and deployment projects or studies and 20 technology assessment and transfer contracts were completed in 2024, as listed in Table 5 on page 44. Appendix C includes two-page summaries of technical projects completed in 2024. As of January 1, 2025, there were 57 open contracts in the Clean Fuels Program; Appendix B lists these open contracts by core technology.

In accordance with California H&SC Section 40448.5.1(d), this annual report must be submitted to the state legislature by March 31, 2025, after approval by the South Coast AQMD Governing Board.

IIIb. 2025 Plan Update

The Clean Fuels Program is re-evaluated annually to develop the annual Plan Update based on a reassessment of technology progress and direction for the agency. The program continually seeks to support developing and deploying cost-effective clean fuel technologies with increased collaboration with OEMs to achieve large-scale deployment. The design and implementation of the Clean Fuels Program Plan must balance the needs in the various technology sectors with technology readiness on the path to commercialization, emission and GHG reduction potential, and co-funding opportunities. South Coast AQMD is committed to developing, demonstrating, and commercializing technologies that reduce criteria pollutants, specifically NOx and toxic air contaminants (TACs). Most of these technologies address SCAB's need for NOx and TAC emission reductions and garner GHG emission reductions and petroleum use. Due to these co-benefits, South Coast AQMD has successfully partnered with the state and public/private partnerships to leverage its Clean Fuels Program funding.

South Coast AQMD engages in outreach and networking efforts to identify technology and project opportunities where funding can make a significant difference in deploying cleaner technologies in SCAB. These activities include close involvement with state and federal collaboratives, partnerships and industrial coalitions, and discussions with OEMs and technology providers on the current state of technologies and development and commercialization challenges. Additionally, unsolicited proposals from OEMs and other clean fuel technology developers are regularly received and reviewed. Potential development, demonstration, and certification projects resulting from these outreach and networking efforts are included in the 2025 Clean Fuels Plan Update.

Assembly Bill (AB) 617[3] requires reduced exposure to communities most impacted by air pollution; TAO conducts additional outreach to AB 617 communities regarding available zero and near-zero emission technologies and incentives to accelerate the deployment of cleaner technologies. Replacement of HD diesel trucks with zero emission trucks was in the Community Emission Reduction Plans (CERPs) for these AB 617 communities, and a zero emission HD truck loaner program was launched in 2023. The Program funded by the Community Air Protection Program (CAPP) provided smaller fleets and independent owner operators the opportunity to try and learn about zero emission trucks for their business operations. The Clean Fuels Program played an important role in developing the ZE technologies.

Today, diesel trucks are still one of the largest NOx emission sources in SCAB. While CARB has the Advanced Clean Trucks (ACT), Advanced Clean Fleets (ACF), and Heavy-Duty (HD) Omnibus regulations in place, there is still a need to tackle interstate truck emissions that travel to and from SCAB. CARB estimates that 60 percent of total on-road HD vehicle miles traveled in SCAB are from vehicles purchased outside of California. This indicates the need for more stringent federal and state standards for on-road HD vehicles. U.S. EPA has acknowledged the need for additional NOx emission reductions through a harmonized and comprehensive national NOx emission reduction program for HD on-highway engines and vehicles. U.S. EPA adopted the final rule "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards" in December 2022 in similar stringency as the CARB Omnibus Standard. Two additional U.S. EPA rules were adopted in March 2024, including the Phase 3 HD GHG and light-duty (LD) and medium-duty (MD) vehicle multi-pollutant standards for model year 2027. These rules emphasize the large adoption of zero-emission LD, MD, and HD vehicles.

The South Coast AQMD Warehouse Actions and Investments to Reduce Emissions (WAIRE) program established as a part of Warehouse Indirect Source Rule (ISR) adoption reduces NOx and diesel particulate matter (DPM) emissions from mobile sources that are attracted to the warehouses. The San Pedro Bay Ports implemented the Clean Truck Fund (CTF) to generate funds to achieve zero emission drayage trucks by 2035. Despite all these major efforts, per the 2022 AQMP, additional NOx emission reductions in SCAB are needed to meet ozone attainment target deadlines.

In the past year, significant federal and state funding has been made available to support the deployment of zero emission vehicles and installing infrastructures. Between 2023 and 2024, South Coast AQMD released several rounds of Carl Moyer and Community Air Protection Program (CAPP) funding announcements to solicit near- and zero- emission vehicle and equipment and associated supporting charging/refueling infrastructure projects totaling over $300 million, and the programs were heavily oversubscribed. In July 2024, the U.S. EPA awarded South Coast AQMD $500 million under the Climate Pollution Reduction Grants (CPRG) to implement the INVEST CLEAN (Infrastructure, Vehicles, and Equipment Strategy for Climate, Equity, Air Quality, and National Competitiveness) to prioritize the emission reductions in the goods movement sectors for their potentially substantial reductions of criteria and hazardous air pollutants, impacts on low-income disadvantaged communities, and the opportunity to drive economic growth, including job creation. This incentive funding will ensure the demonstration and deployment by the Clean Fuels Program to continue to advance to full commercialization.

The Plan Update includes projects to develop, demonstrate and commercialize technologies, from near-term to long-term commercialization, that are intended to provide significant emission reductions over the next five to ten years. Areas of focus include:

- developing and demonstrating technologies to reduce emissions from goods movement and port-

[3] https://ww2.arb.ca.gov/capp

related activities, including zero emission drayage trucks, cargo handling equipment and supporting infrastructure;

- understanding particulate emissions from tire and brake wear;
- demonstrating ultra-low NOx, gaseous and liquid alternative/renewable fueled, large displacement/high efficiency engines and HD zero emission technologies;
- mitigating criteria pollutant emissions from the production of renewable fuels, such as renewable natural gas, diesel, hydrogen, and electricity as well as other renewable, low/zero carbon fuels and waste streams;
- producing transportation fuels and energy from renewable and waste stream sources;
- developing and demonstrating electric-drive (fuel cell, battery, plug-in hybrid, and non-plug-in hybrid) technologies across LD, MD, and HD platforms;
- establishing large-scale hydrogen fueling and electric vehicle (EV) charging infrastructure to support MD and HD zero emission vehicles;
- ultra-fast, higher power charging (1 megawatt (MW)) for HD battery electric vehicles and similar charger rate for MD battery electric vehicles;
- developing and demonstrating high flow fueling protocols and standards to address hydrogen refueling station network health and reliability and expand HD hydrogen refueling stations;
- developing and demonstrating portable hydrogen refueling equipment to address the short-term need for hydrogen refueling and advance these technologies;
- developing and demonstrating green hydrogen production pathways and hydrogen ecosystems to reduce the cost of hydrogen and improve state-wide hydrogen station reliability and availability;
- developing and demonstrating low and zero emission alternative charging solutions (ACS) that support the deployment of permanent EV charging infrastructure and provide temporary backup power generation; and
- developing and demonstrating zero emission microgrids that utilize battery energy storage systems and onsite clean power generation to support transportation electrification demands associated with goods movement and freight handling activities; and workforce training.

Table 6 (page 67) lists potential projects across the ten core technology areas for 2025:

- Hydrogen / Mobile Fuel Cell Technologies and Infrastructure;
- Engine Systems / Technologies (alternative and renewable fuels for truck and rail applications)
- Electric / Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations);
- Zero Emission Infrastructure - both hydrogen and battery electric as well as studies that aid the readiness and management of ZE infrastructure;
- Fueling Infrastructure and Deployment (NG and renewable fuels);
- Stationary Clean Fuel Technologies (including microgrids and stationary clean fuel technology projects, but not in combination with EV and Hydrogen infrastructure);
- Fuel and Emissions Studies;
- Emission Control Technologies;
- Health Impact Studies; and

- Technology Assessment and Transfer/Outreach.

These potential projects, planned for 2025, total $31 million of the Clean Fuels funds, with the anticipated total project costs of $182.9 million, leveraging almost $6 for every $1 of Clean Fuels funds spent. Some proposed projects may also be funded by state and federal grants and incentive programs, including AB 617 CAPP funds, Volkswagen Mitigation, Carl Moyer Program, and others.

[This Page Intentionally Left Blank]

CLEAN FUELS PROGRAM

2024 ANNUAL REPORT AND 2025 PLAN UPDATE

1.1. Background

The South Coast Air Basin (SCAB), which comprises all of Orange County and the urban portions of Los Angeles, San Bernardino and Riverside counties, has the worst air quality in the nation due to a combination of factors, including high vehicle population, high vehicle miles traveled within the region, and geographic and atmospheric conditions favorable for photochemical oxidant (smog) formation. This region, which encompasses SCAB as well as small portions of the Mojave Desert and Salton Sea Air Basins, is home to almost 18 million residents (nearly half the population of California). Due to this confluence of factors, which present unique challenges, the state legislature enabled South Coast AQMD to implement the Clean Fuels Program to accelerate the implementation and commercialization of clean fuels and advanced mobile source technologies.

In 1988, Senate Bill (SB) 2297 (Rosenthal) was signed into law (Chapter 1546). It initially established a "five-year program to increase the use of clean fuels," and created a funding source for the Clean Fuels Program from a $1 motor vehicle registration surcharge. Subsequent legislation extended both the Program and surcharge indefinitely, eventually removing the sunset clause for the Program. That legislation also reaffirmed existence of the Technology Advancement Office (TAO) to administer the Clean Fuels Program. The Clean Fuels Program is an integral part of South Coast AQMD's effort to achieve the significant nitrogen oxides (NOx) reductions called for in the 2022 AQMP.

California Health and Safety Code (H&SC) section 40448.5(e) calls for the Clean Fuels Program to consider, among other factors, current and projected economic costs and availability of fuels, cost-effectiveness of emission reductions associated with clean fuels compared with other pollution control alternatives, use of new pollution control technologies in conjunction with traditional fuels as an alternative means of reducing emissions, potential effects on public health, ambient air quality, visibility within the region, and other factors determined to be relevant by South Coast AQMD. The Legislature recognized the need for flexibility, allowing focus on a broad range of technology areas, including cleaner fuels, vehicles and infrastructure, which helps South Coast AQMD continue to make progress toward achieving its clean air goals.

In 1999, further state legislation was passed which amended the Clean Fuels Program. Specifically, as stated in the H&SC section 40448.5.1(d), South Coast AQMD must submit an annual report to the Legislature, on or before March 31, that includes:

1. Description of the core technologies that South Coast AQMD considers critical to ensure attainment and maintenance of ambient air quality standards and a description of the efforts made to overcome barriers to commercialization of those technologies;
2. Analysis of the impact of South Coast AQMD's Clean Fuels Program on the private sector and on research, development and commercialization efforts by major automotive and energy firms, as determined by South Coast AQMD;
3. Description of projects funded by South Coast AQMD, including a list of recipients, subcontractors, co-funding sources, matching state or federal funds and expected and actual

results of each project advancing and implementing clean fuels technology and improving public health;

4. Title and purpose of all projects undertaken pursuant to the Clean Fuels Program, names of the contractors and subcontractors involved in each project and amount of money expended for each project;
5. Summary of progress made toward the goals of the Clean Fuels Program; and
6. Funding priorities identified for the next year and relevant audit information for previous, current and future years covered by the Clean Fuels Program.

In 1999, SB 98 amended this provision by requiring annual updates to the Clean Fuels Program as well as a 30-day Public Notice to specified interested parties and the public prior to the annual public hearing at which the Governing Board considers action on the Clean Fuels Program. Therefore, South Coast AQMD re-evaluates the Clean Fuels Program every year to develop a plan update based on reassessment of clean fuel technologies and direction of the South Coast AQMD Governing Board. Each year, the plan update targets several projects to achieve near-term emission reductions needed for South Coast AQMD to meet health-based NAAQS.

Furthermore, H&SC section 40448.5.1(a)(2) requires South Coast AQMD to find that the proposed program and projects funded as part of the Clean Fuels Program will not duplicate any other past or present program or project funded by the state board and other government and utility entities. This finding does not prohibit funding for programs or projects jointly funded with another public or private agency where there is no duplication. Concurrent with adoption and approval of the annual report and plan update every year, the Governing Board will consider the efforts TAO has undertaken in the prior year to ensure no such duplication has occurred and attest to that fact within the Resolution.

The following section describes the various panels of external experts that help review the Clean Fuels Program every year.

1.2. Advisory Groups

In 1990, South Coast AQMD initiated an annual review of its technology advancement program by an external panel of experts. That external review process has evolved, in response to South Coast AQMD policies and legislative mandates, into two external advisory groups. The first advisory group, the Technology Advancement Advisory Group (one of six standing Advisory Groups that make up the South Coast AQMD Advisory Council) is made up of stakeholders representing industry, academia, regulatory agencies, scientific community and environmental non-governmental organizations (NGOs). The Technology Advancement Advisory Group serves to:

- Coordinate the Clean Fuels program with related local, state and national activities;
- Review and assess the overall direction of the program; and
- Identify new project areas and cost-sharing opportunities.

The charter for the Technology Advancement Advisory Group (TAAG) calls for approximately 12 technical experts representing industry, academia, state agencies, scientific community and environmental interests. In CY 2024 there were 13 members on TAAG and those members will continue into CY 2025.

In 1999, the second advisory group, the Clean Fuels Advisory Group, was formed as required by SB 98 (Alarcon). Under H&SC Section 40448.5.1(c), this advisory group must comprise 13 members with expertise in clean fuels technology and policy or public health and appointed from the scientific, academic,

entrepreneurial, environmental and public health communities. This legislation further specified conflict-of-interest guidelines prohibiting members from advocating expenditures towards projects in which they have professional or economic interests. The objectives of the SB 98 Clean Fuels Advisory Group are to make recommendations regarding projects, plans and reports, prior to submittal of the required annual report to the South Coast AQMD Governing Board. In 1999, after the formation of the SB 98 Clean Fuels Advisory Group, South Coast AQMD revisited the charter and membership of the Technology Advancement Advisory Group to ensure their functions would complement each other.

On an as-needed basis, changes to the composition of the Clean Fuels Advisory Group are reviewed by the South Coast AQMD Governing Board while changes to the Technology Advancement Advisory Group are reviewed by the South Coast AQMD Governing Board's Technology Committee.

Current membership changes to the Technology Advancement Advisory Group and to the Clean Fuels Advisory Group are considered by the South Coast AQMD Technology Committee and the South Coast Governing Board, respectively, as part of consideration of each year's Annual Report and Plan Update. Members of the Technology Advancement Advisory Group and the SB 98 Clean Fuels Advisory Group are listed in Appendix A, with proposed changes, duly noted, subject to either South Coast AQMD Governing Board approval or the Governing Board's Technology Committee, per the advisory groups' charters.

The review process of the Clean Fuels Program now includes, at minimum: 1) two full-day retreats of both Advisory Groups, typically in the summer and winter; 2) review by other technical experts; 3) occasional technology forums or roundtables bringing together interested parties to discuss specific technology areas; 4) review by the Technology Committee of the South Coast AQMD Governing Board; 5) public hearing of the Annual Report and Plan Update before the full South Coast AQMD Governing Board, along with adoption of the Resolution finding that the proposed program and projects funded as part of the Clean Fuels Program will not duplicate any other past or present program or project funded by the state board and other government and utility entities, as required by the H&SC; and 6) annual submittal of the Clean Fuels Program Annual Report and Plan Update to the Legislature by March 31.

The following section describes the emission reduction targets and strategy of the Clean Fuels Program, which the Advisory Group and Governing Board will review as part of the annual report and plan update.

1.3. Emissions Reduction Targets

The overall strategy of TAO's Clean Fuels Program is based on emission reduction technology needs identified through the AQMP process and South Coast AQMD Governing Board directives to protect the health of the approximately 18 million residents (nearly half the population of California) in SCAB. The 2022 AQMP is the long-term regional blueprint that relies on fair-share emission reductions from all jurisdictional levels (e.g., federal, state and local). The 2022 AQMP is composed of stationary and mobile source emission reductions from traditional regulatory control measures, incentive-based programs, projected co-benefits from climate change programs, mobile source strategies and reductions from federally regulated sources (e.g., aircraft, locomotives and ocean-going vessels). CARB's adopted 2022 SIP Strategy included a revised mobile source strategy required for SCAB to meet the 2015 8-hour ozone standard of 70 ppb by 2037. The adopted 2022 SIP Strategy for both mobile and stationary sources requires rapid deployment of zero emission technologies to achieve air quality targets.

Ground level ozone (a key component of smog) is created by a chemical reaction between NOx and volatile organic compound (VOC) emissions in sunlight. This is noteworthy because the primary driver for ozone

formation in SCAB is NOx emissions, and mobile sources contribute approximately 85 percent of the NOx emissions in this region, as shown in Figure 1. Furthermore, NOx emissions, along with VOC emissions, also lead to the formation of PM2.5 [particulate matter measuring 2.5 microns or less in size, expressed as micrograms per cubic meter (µg/m3)], including secondary organic aerosols.

The emission reductions and control measures in the 2022 AQMP rely on commercial adoption of a mix of currently available zero emission technologies as well as the expedited development and commercialization of clean fuel mobile and stationary advanced technologies in SCAB to achieve air quality standards. Significant reductions are anticipated from implementation of advanced control technologies for on-road and off-road mobile sources. Air quality standards for ozone (70 ppb, 8-hour average) and fine particulate matter, promulgated by U.S. Environmental Protection Agency (U.S. EPA), are projected to require additional long-term control measures for NOx and VOC. The 2022 AQMP identifies that 83 percent NOx emission reductions from the 2018 level and 67 percent additional reductions in 2037 beyond already adopted regulations and programs are necessary to meet the 2015 8-hour ozone standard by 2037. The majority of NOx emission reductions must come from mobile sources, including both on- and off-road sources. Notably, South Coast AQMD is currently one of only two regions in the nation designated as an extreme nonattainment area of the 2015 8-hour ozone NAAQS (the other region is California's San Joaquin Valley). As a result, the 2022 AQMP shows the need for economy-wide transition to zero emission technologies where feasible, and low NOx emission technologies in other applications.

The need for advanced mobile source technologies and clean fuels is best illustrated by Figure 4 which identifies NOx emissions by source category in 2018 and 2037. NOx reductions identified in the 2022 AQMP will require the Clean Fuels Program to accelerate advancement of clean transportation technologies used as control strategies in the AQMP. Given this contribution, significant emission reductions from these sources are needed. 2022 AQMP mobile source strategies call for deploying cleaner technologies (both zero and near-zero emission) into fleets, requiring cleaner and renewable fuels, and ensuring continued clean performance in use. Federal actions are also required to address sources that are subject to federal regulations and beyond the regulatory authority of South Coast AQMD and California Air Resources Board (CARB).

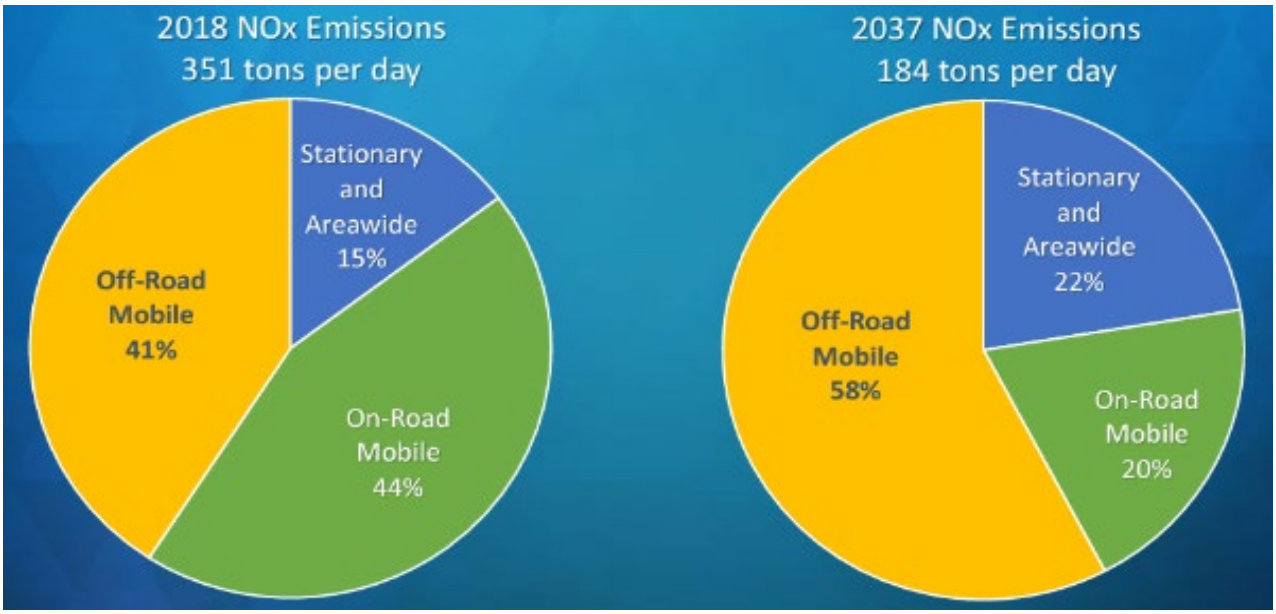


Figure 4: NOx Contribution Source Category in 2018 and 2037

Health studies also indicate a greater need to reduce NOx emissions and TAC emissions. The South Coast AQMD Multiple Air Toxics Exposure Study (MATES) V study (2021), and the prior four MATES studies, assessed air toxic levels, updated risk characterization, and determined gradients from selected sources. MATES VI is currently underway and will expand on the prior MATES studies.

In summary, advanced, energy efficient and renewable technologies are needed for attainment, but also to protect the health of residents, reduce long-term dependence on petroleum-based fuels, and support a more sustainable energy future. Conventional strategies and traditional supply and consumption need to be retooled to achieve national ambient air quality standards (NAAQS). To meet this need for advanced, clean technologies, the South Coast AQMD Governing Board continues to aggressively carry out the Clean Fuels Program and promote alternative fuels through its TAO.

As technologies move towards commercialization, such as battery electric and fuel cell trucks, the Clean Fuels Program partners with large OEMs, such as Daimler Trucks North America, LLC (DTNA), Volvo Group North America, Hyundai Motor Company, PACCAR, and others to deploy these vehicles at scale. These OEM partnerships allow the Program to leverage the research, product development and financial resources that are needed to move advanced technologies from the laboratories to the field and into customers' hands. OEMs have the resources and abilities to design, engineer, test, manufacture, market, distribute and service quality products under brand names that are trusted. This is the type of scale needed to achieve emission reductions to meet NAAQS.

As advanced technologies and cleaner fuels are commercial-ready, there needs to be a concerted effort to get them into the marketplace and on the roads. South Coast AQMD's Carl Moyer Program, which was launched in 1988, along with the recent Volkswagen Mitigation Trust and the Community Air Protection Program (CAPP), help achieve these results. These programs provide incentives to push market penetration of the technologies developed and demonstrated by the Clean Fuels Program. The synergy between the Clean Fuels program and incentive programs enables South Coast AQMD to play a leadership role in both technology development and commercialization efforts targeting reduction of criteria pollutants. Funding for both research, development, demonstration and deployment (RD^3) projects as well as incentives remains

critical given the magnitude of additional funding identified in the 2022 AQMP to achieve NAAQS.

Current federal and state efforts in developing regulations for on- and off-road vehicles and stationary equipment are expected to significantly reduce NOx emissions, but additional measures are needed to achieve 2031 and 2037 ozone attainment deadlines. To support fleet turnover, the Clean Fuels Program emphasizes on commercialization and deployment of clean technology, such as zero emission HD trucks, supporting zero emission infrastructure, as well as studies that plan and prioritize the needs to support the development of zero emission trucks and infrastructure.

The following section provides an overview of the clean technology and implementation strategy for the Clean Fuels Program.

1.4. Clean Technology Development and Implementation

The Clean Fuels Program has encouraged projects that increase the utilization of clean-burning fuels over the 36-year lifetime of the program. Many of the technologies that were supported during the early years of the program, are now seeing commercial deployments, e.g. fuel cell buses, while others saw great success only to be eventually phased out, e.g., methanol buses and vehicles. Of all the technologies that the Clean Fuels Program have supported, there are two recent technologies that have been commercialized and are providing emissions benefits through incentives programs – ultra-low NOx (near-zero emission or (NZE), NG engines and zero emission trucks (ZETs).

The Clean Fuels Program has been supporting the development of low and near-zero emission HD NG engines since the early 2000's. In 2003, South Coast AQMD conducted a joint project with the California Energy Commission (CEC), U.S. Department of Energy (DOE) and National Renewable Energy Laboratory (NREL) to advance development of HD NG engines to meet the upcoming 2010 NOx standard of 0.2 grams per brake horsepower hour (g/bhp-hr). This collaborative initiative resulted in the development of the Cummins-Westport, Inc. (CWI) 8.9-liter engine certified to 0.2 g NOx/bhp-hr, three years before the mandated 2010 national standard. In 2013, recognizing the need for accelerated NOx emission reductions in the HD sector, South Coast AQMD, CEC, and the Southern California Gas Company (SoCalGas) issued a joint solicitation to develop and demonstrate an NZE engine for commercial use. CWI developed and commercialized the first 0.02 g/bhp-hr NOx 8.9-liter NG engine (L9N). Additional projects with CEC, SoCalGas and Clean Energy Fuels Corporation produced the CWI 11.9-liter NZE engine (model ISX12N) certified in 2018 for port fleet operations, also first of its kind, including a 20-truck demonstration project at the San Pedro Bay Ports. These engines are now commercially available and offered by all major truck OEMs.

The Clean Fuels Program has also supported the development of ZETs including battery electric trucks (BETs) and fuel cell electric trucks (FCETs). DOE funded the Zero Emission Cargo Transport I (ZECT 1) project to develop and demonstrate Class 8 BETs. The ZECT I project inspired and influenced various subsequent BET and hybrid truck projects, including subsequent projects such as the CARB Greenhouse Gas Reduction Fund (GGRF) Zero Emission Drayage Truck (ZEDT) project, which demonstrated 44 battery electric and CNG and diesel hybrid electric drayage trucks at multiple California Ports. The GGRF-ZEDT project included 25 BYD 8TT BETs, 12 Peterbilt/Meritor/TransPower BETs, two Kenworth CNG hybrid electric trucks, three Volvo diesel plug-in hybrid electric trucks, and two Volvo VNR BETs. The Clean Fuels Program also supported the development and demonstration of six Class 8 heavy-duty drayage fuel cell, CNG hybrid and diesel hybrid electric trucks under the DOE ZECT II project which was started in 2014 and was completed in 2024. More recently, the Clean Fuels Program co-funded large DTNA and Volvo BET projects. For the Daimler Innovation Fleet project, in 2019, DTNA deployed 14 Class 8 eCascadia and six Class 6 eM2 trucks and installed seven DC fast charging stations at fleet locations. In

2022, Volvo deployed 30 Class 8 BETs and installed Level 2, AC, 50 and 150 kW DC fast chargers, and solar panels integrated with energy storage as part of the CARB GGRF Low Impact Green Heavy Transport Solutions (LIGHTS) project. In 2023, DTNA completed the deployment of two Class 6 and six Class 8 BETs for its Customer Experience project. During this year, they also deployed 10 Class 6 and 25 Class 8 BETs and chargers for commercial fleet distribution/delivery operations as part of their Zero Emission Electric Delivery Trucks project funded by EPA. In 2021, South Coast AQMD was awarded CARB and CEC funding for the Joint Electric Truck Scaling Initiative (JETSI) Pilot project to deploy 100 BETs and 350 kW DC fast chargers for two fleets, NFI Interactive Logistics, LLC (NFI) and Schneider National Inc (Schneider), see Figure 5. In 2023, the Volvo VNR Electric and DTNA eCascadia trucks were deployed and are now commercially available.

Figure 5: Developed, Demonstrated, and Deployed Clean Fuel Technology Trucks

Many more BETs and FCETs are needed to meet the 2031 and 2037 NAAQS ozone standard. Several challenges must be overcome to enable widespread deployments of BETs and price reductions must be achieved on these trucks for at-scale production. These challenges can be addressed by providing an easier process for fleets and independent owner operators to purchase BETs, installing public charging infrastructure, increasing grid capacity at truck delivery sites and truck fleet depots, and determining adequate charging system configurations to accommodate the duty cycles needed for drayage, short, regional haul, and last mile delivery freight truck applications. Also, education, and work force training and development, are needed to improve the ZE adoption.

In July 2024, the U.S. EPA awarded South Coast AQMD $500 million under the Climate Pollution Reduction Grants (CPRG) program to implement the INVEST CLEAN (Infrastructure, Vehicles, and Equipment Strategy for Climate, Equity, Air Quality, and National Competitiveness) project. INVEST CLEAN prioritizes emission reductions in the goods movement sectors for their potential of substantial reductions of criteria and hazardous air pollutants, impacts on low-income overburdened communities, and the opportunity to drive economic growth, including job creation and workforce training.

The lack of charging infrastructure for the BETs is often a hindrance that many truck fleets encounter, thus delaying their truck charging and electrification plans. In addition, the lack of grid capacity and challenges in deploying solar, energy storage, or other technologies to offset grid demand and long lead time to obtain the power needs are some of the barriers in ZE truck deployment. Between 2023 and 2024, South Coast

AQMD released several rounds of the Carl Moyer program and the Community Air Protection Program (CAPP) funding opportunities, totaling over $300 million. Meanwhile, publicly accessible truck charging stations are needed for small fleets and owner operators transiting to ZE truck fleets.[4,5] To mitigate the grid capacity issue, additional technology solutions that provide energy generation from non-grid tied microgrids thus, bypassing the utility complex interconnection requirements, are needed to mitigate the challenges with deploying BETs. South Coast AQMD has been strongly engaged in the development and demonstration of low and zero emission alternative charging solutions (ACS) to support the deployment of zero emission vehicles. The availability of reliable ACS will help fill the void of charging infrastructure delays as well as to provide as a backup generation option during grid outages and public safety power shutoff events. In May 2024, Prologis, Inc. opened the first of its kind 9MW electric vehicle charging depot powered by a non-grid connected microgrid of linear generators and batteries, capable of charging 96 heavy-duty BETs simultaneously.[6]

Today, NOx emissions from heavy-duty diesel trucks still comprise a major contributor to elevated air pollution levels in SCAB. While CARB has the Advanced Clean Trucks (ACT), Advanced Clean Fleets (ACF), and Heavy-Duty (HD) Omnibus regulations in place, there is still a need to tackle interstate truck emissions that travel to and from SCAB. CARB estimates that 60 percent of the total on-road HD vehicle miles traveled in SCAB are from vehicles purchased outside of California, which points to the need for more stringent federal and state standards for on-road HD vehicles. U.S. EPA has acknowledged the need for additional NOx emission reductions through a harmonized and comprehensive national NOx emission reduction program for HD on-highway engines and vehicles. In December 2022, U.S. EPA adopted the final rule "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards" which has a similar level of stringency as the CARB Omnibus Standard. In March 2024, two additional U.S. EPA rules were adopted, including the Phase 3 HD GHG and light-duty (LD) and medium-duty (MD) vehicle multi-pollutant standards for model year 2027. Both these rules emphasized large adoption of zero-emission LD, MD, and HD vehicles.

To quantify some of the emission benefits from NZE and ZE truck deployments, Table 1 summarizes the potential emission reductions as a result of the technologies directly supported by the Clean Fuels Program. Funding support through the South Coast AQMD Technology Advancement Office Incentives programs (e.g., commercial Lawn & Garden, on-Road, locomotive, marine, Volkswagen Mitigation Trust program, Lower emission school bus program) to develop and deploy ZE, NZE and Tier 3/4 Final vehicles and equipment has contributed to NOx, and PM emission reductions in SCAB over time. These programs have an old technology scrappage requirement as established by CARB.

[4] https://www.wattev.com/post/wattev-opens-electric-commercial-truck-charging-depot-in-san-bernardino-second-in-socal-in-the-last

[5] https://www.businesswire.com/news/home/20240327434127/en/Greenlane-Announces-280-mile-Corridor-of-Commercial-EV-Charging-Stations-from-Los-Angeles-to-Las-Vegas

[6] https://www.prologis.com/about/news-press-releases/performance-team-maersk-company-prologis-launch-new-ev-truck-charging

Technology Type	Award Amount	NOx Reductions (tpy)	PM Reductions (tpy)
Zero Emission	$523M	285	7.8
Near-Zero Emission	$147M	765	1.6
Tier 3 to Tier 4 Final	$324M	2,160	48.3
Total	$994M	3,210.4	57.6

Includes funded projects from Carl Moyer, Proposition 1B, VW Mitigation Trust, Voucher Incentive Program and other programs

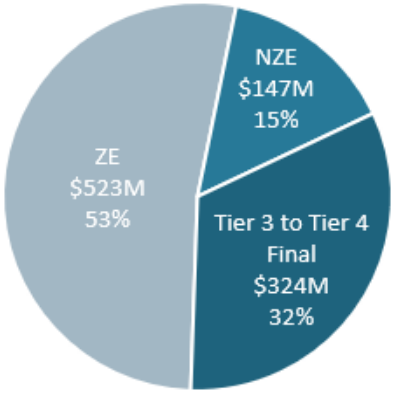


Table 1: Emission Benefits from Incentive Programs (2019 – 2024)

Although the emission reductions may seem modest at about 4% of the total emission reductions for on-road HD diesel trucks (1.69 tpd reductions vs. 44.5 tpd in on-road heavy-duty diesel) in 2024, the continued funding support to the commercialization of clean technologies and equipment from the Clean Fuels program ensures the continued emission reductions in SCAB.

Evaluation of health impacts of exposure to air pollution helps to assess source-specific impacts, guides potential policy and control strategies, and provides essential information to the public. Thus, health impact studies form a key component of the Clean Fuel Program strategy. Since the 1980s, South Coast AQMD has conducted five Multiple Air Toxics Exposure Study (MATES) campaigns s, with MATES V completed in August 2021 and MATES VI currently in preparation phases. MATES uses comprehensive measurements, modeling, and health risk assessment methods to estimate cancer and non-cancer chronic health risks due to exposure to air toxins throughout the South Coast AQMD jurisdiction. A summary of MATES program findings is included in the Core Technology Areas section. Updating MATES is a key Clean Fuels Program Strategy. MATES VI is in the preparation stages, with monitoring scheduled to start in early 2025 and final data and dissemination of findings expected between late 2027 and early 2028. This update will extend the measurements, emission inventory, modeling, health risk analysis, and trends analysis. Two near-road monitoring sites will be added, and one additional site at Mecca will provide data to determine air toxics risk from measurements in the Coachella Valley for the first time in MATES.

MATES VI includes a study that will quantify whether an increased cancer potency factor may result in total cancer risk being dominated by EtO rather than diesel particulate matter, which has driven cancer risk since at least 1998 when MATES II first conducted measurements required to track it. Uncertainties on the importance of the following factors in determining EtO concentrations have been identified: local emission sources, including vehicles and their emission rates, transport of background EtO into SCAB, and secondary formation of EtO in the atmosphere. South Coast AQMD is consulting subject matter experts on these topics and is planning a study to address some of these uncertainties. A source apportionment study using measurements for MATES VI may also identify sources contributing to the observed concentrations.

Despite several current California incentive programs to deploy commercially available cleaner technologies and offset the higher procurement costs of commercially available cleaner technologies,

significant additional resources and technology development are needed to achieve the NAAQS for this region. Several key emerging technologies are discussed in detail later that will provide NOx and GHG co-benefits while requiring fewer vehicle purchase incentives.

The Clean Fuels Program has partnered with large OEMs, such as DTNA, Volvo Group North America, and Hyundai Motor Company, to deploy HD BETs and FCTs. These OEM partnerships allow the Clean Fuels Program to leverage their research, design, engineering, manufacturing, sales and service, and financial resources to move advanced technologies from the laboratories to the field and into customers' hands. The OEMs have the resources to develop advanced technology vehicles such as battery electric and fuel cell powertrains, manufacture large quantities, and utilize their distribution networks to support sales across the state.

The Clean Fuels Program funds various stages of technology projects, typically ranging from Technology Readiness Levels 3-8, to provide a portfolio of technology choices and achieve near-term and long-term emission reduction benefits. Figure 6 outlines the technology readiness progression for development, demonstration and early deployment projects during the pre-commercialization phase, funded by the Clean Fuels Program and the relationship with incentive programs administered by TAO and regulatory implementation during the commercialization phase of clean vehicle technologies and equipment.

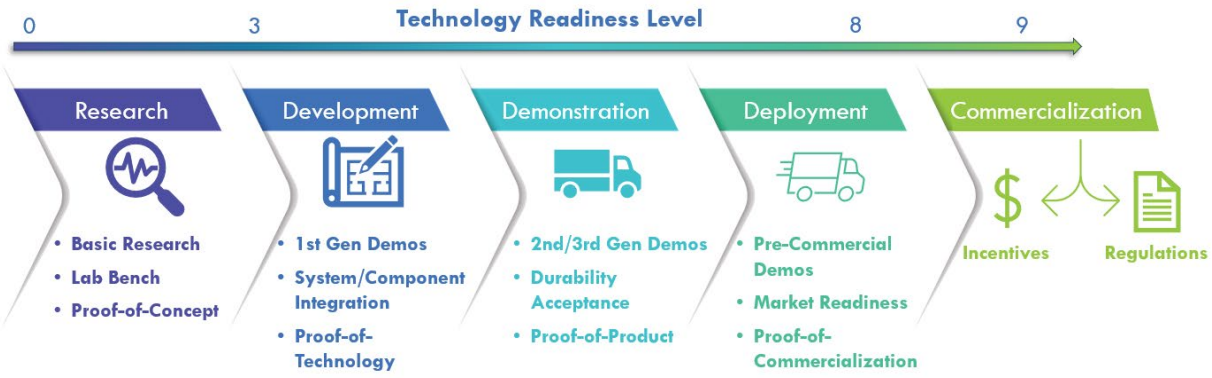


Figure 6: Technology Readiness Stages 3-8 of Clean Fuels Program

1.5. Internal and External Sources of Funding Support

The Clean Fuels Program was established under H&SC Sections 40448.5 and 40512 and Vehicle Code Section 9250.11. This legislation established mechanisms to collect revenues from mobile and stationary sources to support the program objectives and identified the constraints on the use of funds. In 2008, these funding mechanisms were reauthorized under SB 1646 (Padilla), which removed the funding sunset of January 1, 2010, and established the five percent administrative cap instead of the previous cap of two-and-half percent.

Specifically, the Clean Fuels Program is funded through a $1 fee on motor vehicles registered in the South Coast AQMD. Revenues collected from these motor vehicles must be used to support mobile source projects. Stationary source projects are funded by an emission fee surcharge on stationary sources emitting more than 250 tons of pollutants per year within South Coast AQMD. This revenue is typically about $13.5 million and $350,000, respectively, every year. For CY 2024, the funds available through each of these mechanisms were as follows:

- Mobile sources (DMV revenues) $13,772,274
- Stationary sources (emission fee surcharge) $292,707

The Clean Fuels Program allows significant leveraging of Clean Fuels funding, thus its public-private partnerships with private industry, technology developers, academic institutions, research institutions, and government agencies is a key strategy of the Program. Leveraging of the Clean Fuels Fund is based on actual executed contracts and total project costs from the prior year's Clean Fuels Annual Report and Plan Update. In 1998, South Coast AQMD's Carl Moyer Program was launched. The two programs produce a unique synergy, with the Carl Moyer Program (and other subsequent incentive programs) providing the necessary funding to push market penetration of commercial technologies partially developed and demonstrated by the Clean Fuels Program. This synergy enables South Coast AQMD to act as a leader in technology development and commercialization efforts targeting the reduction of criteria pollutants. Since the Carl Moyer Program began, South Coast AQMD has already started implementing other incentive programs (i.e., Volkswagen Mitigation, Proposition 1B-Goods Movement, and Community Air Protection Program), with cumulative funding of over $200 million in 2022. Since 2017, there has been cumulative funding of $370 million in AB 617 Community Air Protection Program (CAPP) incentives, of which $16.6 million will be used for zero emission trucks and charging infrastructure in the East Los Angeles/Boyle Heights/West Commerce, Southeast Los Angeles, San Bernardino/Muscoy, and Wilmington/Carson/West Long Beach[7]. The 2022 AQMP also included control measures to develop an indirect source regulation for the San Pedro Ports and strengthen fleet rules to take advantage of incentives to accelerate emission reductions further.

The Clean Fuels Program also receives grants and cost-sharing revenue contracts from various agencies, on a project-specific basis, that supplement the program. Historically, such cooperative project funding revenues have been received from CARB, CEC, U.S. EPA (including but not limited to their Diesel Emissions Reduction Act or DERA, Clean Air Technology Initiative or CATI, and Targeted Airshed Grant or TAG programs), DOE and U.S. Department of Transportation (DOT). These supplemental revenues depend, in large part, on the originating agency, its budgetary and planning cycle and the specific project or intended use of the revenues.

Table 4 on page 32 lists the federal, state and other revenue totaling almost $8.3 million awarded to South Coast AQMD in 2024 for projects that are part of the overall Clean Fuels Program's RD^3 efforts, even if for financial tracking purposes, revenue is recognized into another special revenue fund other than the Clean Fuels Fund (Fund 31).

The final and perhaps most significant funding source can best be described as an indirect source, i.e., funding not directly received by South Coast AQMD. This indirect source is the cost-sharing provided by private industry and other public and private organizations. The public-private partnerships with private industry, technology developers, academic institutions, research institutions and government agencies are a key strategy of the Clean Fuels Program. Historically, the TAO has been successful in leveraging its available public funds with $4 of outside funding for each $1 of South Coast AQMD funding. Since 1988, the Clean Fuels Program has leveraged nearly $268.7 million into over $1.7 billion in projects. For 2024, the Clean Fuels Program leveraged $1 of Clean Fuels Funds to approximately $3 of outside funding. Through these public-private partnerships, South Coast AQMD shared the investment risk of developing new technologies along with the benefits of expedited development and commercial availability, increased

[7] Wilmington/Carson/West Long Beach will also provide incentive funding for near-zero emission trucks.

end-user acceptance, reduced emissions from demonstration projects and ultimately increased use of clean technologies in SCAB. While South Coast AQMD aggressively seeks to leverage funds, it continues to act in a leadership role in technology development and commercialization efforts, along with its partners, to accelerate the reduction of criteria pollutants. Leveraging available funds and aggressively applying for additional federal and/or state available funds whenever funding opportunities arise is more important than ever, given the magnitude of additional funding needed, as identified in the 2022 AQMP, to achieve NAAQS. The Clean Fuels Program has also avoided duplicative efforts by coordinating and jointly funding projects with major funding agencies and organizations. The major funding partners for 2024 are listed in Table 2 on page 25.

Many technologies that address SCAB's needed NOx reductions align with the state's GHG reduction efforts. U.S. EPA (2023)[8] noted that the transportation sector contributed 28 percent of GHG emissions. Due to these co-benefits, South Coast AQMD has successfully partnered with the state and public/private partnerships to leverage its Clean Fuels funding extensively.

1.6 Core Technology Areas

There is a wide variety of air pollution sources in SCAB that contribute to air quality issues. Clean technologies and equipment are of paramount importance to help tackle air quality issues in the region. The Clean Fuels program has established a broad range of technology areas of focus – the "Core Technology Areas", which are listed below and described throughout the Annual Report and Plan Update:

- Hydrogen / Mobile Fuel Cell Technologies and Infrastructure;
- Engine Systems / Technologies (including alternative and renewable fuels for truck and rail applications);
- Electric / Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations);
- Zero Emission Infrastructure;
- Fueling Infrastructure and Deployment (NG and renewable fuels);
- Stationary Clean Fuels Technologies (including microgrids and renewables);
- Fuel and Emissions Studies;
- Emissions Control Technologies;
- Health Impacts Studies; and
- Technology Assessment and Transfer / Outreach.

[8] U.S. Greenhouse Gas Emissions and Sinks 1990-2021. 2023. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

CLEAN FUELS PROGRAM

2024 ANNUAL REPORT

2.1 Program Report Overview

This report summarizes the progress of the Clean Fuels Program for CY 2024. The Clean Fuels Program cost-shares projects to develop and demonstrate zero, near-zero and low emissions clean fuels and technologies to advance and promote technology development and commercialization not only for SCAB but also for the state of California and the entire nation. These projects are conducted through public-private partnerships with industry, technology developers, academic and research institutions and local, state and federal agencies.

This report also highlights achievements and summarizes project costs of the Clean Fuels Program in CY 2024. During the period between January 1 and December 31, 2024, South Coast AQMD executed 25 new contracts/agreements, projects or studies that support clean fuels and advanced zero, near-zero and low emission technologies (see Table 3). The Clean Fuels Program contribution for these projects was over $8.5 million as cost-share for contracts executed in this reporting period and the total project costs are over $25.8 million at 3:1 ratio.

The projects executed in 2024 address a wide range of issues with a diverse technology mix including near-term emissions reductions and long-term planning efforts. The report provides information on external funding support received into the Clean Fuels Fund as cost-share for contracts executed in this period, and funding support awarded to South Coast AQMD for projects that fall within the scope of the Clean Fuels Program's RD^3 efforts but may have been recognized (received) into another special revenue fund for financial tracking purposes (see Table 4). In 2024, the South Coast AQMD was awarded nearly $8.3 million from CARB's FY 2021-22 and FY 2022-23 Advanced Technology Demonstration and Pilot Projects solicitation for electrification of island ferries and installation of supporting charging infrastructure. More details on this financial summary can be found in section 2.4 of this report. South Coast AQMD will continue to pursue federal, state and private funding opportunities during CY2025 to amplify leverage, while acknowledging that support of a promising technology is not contingent on external cost-sharing and affirming that South Coast AQMD will remain committed to playing a leadership role in developing advanced technologies that lower criteria pollutants in SCAB.

2.2 Program Report Core Technology Areas

Given the diversity of sources that contribute to the air quality problems in SCAB, there is no single technology or "Silver Bullet" that can solve all the problems. A number of technologies are required, and these technologies represent a wide range of applications, with full emissions benefit "payoffs," i.e., full commercialization and mass deployment occurring at different times. The broad technology areas of focus – the "Core Technology Areas" – for the Clean Fuels Program are as follows:

- Hydrogen / Mobile Fuel Cell Technologies and Infrastructure;
- Engine Systems / Technologies (including alternative and renewable fuels for truck and rail applications);
- Electric / Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations);
- Zero Emission Infrastructure;

- Fueling Infrastructure and Deployment (NG and renewable fuels);
- Stationary Clean Fuels Technologies (including microgrids and renewables);
- Fuel and Emissions Studies;
- Emissions Control Technologies;
- Health Impacts Studies; and
- Technology Assessment and Transfer / Outreach.

South Coast AQMD continually seeks to support the deployment of lower-emitting technologies. The Clean Fuels Program is shaped by two basic factors:

1. Zero, near-zero and low emission technologies needed to achieve NAAQS in SCAB; and
2. Available funding to support technology development and deployment within the constraints imposed by that funding.

South Coast AQMD strives to maintain a flexible program to address dynamically evolving technologies and the latest progress in the state of the technology while balancing the needs in the various technology sectors with technology readiness, emissions reduction potential and co-funding opportunities. Although the Clean Fuels Program is significant, national and international activities affect the direction of technology development trends. As a result, the Clean Fuels Program must be flexible to leverage and accommodate these changes in state, national and international priorities. Nonetheless, while state and federal governments have continued to turn a great deal of their attention to climate change, South Coast AQMD has remained committed to developing, demonstrating and commercializing zero and near-zero emission technologies. Fortunately, many, if not the majority, of technology sectors that address our need for NOx reductions also garner GHG reductions. Due to these "co-benefits," South Coast AQMD has been successful in partnering with state and federal government. Even with leveraged funds, the challenge for South Coast AQMD remains the identification of project and/or technology opportunities in which its available funding can make a difference in achieving progressively cleaner air in SCAB.

To achieve this, South Coast AQMD employs various outreach and networking activities as well as evaluates new ways to expand these activities. These activities range from close involvement with state and federal collaboratives, partnerships and industrial coalitions, to the issuance of Program Opportunity Notices (PONs) to solicit project ideas and concepts as well as the issuance of Request For Information (RFIs) to determine the state of various technologies and the development and commercialization challenges faced by those technologies. Additionally, in the absence of PONs, unsolicited proposals from OEMs and other clean fuel technology developers are accepted and reviewed.

Historically, mobile source projects have targeted low-emission developments in LD vehicles, transit buses, MD and HD trucks and non-road applications. These vehicle-related efforts have focused on advancements in engine design, electric powertrains and energy storage/conversion devices (e.g., fuel cells and batteries); and implementation of clean fuels (e.g., NG, propane and hydrogen) including infrastructure development. Stationary source projects have included a wide array of advanced low NOx technologies and clean energy alternatives such as fuel cells, solar power and other renewable and waste energy systems. In recent years, the focus has been on zero and near-zero emission technologies with increased attention to MD and HD trucks to reduce emissions from mobile sources, which contribute to more than 80 percent of the current NOx emissions in SCAB. However, while mobile sources include both on- and off-road vehicles as well as aircraft and ships, only the federal government has the authority to regulate emissions from aircraft and ships. South Coast AQMD is exploring opportunities to expand its authority in ways that would allow the agency to do more to foster technology development for ship and train activities as well as locomotives related to goods movement. In the absence of regulatory authority, South Coast AQMD is utilizing

mitigation funds, funding from San Pedro Bay Ports and industry partners to expand its portfolio of RD^3 projects to include marine and ocean-going vessels to demonstrate emission reduction technology in this sector where NOx emissions are increasing.

The 2022 AQMP included five facility-based mobile source measures, also known as indirect source measures. South Coast AQMD staff has been developing both voluntary and regulatory measures in a process that has included extensive public input. Indirect source measures are distinct from traditional air pollution control regulations in that they focus on reducing emissions from the vehicles associated with a facility rather than emissions from a facility itself.

For example, newly established indirect source measures for warehouses focus on reducing emissions from trucks servicing warehouses. Measures for Ports will concentrate on emissions from ships, trucks, locomotives and cargo handling equipment at the Ports. Measures covering new development and redevelopment projects could aim to reduce emissions from construction equipment, particularly HD diesel earth-moving vehicles.

Specific projects from competitive solicitations, cooperative agency agreements and unsolicited proposals are selected for co-funding. Criteria considered in project selection include emissions reduction potential, technological innovation, potential to reduce costs and improve cost effectiveness, contractor experience and capabilities, overall environmental impacts or benefits, commercialization and business development potential, cost-sharing and cost-sharing partners, and consistency with program goals and funding constraints. The core technology areas for South Coast AQMD programs that meet both the funding constraints and 2022 AQMP needs for achieving clean air are briefly described below.

2.2.1. Hydrogen / Mobile Fuel Cell Technologies and Infrastructure

In 2015, Toyota and Hyundai commercialized LD Mirai and Tucson fuel cell vehicles, respectively. In 2016, Honda launched their Fuel Cell Clarity passenger car, and in mid-2024, they launched their CR-V e:FCEV (plug-in hybrid hydrogen fuel cell electric vehicle) . OEMs continue development efforts and collaborate to broaden application of fuel cells to increase manufacturing scale and reduce cost to commercialize fuel cell vehicles. However, although progress is being made, the greatest challenge for the viability of fuel cell vehicles remains the installation and operation of hydrogen fueling stations. AB 8 requires CEC to allocate $20 million annually from the Alternative and Renewable Fuel and Vehicle Technology Program until there are at least 100 publicly accessible hydrogen stations in operation in California. Of the 107 stations funded by CEC and CARB by the end of 2022, partially funded by South Coast AQMD for those in our region, there is one legacy and 54 retail operational in California. AB 8 also requires CARB to annually assess current and future fuel cell vehicles (FCVs) and hydrogen stations in the marketplace. *The Joint Agency Staff Report on Assembly Bill 8: 2021 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California*[9] was released in December 2021 and stated there were 9,647 fuel cell vehicles registered in California by October 2021. The Hydrogen Fuel Cell Partnership's (H2FCP, previously known as California Fuel Cell Partnership or CaFCP) *The California Fuel Cell Revolution, A Vision For Advancing Economic, Social, and Environmental Priorities* (Vision 2030) includes the need for up to 1,000 refueling stations statewide as well as the need for 200 HD stations to support 70,000 fuel cell trucks by 2035.

Clearly, South Coast AQMD must continue to support infrastructure required to refuel retail fuel cell vehicles and the nexus to MD and HD trucks including reducing the cost to deploy HD hydrogen infrastructure. To that end, South Coast AQMD co-funded a liquid hydrogen station capable of fueling up

[9] https://www.energy.ca.gov/publications/2021/joint-agency-staff-report-assembly-bill-8-2021-annual-assessment-time-and-cost

to 50 fuel cell transit buses and 10 fuel cell transit buses at OCTA. South Coast AQMD Clean Fuels Program funding of $1,000,000 is committed towards the CARB Zero and Near Zero-Emission Freight Facilities (ZANZEFF) Shore to Store project to deploy 10 HD FCETs and install three HD hydrogen stations in Wilmington and Ontario; this contract is also supported by the $1,200,000 Clean Fuels funding committed to the CEC co-funded HD Shell station installed at Port of Long Beach (POLB) property and leased to Toyota. South Coast AQMD is also actively engaged in finding alternatives to reduce the cost of hydrogen (e.g., large-scale hydrogen refueling stations or production facilities) and potential longer-term fuel cell power plant technology. In 2024, South Coast AQMD completed the DOE-funded ZECT project (ZECT 2), to develop and demonstrate HD FCETs. In 2014, five entities were selected to develop and demonstrate a total of seven Class 8 drayage trucks for this project. Those entities were the Center for Transportation and the Environment (CTE) for the development and demonstration of one Class 8 fuel cell range extended electric drayage truck; Gas Technology Institute (GTI) for the development and demonstration of one Class 8 CNG hybrid electric drayage truck; Transportation Power (TransPower) for the development and demonstration o two Class 8 fuel cell range extended electric drayage trucks; US Hybrid for the development and demonstration of two Class 8 fuel cell range extended electric drayage trucks; and, International Rectifier (IR) for the development and demonstration of one diesel hybrid electric drayage truck. Between 2014-2024, six of the seven ZECT II zero-emission drayage truck platforms, were successfully designed, developed, integrated, built, tested, and demonstrated with drayage fleet operators in transportation corridors within areas of the South Coast AQMD jurisdiction in Southern California such as in and around POLA and POLB. In late 2016, IR announced that it was being acquired by Infineon Technologies AG. After the acquisition, the new ownership declined to continue developing the truck. Between 2017 and mid-2024, South Coast AQMD staff and the DOE explored together with numerous truck manufacturers/vendors/developers the fulfillment of the development and demonstration of one (the 7th) heavy-duty truck. This effort was not successful for a number of different reasons such as timeline for the development, concerns about data logging and confidentiality, ZECT II Build America – Buy America Act requirements as well as changes in one OEM's core fuel cell strategy from low pressure to high pressure products in FCEVs. Portable hydrogen refueling was deployed to support the fuel cell vehicles. The project had real-time improvement with on-going debugging and optimizations while the vehicles were under demonstration. All platforms demonstrated sufficient or excess power, torque, and energy to support 82,000lbs Gross Vehicle Weight Rating and gradeability to perform their daily duty cycles. Collectively, the trucks drove over 23,000 miles during their respective demonstration phases. South Coast AQMD also co-funded research studies on hydrogen systems and HD hydrogen fueling infrastructure, and high-flow bus fueling protocols that are led by UC Davis, DOE, and NREL.

2.2.2. Engine Systems / Technologies (including alternative and renewable fuels for truck and rail applications)

Based on data included in the 2022 South Coast AQMD AQMP, MD and HD on-road vehicles contributed approximately 23 percent to SCAB's 2018 NOx emissions inventory. More importantly, on-road HD diesel trucks account for 33 percent of the on-road mobile source PM2.5 emissions. Furthermore, according to CARB, trucks and buses are responsible for 37 percent of California's GHGs and criteria emissions. While MATES IV found a dramatic decrease in ambient levels of diesel PM and other air toxics, diesel PM is still the major driver of air toxics health risks. Clearly, significant emission reductions will be required from mobile sources, especially from the HD sector, to attain the NAAQS. Even with the announced rollout of ZETs in 2021 by Volvo and Daimler, it is anticipated that it would take roughly a decade for a large enough deployment of those trucks to have an impact on air quality.

The use of alternative fuels in HD vehicles can provide significant reductions in NOx and particulate

emissions. The U.S. Environmental Protection Agency (EPA) announced new greenhouse gas (GHG) emissions standards for heavy-duty (HD) vehicles on March 29, 2024. These standards, known as Phase 3, are effective June 21, 2024 The current NOx emissions standard for HD engines is 0.05 g/bhp- hr. South Coast AQMD, along with various local, state and federal agencies, continues to support the development and demonstration of alternative-fueled low emission HD engine technologies, using NG, renewable natural gas or hydrogen, renewable diesel and potentially other renewable or waste stream fuels, for applications in HD trucks, transit and school buses, rail operations, and refuse collection and delivery vehicles to meet future federal emission standards. South Coast AQMD is supporting three projects to convert the 2021 Ford MD gasoline engine to near-zero NOx level by using NG and propane.

In 2021, CARB adopted Heavy-Duty Engine and Vehicle Regulation (Omnibus Regulation), which will drastically reduce NOx emissions in conventional HD engines from 0.20 grams per brake horsepower hour to 0.050 g/bhp-hr in model years 2024 to 2026, and to 0.020 g/bhp-hr in model year 2027. In July 2023, CARB announced the Clean Truck Partnership with leading OEMs and the Engine Manufacturers Association that included harmonization to EPA-Nox Rule with a few differences. This action created alignment of engines standards nationwide starting model year 2027 and heavy-duty engines nation-wide will be subjected to the same lower standard.

2.2.3. Electric / Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations)

There has been more developments and attention on electric and hybrid vehicles due to a confluence of factors, including the highly successful commercial introductions of hybrid LD passenger vehicles, plug-in electric vehicles (PEVs), and battery electric vehicles (BEVs) by the major OEMs and increased public attention to climate change, as well as approval of the CARB Advanced Clean Cars II regulation establishing an annual roadmap for 100% zero-emission new LD vehicles by 2035. This regulation codifies the LD vehicle goals in California Governor Newsom's Executive Order N-79-20.

Technology transfer to MD and HD applications has made significant progress, especially with the commercialization of Class 6 - 8 BETs by the major OEMs and with the demonstration and deployment of MD shuttle buses, delivery vans, transit buses, and cargo handling equipment through freight handling and goods movement in SCAB. As with hydrogen and fuel cell technologies, South Coast AQMD is actively pursuing research, development and demonstration projects for MD and HD BETs and their commercialization. The Clean Fuels Program has also supported the development of ZETs including BETs and FCETs. U.S. DOE funded the ZECT I project to develop and demonstrate Class 8 BETs and plug-in hybrid electric trucks (PHETs): four BETs from TransPower, two BETs from US Hybrid, two series PHETs from TransPower, and three parallel PHETs from US Hybrid. The successful development of those truck models developed under ZECT I project, model year 2023 BETs have an all-electric range of up to 220-275 miles and PHETs have a range of up to 250 miles. The ZECT 1 project inspired and influenced various subsequent BET and hybrid truck projects including subsequent projects such as the GGRF ZEDT project, which demonstrated 44 battery electric and CNG and diesel hybrid electric drayage trucks at multiple California Ports. The ZEDT project included 25 BYD 866 BETs, 12 Peterbilt/Meritor/TransPower BETs, two Kenworth CNG hybrid electric trucks, three Volvo diesel plug-in hybrid electric trucks, and two Volvo VNR BETs. The Clean Fuels Program also supported the development and demonstration of six Class 8 heavy-duty drayage fuel cell, CNG hybrid and diesel hybrid electric trucks under the DOE ZECT II project which was started in 2014 and was completed in 2024. More recently, the Clean Fuels Program co-funded large DTNA and Volvo BET projects. For the DTNA Innovation Fleet project, in 2019, DTNA deployed

14 Class 8 eCascadia and six Class 6 eM2 trucks and installed seven DC fast charging stations at fleet locations. Volvo deployed 30 Class 8 BETs and installed Level 2, AC, 50 kW and 150 kw DC fast chargers, and solar panels integrated with energy storage as part of the CARB GGRF Low Impact Green Heavy Transport Solutions (LIGHTS). DTNA completed the deployment of two Class 6 and six Class 8 BETs for its Customer Experience project. During the year, they also deployed 10 Class 6 and 25 Class 8 BETs and chargers for commercial fleet distribution/delivery operations as part of their Zero Emission Electric Delivery Truck project funded by EPA. In 2021, South Coast AQMD was awarded CARB and CEC funding for the JETSI Pilot Project deployed 100 BETs and 350 kW DC fast chargers for two fleets, NFI and Schneider, see Figure 5. In 2023, the Volvo VNR Electric and DTNA eCascadia trucks were deployed and are now commercially available.

Battery and hybrid electric off-road and marine applications including battery electric yard tractors, forklifts, top handlers, RTG cranes, locomotives, ocean going vessels, and construction equipment are included in multiple demonstration projects to accelerate commercialization and deployment of these technologies. South Coast AQMD has demonstrated a battery electric excavator and wheel loader with Volvo Construction Equipment as part of a FY 18 U.S. EPA Targeted Airshed Grant award and received another FY 22 U.S. EPA Targeted Airshed Grant award to demonstrate 1.5 ton and 2.5 ton asphalt compactors in Coachella Valley. South Coast AQMD is also demonstrating the first battery electric line haul locomotive deployed in California in partnership with U.S. EPA, BNSF, and Progress Rail. In July 2023, a $76 million award was awarded by California State Transportation Agency (CalSTA) in July 2023 under the Port and Freight Infrastructure Program (PFIP) for the “Freight Air Quality Solutions” (FAQS) Project to demonstrate a liquid hydrogen fuel cell freight locomotive. Under the same FY 22 U.S. EPA Targeted Airshed Grant award, a hybrid electric drive diesel hybrid tugboat will be demonstrated by fleet operator with co-funding from POLB and CARB. These pilot demonstration and deployment projects are key to additional emission reductions from the off-road construction, locomotive, and marine sectors.

2.2.4. Fueling Infrastructure and Deployment (Natural Gas/Renewable Fuels)

A key element for increased use of alternative fueled vehicles and resulting widespread acceptance of the technology is the availability of the supporting refueling infrastructure. The refueling infrastructure for gasoline and diesel fuel is well established and accepted by the driving public. Alternative, clean fuels, such as alcohol-based fuels, propane, hydrogen, and even electricity, are less available or accessible, whereas NG and renewable fuels have recently become more readily available and cost-effective. Nonetheless, to realize emissions reduction benefits, alternative fuels, especially fuels from renewable feedstocks, must be developed in tandem with the growth in alternative fueled vehicles. While California appears to be on track to meet its Renewable Portfolio Standard targets of 44 percent by 2024 and 60 percent by 2030 as required by SB 350 (chaptered October 2015), the objectives of the South Coast AQMD are to expand the infrastructure to support zero and near-zero emission vehicles through the development, demonstration and installation of alternative fuel vehicle refueling technologies. However, this category is predominantly targeted at NG and renewable natural gas (RNG) infrastructure and deployment (electric and hydrogen fueling are included in their respective technology categories). The Clean Fuels Program will continue to explore opportunities where current incentive funding is either absent or insufficient.

2.2.5. Stationary Clean Fuel Technologies (including microgrids and renewables)

Given the limited funding available to support low emission stationary source technology development, this area has historically been limited in scope. To gain the maximum air quality benefits in this category, higher polluting fossil fuel-fired electric power generation needs to be replaced with clean, renewable

energy resources or other advanced zero and near zero-emission technologies, such as solar, energy storage, wind, geo-thermal energy, bio-mass conversion and stationary fuel cells. Although combustion sources are lumped together as stationary, the design and operating principles vary significantly and thus the methods and technologies for control of their emissions vary as well. Included in the stationary category are boilers, heaters, gas turbines, linear generators, and reciprocating engines as well as microgrids and some renewables. The key technologies for this category focus on using advanced combustion processes, and on the development of catalytic add-on controls, alternative fuels and technologies and stationary fuel cells in novel applications.

Although stationary source NOx emissions are small compared to mobile source NOx emissions in SCAB, there are applications where cleaner fuel technologies or processes can be applied to reduce NOx, VOC and PM emissions. Recent demonstration projects funded in part by the South Coast AQMD include a local sanitation district retrofitting an existing biogas engine with a digester gas cleanup system and catalytic exhaust emission control. The retrofit system resulted in significant reductions in NOx, VOC and carbon monoxide (CO) emissions. This project demonstrated that cleaner, more robust renewable distributed generation technologies exist that not only improve air quality but enhance power quality and reduce electricity distribution congestion. Another ongoing demonstration project includes retrofitting a low NOx ceramic burner on an oil heater without the use of reagents, such as ammonia or urea, which is anticipated to achieve selective catalytic reduction (SCR) of NOx emissions. SCR requires the injection of ammonia or urea that is reacted over a catalyst bed to reduce the NOx formed during the combustion process. Challenges arise if ammonia distribution within the flue gas or operating temperature is not optimal resulting in ammonia emissions leaving the SCR in a process referred to as “ammonia slip”. The ammonia slip may also lead to the formation of particulate matter in the form of ammonium sulfates. Based on the successful deployment of this project, further emission reductions may be achieved by other combustion sources (such as boilers) with the continued development of specialized low NOx burners without the use of reagents.

2.2.6. Emissions Control Technologies

This broad category refers to technologies that could be deployed on existing mobile sources, aircraft, locomotives, marine vessels, farm and construction equipment, cargo handling equipment, industrial equipment, and utility and lawn-and-garden equipment. The in-use fleet comprises most emissions, especially older vehicles and non-road sources, which are typically uncontrolled and unregulated, or controlled to a much lesser extent than on-road vehicles. The authority to develop and implement regulations for retrofit on-road and off-road mobile sources lies primarily with U.S. EPA and CARB. Both agencies are currently planning research efforts for off-road mobile sources.

Low emission and clean fuel technologies that appear promising for on-road mobile sources should be effective at reducing emissions for off-road applications. For example, immediate benefits are possible from particulate traps and SCR technologies that have been developed for on-road diesel applications although retrofits are often hampered by physical size and visibility constraints. Clean fuels such as NG, propane, hydrogen and hydrogen-natural gas mixtures may also provide an effective option to reduce emissions from some off-road applications, even though alternative fuel engine offerings are limited in this space, but retrofits such as dual-fuel conversions are possible and need to be demonstrated. Reformulated gasoline, ethanol and alternative diesel fuels, such as biodiesel and gas-to-liquid (GTL), also show promise when used in conjunction with advanced emissions controls and new engine technologies. Emissions assessments are important in such projects since the development of a specific technology to reduce one contaminant may contribute to the increase of another contaminant.

2.2.7. Health Impacts Studies

The monitoring of pollutants in SCAB is extremely important, especially when focused on (1) a sector of the emissions inventory (to identify the responsible technology) or (2) exposure to pollution (to assess potential health risks). Several studies indicate that areas with high levels of air pollution can produce irreversible damage to children's lungs. This information highlights the need for further emissions and health studies to identify the emissions from high polluting sectors as well as the resulting health effects. As we transition to new fuels and forms of transportation, it is important to understand the impacts a change in fuel composition will have on exhaust emissions and in turn on ambient air quality. This area focuses on exhaust emissions studies, with a focus on NOx and PM2.5 emissions and a detailed review of other potential toxic tailpipe emissions, for alternative fuel and diesel engines. These types of in-use emissions studies have found significantly higher emissions than certification values for HD diesel engines, depending on the duty-cycle. South Coast AQMD recently completed the fifth Multiple Air Toxics Exposure Study (MATES V), a three-year in-use emissions study of 200 next-generation technology HD vehicles in SCAB. MATES V is aimed at understanding the activity pattern of different vocations and real-world emissions emitted from different technologies. Key findings of the MATES V study showed a 54 percent decline in overall multi-pathway cancer risk compared to findings in MATES IV and diesel PM remains the main risk driver contributing to 67 percent of the overall multi-pathway cancer risk based on population-weighted estimates. Cancer risk decreased at every monitoring station in SCAB with the highest risk at the Inland Valley San Bernardino monitoring station. Communities adjacent to the Ports are in the top 96th percentage of air toxics cancer risk. MATES VI is currently underway and will expand on prior MATES studies by including measurements at two near-road sites, expansion of measurements to the Coachella Valley, a source apportionment study to capture air toxic sources, ethylene oxide measurements and risk analysis, improvements to the emission inventory and air quality model, and initial evaluation of brake and tire wear contribution to PM.

2.2.8. Technology Assessment and Transfer / Outreach

Since the value of the Clean Fuels Program depends on the deployment and adoption of the demonstrated technologies, technology assessment and transfer efforts are an essential part of the Clean Fuels Program. This core area encompasses assessment of advanced technologies, including retaining outside technical assistance as needed, efforts to expedite implementation of low emission and clean fuels technologies, and coordination of these activities with other organizations, including networking opportunities to seek external funding support/cost-share. Assembly Bill (AB) 617[10], which requires reduction of air pollution exposure of individuals in vulnerable and overburdened communities, required TAO to carry out additional outreach in CY 2024 to AB 617 communities to explore and identify available zero and near-zero emission technologies as well as the incentives to accelerate the implementation of cleaner technologies into those communities. TAO staff also provide input as part of working groups, such as the San Pedro Bay Ports Technology Advancement Program, Metro I-710 South Corridor Task Force, Electric Power Research Institute (EPRI) eTRUC technical advisory committee, CALSTART EnergIIZE Funding Advisory Committee, 21st Century Truck Partnership Charging and Infrastructure Work Group, LA 28 Olympic and Paralympic Games Sustainability Working Group, and the Los Angeles Cleantech Incubator projects. Technology transfer efforts also include support for various clean fuel technology incentive programs (i.e., AB 617 CAPP, Carl Moyer Program, Proposition 1B-Goods Movement, etc.). Furthermore, community and stakeholder outreach has been included in grant proposals and funded projects administered by the Clean Fuels Program. Thus, the other spectrum of this core technology is information dissemination to

[10] https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program/about

educate and promote awareness of the public and end users. At various events, TAO staff coordinated information booths to answer questions from the general public and participated on discussion panels on zero and near-zero emission technologies. Those events included the Annual International Onboard Sensing, Analysis, and Reporting Conference, the California Hydrogen Leadership Summit, 35th Real World Emissions Workshop, Driving Mobility 11, Electric & Hybrid Marine Technology Conference, Hydrogen Village 2024, Irvine Clean Energy Conference, Los Angeles Auto Show, SoCal Electrified Drive Event at the Orange County Auto Show, Clean Mobility Forum and CoMotion LA. While South Coast AQMD's Legislative, Public Affairs & Media Office oversees and carries out such education and awareness efforts on behalf of the entire agency, TAO cosponsors and occasionally hosts various technology-related events to complement their efforts (see section 2.4.4.10for a description of the technology assessment and transfer contracts executed in CY 2024 as well as a listing of the 21 conferences, workshops and events funded in CY 2024. Throughout the year, staff also participates in programmatic outreach for TAO incentive programs, including the AB 617 CAPP, Carl Moyer, Proposition 1B-Goods Movement, Volkswagen Mitigation, Replace Your Ride, U.S. EPA funded Commercial Electric Lawn and Garden Incentive and Exchange, residential lawn mower and residential EV charger rebate programs.

2.3. Barriers, Scope, Impact, and RD[3]

2.3.1. Overcoming Barriers

Commercialization and implementation of advanced technologies come with a variety of challenges and barriers. A combination of real-world demonstrations, education, outreach, regulatory impetus and incentives is necessary to bring new, clean technologies to market. To gain the maximum emissions benefits from any technology, widespread deployment and user acceptance must occur. The product manufacturers must overcome technical and market barriers to ensure a competitive and sustainable business. Barriers include project-specific issues as well as general technology concerns.

Technology Implementation Barriers

- Viable commercialization path
- Technology price/performance parity with convention technology
- Consumer acceptance
- Fuel availability/convenience issues
- Certification, safety and regulatory barriers
- Quantifying emissions benefits
- Sustainability of market and technology
- Supporting infrastructure

Project-Specific Issues

- Identifying committed demonstration sites
- Overall project cost and cost-share using public funds
- Securing charging or fuel infrastructure
- Identifying and resolving real and perceived safety issues
- Quantifying actual emissions benefits
- Viability of technology providers

Other barriers include reduced or shrinking research budgets, infrastructure and energy uncertainties and risks, sensitivity to multi-media environmental impacts and the need to find balance between environmental needs and economic constraints. South Coast AQMD seeks to address these barriers by establishing relationships through unique public-private partnerships with key stakeholders; e.g., industry, end-users and other government agencies with a stake in developing clean technologies. Partnerships that involve all key stakeholders are essential to address these challenges in bringing advanced technologies from development to commercialization.

Each of these stakeholders and partners contributes more than just funding support. Industry can contribute technology production expertise as well as the experience required for compatibility with process operations. Academic and research institutions bring current technology knowledge and testing proficiency. Governmental and regulatory agencies can provide guidance in identifying sources with the greatest potential for emissions reductions, assistance in permitting and compliance issues, coordinating of infrastructure needs, facilitation of standards and outreach. There is considerable synergy in developing technologies that address multiple goals of public and private agencies regarding environment, energy and transportation.

2.3.2. Scope and Benefits

Since the time needed to overcome barriers can be long and the costs high, manufacturers and end-users

find it challenging to undertake the risks in developing advanced technologies prior to commercialization. The Clean Fuels Program accelerates commercialization of these technologies by co-funding research, development, demonstration and deployment projects to share the risk of emerging technologies with technology developers and eventual users.

Figure 7 below provides a conceptual design of the wide scope of the Clean Fuels Program. As mentioned in the Core Technology Areas section, various stages of technology projects are funded not only to provide a portfolio of emissions technologies but to achieve emission reductions in the near-term and long-term horizon. The Clean Fuels Program funds projects in the Technology Readiness Level ranging between 3-8.

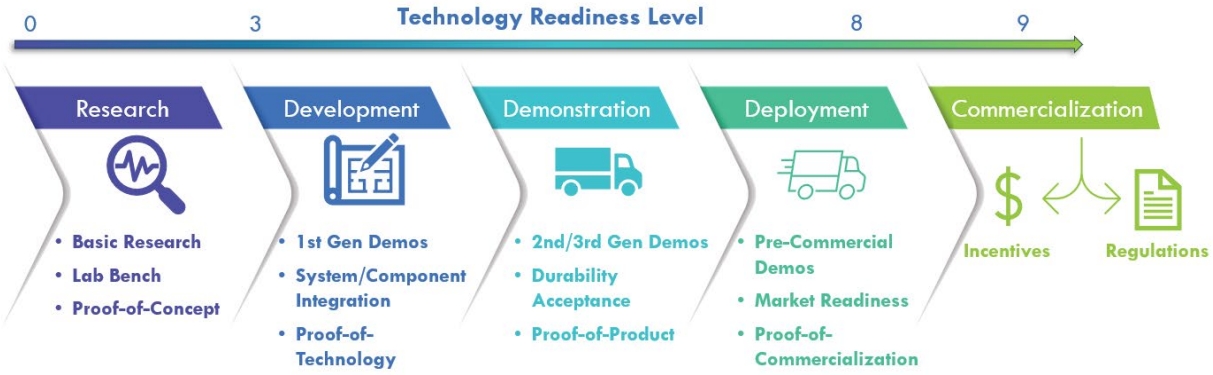


Figure 7: Technology Readiness Stages 3-8 of Clean Fuels Program

Due to the nature of these advanced technology $R\,D^{3}$ projects, benefits are difficult to quantify since their full emissions reduction potential may not be realized until sometime in the future, or not at all if displaced by superior technologies. Nevertheless, a good indication of the impacts and benefits of the Clean Fuels Program overall are provided by this selective list of sponsored projects that have resulted in commercialized products or helped to accelerate advanced technologies. As a partial estimate of the impacts of clean fuels program, the emission benefits from SCAQMD's own Incentive Programs for near-zero, zero emission and off-road categories were listed under Table 1.

- Projects that led to commercialization of near-zero NOx engine for HD vehicles:
    - CWI: development and certification of near-zero NOx NG 8.9L and 12L engines (0.02 g/bhp-hr);
    - Southwest Research Institute (SwRI) project developed a near-zero NOx HD diesel engine; and
    - CNG hybrid electric drayage trucks that were part of DOE ZECT II project, CARB GGRF project, and demonstration projects with DOE/NREL/CEC.
- Projects that led to advancement and commercialization of hydrogen fuel cell MD and HD vehicles:
    - Kenworth Fuel Cell Range Extended Electric Drayage Truck project;
    - SunLine Transit Agency Advanced Fuel Cell Bus project;
    - UPS demonstration of fuel cell delivery trucks;
    - Kenworth, TransPower, US Hybrid, Cummins fuel cell drayage trucks under ZECT II project; and
    - Hyundai's Class 8 fuel cell truck development and demonstration projects.

- Projects that led to advancement and commercialization of battery-electric MD and HD vehicles:
    - Early BETs as part of CARB GGRF ZEDT, ZECT I and ZECT II
    - Volvo' Volvo LIGHTS and Switch-On projects: Pilot deployments of Volvo Class 8 BET t;
    - Daimler's Innovation Fleet Project, Customer Experience Project and Zero Emission BET Delivery Truck Project;
    - JETSI: a follow-on large scale deployment with two fleets for 50 Class 8 BETs each;

South Coast AQMD played a leading or major role in the development of these technologies, but their benefits could not have been achieved without all stakeholders (i.e., manufacturer, end-users and government) working collectively to overcome the technology, market and project-specific barriers encountered at every stage of the RD^3 process.

2.3.3. Strategy and Impact

In addition to the feedback and input detailed in the Advisory Groups section, South Coast AQMD actively seeks additional partners for its program through participation in various working groups, committees, partnerships, councils and task forces. This participation has resulted in coordination of the Clean Fuels Program with state and federal government organizations, including CARB, CEC, U.S. EPA, U.S. DOE, U.S. DOT, and several national laboratories. Coordination also includes the AB 2766 Discretionary Fund Program administered by the Mobile Source Air Pollution Reduction Review Committee (MSRC), various local air districts including but not limited to Bay Area AQMD, Sacramento Metropolitan AQMD, San Diego Air Pollution Control District (San Diego APCD) and San Joaquin Valley Air Pollution Control District (SJVAPCD), as well as the National Association of Fleet Administrators (NAFA), major local transit districts, local gas (i.e., Southern California Gas Company) and electric utilities (i.e., Southern California Edison, Los Angeles Department of Water and Power), national laboratories including but not limited to the National Renewable Energy Laboratory, San Pedro Bay Ports and several universities with research facilities, including but not limited to Universities of California Berkeley, Davis, Irvine, Los Angeles and Riverside, and West Virginia University. The list of organizations with which South Coast AQMD coordinates research and development activities also includes organizations specified in H&SC Section 40448.5.1(a)(2).

In addition, South Coast AQMD holds periodic meetings with several organizations specifically to review and coordinate program and project plans. For example, South Coast AQMD staff meets with CARB staff to review research and development plans, discuss project areas of mutual interest, avoid duplicative efforts and identify potential opportunities for cost-sharing. Periodic meetings are also held with industry-oriented research and development organizations, including but not limited to the Hydrogen Fuel Cell Partnership, California Stationary Fuel Cell Collaborative, EPRI, Veloz, Los Angeles Cleantech Incubator Regional Transportation Partnership, and West Coast Collaborative. The coordination efforts with these various stakeholders have resulted in several cosponsored projects.

Descriptions of key contracts executed in CY 2024 are provided in the next section of this report. It is noteworthy that most projects are cosponsored by various funding organizations and include active OEM involvement. Such partnerships are essential to address commercialization barriers and expedite implementation of advanced technologies. Table 2 below lists major funding agency partners and

manufacturers actively involved in South Coast AQMD projects for this reporting period. It is important to note that, although not listed, there are many other technology developers, small manufacturers and project partners who make important contributions critical to the success of the Clean Fuels Program. These partners are identified in the more detailed 2024 Project Summaries by Core Technology Areas contained within this report, as well as Table 4 which lists federal, state and local funding awarded to South Coast AQMD in CY 2024 for RD^3 projects (which will likely result in executed project contracts in 2025).

Table 2: South Coast AQMD Major Funding Partners in CY 2024

California Air Resources Board	Southern California Gas Company
California Energy Commission	University of California, Riverside
Range Energy, Inc.	University of California Alianza MX
Zero Emission Industries, Inc.	Crowley Maritime

Section 2.3.3. broadly address South Coast AQMD's impact and benefits by describing specific accomplishments including commercial or near-commercial products supported by the Clean Fuels Program in CY 2024. Such examples are provided in the following sections on TAO Technology Research, Development, Demonstration, and early Deployment projects and Commercialization efforts.

2.3.4. Research, Development, Demonstration and Deployment

An example of the impact of South Coast AQMD research and development coordination efforts in 2024 include: Development and Demonstration of Electric-Powered Trailer for Heavy-Duty Vehicles.

- **Development and Demonstration of Electric-Powered Trailer for Heavy-Duty Vehicles**

Hybridization of HD class 8 trucks with electric-powered trailers is an innovative technology that provides an immediate opportunity to reduce emissions from goods movement activities throughout SCAB. The electric trailers provide propulsion assistance and regenerative braking that is expected to result in fuel savings and the reduction of criteria and GHG pollutants. The technology is also expected to extend the range of new zero-emission trucks through the trailer's propulsion assistance. Electric-powered trailers do not require any tractor retrofitting (no data connections, etc.) and rely on the conventional drop and hook paradigm, using only standard interfaces. The trailers use an embedded kingpin sensor to detect tractor motion and performance (accelerating, braking, etc.) and augments this behavior with propulsion assistance and/or regenerative braking. When a tractor-trailer is accelerating as it enters a freeway on-ramp, the trailer powertrain will provide propulsive force, reducing the amount of energy the tractor must expend in order to get up to speed. Similarly, when tractor-trailer is coming to a stop at a traffic light, the trailer can use regenerative braking to recapture its own kinetic energy, and reduce the force needed by the tractor to bring the system to a stop. The trailer is able to manage its own acceleration and braking to regulate kingpin force. This allows the tractor to achieve similar performance as if it were in an unloaded state.

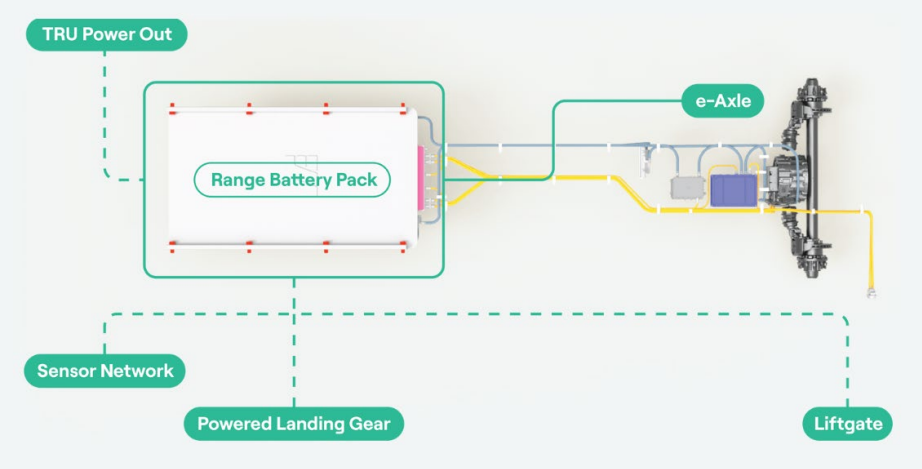


Figure 8: Range Energy Trailer Technology Overview

For this project, Range Energy, Inc. will develop battery electric-powered trailers that use standard interfaces to connect with diesel or electric tractors without retrofitting. The demonstration will be conducted for the period of one month and will include the in-use emissions measurements to evaluate the impact of emissions reduction from the utilization of electric-powered hybrid trailer.

UCR/CE-CERT will evaluate the feasibility and benefit of battery powered trailer assist system as a way to deliver energy to fleets with mostly diesel conventional trucks. The evaluation will include the emissions of a baseline truck operating on normal routes as well as the same or similar truck operating on the same routes with the power assisted trailer, denoted the "control". The approach will utilize Portable Emissions Measurement System (PEMS) testing on one day with the baseline and one day with the control. UCR will also work with the fleet to allow for the installation of UCR's new low-cost on-board sensing system called OSAR (named from Onboard Sensing Analysis and Reporting). The PEMS will be utilized for one day on each vehicle where the OSAR system will be installed and operated for the duration of the demonstration.

Figure 9: Range Energy Trailer in Deployment

Range Energy and its fleet partner will conduct a multi-phase pilot of Range Energy's powered trailers in the fleet partner's beverage transport operations in SCAB. This will include the deployment of at least one prototype unit in 2023, and further units in 2024.

During the pilot, Range Energy's trailers will be towed by the fleet partner's diesel and electric tractors in typical beverage transport operated by fleet partner personnel at the fleet partner facilities, and on selected

fleet partner routes. They will be loaded in a typical manner as other fleet partner trailers. Alongside operational and technical testing, Range Energy will lead efforts to gather feedback from a broad range of stakeholders regarding the impacts of deploying powered trailers. These stakeholders may include, for example, truck drivers, safety officials, fleet partner customers, leaders of communities where the pilots are taking place, and fleet partner executives, among others.

The commercial goals of this pilot will be to collect data to inform a future commercial relationship between Range Energy and its fleet partner, as well as product development and operational planning at the two companies. Data categories will include the following:

- Fuel-savings and imputed emissions-reductions data
- Drive cycles and charge state data
- Trailer utilization data
- Operational fit data
- Charging schedule data
- Maintenance and reliability data

Deliverables from this pilot will include:

- A comparison of the actual fuel consumption of tractor-trailer trips on selected routes compared to historical fuel consumption on such routes
- For any routes completed using ZEV tractors, a comparison of the real-world range and/or asset utilization achieved compared to historical performance on such routes
- A data package including route data and trailer powertrain data to be used for future trailer assist optimization
- A detailed breakdown of operational usage for each asset, including uptime, dock time, charge time, and downtime

Air Quality Benefits and Cost

Both Range Energy and the fleet partner are strong supporters of improving air quality in SCAB, particularly in historically impacted communities, and have been supporters of past AQMD programs to this effect. Range Energy's powered trailers are projected to reduce emissions from tractor-trailer operations by upwards of 40 percent in typical usage and expand the suitability of ZEV trucks for a broader range of applications. Applying these ratios to the fleet partner's fleet yields potential emissions reductions on the scale of 250,000 tons of CO2 annually. Further compounding the benefits are the shorter projected scale-up time of powered trailers vs. other electric propulsion platforms in the Class 8 space, allowing more of these emissions savings to be realized earlier on.

All the fleet partner's warehouse facilities in SCAB are located within census tracts containing priority populations. Range Energy's powered trailers will reduce emissions in these communities, furthering existing efforts by the fleet partner to improve air quality in these areas.

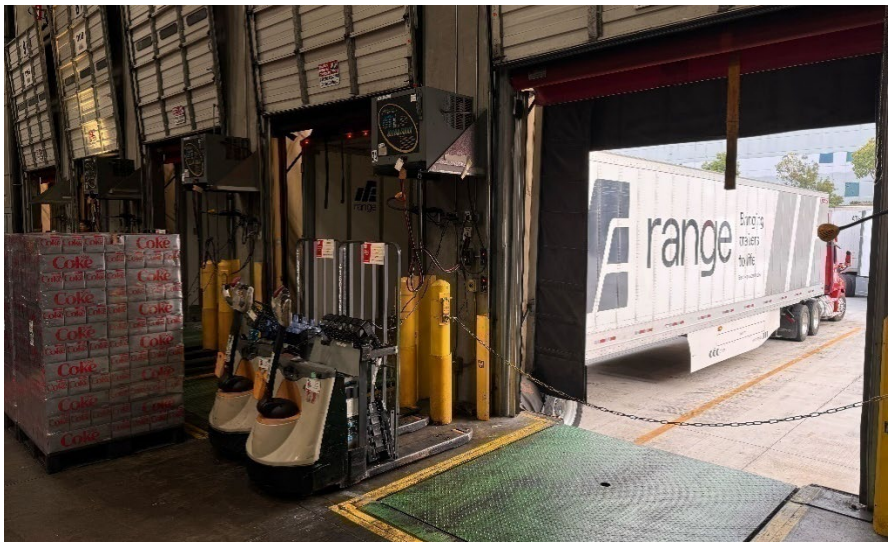


Figure 10: Range Energy Trailer in Deployment in SCAB

SCAB Deployment and Demonstration

As of early 2025, the Range Energy trailer has been in demonstration with a beverage delivery company since October 2024. To date, over 8000 miles traveled and over 3200 kWh energy charged. The trailer is mainly hauled by two tractors, 2018 Freightliner DD13 and 2023 Freightliner DD13, both have UCR's OSAR system installed for emissions evaluation. The charging is provided by a mobile Kempower DC charger using the building's existing 480V hook-up. The emissions evaluation is still in progress, but preliminary data is seeing 20-80 percent MPG gains to the diesel tractor. The project will be completed with PEMS testing and report done by mid-2025. As a follow up project, Range Energy is under the process of performing another demonstration project integrating a zero-emission transportation refrigeration unit (TRU) onto the trailer.

2.4. Funding & Financial Summary

The Clean Fuels Program supports clean fuels and technologies that appear to offer the most promise in reducing emissions, promoting energy diversity, and in the long-term, providing cost-effective alternatives to current technologies. To address the wide variety of pollution sources in SCAB and the need for reductions now and in the future, using revenue from a $1 motor vehicle registration fee (see Internal and External Sources of Funding Support on page 10), South Coast AQMD seeks to fund a wide variety of projects to establish a diversified technology portfolio to proliferate choices with the potential for different commercial maturity timing. Given the evolving nature of technology and changing market conditions, such a representation is only a "snapshot-in-time," as reflected by the projects approved by the South Coast AQMD Governing Board.

As projects are approved by the South Coast AQMD Governing Board and executed into contracts during the year, finances may change to reflect updated information provided during the contract negotiation process. As such, the following represents the status of the Clean Fuels Fund as of December 31, 2024.

2.4.1. Funding Commitments by Core Technology Areas

South Coast AQMD continued its successful leveraging of public funds with outside investment to support the development of advanced clean air technologies. During the period from January 1 through December 31, 2024, a total of 25 contracts/agreements, which consist of 5 projects and 20 technology transfer and outreach contracts that support clean fuels were executed or amended (affecting dollars), as shown in Table 3. The distribution of funds based on technology area is shown graphically in Figure 11. This wide array of technology support represents South Coast AQMD's commitment to researching, developing, demonstrating and deploying potential near-term and longer-term technology solutions.

The project commitments that were contracted or purchased for the 2024 reporting period are shown below with the total projected project costs:

- South Coast AQMD Clean Fuels Fund Contribution $8,559,904
- Total Cost of Clean Fuels Projects $25,833,283

Traditionally, every year, the South Coast AQMD Governing Board approves funds to be transferred to the General Fund Budget for Clean Fuels administration. However, starting with FY 2017, fund transfer from Clean Fuels Fund to the General Fund was handled through the annual budget process. When the Governing Board approved South Coast AQMD's FY 2024-25 Budget on May 3, 2024, it included $1 million from Clean Fuels Fund recognized in TAO's budget for technical assistance, workshops, conferences, co-sponsorships and outreach activities, as well as postage, supplies and miscellaneous costs. Only the funds committed by December 31, 2024, are included within this report. Any portion of the Clean Fuels Fund not spent by the end of Fiscal Year 2024-25 ending June 30, 2025, will be returned to the Clean Fuels Fund. For Clean Fuels executed and amended contracts, projects and studies in 2024, the average South Coast AQMD contribution was leveraged with $3 of outside investment. The typical historical leverage amount is $4 for every $1 of the South Coast AQMD Clean Fuels Fund, but from 2016 to 2023 there were several significant contracts in funding and impact that should make tangible progress toward developing and commercializing clean transportation technologies.

During 2024, distribution of funds for South Coast AQMD executed contracts, purchases and contract amendments with additional funding for the Clean Fuels Program totaling over $8.5 million are shown in Figure 11 below.

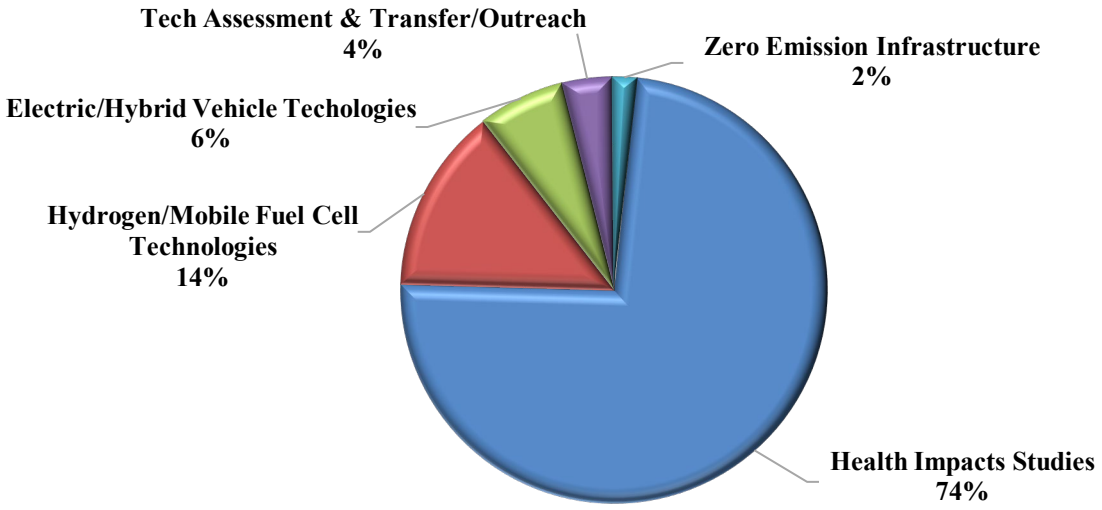


Figure 11: Distribution of Funds for Executed Clean Fuels Projects CY 2024 ($8.5M)

Additionally, South Coast AQMD continued to seek funding opportunities and was awarded nearly $8.3 million in CY 2024 for RD[3] projects as listed in Table 4. As of January 1, 2025, there were 57 open Clean Fuels Fund contracts. Appendix B lists these contracts by core technology.

2.4.2. Review of Audit Findings

State law requires an annual financial audit after the closing of each South Coast AQMD fiscal year. The financial audit is performed by an independent Certified Public Accountant selected through a competitive bid process. For the fiscal year ended June 30, 2024, the firm of Lance, Soll & Lunghard, LLP conducted the financial audit and gave the South Coast AQMD an "unmodified opinion" to South Coast AQMD's Annual Comprehensive Financial Report, the highest obtainable. Notably, South Coast AQMD has achieved this rating on all prior annual financial audits. There were no adverse internal control weaknesses with regard to South Coast AQMD financial statements, which include the Clean Fuels Program revenue and expenditures.

2.4.3. Project Funding Detail by Core Technology Areas

The 25 new and continuing contracts/agreements, projects and studies that received South Coast AQMD funding in CY 2024 are summarized in Table 3, together with funding authorized by South Coast AQMD and project partners.

Table 3: Contracts Executed or Amended (w/$) between January 1 & December 31, 2024

Contract	Contractor	Project Title	Start Term	End Term	South Coast AQMD $	Project Total $
Hydrogen / Mobile Fuel Cell Technologies and Infrastructure						
24166	Zero Emission Industries Inc	Development of a Portable Liquid Hydrogen Fueling System	06/27/24	04/30/26	1,175,000	7,168,750
24235	Air Products and Chemicals Inc	License Agreement to Operate and Maintain Publicly Accessible Hydrogen Fueling Station at SCAQMD's Diamond Bar HQs	04/10/24	01/09/25	0	0
Electric / Hybrid Vehicle Technologies and Related Infrastructure						
24123	Range Energy Inc	Development and Demonstration of Electric Powered Trailer for Heavy-Duty Vehicles	06/03/24	06/02/25	500,000	4,242,000
24318	University Of California Riverside	Evaluation of Electric Powered Trailer for Heavy-Duty Vehicles	12/11/24	2/10/25	50,000	50,000
Zero Emission Infrastructure						
24131	University Of California Riverside	Regional Medium- and Heavy-Duty Zero Emission Vehicle Infrastructure Analysis	05/10/24	03/31/25	150,000	300,000
Health Impacts Studies						
Fund Transfer	Various	Conduct Sixth Multiple Air Toxics Exposure Study (MATES VI)	12/01/23	06/30/28	6,368,681	10,767,987
Technology Assessment and Transfer / Outreach						
24173	Integra Environmental Consulting Services Inc	Technical Assistance to Support Technology Advancement Office Mobile Source Incentive and Technology Demonstration Programs	05/01/24	04/30/26	75,000	75,000
24180	Social and Environmental Entrepreneurs, Inc. DBA Tecolote Perch	Outreach and Proposal Development for Community Engagement and Benefit Component for Climate Pollution Reduction Grant Proposal	02/23/24	08/22/24	30.000	30.000
24192	Yassamin Kavezade DBA MYK Strategies	Research, Outreach, and Proposal Development for Community Engagement and Benefits Component for Climate Pollution Reduction Grant Proposal	02/13/24	08/12/24	25,000	25,000
Various	Various	Cosponsor 21 Conferences, Workshops & Events plus 3 Memberships	01/01/24	12/31/24	183,541	3,171,864
Direct Pay	Various	Advanced Technology Program Expenses	01/01/24	12/31/24	2,682	2,682
						$25,833,283

Table 4: Summary of Federal, State and Local Funding Awarded or Recognized in CY 2024

Awarding Entity or Program	Award (*) or Governing Board Date	Purpose	Contractors	Award Total/ Fund
CARB Advanced Technology Demonstration and Pilot Projects	05/03/24	Electrification of Balboa Island Ferries and Installation of Supporting Charging Infrastructure	Balboa Island Ferry	$8,297,548 Fund 83
Table 4 provides a comprehensive summary of revenue awarded to South Coast AQMD during the reporting CY (2024) for TAO's RD³ efforts which falls under the umbrella of the Clean Fuels Program, regardless of whether the revenue will be received into the Clean Fuels Program Fund (31) or the South Coast AQMD pass-through contract has been executed.				**$8,297,548**

2.4.4. Project Summaries by Core Technology Area

The following summaries describe the contracts, projects and studies executed, or amended affecting dollars, in CY 2024. They are listed in the order found in Table 3 by category and contract number. As required by H&SC Section 40448.5.1(d), the following project summaries provide the project title; contractors and, if known at the time of writing, key subcontractors or project partners; South Coast AQMD cost-share, cosponsors and their respective contributions; contract term; and a description of the project.

2.4.4.1. Hydrogen / Mobile Fuel Cell Technologies and Infrastructure

- **24166: Development of a Portable Liquid Hydrogen Fueling System**

Contractor: Zero Emission Industries Inc	South Coast AQMD Cost-Share	$ 1,175,000
	Cosponsors:	
	CEC	5,250,000
	SoCalGas	500,000
	Zero Emission Industries Inc	300,000
	Crowley Maritime	243,750
Term: 06/27/24– 04/30/26	Total Cost:	$ 7,168,750

Zero Emission Industries Inc (ZEI) will develop, build, and demonstrate a first-of-its-kind portable zero boil-off liquid hydrogen (LH2) bunkering system capable of supplying a week's worth of fuel to a vessel, locomotive, or equivalent equipment (~ 3500 kg) in under two hours. The system will be self-contained, capturing boil-off hydrogen gas then compressing and storing the hydrogen to provide power to an onboard PEM fuel cell to run the system. This novel system will increase system efficiency and financial viability while allowing for flexible deployment that follows relevant land-based and marine codes and standards. The system will help with the deployment of zero-emission marine vessels and locomotives and will be portable to avoid monopolizing valuable space while simultaneously enabling the bunkering and dispensing of liquid hydrogen. In addition, the system can be stored remotely and only moved when needed. Compared to a permanently installed hydrogen fueling station, this LH2 bunkering system is estimated to cost ten times less, can be used at multiple port terminal berths, and enables immediate deployment of LH2-powered vessels and locomotives by eliminating on-site construction timelines. ZEI will also demonstrate the technology with the project partners at one or more California Ports to fuel locomotives, fuel cell shore power, or cold ironing systems. South Coast AQMD funding will be used towards developing, building, testing, validating, and demonstrating the portable LH2 refueling system.

- **24235: License Agreement to Operate and Maintain Publicly Accessible Hydrogen Fueling Station at SCAQMD's Diamond Bar HQs**

Contractor: Air Products and Chemicals Inc	South Coast AQMD Cost-Share	$ 0
Term: 04/10/24– 01/09/25	Total Cost:	$ 0

Under Contract 15150, Air Products & Chemicals, Inc. (APCI) constructed South Coast AQMD's current hydrogen station and will maintain it through January 9, 2025, with a month-to-month term thereafter. This no-cost license agreement establishes the rights and responsibilities for the day-to-day operation of South Coast AQMD's onsite hydrogen station and coincides with the term of APCI Contract 15150.

2.4.4.2. Electric / Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations)

- **24123: Development and Demonstration of Electric Powered Trailer for Heavy-Duty Vehicles**

Contractor: Range Energy Inc	South Coast AQMD Cost-Share	$ 500,000
Term: 06/03/24 – 06/02/25	Total Cost:	$ 4,242,000

Hybridization of HD class 8 trucks with electric-powered trailers is an innovative technology that provides an immediate opportunity to reduce emissions from goods movement activities throughout SCAB. Range Energy has developed battery electric-powered trailers that use standard interfaces to connect with diesel or electric tractors without retrofitting. The electric trailers provide propulsion assistance and regenerative braking that is expected to result in fuel savings and the reduction of criteria and GHG pollutants. The technology is also expected to extend the range of new zero-emission trucks through the trailer's propulsion assistance. Overall, this demonstration project will quantify emission benefits and effectiveness of an electric-powered trailer to reduce emissions from diesel trucks. Additionally, this technology is expected to be further developed to help replace the need for diesel engines powering transport refrigeration units upon trailers in the near future. Range Energy will develop and provide an electric-powered hybrid trailer to a local fleet that will place the trailer into operation using a diesel truck. The demonstration will be conducted for the period of one month and will include the in-use emissions measurements to evaluate the impact of emissions reduction from the utilization of electric-powered hybrid trailer. The electric-powered trailers can be installed into any tractor (i.e., diesel, battery electric and hydrogen/fuel cell) without retrofitting. The trailer will use an embedded sensor to detect the tractor's motion and performance (accelerating, braking, etc.) and augment the behavior with propulsion assistance and/or regenerative braking.

- **24318: Evaluation of Electric Powered Trailer for Heavy-Duty Vehicles**

Contractor: University of California Riverside	South Coast AQMD Cost-Share	$ 50,000
Term: 12/11/24 – 12/10/25	Total Cost:	$ 50,000

UCR/CE-CERT will assist Range Energy with emission measurements and analyzing fuel-savings that will help quantify emission benefits along with understanding operational cost benefits or disbenefits to using an electric trailer in a routine truck delivery route. UCR/CE-CERT will evaluate the feasibility and benefit of battery powered trailer assist system as a way to deliver energy to fleets with mostly diesel conventional trucks. The evaluation will include the emissions of a baseline truck operating on normal routes as well as the same or similar truck operating on the same routes with the power assisted trailer, denoted the "control".

The approach will utilize Portable Emissions Measurement System (PEMS) testing on one day with the baseline and one day with the control. As an optional task, UCR/CE-CERT will try to work with the fleet to allow for the installation of UCR's new low-cost on-board sensing system called OSAR (named from Onboard Sensing Analysis and Reporting). The PEMS will be utilized for one day on each vehicle where the OSAR system will be installed and operated for the duration of the demonstration.

2.4.4.3. Zero Emission Infrastructure

- **24131: Regional Medium- and Heavy-Duty Zero Emission Vehicle Infrastructure Analysis**

Contractor: University of California Riverside	South Coast AQMD Cost-Share	$ 150,000
	Cosponsors:	
	University of California Alianza MX	125,000
	University of California Riverside / CE-CERT	25,000
Term: 05/10/24 – 03/31/25	Total Cost:	$ 300,000

The MD/HD transportation sector continues to be a significant source of harmful air pollutant emissions in SCAB, presenting an opportunity for improving local air quality and addressing climate change. NOx emission from these trucks are more than three and a half times that from the 200 highest emitting stationary sources (i.e., refineries, power plants, and the rest of the Regional Clean Air Incentive Market (RECLAIM) program). Attainment of federal ozone standards is only feasible with rapidly addressing emissions from these vehicles and other mobile sources. Transitioning the MD/HD transportation sector to ZEV powered by low or zero-emission electricity and hydrogen is crucial to achieve California's climate and air quality goals, including meeting the NAAQS for SCAB. This transition is pursued through initiatives including Advanced Clean Trucks and Advanced Clean Fleets regulations. However, a significant challenge lies in planning, building, and deploying the necessary charging and fueling infrastructure. Challenges include limitations in electrical grid capacity, integration costs, and land use constraints. Addressing these issues is essential for successfully implementing ZEV in the MD/HD transportation sector and meeting California's environmental and air quality objectives. As such, it is critical to perform studies that provide essential information to promote MD/HD ZEV infrastructure planning for commercial and industrial operations, and identify key barriers associated with transitioning trucking to ZEV platforms. UC Riverside has several ongoing and recently completed projects that focus on MD/HD ZEVs, i.e., FCEVs, BEVs and infrastructure deployment. The existing studies create the foundation for the tasks being proposed for this contract. With South Coast AQMD support, UC Riverside will expand the scope of the existing studies focusing on MD/HD ZEV planning and deployment throughout SCAB. As a part of this study, UC Riverside will provide important information for South Coast AQMD to promote MD/HD ZEV infrastructure planning for commercial and industrial operations. Additionally, UC Riverside will identify critical resources and other needs to transitioning trucking to ZEV platforms. The data collection, analysis, and modeling performed as a part of this agreement will help facilitate smoother ZEV facility deployments. The specific South Coast AQMD tasks will further detail the cost and technical specifications and quantify the air quality benefits anticipated from MD/HD ZEV deployments. The combined efforts will promote a smoother transition to ZEVS, including strategic ZEV infrastructure development, which is needed to adopt MD/HD ZEV technology successfully.

2.4.4.4. Health Impacts Studies

- **Fund Transfer: Conduct Sixth Multiple Air Toxics Exposure Study (MATES VI)**

Contractor: Various	South Coast AQMD Cost-Share	$ 6,368,681
	Cosponsor	
	South Coast AQMD General Fund	4,399,306
Term: 12/01/23 – 06/30/28	Total Cost:	$ 10,767,987

Since 1987, South Coast AQMD has conducted five Multiple Air Toxics Exposure Studies (MATES), a Governing Board environmental justice initiative, to characterize the concentration of airborne toxic compounds within SCAB and to determine the region-wide cancer risks associated with major airborne carcinogens. However, as each successive MATES campaign builds on the previous work, each iteration added additional goals and objectives and employed more sophisticated measurement and modeling techniques. Results of MATES are used to provide public information about air toxics and associated health risks throughout the region, evaluate progress in reducing air toxics exposure, and provide direction to future toxics control programs. Previous MATES campaigns have also identified unknown air toxics sources and have been critical in the interpretation of data from special air toxics monitoring studies in communities throughout the region. MATES continues to be the most sophisticated regional air toxics analysis conducted in the nation, taking advantage of the extensive air quality monitoring, modeling, and analysis expertise and resources at South Coast AQMD. MATES VI field measurements will be conducted over a one-year period at ten fixed sites to evaluate air toxics levels. MATES VI monitoring is being extended to the Coachella Valley for the first time. In addition, two of the ten monitoring locations will be sited adjacent to freeways to capture near-road air toxics impacts. MATES VI will also include measurements of ultrafine particle (UFP) and black carbon (BC) concentrations, which can be compared to the UFP and BC levels measured in MATES IV and MATES V, continuous measurement of metals, some of which are chemical tracers for non-exhaust vehicular emissions, and measurement of ammonia, a key precursor to PM2.5 formation in the region. Currently South Coast AQMD operates only one ammonia monitor in Coachella Valley and more measurements as part of MATES VI can help better understand the sources of ammonia across South Coast AQMD ’s jurisdiction. While MATES VI is focused on air toxic impacts, these ammonia measurements and particle speciation measurements will provide additional information about the sources and composition of PM2.5, which will assist in the design of control strategies to attain federal PM2.5 standards. In addition to the fixed site monitoring, MATES VI will include a special study to characterize emissions of ethylene oxide (EtO) in ambient air and at the near-road sites to assess the contribution of vehicular emissions to background EtO concentration levels. The Clean Fuels funds are being used for staffing, technical support and supply and equipment purchases to carry out MATES VI.

2.4.4.5. Technology Assessment and Transfer / Outreach

- **24173: Technical Assistance to Support Technology Advancement Office Mobile Source Incentive and Technology Demonstration Programs**

Contractor: Integra Environmental Consulting Services Inc	South Coast AQMD Cost-Share	$ 75,000

Term: 05/01/24 – 04/30/26	Total Cost:	$ 75,000

There is a critical need in SCAB to reduce NOx emissions and demonstrate attainment of the ozone national ambient air quality standards, as outlined in the 2022 AQMP. Despite significant reductions already achieved through regulatory and incentive-based programs, mobile sources continue to dominate SCAB's NOx emissions. Therefore, it is vitally important that new feasible and cost-effective mobile source control technologies be aggressively developed and commercialized, and large-scale incentive funding programs continue to be implemented in an expeditious manner to maximize the needed NOx and Diesel particulate matter (DPM) reductions from mobile sources to improve the regional and local air quality. Because of the extensive air quality challenges in SCAB and the need to expand existing programs, external expertise is needed to augment in-house expertise and assist staff in developing and implementing incentive programs and technology demonstration projects. Mr. Zorik Pirveysian of Integra Environmental Consulting Services, Inc. has over 36 years of experience in air quality policy, planning, emissions inventory and control strategy development. He has been directly and intimately involved in large scale air quality management planning efforts, emissions inventory development specifically with criteria pollutants and greenhouse gases, control strategy development primarily for mobile sources, zero- and low-emissions technology evaluations, and development and implementation of incentive programs. Zorik has a B.S. degree in Chemical Engineering from California State University, Northridge, and an M.S. degree in Environmental Engineering from the University of Southern California. Under this contract, Mr. Pirveysian will provide technical expertise across a broad spectrum of incentive and R&D programs to be implemented under Technology Advancement Office (TAO) activities on an-as-needed basis. Mr. Pirveysian has expert, in-depth understanding of both the incentive and R&D programs.

- **24180: Outreach and Proposal Development for Community Engagement and Benefit Component for Climate Pollution Reduction Grant Proposal**

Contractor: Social and Environmental Entrepreneurs, Inc. DBA Tecolote Perch	South Coast AQMD Cost-Share	$ 30,000
Term: 02/23/24 – 08/22/24	Total Cost:	$ 30,000

This contract leverages staff resources with specialized outside expertise. Social And Environmental Entrepreneurs, Inc. DBA Tecolote Perch will provide a strategic and comprehensive approach for outreach and coordination to facilitate community-based organization engagement, and program development for the community engagement and benefit component of the Climate Pollution Reduction Grant (CPRG) proposal. U.S. EPA is requiring community engagement as part of CPRG proposal development and to include both direct and indirect community benefits in the proposed project(s). Tecolote Perch brings experience working with low-income and disadvantaged communities, specifically related to goods movement including heavy-duty trucks, railyards, warehouses and distribution facilities, and off-road equipment. Tecolote Perch has unique experience and relationships working with community groups which have focused on Inflation Reduction Act programs, goods movement, and community engagement and benefits programs. Further, Tecolote Perch's leadership are experts in environmental justice with direct experience at the highest levels on national working groups advising the federal government.

- **24192: Research, Outreach, and Proposal Development for Community Engagement and Benefits Component for Climate Pollution Reduction Grant Proposal**

Contractor: Yassamin Kavezade DBA MYK Strategies	South Coast AQMD Cost-Share	$ 25,000
Term: 02/13/24 – 08/12/24	Total Cost:	$ 25,000

This contract leverages staff resources with specialized outside expertise. Yassi Kavezade will assist in providing a strategic and comprehensive approach for the research, outreach, and program development for the community engagement and benefit component of the CPRG proposal. U.S. EPA is requiring community engagement as part of CPRG proposal development and to include both direct and indirect community benefits in the proposed project(s). Ms. Kavezade brings experience working with low-income and disadvantaged communities in the Inland Empire, specifically related to goods movement including heavy-duty trucks, railyards, warehouses and distribution facilities, and off-road equipment. Further, Ms. Kavezade has experience as a policy lead on local, regional, and national policies related to the goods movement sector.

- **Various: Cosponsor 21 Conferences, Workshops and Event plus 3 Memberships**

Contractor: Various	South Coast AQMD Cost-Share	$ 183,541
	Cosponsors:	
	Various	2,988,323
Term: 01/01/24 – 12/31/24	Total Cost:	$ 3,171,864

South Coast AQMD regularly participates in and hosts or cosponsors conferences, workshops and miscellaneous events. In CY 2024, South Coast AQMD provided funding for 21 conferences, workshops and events as follows: Clean Fuels Advisory Group Retreats; California Electric Transportation Coalition LA Auto Show; 13th Annual International Onboard Sensing, Analysis, and Reporting Conference; Real World Emissions Workshop; Western Riverside Council of Governments ALTCAR event; Tyre Emissions & Sustainability USA Conference; California Science & Engineering Fair; CALSTART Member Symposium; Southern California Chinese-American Environmental Protection Association Activities; Coolest in LA event, Hydrogen Village event; California Hydrogen Leadership Summit; Driving Mobility 11 Symposium; Women in Green Breakfast; Irvine Clean Energy Conference (ICEC); Clean Mobility Forum; Sustain SoCal 15th Annual Energy Event; SoCal Electrified Drive Event; and CoMotion LA. Additionally, for 2024, three memberships were renewed for participation in CALSTART, a nonprofit organization working nationally and internationally with businesses and governments to develop clean, efficient transportation solutions; California Hydrogen Business Council (CHBC), a membership-based trade association, to educate the public and policymakers on the substantial benefits of hydrogen and to develop and advance policy positions that support the commercialization of hydrogen in the energy and transportation sectors to achieve California's climate, air quality, and decarbonization goals; and Hydrogen Fuel Cell Partnership (H2FCP), an industry/government collaboration aimed at expanding the market for FCEVs to create a cleaner, more energy-diverse future with no-compromise ZEVs.

- **Direct Pay: Advanced Technology Program Expenses**

Contractor: Various	South Coast AQMD Cost-Share	$ 2,682
Term: 01/01/24 – 12/31/24	Total Cost:	$ 2,682

South Coast AQMD's Technology Advancement Office offers funding for research, development, demonstration and deployment of transformative transportation technologies, incentive funding to accelerate fleet turnover of both on- and off-road transportation, and rebates for residential electric lawn mowers and home EV charging, among other programs. Technology Advancement Office also performs various technology outreach and education activities. Occasional expenses are incurred in addressing program implementation issues and to support administrative, outreach and education, and related activities to successfully implement and oversee these programs. This direct pay covers the cost of temporary staff services to meet the goals and objectives of the Technology Advancement Office Clean Fuels Program.

2.5. Progress and Results

Given the large number and diversity of emission sources contributing to the air quality problems in the SCAB, there is no single technology or "silver bullet" that can solve all the region's problems. Only a portfolio of different technologies can successfully achieve the required emission reductions needed to meet the upcoming 2023 and 2032 air quality standards as well as the state's 2050 climate goals. Therefore, the South Coast AQMD continues to support a wide range of advanced technologies, addressing not only the diversity of emission sources, but also the time frame to commercialization of these technologies. Projects cofunded by the South Coast AQMD's Clean Fuels Program include emission reduction demonstrations for both mobile and stationary sources, although legislative requirements limit the use of available Clean Fuels funds primarily to on-road mobile sources. The funded projects not only expedite the development, demonstration and commercialization of zero and near-zero emission technologies and fuels, but also demonstrate the technical viability to technology providers, end-users and policymakers.

In the early years, the mobile source projects funded by the Clean Fuels Program targeted low emissions technology developments in automobiles, transit buses, medium- and HD trucks and off-road applications. Over the last several years, the focus has largely shifted to zero emission technologies for medium- and HD trucks, especially those in the goods movement and freight handling industry.

Table 5 provides a list of 31 projects and contracts completed in 2024. Summaries of the completed technical projects are included in Appendix C. Selected projects completed in 2024 which represent a range of key technologies from near-term to long-term are highlighted below: (a) Opposed Piston Engine Development and Demonstration Project and (b) Advancing Zero-Emission Solutions: Microgrid Projects Transforming Urban Air Quality.

- **Opposed Piston Engine Development and Demonstration Project**

The opposed-piston engine (OPE) promises a practical and economically viable solution for the reduction of nitrous oxide (NOx) emissions and carbon dioxide (CO2) as mandated by CARB Heavy-Duty Engine and Vehicle Omnibus Regulation. The project was awarded under CARB's Low Carbon Transportation Greenhouse Gas (GHG) Reduction Fund Investments, with total project costs estimated at $16.7 million. SCAQMD contributed $1 million to the project. The OPE resolves one of the conundrums of emissions reduction: achieving ultra-low NOx emissions without increasing CO2 and without costly additional emissions technology. Conventional, four-stroke engines induct a full cylinder of air during the intake stroke that dilutes the engine's exhaust heat; high exhaust enthalpy is necessary to enable rapid catalyst light-off and maintain the catalyst temperature required to achieve lower NOx and CO2 emissions. OPEs, by contrast, utilize heat scavenging to reduce the amount of additional exhaust enthalpy required to maintain catalyst temperature while undertaking less gas exchange work to achieve simultaneous reductions in NOx and CO2 emissions.

This demonstration sought to investigate the application of OPE technology in HD trucking operations. OPEs were first designed in the late 1800s and have been used in various applications, including in ships,

airplanes, submarines, trains, and other modes of transportation. However, gas exchange and combustion are one continuous cycle for OPEs and other two-stroke engines and changing one part of the system affected every other; improvements were made by trial and error—an expensive and time-consuming endeavor. OPEs fell out of favor in emissions-regulated applications like cars and trucks because meeting those emissions requirements was more difficult to achieve. However, with the advent of supercomputers and sophisticated chemically reactive computation fluid dynamics, design changes could be evaluated electronically, and millions of iterations could be evaluated to find the right combination of features. Promising OPE design candidates could be evaluated and refined experimentally, and the computer models could be correlated with measured results to make the models more effective at predicting real world results. Combined with a matured, HD truck market with an existing supply chain of widely available components and auxiliary systems, as well as the growing amount of research and data collection on the HD truck sector—including on fuel consumption, fuel efficiency, and emissions controls—these tools and processes have made it feasible to achieve ultra-low NOx and GHG reductions with a HD OPE truck. The funding provided by CARB enabled Achates' development of the HD OPE truck through design, assembly, engine testing, and vehicle installation to its first demonstration and in-use testing as part of Walmart Inc.'s fleet.

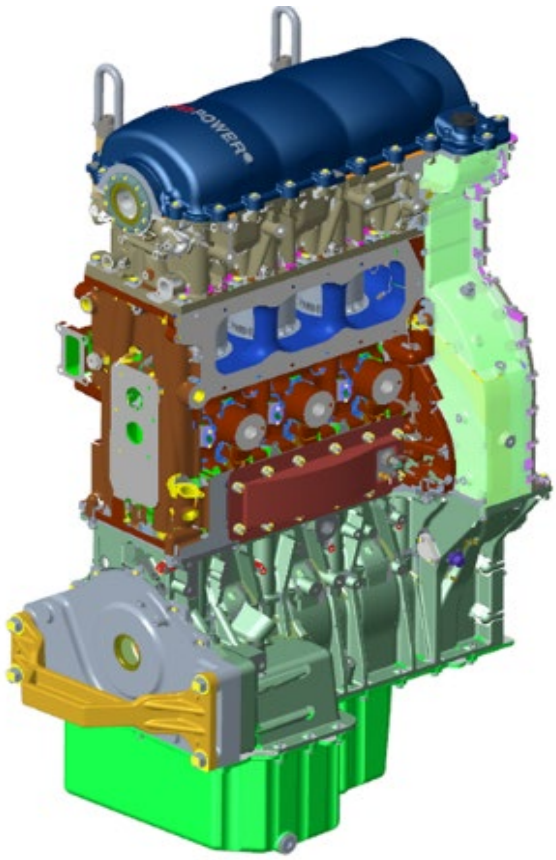


Figure 12: The Main Engine Structure

In the first two months of demonstration, the OPE HD truck ably performed the same duty cycle as the conventional trucks operating out of Walmart's distribution center in Porterville, California. Monitoring and testing showed the OPE truck used 10% less fuel than the conventional baseline truck, and NOx emissions in compliance with the CARB OMNIBUS in-use NOx emission limit by at least 30%. The tables below demonstrate the project results from on-road fleet testing and PEMS testing.

- **Advancing Zero-Emission Solutions: Microgrid Projects Transforming Urban Air Quality**

The two initiatives that were led by UCI Advanced Power and Energy Program, the Microgrid Backup Air Quality Attributes and the Microgrid Transit Air Quality Attributes projects, show the potential of microgrid zero-emission technologies to address pressing environmental challenges.

Microgrid Backup Air Quality Attributes

Extreme weather events and grid outages, intensified by climate change, have driven increased use of backup generators (BUGs). Primarily diesel and gasoline-powered, these generators significantly contribute to urban air pollution. The project assessed emissions from BUGs, modeled future scenarios for their deployment, and explored alternatives like renewable energy sources, hydrogen, and fuel cells. Thirty-seven scenarios were developed, ranging from uncontrolled growth in diesel BUGs to aggressive adoption of zero-emission technologies.

Findings highlighted the significant air quality impacts of BUGs. A 12-hour operation of the 2022 BUG fleet during an outage in fire-threat areas produced 0.281 tons per hour (ton/hr) of NOx emissions and 0.08 ton/hr of PM, matching emissions from all SCAB refineries combined. Ozone levels increased by over 4 ppb in sensitive areas, while PM2.5 rose by up to 8 µg/m3 during winter outages. However, scenarios with a 75% replacement of retired BUGs with zero-emission technologies showed drastic reductions in these pollutants, preventing one incidence of premature mortality and numerous pollution-related illnesses per outage.

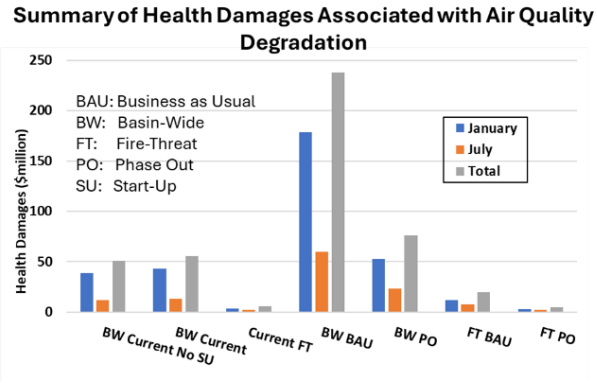


Figure 13: Summary of Health Damages Associated with Air Quality Degradation

The study emphasized that transitioning to zero-emission BUG alternatives could yield immediate and long-term public health benefits, improve urban air quality, and enhance grid resiliency.

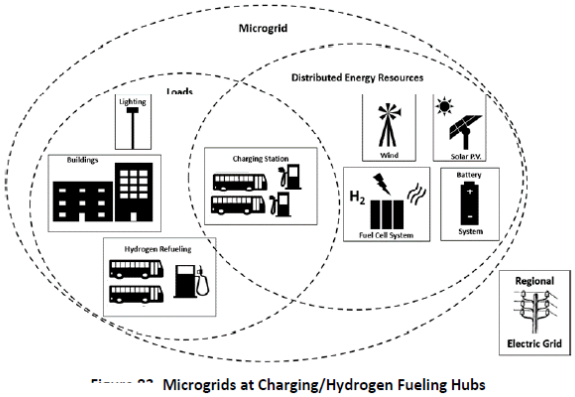
Microgrid Transit Air Quality Attributes

The public transportation sector holds immense potential for emission reductions, particularly in urban centers and disadvantaged communities. The Microgrid Transit Air Quality Attributes project focused on deploying zero-emission buses (ZEBs) in microgrid settings like university campuses and transit hubs.

This comprehensive benefit-cost analysis compared battery-electric buses (BEBs) and hydrogen fuel cell electric buses (FCEBs) to conventional diesel and compressed natural gas (CNG) buses. The analysis evaluated total cost of ownership (TCO), infrastructure needs, and the potential of ZEBs as distributed energy resources (DERs). Future scenarios modeled included cost reductions in fuel cells, batteries, and infrastructure due to technological advancements.

Results indicated that while ZEBs currently have higher TCOs than CNG buses, cost targets for batteries, fuel cells, and hydrogen could make ZEBs more economical in the long term. BEBs and FCEBs showed substantial reductions in greenhouse gas emissions, particularly when powered by renewable energy. For example, a FCEB operating with on-site hydrogen production had a far lower carbon footprint compared to its diesel counterpart.

ZEBs were also identified as valuable DERs. Their high energy density and predictable schedules make them suitable for load leveling during grid-tied



Microgrids at Charging/Hydrogen Fueling Hubs

Figure 14: Microgrids at Charging/Hydorgen Fueling Hubs

operations and for supporting critical loads during outages. Additionally, on-site hydrogen production and smart charging strategies minimize grid upgrades and reduce infrastructure costs.

The project underscored the dual benefits of ZEBs: reducing urban emissions and enhancing equity by targeting disadvantaged communities disproportionately affected by air pollution.

Conclusion

These projects demonstrate the transformative potential of zero-emission technologies in improving air quality and public health. Replacing traditional diesel and gasoline generators with renewable energy solutions and integrating ZEBs into transit systems can significantly reduce emissions, mitigate health risks, and enhance grid resiliency. The findings call for continued investment in innovative solutions and supportive policies to accelerate the transition to zero-emission alternatives.

Table 5: Projects Completed between January 1 & December 31, 2024

Contract	Contractor	Project Title	Date
Hydrogen / Mobile Fuel Cell Technologies and Infrastructure			
17312†	Cummins Electrified Power NA Inc	ZECT II - Develop Fuel Cell Range-Extended Drayage Truck	May 2024
15366†	Engineering, Procurement & Construction LLC	Operate and Maintain Publicly Accessible Hydrogen Fueling Station at SCAQMD's Diamond Bar HQs	Apr 2024
21386	National Renewable Energy Laboratory	CA Hydrogen Heavy-Duty Infrastructure Research Consortium H2@Scale Initiative	Dec 2024
22082	Frontier Energy Inc	High Flow Bus Fueling Protocol Development	Aug 2024
Engine Systems / Technologies			
18194	CALSTART Inc	Development and Demonstration of Near-Zero Emission Opposed Piston Engine	Dec 2024
20092	Southwest Research Institute	Natural Gas Engine and Vehicles Research and Development – Pent-Roof Medium Duty Natural Gas Engine	Apr 2024
20316	US Hybrid	Natural Gas Engine & Vehicles Research & Development - Plug-In Hybrid CNG Drayage Truck (PHET)	Jun 2024
Fuel and Emission Studies			
21083	University of California Riverside	Assess Emissions Impacts of Hydrogen-Natural Gas Fuel Blend on Natural Gas Engines	Sept 2024
21169†	West Virginia University Research Corp	Evaluation of Vehicle Maintenance Costs Between NG and Diesel Fueled On-Road Heavy-Duty Vehicles	Mar 2024
Stationary Clean Fuels Technologies			
21266	University of California Irvine	Develop Model for Connected Network of Microgrids	Feb 2024
22262	University of California Irvine	Study of Fuel Cell Microgrids for Backup Power and Transit	Sept 2024
Technology Assessment and Transfer / Outreach			
15380†	ICF Resources LLC	Technical Assistance with Goods Movement, Alternative Fuels and Zero-Emission Transportation Technologies	Dec 2024
19078†	Green Paradigm Consulting Inc	Technical Assistance with Alternative Fuels, Evs, Charging & Infrastructure and Renewable Energy	Sept 2024
21260†	Fred Minassian	Technical Assistance with Incentive and Research and Development Programs	Oct 2024
24022†	CoMotion Inc	Cosponsor the 2023 CoMotion LA Event	Jan 2024
24063†	CivicWell	Cosponsor the 2023 Clean Mobility Forum	Jan 2024
24081†	California Electric Transportation Coalition	Cosponsor the California Electric Transportation Coalition 2023 LA Auto Show	Jan 2024
24085†	Coordinating Research Council Inc	Cosponsor the 34th Real World Emissions Workshop	May 2024

Table 5: Projects Completed between January 1 & December 31, 2024 (cont'd)

Contract	Contractor	Project Title	Date
Technology Assessment and Transfer / Outreach (cont'd)			
24104†	TRC Environmental Corporation	Cosponsor the 2024 California Hydrogen Leadership Summit	Jul 2024
24107†	Southern California Chinese American Environmental Protection Association	Cosponsor the Southern California Chinese American Environmental Protection Association 2024	Jun 2024
24136†	Climate Resolve	Cosponsor Coolest in LA 2024	Mar 2024
24142†	Solar Energy Trade Shows LLC DBA RE+ EVENTS	Cosponsor Hydrogen Village 2024	Apr 2024
24180†	Social And Environmental Entrepreneurs Inc DBA Tecolote Perch	Outreach and Proposal Development for Community Engagement and Benefit Component for Climate Pollution Reduction Grant Proposal	Aug 2024
24192†	Yassamin Kavezade DBA MYK Strategies	Research, Outreach, and Proposal Development for Community Engagement and Benefits Component for Climate Pollution Reduction Grant Proposal	Aug 2024
24312†	Sustain SoCal	Cosponsor the 2024 Driving Mobility 11	Jul 2024
25034†	University of California Irvine	Cosponsor the Irvine Clean Energy Conference (ICEC) 2024	Dec 2024
25039†	CALSTART Inc	Cosponsor the 2024 Clean Mobility Forum	Nov 2024
25041†	CoMotion Inc	Cosponsor the 2024 CoMotion LA Event	Dec 2024
25053†	Orange County Automobile Dealerships Association	Cosponsor the 2024 SoCal Electrified Ride Experience at OC Auto Show	Oct 2024
25068†	United States Green Building Council – Los Angeles Chapter	Cosponsor the 2024 Women in Green Breakfast	Oct 2024
25092†	Sustain SoCal	Cosponsor the 2024 15th Annual Energy Event	Nov 2024

†Two-page summary reports (as provided in Appendix C) are not required for level-of-effort technical assistance contracts, leases or cosponsorships; or it was unavailable at time of printing this report.

[This Page Intentionally Left Blank]

CLEAN FUELS PROGRAM

2025 PLAN UPDATE

3.1 Program Plan for 2025 Overview

The Clean Fuels Program has evolved over the years but continues to fund a broad array of technologies spanning near- and long-term implementation. Similarly, planning will remain an ongoing activity for the Clean Fuels Program, which must remain flexible to address evolving technologies as well as capitalize on the latest progress in technologies, research areas and data. Therefore, every year, South Coast AQMD re-evaluates the Clean Fuels Program to develop a Plan Update based on reassessment of clean fuel technologies and direction of the South Coast AQMD Governing Board.

This Plan Update for CY 2025 targets several projects to achieve near-term emission reductions needed for the South Coast to meet health-based NAAQS. This plan includes cost-share projects to develop and demonstrate zero, near-zero and low emissions clean fuels and technologies to advance and promote technology development and commercialization that will not only impact SCAB but also the state of California and the entire nation. Just as in past years, the projects planned for CY 2025 will be conducted through public-private partnerships with industry, technology developers, academic and research institutions and local, state and federal agencies.

3.2. Program Plan for 2025 Core Technology Areas

This Draft 2025 Plan Update includes projects to research, develop, demonstrate, and deploy a variety of advanced technologies, from near-term to long-term, that are intended to address the following challenges:

1) implementation of federal requirements, such as the more stringent federal 8-hour ozone standard of 70 ppb promulgated by the U.S. EPA in late 2015;
2) implementation of new technology measures, including accelerated development of technologies nearing commercialization and deployment of commercially ready technologies;
3) development of electric vehicle charging infrastructure and assess the readiness of the existing power grid; and development of alternative charging solutions to support the deployment of electric vehicles;
4) necessity to improve hydrogen refueling station network reliability and availability, support alternative hydrogen production, and the application of mobile hydrogen refueling where needed; and
5) continued development of near-term cost-effective approaches.

The overall scope of projects in the Draft 2025 Plan Update remains sufficiently flexible to address new technologies and control measures identified in the 2022 AQMP, dynamically evolving technologies, and new research and data. The latter includes findings from MATES V and emission inventories periodically updated by CARB.

Project objectives range from near-term to long-term within the core technology areas defined later in this section. The Clean Fuels Program concentrates on supporting development, demonstration, and technology

commercialization and deployment efforts rather than fundamental research. The nature and typical time-to-product for Clean Fuels Program projects are described below, from near-term to long-term.

- Deployment or technology commercialization efforts focus on increasing the utilization of clean technologies in conventional applications, promising immediate and growing emission reduction benefits. It is often difficult to transition users to non-traditional technologies or fuels due to higher upfront costs, limited refueling infrastructure, or required changes to user behavior, even if these technologies or fuels offer significant emission reduction benefits. In addition to the government's role in reducing risk by funding technology development and testing, it is also necessary to offset upfront purchase costs through incentives to accelerate the use of cleaner technologies. The increased use of these clean fuel technologies also depends on efforts to increase stakeholder confidence that these technologies are viable and cost-effective in the long term.
- Field demonstrations provide a controlled environment for manufacturers to gain real-world experience and address end-user issues that arise before the commercial introduction of technologies. They also provide real-world evidence of performance to allay early adopters' concerns and provide preliminary emissions reduction potential.
- Technology development projects are typically more advanced and require two or more years. Additionally, field demonstrations to gain long-term performance verification may also be needed before commercialization. Certification and commercialization would be expected to follow. Projects may involve the development of emerging technologies that are considered long-term and higher risk but with significant emission reduction potential. Additionally, field demonstrations to gain long-term performance verification may also be needed prior to commercialization. In addition to field demonstrations, large-scale pilot deployments are key to full certification and commercialization.
- Clean fuel vehicle technologies might be more mature but unable to deploy further due to higher costs and the need to support infrastructure. This is true for all clean fuel technologies but especially true for fuels with higher production costs.

The goal of the program is to fund viable projects in all 10 core technology areas which have been identified as having the greatest potential to enable the emission reductions needed to achieve the NAAQS, thus forming the core of the Clean Fuels Program:

- Hydrogen / Mobile Fuel Cell Technologies and Infrastructure;
- Engine Systems / Technologies (including alternative and renewable fuels for truck and rail applications);
- Electric / Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations);
- Zero Emission Infrastructure;
- Fueling Infrastructure and Deployment (NG and renewable fuels);
- Stationary Clean Fuels Technologies (including microgrids and renewables);
- Fuel and Emissions Studies;
- Emissions Control Technologies;
- Health Impacts Studies; and
- Technology Assessment and Transfer / Outreach.

However, due to funding limitations, not all technology areas will be funded in 2025. The focus will remain on control measures identified in the 2022 AQMP, with consideration for the availability of suitable projects. The project categories identified below are appropriate within the context of the current air quality challenges and opportunities for technological advancement.

Within these technology areas, there are significant opportunities for South Coast AQMD to leverage its funds with other funding partners to expedite the demonstration and deployment of clean technologies in SCAB. A concerted effort is continually made to form public-private partnerships to maximize leveraging of Clean Fuels funds.

Several of the core technology areas discussed below are synergistic. For example, an HD vehicle, such as a transit bus or drayage truck, may utilize a hybrid electric drive train with a fuel cell operating on hydrogen fuel or an internal combustion engine (ICE) operating on an alternative fuel as a range extender. Components of the core hybrid electric system may overlap. Similarly, a hydrogen powered engine may utilize an NG HD vehicle that combusts gaseous fuel and requires a compressed tank storage system; similar combustion and fuel storage components may overlap.

Priorities may shift during the year in keeping with the diverse and flexible technology portfolio approach or to leverage opportunities such as cost-sharing by the state or federal government or other entities. Priorities may also shift to address specific technology issues that affect residents within the South Coast AQMD's jurisdiction. For example, the AB 617 CAPP, signed by the Governor in 2017, implements emission reduction actions and provides incentive funding for designated AB 617 communities. The six AB 617 communities within the South Coast region designate funding priorities in their Community Emission Reduction Plans (CERPs). Additional flexibility will be needed to develop new strategies and technologies for those overburdened communities.

3.2.1. Hydrogen / Mobile Fuel Cell Technologies and Infrastructure

South Coast AQMD supports hydrogen fuel cell technologies as one option in the technology portfolio; the agency is dedicated to assisting federal and state government programs to deploy LD, MD, and HD fuel cell electric vehicles (FCEVs).

Calendar Years 2015-2019 were a critical timeframe for the introduction of LD hydrogen FCEVs. In 2014, Hyundai introduced the Tucson FCEV for lease. In 2015, Toyota commercialized the Mirai, the first FCEV available to consumers for purchase. In December 2016, Honda started commercial lease of its 2017 Clarity FCEV. The 2019 Hyundai Nexo was the second FCEV offered for sale and lease in California. In the past, Clean Fuels funding has gone towards leases for LD FCEVs as part of its technology outreach efforts for conferences and events in overburdened communities. Although in recently years, the availability of LD FCEV model has decreased, major OEMs still committed in supporting FCEVs in California.

Fuel cells can play a role in MD and HD applications where battery recharge time and vehicle range, although improving, need to be enhanced to meet fleet operational requirements. The H2FCP 2030 Vision[11], released in July 2018, provides a broader framework for the earlier MD and HD Fuel Cell Electric Truck Action Plan completed in October 2016, which focused on Class 4 parcel delivery trucks and Class 8 drayage trucks with infrastructure development and established metrics for measuring progress. The

[11] CaFCP's The California Fuel Cell Revolution, A Vision For Advancing Economic, Social, and Environmental Priorities (Vision 2030), September 4, 2018.

H2FCP's HD Vision, released in July 2021, sets an interim milestone of 70,000 Class 8 fuel cell electric trucks supported by 200 HD hydrogen stations operating in California and beyond by 2035.

South Coast AQMD has created many alliances with large OEMs and will continue to fund projects over the next year to develop HD fuel cell trucks. One player in the HD fuel cell truck space is Cummins, who acquired Hydrogenics and Efficient Drivetrains, Inc. (EDI) to develop fuel cell powertrains. Cummins is working on a CEC/South Coast AQMD project to develop and demonstrate fuel cell drayage trucks with next generation fuel cell modules – easy to package system design and other innovative integration strategies. Another is Hyundai; in June 2021, South Coast AQMD recognized $500k from the U.S. EPA to demonstrate two Hyundai Class 8 fuel cell trucks with a range of up to 500 miles for regional and long-haul operations and another $3,500,000 to expand the demonstration with another five fuel cell trucks. In 2022, Volvo and Daimler also announced a joint venture to develop fuel cell powered trucks. Though the Southern California fuel cell fleet has been impacted by the closure of the three HD H2 fueling stations, when fuel was available, the MD and HD fuel cell trucks have demonstrated viability.

The H2FCP Fuel Cell Electric Bus Road Map released in September 2019 supports implementing CARB's Innovative Clean Transit and Zero Emission Airport Shuttle regulations. SunLine Transit Agency (SunLine) received a U.S. EPA Targeted Airshed grant in June 2020 to deploy six fuel cell transit buses, in addition to their existing fleet of 26 fuel cell and four battery electric transit buses as well as a recently upgraded 900 kg/day hydrogen station capable of supporting up to 30 fuel cell transit buses. SunLine has accepted and commissioned five of the buses into its fleet. In August 2021, the Clean Fuels Program committed $531,166 to a $2 million project to develop and demonstrate two MD fuel cell transit buses at SunLine. Additional outlets for hydrogen fueling infrastructure for these buses will also be developed.

In March 2021, Frontier Energy was awarded $25,000 to perform a high-flow bus fueling protocol development project as a part of the DOE H2@Scale program with partners including SoCalGas, Shell, and NREL. NREL was also awarded $25,000 for California HD Infrastructure Research, and UC Davis was awarded $50,000 for California Hydrogen Systems Analysis. Projects aim to fill in the gaps between LD and HD hydrogen fueling infrastructure to encourage expanding hydrogen fueling infrastructure as more state and federal policies are developed or passed. In addition, as more fuel cell MD/HDVs are commercialized, this research becomes more pivotal to ensuring sufficient hydrogen fueling stations are available.

Fuel cells are also being considered for power generation applications. Stationary fuel cells operating in prime or backup power applications are becoming more available. RockeTruck is developing and demonstrating a mobile fuel cell trailer capable of continuously producing 35 KW of power for 48 hours. The trailer uses the Honda Clarity fuel cell. The project is designed to supply charging capability in emergencies and remote locations. The trailer can also charge vehicles when stranded from loss of charge.

The Draft 2025 Plan Update identifies key opportunities while leading the way for pre-commercial demonstrations of OEM FCEVs. Future projects may include the following:

- development and demonstration of cross-cutting fuel cell applications (e.g. scalable and cost-effective fuel cell powertrain components);
- development and demonstration of fuel cells in off-road, locomotive, and commercial harbor craft applications such as port cargo handling equipment, switcher locomotives, and tugs;
- demonstration of FCEVs in controlled fleet applications in SCAB;

- coordination with FCEV OEMs to establish a roadmap to commercialization by overcoming barriers to economically competitive FCEVs and developing realistic scenarios for large scale deployment;
- development and implementation of strategies with government and industry to build increasing scale and renewable content in the hydrogen market including certification and testing of hydrogen as a commercial fuel to create a business case for investments as well as critical assessments of market risks to guide and protect these investments;
- repurposing fuel cells and hydrogen tanks for other secondary energy production and storage uses, as well as reusing fuel cells and hydrogen tanks, and approaches to recycle catalysts and other metals; and
- fuel cell standby power generators.

3.2.2. Engine Systems/Technologies (including alternative and renewable fuels for truck and rail applications)

To achieve the emission reductions required for SCAB, ICEs used in the HD sector will require widespread implementation of zero emission technologies as outlined in CARB's 2022 Mobile Source Strategy and 2022 AQMP. However, the path to 100 percent zero emission trucking sector will take time Meanwhile, with the recent CARB announcement, ICE engines will slowly transition to ultra-low NOx level starting MY 2024.

The effort with low emission ICE engines started back in 2016, when Cummins natural gas achieved a new ultra-low NOx threshold by commercializing the first on-road HD engine to be certified to CARB's optional low NOx standard of 0.02g NOx/bhp-hr, 90 percent cleaner than the existing federal standard. Powering these vehicles with low Carbon Intensity renewable fuels or biomethane to help address GHG objectives became a popular alternative for the HD transportation sector. Later, Cummins also certified the different displacement version of the engine for more market sectors including a more powerful 15L NG engine available starting MY 2024.

Although no 0.02g NOx diesel technology is commercially available today, development and demonstration efforts have proven low NOx diesel technology is viable. Both CARB and U.S. EPA has adopted lower NOx regulations stating MY 2027. Low NOx diesel technology is expected to operate alongside battery electric, fuel cell, natural gas and others. We do expect next generation lower NOx diesel engines to be commercially available in the MY 2027 timeframe, in time for the phase in of the U.S. EPA and CARB regulations.

More recently, Cummins announced a hydrogen powered ICE with near-zero NOx capabilities ready for implementation also in the 2027 timeframe. While using hydrogen in fuel cells is a core strategy to achieve the air quality goals in this region, in the near term, it is possible to use hydrogen in ICE for on- and off-road vehicles as a bridge technology to fuel cells. Hydrogen ICE has the benefit of using existing engine platforms, insensitivity to hydrogen quality, and use of existing hydrogen production and distribution systems that can deploy hydrogen refueling infrastructure which could later complement fuel cell vehicles. Recognizing the importance of hydrogen fuel, there is a need for research and development that can achieve significant efficiency and emissions improvements in hydrogen combustion engines. As a result, the Draft 2025 Plan Update includes on-road truck demonstrations and real-world emissions benefit analysis using hydrogen as a fuel for internal combustion.

The Draft 2025 Plan Update continues to Incorporate pursuit of cleaner engines and hybrid powertrains for the HD sector but is starting to transition to zero emission technologies. Future engine projects will continue to support the development, demonstration and emissions verification/certification of engines and powertrains that can achieve needed near-term emission reductions. At the same time, aggressive GHG emission reduction targets set forth by both CARB and U.S. EPA have invigorated interest in revisiting low- and zero carbon alternative fuels for those high power/torque applications such as hydrogen ICE. While the GHG benefit is relatively easy to assess by fuel source, it is also important to understand the criteria emissions impact under real-world conditions and over its useful lifetime to ensure reduction of criteria pollutants and GHGs are fully realized.

The Draft 2025 Plan Update includes potential projects that the South Coast AQMD might participate with federal, state, and other private entities towards these efforts. Specifically, these projects are expected to target the following:

- demonstration of ultra-low emissions and improved higher efficiency gaseous and liquid fuel powered engines for HD vehicles and high horsepower application projects;
- demonstration of gaseous and liquid fuel powered engines to support hybrid and plug-in hybrid vehicle technology;
- demonstration of alternative fuel engines for on- and off-road applications;
- vehicle level demonstration of engine systems that employ advanced engine design features, cylinder deactivation, improved exhaust or recirculation systems, and aftertreatment devices; and
- further development of robust aftertreatment systems which can maintain certified emissions levels under a wide variety of duty cycles and throughout the vehicle's useful life.

U.S. EPA's recent adoption of a national low NOx standard for on-highway HD engines starting in 2027 will further motivate manufacturers to develop lower-NOx emitting technologies expected to result in greater NOx emission reductions. Low- and zero carbon alternative fuels for new low emitting engines will continue to emerge as timelines for GHG reductions approach.

3.2.3. Electric / Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations)

To meet the NAAQS, a primary focus continues to be on zero and near-zero emission technologies. A key strategy to achieve these goals is through wide-scale transportation electrification. South Coast AQMD supports projects to address concerns regarding cost, battery life, all-electric range, and OEM commitment. Integrated transportation systems can encourage further emission reductions by matching EVs to typical consumer and fleet duty cycles and demands including drayage, short regional haul, and last mile delivery. There are Class 8 BETs CARB and U.S. EPA certified, commercially available, and eligible for incentives from Hybrid and Zero Emission Truck and Bus Voucher Incentive Project (HVIP), Carl Moyer, Volkswagen Mitigation Trust, Voucher Incentive Program, and CAPP funding.

Developing and deploying zero emission goods movement and freight handling technologies remains one of the top priorities for the South Coast AQMD to support balanced and sustainable growth at the San Pedro Bay Ports and freight/logistics facilities throughout SCAB. South Coast AQMD continues to work with our

regional partners, including the San Pedro Bay Ports, Southern California Association of Governments (SCAG) and Los Angeles County Metropolitan Transportation Authority (Metro) to demonstrate and deploy technologies that are technically feasible, cost-effective with the assistance of incentives and/or grant funding, and beneficial to all stakeholders. Specific technologies include zero emission trucks/freight handling equipment (battery and/or fuel cell), plug-in hybrid powertrains, and linear synchronous truck motors. The California Sustainable Freight Action Plan also outlines a blueprint to transition the state's freight system to an environmentally cleaner, more efficient, and economical system, including a call for a zero and near-zero emission vehicle pilot project in Southern California. The Zero Emission 2028 Roadmap 2.0 for the Los Angeles 2028 Olympics corroborates this effort, calling for an additional 25% each in GHG and criteria pollutant reductions. The San Pedro Bay Ports Clean Air Action Plan Update (2017) calls for zero emissions cargo handling equipment by 2030 and zero emission drayage trucks by 2035, respectively.

South Coast AQMD will fund battery electric vehicles and equipment under the INVEST CLEAN program. They include heavy-duty Class 8 trucks and Class 4 and 5 trucks in SCAG's Last Mile Freight Program. Additionally, INVEST CLEAN will support the deployment of cargo handling equipment (CHE) to accelerate the commercialization of battery electric CHE at goods movement facilities such as warehouses, intermodal railyards, airports, ports, and freight facility centers. Examples of CHE are rubber-tired gantry (RTG) cranes, yard trucks, forklifts, side handlers, top picks and reach stackers. INVEST CLEAN also has a significant portion of funding for battery electric locomotives to encourage the development and deployment of zero-emission switcher locomotive technologies.

HD hybrid vehicles have historically been optimized for fuel economy; under the adopted CARB and U.S. EPA regulation, new hybrid powertrains must co-optimize for both criteria emissions and fuel economy by either meeting the criteria standard by the engine itself or as a combined system. Furthermore, CARB's Advanced Clean Trucks (adopted 2020) and Advanced Clean Fleets (adopted 2022) regulations allow sales of plug-in hybrid vehicles capable of zero-emission operation as an alternative compliance pathway for meeting the manufacturer and fleet zero emission vehicle mandate. New, ongoing, and recently completed zero emission battery electric technology projects include: 1) JETSI Pilot Project with the deployment of 100 Daimler and Volvo Class 8 BETs for drayage and regional haul at NFI and Schneider; 2) Switch-On Project with the deployment of 70 Volvo Class 8 battery electric drayage/freight trucks at eight fleets; 3) Daimler Zero Emission Electric Delivery Truck project, commercial deployment of 35 Daimler Class 6 and Class 8 BETs, 4) development and demonstration of two Cummins/Meritor battery electric Class 8 refuse trucks, and 5) development and demonstration of battery powered electric trailer technology with Range Energy for both zero emission and conventional trucks.

A new emerging technology is a battery-powered trailer that can assist and recover energy with onboard energy storage and electric motors. It is expected to increase the range when used with zero emission trucks or increase the range and reduce emissions with conventional trucks. SCAQMD has partnered with Range Energy to demonstrate a "dry van" version with a fleet in SCAB and perform emissions testing on a diesel tractor. The "dry van" project is expected to be completed in early 2025. The electrified trailer can also be used to power TRU, which currently requires onboard diesel generated; the discussion for a refrigerated trailer project is in progress.

Other emerging technology developments are faster charging and electrification for the medium-duty work truck segment. In 2023, U.S. EPA awarded $500,000 to develop and demonstrate an electrified power-take-off (PTO) system for job site power for class 4 medium-duty electric trucks. There is also an ongoing project discussion looking at faster charging electrified work trucks for class 3/4/5 platforms via different battery chemistry and anode material. A faster-charging work truck can meet the increased duty-cycle demand

from different fleet users and allow for a higher payload. Some examples include higher voltage batteries, newer battery chemistry, and vehicle-to-grid capabilities. Another new technology is battery-swap trucks; these trucks have the advantage of faster recharging (swap) compared to traditional or even megawatt-level charging. Moreover, the battery swap station can have lower grid demand and a smaller footprint than traditional chargers. The battery-swap trucks are growing rapidly in overseas markets; their fast-swapping ability and easier infrastructure deployment can be an alternative solution to certain applications in the U.S.

As South Coast AQMD continues its commitment to EVs and as they become more cost-competitive and attractive to consumers, an increasing flow of EVs reaching end-of-life is expected. In a period of approximately five to ten years, a large number of EVs are expected to retire from service. As EVs are retired from service, their batteries can be sold as-is, remanufactured, repurposed, recycled, or discarded as hazardous waste. These EV batteries contain valuable minerals, such as lithium, crucial to our low carbon future. Lithium is becoming an increasingly critical resource as the state moves toward a clean energy future. Proper management of battery materials presents an opportunity to drive sustainability by planning when these EV batteries reach their end of life. At the same time, we expect new battery materials/chemistry to emerge and reduce dependence on lithium.

Voltu Motor Inc.'s OnBoard Fast Charger is a fast-charging powertrain solution that uses a bidirectional inverter paired with purpose-built motors to manage the power to the wheels and enable 200 kWh charging on AC from a standard three-phase outlet. The technology uses motor inverter power switches in conjunction with the motor coils to fast-charge the battery pack. Ten Voltu electrified Ford F350 work trucks will be used alongside ICE equivalent trucks and tested for performance. This project is planned to be completed in March 2025.

Enevate will demonstrate a fast-charging solution and the capability of Class 4/5 trucks to charge in 15 minutes from zero to eighty percent. It will also test the performance and ability to charge quickly upgraded Class 4/5 trucks with a newly developed battery pack. The project is planned to be completed in mid-2026.

Range Energy will test a battery-powered TRU. Chargers will be installed at the fleet site, and the trailer and trailer-installed equipment will be charged. The following equipment will be tested: 1) modified hybrid-electric TRU with power from an onboard battery; 2) electric powered trailer system, including an onboard battery and e-axle; and 3) electric vehicle supply equipment operated with 480V 3-phase AC circuits. This project aims to measure range extension from regenerative braking, track energy usage and generation from the e-axle and TRU and demonstrate the benefits of 3-phase AC charging hardware. This project is planned to be completed in late 2024.

RockeTruck is developing and demonstrating a mobile fuel cell trailer capable of producing 35 KW of power continuously for 48 hours. The trailer uses the Honda Clarity fuel cell. The project is designed to supply charging capability in emergency situations and remote locations. The trailer can also charge vehicles when stranded due to a loss of charge.

New, ongoing, and recently completed zero emission battery electric technology projects include: 1) JETSI Pilot Project with deployment of 100 Daimler and Volvo Class 8 BETs for drayage and regional haul at NFI and Schneider funded by $16 million from CARB, $11 million from CEC, $8 million from MSRC, $5.5 million from the Clean Fuels Fund, $5 million from SCE, and $3 million from the San Pedro Bay Ports; 2) Switch-On Project with deployment of 70 Volvo Class 8 battery electric drayage/freight trucks at eight fleets funded with $20 million from the U.S EPA Targeted Airshed grant; 3) Daimler Customer Experience project to demonstrate eight Class 6 and 8 BETs and fast charging infrastructure funded with

$1 million by the Clean Fuels Fund; 4) Daimler Innovation Fleet project to demonstrate five Class 6 and 15 Class 8 BETs with $13 million from the Clean Fuels Fund , $1 million from the U.S. EPA Clean Air Technology Initiative grant, and $2 million from the San Pedro Bay Ports; 5) Daimler Zero Emission Electric Delivery Truck project, a commercial deployment of 35 Daimler Class 6 and Class 8 BETs funded by $4 million from the U.S. EPA Targeted Airshed grant, and 6) development and demonstration of two Cummins/Meritor battery electric Class 8 refuse trucks with South Coast AQMD Special Revenue Funds.

Opportunities to develop and demonstrate technologies that could enable expedited widespread use of pre-commercial and commercial battery electric and hybrid-electric vehicles in SCAB include the following:

- demonstration of battery electric technologies for cargo handling and container transport operations, e.g., HD battery electric drayage trucks;
- large scale deployments of commercial battery electric vehicles (i.e. 50 or more vehicles) to prove feasibility and develop fleet tools to assist in successful operation for drayage and short regional haul operations;
- demonstration of MD battery electric vehicles in package delivery or last mile operations, e.g., battery electric delivery vans;
- development and demonstration of battery electric off-road equipment, e.g. battery electric off-road construction equipment, yard tractors, forklifts, or top handlers with wireless charging;
- demonstration of niche application battery electric MD and HD vehicles, including school and transit buses, shuttle buses, MD vocational trucks, and refuse trucks with short-distance fixed service routes;
- demonstration of integrated programs that make the best use of electric drive vehicles through interconnectivity between fleets of shared electric vehicles and mass transit, and rideshare services that cater to multiple users and residents in disadvantaged communities;
- development of eco-friendly intelligent transportation system (ITS), geofencing, and Eco-Drive strategies to maximize emission reductions and energy consumption when driving in disadvantaged communities; demonstrations that encourage electric drive vehicle deployment in autonomous applications; optimized load-balancing strategies and improved characterization of in-duty drayage cycles and modeling/simulations for cargo freight and market analysis for zero emission HD trucks;
- development of higher density, faster charging battery technologies for use in MD and HD vehicles;
- repurposing EV batteries for other or second life energy storage uses, as well as reusing battery packs and approaches to recycle lithium, cobalt and other critical materials in EV manufacture;
- development of electrified trailer technology, to support the efficiency and emissions of zero emission and conventional trucks and support electrified TRU operation; and
- development of a methodology to increase capability to accept fast-charging and resultant life cycle and demonstration of effects of fast-charging on battery life and vehicle performance.

3.2.4. Zero Emission Infrastructure

Significant demonstration and commercialization efforts for zero emission infrastructure are funded by the Clean Fuels Program as well as other local, state and federal programs. Zero emission infrastructure has become an increasing focus of the Clean Fuels Program to support large-scale demonstration and

deployment of hydrogen fuel cell and battery electric vehicles and equipment. This stand-alone category was created in the 2023 Plan Update, separate from Hydrogen/Fuel Cell and Electric/Hybrid Technologies.

3.2.4.1. Hydrogen Refueling Infrastructure

With lead times on retail-level hydrogen fueling stations requiring 18-36 months for permitting, construction, and commissioning, plans for future stations must be implemented. While coordination with the California Division of Measurement Standards (DMS) to establish standardized measurements for hydrogen fueling started in 2014, additional efforts to offer hydrogen for sale in higher volumes are still needed specifically with upcoming ZE vehicle and infrastructure policy deadlines on a national and state level. Moreover, CARB's Low Carbon Fuel Standard (LCFS) regulation provides incentives for producing and dispensing the low carbon intensity (CI) hydrogen for FCEVs, enabling station operators to remain solvent and cover part of their operational cost and consequently reducing the dollar per kilogram cost of hydrogen for consumers. Lastly, a deliberate and coordinated effort is necessary to ensure that hydrogen stations are developed with design flexibility to address specific location limitations, robust hydrogen supply, and fueling reliability matching those of existing gasoline and diesel fueling stations. The current network of hydrogen fueling stations to support the current number of LD FCEVs on the road and future MHD FCEVs is insufficient, and the supply of hydrogen and additional hydrogen production, specifically carbon-neutral hydrogen, continue to be challenges that need to be addressed.

In 2019, the Clean Fuels Program awarded $1.2 million to Equilon (Shell) as part of the H2Freight project for a new 1,000 kg/day HD hydrogen fueling station using hydrogen produced by a new tri-generation fuel cell on Port of Long Beach property leased by Toyota. The station was commissioned in July 2021, and Shell continues to operate and maintain this station to consumers, including Toyota and other fleet operators that commit to use FCEVs. As part of the $83 million Shore-to-Store project led by the Port of Los Angeles, for which the Clean Fuels Program committed $1 million, Toyota and Kenworth deployed 10 Class 8 fuel cell trucks and Equilon (Shell) built two large capacity hydrogen fueling stations in Wilmington and Ontario. Kenworth leveraged the development of the fuel cell truck demonstrated in South Coast AQMD's ZECT 2 project and integrated Toyota's fuel cells into the Kenworth trucks. These fuel cell trucks are deployed at fleets, including UPS, Total Transportation Services, Southern Counties Express, and Toyota Logistics Services at the Ports of Los Angeles and Port Hueneme, as well as other fleets in Riverside County. Most of the fuel cell trucks completed the demonstration phase. Also, in November 2022, the Ontario and Wilmington stations were commissioned, providing 24-hour unstaffed service. However, in early 2024, Shell announced the closure of all its light-duty hydrogen stations in California, including pausing operations of the three publicly accessible heavy-duty stations.[12] . In contrast, when sufficient fueling is available, the FCETs are running well, like the NorCAL ZERO project that operates a fleet of 30 FCETs out of the port of Oakland.[13] South Coast AQMD continues to work with H2FCP to achieve a reliable hydrogen refueling network in California through demonstrating and developing standards, protocols, and green hydrogen production pathways. South Coast AQMD is also participating in the Angeles Link project, which seeks to build a dedicated hydrogen pipeline to bring clean, renewable hydrogen to SCAB, as well as the DOE-funded Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES) efforted for California's initiative to accelerate renewable hydrogen projects and the necessary infrastructure. TAO is also discussing with technology providers about looking at new ways to expand the production of clean, renewable hydrogen through different sources.

[12] https://www.autoweek.com/news/a46791348/shell-closes-hydrogen-stations-california/

[13] https://www.portofoakland.com/port-of-oakland-celebrates-hydrogen-powered-trucks-project/

New, ongoing, and recently completed hydrogen infrastructure projects include: 1) Port of Los Angeles Shore-to-Store project with the deployment of two 400 kg/day hydrogen fueling stations in Wilmington and Ontario for HD fuel cell trucks and 2) retrofit of existing hydrogen infrastructure stations to accommodate HD fuel cell trucks by First Element to demonstration Hyundai Class 8 fuel cell trucks, 3) Equilon (Shell) project to develop a new 1000 kg/day HD hydrogen fueling station in Port of Long Beach, 4) Toyota Tsusho America, Inc. (TAI) project to demonstrate zero-emission port equipment and mobile hydrogen refueler, 5) Zero Emission Industries, Inc, (ZEI) project to demonstrate a portable liquid hydrogen fueling system for marine and locomotive applications, and 6) replace and expand the existing LD hydrogen refueling station at South Coast AQMD headquarters with FirstElement Fuel, Inc.

There are numerous fuel cell applications for off-road equipment; however, one of the primary challenges is the need for more access to hydrogen fueling stations in these settings. Installing on-site hydrogen refueling infrastructure would be costly and impractical, particularly in land-constrained areas like port complexes. The Clean Fuels Program awarded TAI $900,000 to develop and demonstrate a fuel cell-powered mobile hydrogen refueler to address this issue. This mobile refueler currently provides the hydrogen for fuel cell-powered cargo handling equipment (CHE) at the Port of Los Angeles. This demonstration will give valuable insights into the technical requirements of mobile hydrogen fueling and the economic viability of this approach within a port complex.

3.2.4.2. Electric Charging Infrastructure

The challenges of installing charging infrastructure include costs, permitting, Underwriters Laboratories (UL) certification of equipment, utility interconnection requirements and extended timeline and requirements for grid upgrades, all of which need to be better understood and streamlined. In addition, CPUC modeling and forecasting need to be updated to reflect increased regulatory requirements from ACT, ACF, and ISR regulations, which require fleets to begin transitioning to BETs. Under existing CPUC regulations, investor-owned utilities can only build just in time grid upgrades and need to have the ability to upgrade the grid in advance of these deployments in high priority corridors such as the I-710 where there is significant truck traffic between the San Pedro Bay Ports and the warehouse facilities in the Inland Empire.

Continued technology advancements in LD infrastructure have facilitated the development of corresponding codes and standards for MD and HD infrastructure including the adoption of a Megawatt Charging Standard (MCS) for high power megawatt charging. Additionally, SCE's Charge Ready Transport Program and the Los Angeles Department of Water and Power's (LADWP) Commercial EV Charging Station Rebate Program include funding for charging infrastructure.

LD EV charging infrastructure is commercially available, and the market aligns with the North American Combined Charging Standard (CCS1). MD and HD charging infrastructure using CCS1 connectors are commercially available in an early deployment stage. The CCS1 connector continues to be the standard for MD and HD charging up to 350 kW direct current (DC) in the United States. Charging Interface Initiative (CharIN) released a Megawatt Charging System (MCS) connector in June 2022 for Class 6 -8 EVs designed for a maximum current of 3,000 A at up to 1,250V for charging up to 3.75 MW DC, which has not yet been adopted. Currently there are no commercially available MD or HD EVs capable of accepting charging above 350 kW DC. There is also an agreed upon SAE J3068 connector standard for single-phase and three-phase AC charging as well as Tesla's semi charging connector. The challenges and costs of installing MD and HD charging infrastructure increase exponentially compared to LD infrastructure due to higher power requirements.

South Coast AQMD seeks state and federal funding to lead local and regional collaboratives to create MD/HD charging infrastructure networks. SCAG is developing a six-county regional MD/HD charging and hydrogen fueling infrastructure plan as part of the CEC eTRUC project to develop and demonstrate high power DC fast charging for HD BETs. A detailed plan for the San Pedro Bay Ports and the I-710 corridor will be created using advanced modeling and additional data sources. Metro has committed $50 million of its funding in a related effort to deploy charging for HD BETs between the San Pedro Bay Ports and along the I-710 corridor. South Coast AQMD also partnered with private entities to build and expand the MD/HD charging network and submitted proposals to the federal government to support the BETs and equipment at the Ports and facilitate electrifying long-haul transportation. Additional state and federal funding opportunities exist under CARB, CEC, and U.S. EPA for HD electrification and climate pollution reduction. In July 2024, South Coast AQMD received an award of $500M from the U.S. EPA under the Climate Pollution Reduction Grants (CPRG) for the project Infrastructure, Vehicles, and Equipment Strategy for Climate, Equity, Air Quality, and National Competitiveness (INVEST CLEAN). Focusing on the electrification of the goods movement sector, INVEST CLEAN will allocate significant funding to support the installation of heavy-duty truck charging infrastructure in Southern California. More than 1,000 heavy-duty truck chargers are expected to be developed in the following few years to help accelerate the deployment of battery-electric heavy-duty trucks alongside the currently available state-funded infrastructure programs.

Meanwhile, private fleets seek alternatives to build faster infrastructure, such as non-grid-connected microgrids. In May 2024, Prologis and Performance Team launched Southern California's largest HD electric vehicle microgrid charging depot. The charging depot is located in Torrance, near the Ports of Los Angeles and Long Beach, and can charge up to 96 electric trucks simultaneously. This microgrid uses 2.75 megawatts of Mainspring Energy's linear generators, along with 18 MWh of batteries to provide up to 9 MW of charging capacity. The flexible fuel linear generators run on natural gas and can be grid-connected but currently operate independently.

Another example of a microgrid is GenCell, a hydrogen fuel cell energy solution provider, is launching a backup power solution at University of California Los Angeles (UCLA) campus. Their solution incorporates battery storage and hydrogen fuel cell technology to provide power to electric vehicle chargers when grid power is insufficient. The GenCell unit can store energy from the grid or the fuel cell to power multiple vehicle chargers. This project is planned to be completed in October 2026.

Aside from grid supporting technologies, with the upcoming funding for infrastructure development, there is an increasing need for planning tools and grid analysis tools for fleet owners, regulatory agencies, and infrastructure developers to better understand the grid capacity and plan efficiently. South Coast AQMD executed a $150,000 contract with UCR for technical planning Medium-Duty and Heavy-Duty ZEV infrastructure deployment and perform criteria and benefits analysis for Southern California as part of CEC MD/HD blueprint project. There are ongoing discussions with various research entities to expand the scope of fleet tools and grid analysis to support the upcoming ISRs and infrastructure grant solicitations.

New, ongoing, and recently completed electric charging infrastructure projects include: 1) JETSI Pilot Project with installation of 350 kW DC fast chargers to support 100 Daimler and Volvo Class 8 BETs at NFI and Schneider; and 2) Switch-On Project with installation of multiple DC fast chargers to support 70 Volvo Class 8 battery electric drayage/freight trucks at eight fleets, 3) GenCell UCLA Mircogrid demonstration at UCLA; and 4) EPRI eTRUC project to develop and demonstrate MCS chargers at Travel Centers of American Ontario.

The Draft 2025 Plan Update identifies key opportunities while clearly leading the way for demonstration and deployment of hydrogen fueling and charging infrastructure. Future projects may include the following:

- continued development and demonstration of distributed hydrogen production and fueling stations from multiple providers, including energy stations with electricity and renewable hydrogen co-production and higher pressure (10,000 psi) hydrogen dispensing and scalable/higher throughput;
- development of additional sources of hydrogen production and local generation of hydrogen for fueling stations far from local production sources to better meet demand of FCVs;
- development of carbon-natural (or low carbon intensity) hydrogen production, distribution, and infrastructure network through a partnership with regional hydrogen hub projects;
- large scale deployments of commercial large fleet and public charging infrastructure to meet needs for owner operators/small fleets/large fleets for various segments (drayage, last mile delivery, short regional haul, and corridor charging for long-haul applications);
- development of fleet tools and grid assessment studies to assist in successful operation for drayage, last mile delivery, short regional haul and long-haul applications;
- development of low and zero emission alternative charging solution (ACS) technologies to accommodate delays in deploying permanent EV charging infrastructure due to lead times for grid upgrades or provide temporary power and/or backup power generation;
- development and demonstration of micro-grid systems to support non-grid connected EV charging, load-shifting, energy resilience, and lower operating energy costs;
- demonstration, installation, and expansion of infrastructure to support battery electric and fuel cell electric LD, MD and HD fleets, and ways to reduce cost and incentivize incremental costs over conventionally fueled vehicles, meet fleet operational needs, improve reliability, and integrate with battery energy storage, renewable energy and energy management strategies (e.g., vehicle-to-grid or vehicle-to-building functionality, demand response, load management);
- creation of MD/HD charging and hydrogen fueling regional infrastructure planning efforts; and
- deployment of infrastructure corresponding to codes and standards specific to LD, MD and HD vehicles, including standardized connectors, fuel quality, communication protocols, and open standards and demand response protocols for EV chargers to communicate across charging networks, fleet telematics, and vehicle platforms.

3.2.5. Fueling Infrastructure and Deployment (NG and renewable fuels)

The Clean Fuels Program in the past has provided funding for renewable natural gas (RNG) infrastructure including: 1) upgrade and buildup of public and private RNG infrastructure projects, 2) expansion of the network of public access and fleet fueling RNG stations based on the population of existing and anticipated vehicles, 3) infrastructure to accommodate transportation fuels with very low gaseous and GHG emissions, and 4) local production of clean, low carbon intensity, renewable transportation fuels. There are commercial public access RNG refueling stations throughout Southern California, and a certain percentage of renewable gas is in the pipeline. Additionally, incentive funds have been made available for RNG infrastructure. The Clean Fuels Program expects minimum funding to be allocated for RNG infrastructure but maintains this category to provide continued support for past efforts.

3.2.6. Stationary Clean Fuel Technologies (including microgrids and renewables)

Although stationary source NOx emissions are small compared to mobile sources in SCAB, there are applications where clean fuel technologies or processes can be applied to reduce NOx, VOC and PM emissions. As discussed in engine systems, low and zero carbon fuels could also be used in stationary applications; it is easier to develop optimized engine systems and stationary sources typically operate in steady-state modes.

Additionally, with the rapid development of battery electric vehicles, alternative energy storage could be achieved through vehicle-to-grid or vehicle-to-building technologies, as well as power-to-gas that could allow curtailed renewable electricity to be stored as hydrogen fuel. Microgrid demonstration and deployment projects to support large scale deployment of zero emission vehicles and equipment could also be incorporated into new or existing deployment projects to facilitate the installation of infrastructure. A few ongoing projects such as the UCR's Sustainable Integrated Grid Initiative and UCI's Advanced Energy and Power Program, funded partly by the South Coast AQMD, for example, could assist in evaluating these technologies.

In 2019, linear generators were introduced as a new and alternative technology for power generation applications. Unlike traditional internal combustion engines (ICEs), linear generators produce electricity by driving magnets through copper coils in a linear motion. A unique feature of linear generators is that the thermochemical reaction occurs at lower temperatures than ICE, resulting in lower emissions without add-on control devices (e.g., selective catalytic reduction). Linear generators are also fuel agnostic and can run on fuels such as hydrogen, ammonia, and biogas. Currently, linear generators are being used for stationary prime power applications, but it is anticipated that they can also be used for emergency backup power applications.

Projects conducted under this category may include:

- development and demonstration of reliable, low emission stationary technologies and fuels (e.g., new innovative low NOx burners and fuel cells);
- exploration of renewables, waste gas and produced gas sources for cleaner stationary technologies;
- evaluation, development and demonstration of advanced control technologies for stationary sources;
- vehicle-to-grid, vehicle-to-building, or other stationary energy demonstration projects to develop sustainable, low emission energy storage alternatives and reduce total cost of ownership (TCO); and
- development and demonstration of microgrids with linear generators/photovoltaic/fuel cell/battery storage/EV chargers and energy management to support large scale deployment of zero emission vehicles and equipment.

The development, demonstration, deployment and commercialization of advanced stationary clean fuel technologies will support control measures in the 2022 AQMP that reduce emissions of NOx and VOCs from traditional combustion sources by replacement or retrofits with zero and near-zero emission technologies. In 2023, UCI was awarded $150,000 to study regional air quality and health impacts of

utilizing Hydrogen Blends in commercial buildings and industrial applications as a part of a CEC award that focuses on the decarbonization of California.

3.2.7. Fuel and Emissions Studies

Monitoring of pollutants in SCAB is extremely important, especially when linked to a particular sector of the emissions inventory. This information highlights the need for further emission studies to identify emissions from high polluting sectors resulting from these technologies.

Over the past decade, the South Coast AQMD has funded emission studies to evaluate the impact of tailpipe emissions of biodiesel, renewable diesel, and ethanol fueled vehicles mainly focusing on criteria pollutants and GHG emissions. These studies showed that biofuels, especially biodiesel in some applications and duty cycles, can contribute to higher NOx emissions while reducing other criteria pollutant emissions. South Coast AQMD expects additional fuel and emission studies needed on non-carbon containing fuel such as hydrogen.

In addition, as the market share for gasoline direct injection (GDI) vehicles has rapidly increased from 4 percent of all vehicle sales in the U.S. to an estimated 60 percent between 2009 and 2016, it is important to understand the air quality impacts of these vehicles. South Coast AQMD has funded studies to investigate both the physical and chemical composition of tailpipe emissions, focusing on PM from GDI vehicles as well as secondary organic aerosol formation formed by the reaction of gaseous and particulate emissions from NG and diesel HD vehicles. The results of these studies suggest adding a particulate filter to control particulate emissions from GDI vehicles. In 2024, the U.S. Environmental Protection Agency (U.S. EPA) adopted the new multi-pollutant standard for LD and MD vehicles starting with the model year 2027, which further lowered the PM standard that will require a particulate filter.

In recent years, non-exhaust PM emissions have been gaining attention. Vehicles emit inhalable particles from the exhaust system but also from non-exhaust sources including brake wear, tire and road wear, clutch wear and road dust resuspension. The non-exhaust sources are not regulated because they are difficult to measure and control. Model predictions suggest that non-exhaust sources will eventually dominate traffic-related emissions of both PM2.5 and PM10. The Clean Fuels program has been engaged in research efforts to support MATE VI efforts, including awarding an RFP in August 2024 to study ambient exposure from non-exhaust PM sources. At the same time, CARB and others are conducting ongoing research to assess the emission factor directly from non-exhaust PM sources. The clean fuels program must join forces with other agencies to better understand the contribution to the overall emissions inventory.

Based on higher average summer temperatures over the past few years, there is interest in how higher temperatures impact ozone formation. A project was launched in 2019 to evaluate meteorological factors and trends contributing to recent poor air quality in SCAB. These types of studies may be beneficial in supporting the CERPs developed under AB 617, as well as other programs targeting benefits to residents in disadvantaged communities. With the phase in of various CARB regulations such as the Omnibus regulation HD inspection and maintenance (HD I/M) program as well as the upcoming MATES VI study in 2025, there will be a continued need for the Clean Fuels Program to focus on additional fuels and emissions studies, some areas of focus include:

- demonstration of remote sensing technologies to target different high emission applications and sources;

- studies to identify health risks associated with ultrafine and ambient particulate matter to characterize toxicity and determine specific combustion sources, and support MATES VI;
- in-use emission studies using biofuels, including renewable diesel and other alternative fuels such as hydrogen;
- in-depth emission studies of non-ICE sources, such as linear generators;
- in-use emission studies to determine the impact of new technologies, in particular new near-zero emission engine technologies and hybrids on local air quality as well as the benefit of telematics on emission reduction strategies;
- emissions studies of non-exhaust PM from vehicular sources;
- on-board sensing and reporting system to identify low exposure truck routes;
- particulate matter emission study for brake- and tire-wear for LD, MD, and HD vehicles and locomotives;
- lifecycle energy and emissions analyses to evaluate conventional and alternative fuels;
- analysis of fleet composition and its associated impacts on criteria pollutants;
- evaluation of emissions impact of low- and zero-carbon fuels/blends on the latest technology engines; and
- evaluation of the impact of higher ambient temperatures on primary and secondary air pollutants emissions.

3.2.8. Emission Control Technologies

Over the last several decades, diesel emissions have been greatly reduced with introduction of RNG, hydrogen, biofuels, synthetic and low carbon fuels into the engine but also via aftertreatment controls such as close coupled catalysts, advanced SCR and DPF catalysts coupled with electrically heated diesel exhaust fluid (DEF) dosers as well as advanced control strategies using cylinder deactivation, which have proven to lower emissions to near-zero and increase efficiency. Recently, particulate matter (PM and PN) emissions from GDI fueled LD vehicles, gaseous and gasoline fueled MD and HD vehicles have gathered attention due to the lack of particulate filters. While relative PM levels are low and below the applicable standard, concerns on ultra-fine emissions needs to be assessed especially with the recent adoption of the U.S. EPA LD/MD regulation requiring particulate filter. South Coast AQMD will continue to fund studies to help mitigate emissions concerns all internal combustion engines as new as new emerging technology such as the linear generator. On another hand, onboard emissions sensors have been identified by CARB and other agencies as a reliable method for assessing in-use emissions compliance. Researchers have proposed to use sensors, coupled with GPS, cellular connection, weather, traffic, and other online air quality models together to enable advanced concepts like Geofencing, Eco-routing, and more. Similar strategies have been presented in CARB's latest 2022 SIP Strategy. The most promising of these technologies will be considered for funding, specifically:

- demonstration of particulate filter technology for LD, MD and HD gasoline and gaseous fueled vehicles;
- develop, evaluate, and demonstrate onboard sensor-based emissions monitoring methodology; and

- develop emissions control technology for new emerging technologies such as linear generators and hydrogen ICEs.

3.2.9. Health Impacts Studies

Assessment of potential health risks linked to exposure to pollution is extremely important. South Coast AQMD has conducted five Multiple Air Toxics Exposure Study (MATES) campaigns since the 1980s, with MATES V completed in August 2021 and MATES VI currently in preparation phases. MATES V used comprehensive measurements and modeling and health risk assessment methods to estimate cancer and non-cancer chronic health risks due to exposure to air toxics throughout the South Coast AQMD jurisdiction, where cancer risk is the expected number of additional cancers over a 70-year lifetime in a population of one million individuals if they are exposed to the measured or modeled air toxics levels for 30 years. MATES V found that model population-weighted average air toxics cancer risk decreased from 997 per million in 2012 (MATES IV) to 455 per million in 2018 in SCAB and 357 to 250 per million in Coachella Valley. The highest risk locations in 2018 were at Los Angeles Airport (LAX), the San Pedro Bay Ports, and along major goods movement and transportation corridors. At the ten MATES V monitoring sites, located in areas that are disproportionately impacted by pollution and disadvantaged based on socioeconomic indicators, the cancer risk ranged from 585 to 842 per million, 40 percent lower than in 2012. Since at least 1998, when MATES II first conducted measurements required to track it, diesel PM has been the largest contributor to air toxics cancer risk, accounting for approximately 50 percent of the risk in 2018 (MATES V). MATES V estimated chronic non-cancer risk for the first time in a MATES campaign, with chronic hazard indices of 5 to 9 at the 10 stations, where a hazard index greater than 1 indicates that no chronic health risks are expected. MATES V also included advanced air monitoring to characterize the impacts of VOC emissions from major refineries in SCAB to surrounding communities.

Furthermore, despite recent advancements in toxicological research related to air pollution, the relationship between particle chemical composition and health effects is still not completely understood, especially for biofuels, CNG and other alternative fuels. In 2015, South Coast AQMD funded chamber studies as part of the 200-vehicle study to further investigate the toxicological potential of emissions from MD and HD vehicles, such as ultrafine particles and vapor phase substances, and to determine whether substances such as volatile or semi-volatile organic compounds are being emitted in lower mass emissions that could pose harmful health effects. The results indicated higher SOA emissions from CNG vehicles compared to baseline, due to excess lube oil consumption, ammonia emissions and lack of particulate filters.

Therefore, the MATES VI program includes studies to estimate exposure to break wear particles (BWP) and tire and road wear particles (TRWP) to provide information about the chemical composition of tires and brakes used in commercial LD and HD vehicles, which will be instrumental to determine which measurements should be conducted to attribute PM mass and gas phase markers to these sources. MATES VI will also include a special study to characterize emissions of ethylene oxide (EtO) in ambient air and at the near-road sites to assess the contribution of vehicular emissions to background EtO concentration levels. These proposed studies will require specialized instrumentation and expertise. Although South Coast AQMD already possesses some of the monitoring and laboratory equipment needed for MATES VI, the Clean Fuels Program will provide $5 million to purchase additional equipment and supplies and retain temporary staff necessary to complete all the proposed measurements.

3.2.10. Technology Assessment and Transfer/Outreach

Since the Clean Fuels Program depends on the deployment and adoption of demonstrated technologies, technology transfer and outreach efforts are essential to its success. This core area encompasses assessment of advanced technologies, including retaining outside technical assistance to expedite implementation of low emission and clean fuel technologies, coordinating activities with other organizations and educating end users of these technologies. Technology transfer efforts include supporting various incentive programs that encourage the purchase of cleaner technologies, cosponsoring technology-related conferences, workshops, and other events, and disseminating information on advanced technologies to various audiences (i.e., residents in AB 617 or disadvantaged communities, local governments, funding agencies, technical audiences). South Coast AQMD's AB 617[14] program is designed to reduce emissions in communities disproportionately impacted by air pollution. TAO conducted additional outreach to AB 617 communities regarding available zero and near-zero emission technologies and incentives to accelerate the adoption of cleaner technologies. Incentivizing deployment of zero emission HD trucks has been included in the CERPs and an RFP for zero emission HD truck incentive funding was released in September 2023 for four out of the six AB 617 communities.

South Coast AQMD is in the process of executing a contract with California State University, Los Angeles (Cal State LA), to support workforce training and professional development of EV battery engineers. Cal State LA is one of 12 selected universities nationwide to participate in the Battery Workforce Challenge (BWC), an initiative aimed at advancing EV technology. This competition challenges universities and their partners to design, build, test, and integrate advanced EV battery packs into a vehicle. The design and development of advanced batteries are a key component to electrify the transportation sector. This program will prepare and train the next generation of engineers and technicians to handle the increased demand for EVs. In 2018, South Coast AQMD supported a similar competition that resulted in participating students from disadvantaged backgrounds of East Los Angeles securing high-pay engineering jobs.

INVEST CLEAN will also implement a comprehensive workforce training program in partnership with the NECA and IBEW and supported by more than three (3) universities, seven (7) colleges, one (1) community college, and seven (7) educational related institutions. Through INVEST CLEAN, South Coast AQMD and partners will support a world-class apprenticeship pipeline that opens pathways into high-quality union careers performing CPRG related work. This approach is centered around joint-labor-management apprenticeship programs, which are designed to foster a diverse, highly skilled, and sustainable workforce equipped to meet the challenges of today and tomorrow. Workforce training will ensure enough drivers and technicians will operate and maintain the battery-electric equipment implemented with INVEST CLEAN. In addition to the NECA – IBEW partnership, the GHG Reduction Measure for the ZE locomotive deployment will include onsite and classroom training. Each locomotive deployed will be supported by at least one dedicated expert from the manufacturer in locomotive and battery technology. This technician will be on the ground to support the safe and efficient operation of the locomotive and charging process, as well as provide "on the job" training to the operators and maintainers of the locomotive. This hands-on "train the trainer" methodology will provide the rail operators with best practices for locomotive operations and maintenance practices to prepare the operator on transitioning to ZE equipment.

[14] http://www.aqmd.gov/nav/about/initiatives/environmental-justice/ab617-134

3.3. Target Funding Allocations to Core Technology Areas

Figure 15 presents the potential funding allocations of available Clean Fuels Program funds for CY 2025, based on South Coast AQMD projected program costs of $31 million for all potential projects. The actual project expenditures for 2025 will be less than the total South Coast AQMD projected program costs since not all projects will materialize. Target allocations are based on balancing technology priorities, technical challenges and opportunities discussed previously, and near term versus long term benefits with the constraints on available South Coast AQMD funding. Although the Clean Fuels Program must consider the cost-effectiveness of emission reductions as one of the several factors in determining which technologies to fund, the Legislature allows for flexibility in prioritizing technologies with higher cost-effectiveness if it is deemed necessary for South Coast AQMD to meet the NAAQS. The 2022 AQMP specifically calls for accelerated deployment of zero emission technologies wherever feasible to achieve the 2015 8-hour ozone NAAQS standard. The associated CARB 2020 Mobile Source Strategy shows the need for rapid implementation of zero-emission transportation. Specific contract awards throughout 2025 will be based on this proposed allocation, the quality of proposals received, the evaluation of projects against standardized criteria, and, ultimately, South Coast AQMD Governing Board approval. Some of the Clean Fuels Program projects may utilize the MSRC discretionary fund depending on the project types and the MSRC's annual Work Program.

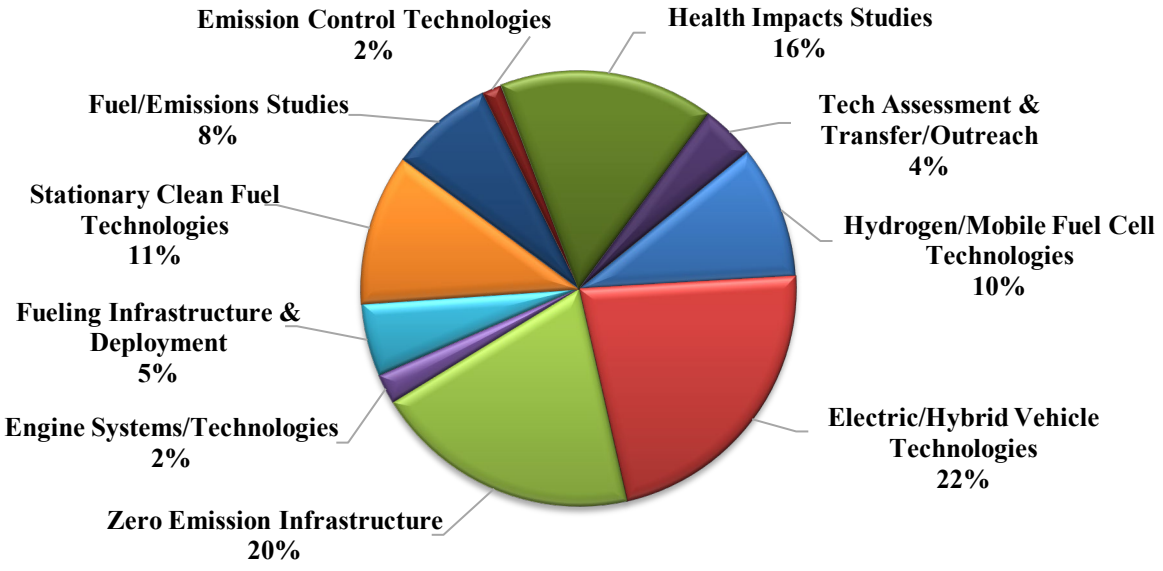


Figure 15:Projected Cost Distribution for Potential South Coast AQMD Projects in 2025 ($31M)

3.4. Potential Projects

This section presents the Clean Fuels Program Plan Update for 2025. The proposed projects are organized by program areas and described in further detail, consistent with the South Coast AQMD budget, priorities and the best available information on the state-of-the-technology. Although not required, this Plan also includes proposed projects that may also be funded by revenue sources other than the Clean Fuels Program, through state and federal grants for clean fuel technologies, incentive programs such as AB 617 Community Air Protection Program (CAPP) funding, Volkswagen Mitigation and Carl Moyer, and VOC and NOx mitigation.

Table 6 summarizes potential projects for 2025 and the distribution of South Coast AQMD costs in some areas compared to 2024. The funding allocation continues the focus on development and demonstration of zero and near-zero emission technologies including infrastructure to support vehicles and off-road equipment. For the 2025 Draft Plan Update, there is a continuing focus on zero emission technologies including funding for hydrogen/fuel cell technologies, electric/hybrid technologies, and zero emission infrastructure. Zero emission infrastructure was formerly included within hydrogen/fuel cell and electric/hybrid technologies, but given its increasing importance it is now being presented as a separate category. There are significant decreases in funding for RNG infrastructure and engine systems/ technologies as near-zero engine development has been significantly reduced as funding is increasingly shifted to zero emission technologies and infrastructure for future planned projects in 2025, including:

- HD zero emission battery electric and fuel cell trucks;
- HD zero emission infrastructure development, demonstration, deployment and planning, including ACS solutions:
- Fleet planning tools and grid studies to aid the upcoming zero emission truck and infrastructure programs;
- Microgrids, and low- and zero emission power generation demonstrations to support zero emission infrastructure;
- Other Microgrid demonstrations to support vehicle to grid/home concepts;
- Battery and fuel cell electric transit and school bus fleet charging/fueling infrastructure;
- HD diesel truck replacements with zero emission trucks; and
- Fuel and emissions studies, such as airborne measurements and analysis of NOx emissions and assessing emission impacts of hydrogen-fueled ICE, and testing for particulate matter emissions from brake- and tire-wear.

As in prior years, funding allocations again align well with the South Coast AQMD's FY 2024-25 Goals and Priority Objectives, which include supporting the development of cleaner advanced technologies. Overall, the Clean Fuels Program is designed to ensure a broad portfolio of technologies, complement state and federal efforts, and maximize opportunities to leverage technologies synergistically.

Once fully developed, each of the proposed projects described in this Plan will be presented to the South Coast AQMD Governing Board for approval before contract initiation. This Plan Update reflects the maturity of the proposed technology and identifies contractors to implement projects, participating host

sites and fleets, and securing sufficient cost-sharing to complete projects, and other necessary factors. Recommendations to the South Coast AQMD Governing Board will include descriptions of technologies to be demonstrated or deployed, their applications, the proposed scope of work, and capabilities of the selected contractor(s) and project teams, in addition to the expected costs and project benefits as required by H&SC 40448.5.1.(a)(1). Based on communications with all organizations specified in H&SC 40448.5.1.(a)(2) and a review of their programs, projects proposed in this Plan do not appear to duplicate any past or present projects.

3.4.1. Funding Summary of Potential Projects

The remainder of this section contains the following information for each of the potential projects summarized in Table 6.

Proposed Project: Descriptive title and a designation for future reference.

Expected South Coast AQMD Cost: Estimated proposed South Coast AQMD cost-share as required by H&SC 40448.5.1.(a)(1).

Expected Total Cost: The estimated total project cost, including South Coast AQMD's cost-share and the cost-share of outside organizations, is expected to be required to complete the proposed project. This indicates how much South Coast AQMD public funds are leveraged through its cooperative efforts.

Description of Technology and Application: Brief summary of the proposed technology to be developed and demonstrated, including expected vehicles, equipment, fuels, or processes that could benefit.

Potential Air Quality Benefits: Brief discussion of expected benefits of the proposed project, including anticipated contribution towards meeting the goals of the 2022 AQMP, as required by H&SC 40448.5.1.(a)(1). In general, the most important benefits of any technology research, development and demonstration program are not necessarily realized in the near-term. Demonstration projects are generally intended to be proof-of-concept for an advanced technology in a real-world application. While emission benefits, for example, will be achieved from the demonstration, true benefits will be seen over a longer term, as a successfully demonstrated technology is eventually commercialized and implemented on a wide scale.

Table 6: Summary of Potential Projects for 2025

Proposed Project	Expected SCAQMD Cost $	Expected Total Cost $
Hydrogen/Mobile Fuel Cell Technologies		
Develop and Demonstrate Hydrogen Research to Support Innovative Technology Solutions for Fueling Fuel Cell Vehicles	100,000	900,000
Develop and Demonstrate MD and HD Fuel Cell Vehicles	3,000,000	14,850,000
Subtotal	$3,100,000	$15,750,000
Engine Systems/Technologies		
Develop and Demonstrate Advanced Gaseous- and Liquid-Fueled MD and HD Engines and Vehicle Technologies to Achieve Ultra-Low Emissions	500,000	2,000,000
Develop and Demonstrate Low Emission Locomotive Technologies and After Treatment Systems	200,000	1,500,000
Subtotal	$700,000	$3,500,000
Electric / Hybrid Vehicle Technologies and Related Infrastructure		
Develop and Demonstrate MD and HD On-Road Battery Electric Vehicles and Equipment	6,850,000	102,800,000
Demonstrate Light-Duty Battery Electric Vehicles and Plug-In Hybrid Vehicles	160,000	160,000
Subtotal	$7,010,000	$102,960,000
Fueling Infrastructure and Deployment (NG and renewable fuels)		
Demonstrate Low-Emission Engine/Generation Technology	1,000,000	2,000,000
Develop, Maintain and Expand Renewable Fuel Infrastructure	300,000	1,000,000
Demonstrate Renewable Transportation Fuel Production and Distribution Technologies	400,000	1,500,000
Subtotal	$1,700,000	$4,500,000
Zero Emission Infrastructure		
Develop and Demonstrate Hydrogen Production and Fueling Stations	2,000,000	15,000,000
Develop and Demonstrate Permanent Electric Charging Infrastructure	1,700,000	4,700,000
Develop and Demonstrate Innovative Charging Solutions for Grid Support	2,200,000	5,000,000
Charging and Grid Optimization Platform for Transportation (CHARGE-OPT)	300,000	600,000
Subtotal	$6,200,000	$25,300,000
Stationary Clean Fuel Technologies		
Develop and Demonstrate Microgrids with Photovoltaic/Fuel Cell/Battery Storage/Energy Management	1,000,000	4,000,000
Develop and Demonstrate Zero or Near-Zero Emission Energy Generation Alternatives	2,500,000	7,000,000
Subtotal	$3,500,000	$11,000,000

Table 6: Summary of Potential Projects for 2025 (cont'd)

Proposed Project	Expected SCAQMD Cost $	Expected Total Cost $
Fuel and Emissions Studies		
Conduct In-Use Emission Studies including MATES VI for Advanced Technology Vehicle Demonstrations	1,000,000	4,000,000
Conduct Emission Studies including MATES VI on Biofuels, Alternative Fuels and Other Related Environmental Impacts	1,000,000	4,000,000
Identify and Demonstrate In-Use Fleet Emission Reduction Technologies and Opportunities	400,000	1,500,000
Subtotal	$2,400,000	$9,500,000
Emission Control Technologies		
Onboard Sensors for On-Road/Off-Road Vehicles	250,000	1,000,000
Integration of On-Road Technologies in Off-Road Applications	200,000	1,000,000
Subtotal	$450,000	$2,000,000
Health Impacts Studies		
Conduct Monitoring and Support MATES VI Program Implementation	5,000,000	5,000,000
Subtotal	5,000,000	5,000,000
Technology Assessment and Transfer/Outreach		
Assess and Support Advanced Technologies, Disseminate Information and Support Workforce Training	750,000	2,000,000
Support Implementation of Clean Fuels Incentives and Demonstration Projects	350,000	400,000
Subtotal	$1,100,000	$2,400,000
TOTALS FOR POTENTIAL PROJECTS	**$31,310,000**	**$182,910,000**

3.4.2. Technical Summaries of Potential Projects

3.4.2.1. Hydrogen / Mobile Fuel Cell Technologies and Infrastructure

Proposed Project: Develop and Demonstrate Hydrogen Research to Support Innovative Technology Solutions for Fueling Fuel Cell Vehicles

Expected South Coast AQMD Cost: $100,000

Expected Total Cost: $900,000

Description of Technology and Application:

California regulations require automakers to place increasing numbers of ZEVs into service every year. By 2050, CARB projects that 87 percent of LD vehicles on the road will be zero emission battery and FCVs.

Many stakeholders are working on hydrogen and fuel cell products, markets, requirements, mandates and policies. California has been leading the way for hydrogen infrastructure and FCV deployment. This leadership has advanced a hydrogen network that is not duplicated anywhere in the U.S. and is unique worldwide for its focus on providing a retail fueling experience. In addition, the advancements have identified many lessons learned for hydrogen infrastructure development, deployment and operation. Other interested states and countries are using California's experience as a model case, making success in California paramount to enabling market acceleration and uptake in the U.S. U.S. leadership for hydrogen technologies is rooted in California, a location for implementing many DOE H2@Scale pathways, such as reducing curtailment and stranded resources, reducing petroleum use and emissions, and developing and creating jobs. The technical research capability of the national laboratories can be used to assist California in decisions and evaluations, as well as to verify solutions to problems impacting the industry. Because these challenges cannot be addressed by one agency or one laboratory, in 2018, a hydrogen research consortium was organized to combine and collaborate. Moreover, in 2022, California announced its intention to develop a renewable hydrogen hub as a part of the DOE announcement for an $8B funding opportunity to establish up to ten regional hydrogen hubs to build self-sustaining hydrogen economies of producers and infrastructure in the nation. The Governor's Office of Business and Economic Development (GO-Biz) established the Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES) to unite critical public and private stakeholders to build the framework for a California renewable, clean hydrogen hub.

The California Hydrogen Infrastructure Research Consortium focuses on top research needs and priorities to address near-term problems and support California's continued leadership in innovative hydrogen technology solutions needed for fueling FCEVs. These tasks also contribute significantly to the DOE H2@Scale Initiative. For instance, advances in fueling methods and components can support the development of supply chains and deployments. Tasks completed include data collection from operational stations, component failure fix verification (i.e., nozzle freeze lock), reporting about new fueling methods for MD and HD applications and HD tasks to develop HD reference station design, model HD station capacity with high flowrates and provide near-real-time verification of fuel quality with on-site hydrogen contaminant detectors (HCDs) for use at both LD and HD stations. The tasks are supported by leading researchers at NREL and coordinating national labs and managed in detail (e.g., schedule, budget, roles, milestones, tasks, reporting requirements) in a hydrogen research consortium project management plan. The UC Davis Institute of Transportation study on hydrogen systems analysis in 2021 is intended to evaluate the current hydrogen policies and their impact on carbon-neutral transportation by 2050 with data analysis and modeling support of the current hydrogen resources.

These efforts are complemented by projects undertaken and supported by the H2FCP and its members over the last few years such as the H2 Fuel Cell Electric Trucks, A Vision for Freight Movement in California – and Beyond document released in July 2021 establishing a vision for 70,000 Class 8 FC trucks supported by 200 hydrogen fueling stations by 2035, including barriers that need to be overcome, CARB's Advanced Clean Truck Regulation adopted in June 2020, and anticipated adoption of the Advanced Clean Fleets Regulation in 2022.

This project area would enable co-funding support for additional or follow on mutually agreed technical tasks with the California Hydrogen Infrastructure Research Consortium members, the H2FCP, UC Davis as well as other collaborative efforts that may be undertaken to advance hydrogen infrastructure technologies including the upcoming hydrogen hubs efforts.

Potential Air Quality Benefits:

The 2022 AQMP identifies the use of alternative fuels and zero emission transportation technologies as necessary to lower NOx and VOC emissions to meet federal air quality standards. One of the major advantages of FCEVs is the fact that they use hydrogen, a fuel that can be domestically produced from a variety of resources such as NG (including biogas), electricity (stationary turbine technology, solar or wind), and biomass. The technology and means to produce hydrogen fuel to support FCEVs are available but require optimization to achieve a broad market scale. The deployment of large numbers of FCEVs, which is one strategy to attain air quality goals, requires a well-planned and robust hydrogen fueling infrastructure network. These South Coast AQMD projects, with significant additional funding from other governmental and private entities, will work towards providing the necessary hydrogen production and fueling infrastructure network for our region.

Proposed Project: Develop and Demonstrate MD and HD Fuel Cell Vehicles

Expected South Coast AQMD Cost: $3,000,000

Expected Total Cost: $14,850,000

Description of Technology and Application:

This proposed project would support evaluation, including demonstrating promising fuel cell technologies for applications using direct hydrogen with proton exchange membrane (PEM) fuel cell technology. Battery dominant fuel cell hybrids are another potential technology that can reduce costs and enhance the performance of FCEVs.

The California ZEV Action Plan specifies actions to help deploy an increasing number of ZEVs, including MD and HD ZEVs. CARB's Advanced Clean Truck and Fleet and Innovative Clean Transit Bus Regulations will also increase the deployment of MD and HD FCVs. Fleets are useful demonstration sites because economies of scale exist in central fueling, training skilled personnel to operate and maintain FCVs, monitoring and collecting data on vehicle performance, and OEM technical and customer support. In some cases, MD and HD FCVs could leverage the growing network of hydrogen stations and provide an early base load of fuel consumption until the number of LD FCVs grows. These vehicles could include hybrid-electric vehicles powered by fuel cells and equipped with batteries capable of charging from the grid and even supplying power to the grid.

In 2012, the DOE awarded South Coast AQMD funds to demonstrate Zero Emission Container Transport (ZECT) technologies. In 2015, the DOE awarded South Coast AQMD additional funds to develop and demonstrate additional fuel cell truck platforms and vehicles under ZECT II. Both ZECT I and ZECT II enabled the largest strides in the Technology Readiness Level (TRL) of hybrid, battery electric, and fuel cell HD trucks on the overall vehicle design and architecture. The fuel cell drayage truck's TRL before this project was at a strong Level 4 with several proof-of-concept vehicles constructed, and it has advanced the TRL to Level 7 with ZECT II. The Clean Fuels Program cost-shared the demonstration of transit buses at OCTA which was completed in September 2021. In 2020, the U.S. EPA Targeted Airshed Grant Program awarded South Coast AQMD six fuel cell transit buses to be deployed at SunLine Transit which were also cost-shared by the Clean Fuels Program, Subsequently, in 2022 and 2023, the U.S. EPA awarded South Coast AQMD two additional grants for development and demonstration fuel cell trucks that will also be cost-shared by Clean Fuels Program.

This category may include projects in the following applications:

On-Road:	**Off-Road:**
• Transit Buses	• Vehicle Auxiliary Power Units
• Shuttle Buses	• Construction Equipment
• MD & HD Trucks	• Lawn and Garden Equipment
• Specificality trucks such as refuse	• Cargo Handling Equipment

Potential Air Quality Benefits:

The 2022 AQMP identifies the need to implement ZEVs. South Coast AQMD adopted fleet regulations that require public and some private fleets within SCAB to acquire alternatively fueled vehicles when making new purchases. CARB is revising the Advanced Clean Fleets for adoption in 2022 to impose 100 percent

zero emission vehicle fleet targets for last mile delivery, drayage and public fleets in 2035. In the future, such vehicles could be powered by zero emission fuel cells operating on hydrogen fuel. The proposed projects have the potential to accelerate the commercial viability of FCEVs. Expected immediate benefits include the establishment of zero and near-zero emission proof-of-concept vehicles in numerous applications. Over the longer term, the proposed projects could help foster wide-scale implementation of FCEVs in SCAB. The proposed projects could also lead to significant fuel economy improvements, manufacturing innovations and the creation of high-tech jobs in Southern California, besides realizing the air quality benefits projected in the AQMP as well as GHG reductions. Currently, the trucks in the ZECT II project have a targeted range of 150 miles. Future projects would include extending the range of the FCVs up to 400 miles and demonstrating improvements in the reliability and durability of powertrain and hydrogen storage systems. For fuel cell transit buses, projects are being proposed that reduce the cost of the fuel cell bus to less than $1 million through advanced technologies for the fuel cell stack, higher density and lower cost batteries, and increased production volumes.

3.4.2.2. Engine Systems / Technologies (including alternative and renewable fuels for truck and rail applications)

Proposed Project: Develop and Demonstrate Advanced Gaseous- and Liquid-Fueled MD and HD Engines and Vehicle Technologies to Achieve Ultra-Low Emissions

Expected South Coast AQMD Cost: $200,000

Expected Total Cost: $1,500,000

Description of Technology and Application:

The objective of this proposed project would be to support development and certification of near-commercial prototype low emission MD and HD gaseous- and liquid-fueled engine technologies, as well as integration and demonstration of these technologies in on-road vehicles. The NOx emissions target for this project area is 0.02 g/bhp-hr or lower and the PM emissions target is below 0.01 g/bhp-hr. The recent adoption of U.S. EPA and CARB low NOx regulation commenced the transformation to near-zero NOx engines starting MY 2027 but there will be no availability of MY 2024 CARB compliant engines until at least MY 2026. Moreover, the adoption of U.S. EPA HD GHG Phase 3 National Proposed Rulemaking further promoted development of internal combustion engines using non-carbon containing fuels such as hydrogen. This effort is expected to result in several projects, including:

- demonstration of advanced engines in MD and HD vehicles and high horsepower and long haul (HP) applications;
- field demonstrations of advanced technologies in various fleets operating with different classes of vehicles;
- development and demonstration of ultra-low emission renewable fueled hybrid powertrain technology; and
- development and demonstration of optimized engine systems for use with low- and zero carbon alternative fuels such as hydrogen.

Anticipated fuels for these projects include but are not limited to alternative fuels (fossil fuel-based and renewable natural gas, propane, hydrogen blends, ethanol, electric and hybrid), conventional and alternative diesel fuels, ultra-low sulfur diesel, renewable diesel, dimethyl ether and gas-to-liquid fuels. There has been significantly more interest as well as a mandate requiring the use of renewable fuels across all sectors due to CARB's Low Carbon Fuel Standard (LCFS). Projects listed under Fuel/Emissions Studies will assess the emissions impact of renewable fuels on past and future optimized combustion technologies. Several key diesel engine development projects that have demonstrated the ability to achieve 0.02 g/bhp-hr NOx under all conditions are near the on-road truck demonstration stage. Truck integration and packaging are another critical step towards commercialization. Prototype trucks are typically placed in revenue service to collect real-world performance data as well as end user feedback for production engines. Furthermore, with the new in-use and low-load emissions requirements within the CARB Omnibus and the U.S. EPA Clean Trucks Plan regulations, we expect these new generation of ultra-low emission engines to comply with the low emissions standard for their full useful life.

Moreover, as incentive funding shifts away as clean combustion technologies reach full commercial readiness, development of cost-effective technologies that do not rely on incentives are key to drive additional market penetration and emissions reduction. In August 2023, CARB adopted amendments to the already

passed Omnibus Regulation, proposing alignment with the adopted U.S. EPA Clean Truck Plan NOx rule in MY 2027 and provisions for allowing sale of legacy engines starting MY 2024. South Coast AQMD is closely monitoring low emission ICE availability and ensuring the lowest possible emissions ICEs are being deployed in our region. Due to the slow fleet turn over, the legacy 2010+ diesel fleet will remain in service well into the 2030s and beyond, especially for the high powered applications. Thus, continued development of cost-effective low emission engine technologies is key to reduce the impact of legacy fleets in our region.

Potential Air Quality Benefits:

This project is intended to expedite the commercialization of near-zero emission gaseous- and liquid-fueled MD and HD engine technology both in SCAB and in intrastate operation. The emissions reduction benefits of replacing one 4.0 g/bhp-hr HD engine with a 0.02 g/bhp-hr engine in a vehicle that consumes 10,000 gallons of fuel per year is about 1,400 lb/yr of NOx. MD and HD engines between 6L to 12L using NG and propane achieving NOx emissions of 0.02 g/bhp-hr have been certified and commercialized, with larger displacement and advanced technology (e.g., opposed piston) engines still undergoing development. Further, renewable or blended alternative fuels can also reduce HD engine particulate emissions by over 90 percent compared to current diesel technology. The key to future engine system project success are emissions, cost-effectiveness and availability of future incentives. This project is expected to lead to increased availability of low emission alternative fuel HD engines. Fleets can use the engines and vehicles emerging from this project to comply with South Coast AQMD fleet regulations and towards compliance of the 2022 AQMP control measures as well as future CARB and U.S. EPA low NOx regulations.

Proposed Project: Develop and Demonstrate Low Emission Locomotive Technologies and After Treatment Systems

Expected South Coast AQMD Cost: $500,000

Expected Total Cost: $2,000,000

Description of Technology and Application:

This project aims to support the development and demonstration of gaseous and liquid-fueled locomotive engines. With the upcoming revision of locomotive regulations and the plan to establish Tier 5 or cleaner locomotive emission standards and the adoption of the rail ISR in 2024, railroads are exploring the possibility of transitioning from diesel to cleaner fuels or installing aftertreatments to the existing locomotives. The railroad is also considering alternative fuels for its potential economic benefit as compared with diesel fuel. The requirements of locomotive engines as primary generators of electricity to power the locomotive poses serious challenges. From an operational standpoint, there is a significant difference between NG and diesel energy density, a fuel tender would need to provide sufficient fuel for an acceptable range. Locomotives operate at a specific duty cycle different than conventional on-road engines. The engines often run at low speed and have extended periods of idle time. The durability requirements also surpass other forms of transportation.

Large displacement gaseous fueled engines are still in early stages of commercialization in the U.S., especially in the locomotive sector. Engine emissions are expected to be below the current 0.2g/bhp-hr NOx standard. Adaptation of alternative fueled locomotives in coordination with required infrastructure improvements by leading manufacturers in the industry, shows great potential for further research and cost savings with fewer maintenance costs and better reliability. Depending on the type of combustion strategy, aftertreatments are likely needed to achieve Tier 4 or cleaner emission standards. Urea-based selective catalytic reduction (SCR) or exhaust gas recirculation (EGR) can be used to reduce NOx emissions and methane slip. Similar low and zero carbon fueled engines could migrate as a retrofit option.

Potential Air Quality Benefits:

The 2022 AQMP identifies the use of low emissions technologies for locomotives where zero emission technologies are not yet commercially available. This project is expected to reduce emissions of around 97 tons per year of NOx per locomotive. The reduction of PM and GHG emissions also show great potential mitigation in environmental justice communities.

3.4.2.3. Electric / Hybrid Vehicle Technologies and Related Infrastructure (including battery electric and hybrid electric trucks and container transport technologies with zero emission operations)

Proposed Project: Develop and Demonstrate MD and HD On-Road Battery Electric Vehicles and Equipment

Expected South Coast AQMD Cost: $6,850,000

Expected Total Cost: $102,800,000

Description of Technology and Application:

The South Coast AQMD has long promoted early demonstrations of next-generation LD vehicle propulsion technologies (and fuels). However, given the commercial availability of LD EVs and relatively low LDV emissions inventory, priorities have shifted. South Coast AQMD will continue to evaluate market offerings and proposed technologies in LD vehicles to determine if any future support is required.

Meanwhile, MD and HD vehicles only make up 5[15] percent of vehicles in the U.S. and drive 11[16] percent of all vehicle miles traveled each year and yet are responsible for more than 30[17] percent of all the fuel burned annually. Moreover, the 2022 AQMP identified MD and HD vehicles as the largest source of NOx emissions in SCAB. Electric and hybrid technologies have gained momentum in the LD sector with commercial offerings by most of the automobile manufacturers. Unfortunately, given the advances in LD sector, significant emission reductions are still needed for MD and HD vehicles and off-road equipment, exacerbated by low turnover of these vehicles by fleets and high incremental costs for battery and hybrid electric vehicles and equipment compared to conventional-fueled vehicles and equipment.

Vehicle categories to be considered for potential or future demonstration and deployment projects include drayage/freight/regional haul trucks, utility trucks, last mile delivery vans, shuttle buses, transit buses, waste haulers, construction equipment, cranes and other off-road equipment such as yard tractors, forklifts, top handlers, and RTG cranes. Innovations that may be considered for demonstration and deployment include advancements in the auxiliary power unit, either ICE or other heat engine; and battery-dominant plug-in hybrid systems utilizing off-peak charging, with advanced battery technologies including alternative chemistries, design, and management systems. Alternative fuels are preferred in these projects, e.g., natural gas, especially from renewable sources, LPG, hydrogen, gas-to-liquid (GTL) and hydrogen-natural gas blends, but conventional fuels such as gasoline, renewable diesel, or even modified biodiesel may be considered if emission benefits can be demonstrated as equivalent or superior to alternative fuels. Both new designs and retrofit technologies and related charging infrastructure will be considered.

Electric vehicle technology has seen rapid early successes as both on-road vehicles and off-road equipment are transitioning increasingly towards zero emission technologies. Off-road equipment includes cargo handling equipment as well as construction equipment. The JETSI Pilot Project included deployment of 100

[15] https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances

[16] https://www.bts.gov/content/us-vehicle-miles

[17] https://www.bts.gov/content/fuel-consumption-mode-transportation

Daimler and Volvo Class 8 BETs and the Volvo LIGHTS project included deployment of 30 Volvo Class 8 BETs and 29 battery electric yard tractors and forklifts. Volvo Construction Equipment recently finished demonstrating a small battery electric compact excavator and wheel loader in California that was commercially released in late 2021. Several other manufacturers have released battery electric and hybrid equipment, and more are becoming commercially available. CARB has introduced the Clean Off-Road Equipment Voucher Incentive Project (CORE), successfully deploying zero-emission cargo handling equipment and switcher locomotives. The most recent round of funding in 2022 also included off-road construction equipment. Since the applications are more diverse in this sector, continued development and incentives are needed to accelerate progress in this sector, especially for large mobile off-road equipment where infrastructure solutions are more difficult and will require alternative charging solutions (ACS).

New and emerging technologies including higher power charging as well as different battery chemistry and technology. This category also includes battery swap technologies and well as electrified trailer technologies.

This project category will develop and demonstrate the following:

- various electric vehicles and equipment;
- studies for anticipated costs for electric vehicles and equipment;
- customer interest and preferences for these alternatives;
- new innovative technology such as higher power charging, new battery technology/chemistry, and battery-swap technologies;
- battery electric and hybrid-electric MD and HD vehicles (e.g., drayage/freight/regional haul trucks, utility trucks, delivery vans, shuttle buses, transit buses, waste haulers); and
- development and demonstration of battery electric off-road equipment, (e.g., battery electric off-road cargo handling such as yard tractors, forklifts and top-handlers, and construction equipment.

Potential Air Quality Benefits:

The 2022 AQMP identifies zero or near-zero emission vehicles as a key attainment strategy. Plug-in hybrid electric technologies have the potential to achieve near-zero emissions while retaining the range capabilities of conventional-fueled vehicles, a key factor expected to enhance broader consumer acceptance. Given the variety of EV systems under development, it is critical to determine actual emission reductions and performance metrics compared to conventional-fueled vehicles. Successful demonstration of optimized prototypes would promise to enhance the deployment of zero and near-zero emission technologies.

Expected benefits include establishing criteria for emission evaluations, performance requirements, and customer acceptability of the technology. This will help both regulatory agencies and OEMs to expedite introduction of zero and near-zero emission vehicles in SCAB, which is a high priority of the 2022 AQMP.

Proposed Project: Demonstrate Light-Duty Battery Electric Vehicles and Plug-In Hybrid Vehicles

Expected South Coast AQMD Cost: $160,000

Expected Total Cost: $160,000

Description of Technology and Application:

South Coast AQMD has included BEVs and PHEVs in its demonstration fleet since developing early conversion vehicles. At the headquarters, South Coast AQMD installed 94 Level 2 EV charging ports in 2017 and a DC fast charger with CHAdeMO and CCS1 connectors in 2018 to support public and workplace charging as a means of educational outreach regarding BEV and PHEV technology. Additionally, 30 networked Level 2 fleet chargers were added through the Southern California Edison Charge Ready Fleet program in 2020. In 2024, South Coast AQMD is in the process of updating these chargers to the latest standards.

LD BEVs and PHEVs are now widely available and continuously improving with the latest technology, safety, features, and reliability. Some OEMs have proposed vehicle-to-home concepts using BEVs as backup power solutions. As a result, the Clean Fuels Program will continue to evaluate commercially available LD PHEVs and BEVs.

Potential Air Quality Benefits:

The 2022 AQMP identifies the need to implement LD EVs. South Coast AQMD's adopted fleet regulations require public and some private fleets within SCAB to acquire alternatively fueled vehicles when making new purchases. In the future, such vehicles could be powered by BEVs. The proposed projects can potentially accelerate the commercial viability of BEVs and PHEVs. Expected immediate benefits include the deployment of ZEVs in South Coast AQMD's demonstration fleet. Over the longer term, the proposed projects could help foster wide-scale implementation of ZEVs in SCAB. The proposed projects could also lead to significant fuel economy improvements, manufacturing innovations and the creation of high-tech jobs in Southern California, besides realizing the air quality benefits projected in the 2022 AQMP.

3.4.2.4. Zero Emission Infrastructure

Proposed Project: Develop and Demonstrate Hydrogen Production and Fueling Stations

Expected South Coast AQMD Cost: $2,000,000

Expected Total Cost: $15,000,000

Description of Technology and Application:

Alternative fuels, such as hydrogen and the use of advanced technologies, such as FCEVs, are necessary to meet future clean air standards. A key element in the widespread acceptance and increased use of alternative fuel vehicles is the development of a reliable and robust infrastructure to support the fueling of vehicles, cost-effective production and distribution and clean utilization of these new fuels.

A challenge to the entry and acceptance of direct-hydrogen FCVs is the limited number and scale of hydrogen fueling and production sites. This project would support developing and demonstrating hydrogen fueling technologies with a focus on MD/HD fueling infrastructure. Proposed projects would address:

Fleet and Commercial Fueling Stations: Further expansion of the hydrogen fueling network to both on- and off-road equipment, based on retail models, providing renewable generation, adoption of standardized measurements for hydrogen fueling, other strategic fueling locations, dispensing pressures that support zero emission vehicle deployment.

Energy Stations: Multiple-use energy stations that can produce hydrogen for FCVs or stationary power generation are considered an enabling technology and potentially cost-competitive with large-scale reforming. System efficiency, emissions, hydrogen throughput, hydrogen purity, and system economics will be monitored to optimize strategies for hydrogen fueling infrastructure deployment, producing power and hydrogen from renewable feedstocks (e.g., biomass, digester gas), and storing hydrogen on a larger scale.

Innovative Fueling Appliances: Home or small scale fueling/charging or portable refueling solutions are an attractive advancement for alternative clean fuels for potential applications. This project would evaluate an innovative hydrogen refueler for cost, compactness, performance, durability, emission characteristics, ease of assembly and disassembly, maintenance and operations. Other issues such as setbacks, building permits, building code compliance and UL ratings for safety would also be evaluated.

Innovative Hydrogen Production: new and innovation pathways to provide local production of renewable hydrogen. This could either align or supplement California hydrogen hub effort. The production could also include efforts such as a dedicated hydrogen pipeline similar to CNG.

CARB projections for on-road FCEVs counts are now 30,800 in 2024 and 61,000 in 2027 in California[18] and the majority of these do not include MD and HD vehicles deployed in SCAB. To meet demand, the number of hydrogen fueling infrastructures needs to be significantly increased and become more reliable in terms of uptime and supply. South Coast AQMD will seek additional funding from CEC and CARB to construct and

[18] California Air Resources Board. *2021 Annual Evaluation of Fuel Cell Vehicle Deployment & Hydrogen Fuel Station Network Development* (AB 8 Report). September 2021.

operate hydrogen fueling stations and take advantage of funding opportunities that may arise soon with the California hydrogen hub application and others, such as the anticipated adoption of the Advanced Clean Fleets Regulation.

Potential Air Quality Benefits:

The 2022 AQMP identifies using alternative clean fuels in mobile sources as a key attainment strategy. Under AQMP goals, the South Coast AQMD has several fleet rules in effect that require public and certain private fleets to purchase clean-burning alternative-fueled vehicles when adding or replacing vehicles to their vehicle fleets. The Warehouse Indirect Source Rule (ISR) also requires certain warehouse owners and operators to comply with the rule through preapproved actions, such as by operating clean fuel vehicle technologies. FCEVs constitute some of the cleanest alternative-fuel vehicles today. Since hydrogen is a key fuel for FCEVs, this project would address some of the barriers faced by hydrogen as a fuel with a focus on MD/HD infrastructure and thus assist in accelerating its acceptance and ultimate commercialization. In addition to supporting the immediate deployment of the demonstration fleet, expanding the hydrogen fuel infrastructure should contribute to the market acceptance of fuel cell technologies in the long run, leading to substantial reductions in NOx, VOC, CO, PM and toxic compound emissions from vehicles.

Proposed Project: Develop and Demonstrate Permanent Electric Charging Infrastructure

Expected South Coast AQMD Cost: $1,700,000

Expected Total Cost: $4,700,000

Description of Technology and Application:

There is a critical need to address gaps in EV charging infrastructure availability. Forty-one percent of the 3,916,106[19] EVs sold in the U.S. since 2010 were in California, and of those sales in California, almost half (44 percent) of CVRP[20] rebates issued as of July 2023 were for vehicles in the South Coast AQMD jurisdiction. In addition, the California ZEV Action Plan, which was updated in 2018, calls for 5 million ZEVs and supporting infrastructure by 2030.

There are separate challenges associated with infrastructure for LD EVs versus MD and HD EVs, which are on opposite ends of the commercialization spectrum. LD EVs and charging infrastructure have long been commercially available with an SAE J1772 connector standard for Level 1 and Level 2 charging. In recent months, multiple LD OEMs and EVSE providers have adopted the CCS1 connector moving towards more reliable, harmonized LD charging network availability of public fast charging and workplace charging continues to increase and is needed particularly for residents in multi-unit dwellings without easy access to home charging. The availability and costs of infrastructure deployment remain the main challenges for LD EVs.

MD and HD EVs are becoming more commercially available, with multiple OEMs supplying Class 4 through Class 8 battery electric vehicles. Standards for charging infrastructure to support MD and HD EVs have generally been with the CCS1 connector in North America, although Tesla has adopted a different connector for their semi-trucks. A separate Megawatt Charging System (MCS) connector is under development by the Charging Interface Initiative (CharIN) for Class 6 -8 EVs for charging up to 4.5 MW DC. There is also an agreed upon SAE J3068 connector standard for single-phase and three-phase AC charging. The challenges and costs of installing MD and HD charging infrastructure have exponentially increased compared to LD infrastructure. Further, innovative solutions must be explored and demonstrated for off-road mobile applications where a fixed charging solution is not feasible. For urbanized public charging hub and fleet depot charging, significant funding has already been provided by the Bipartisan Infrastructure Law and the Inflation Reduction Act, as well as various state funding programs that can support widespread EVSE projects to be funded within the next few years. For corridor charging, South Coast AQMD has partnered with private entities to submit proposals to the DOT to support battery electric vehicles and equipment at the Ports and facilitate electrifying long-haul transportation. Another emerging technology is the popularity of battery-swap trucks and its swap stations in other markets, but those are still in very early stages in the U.S.

Alongside various deferral and state incentive funds for charging infrastructure, the clean fuels program will continue to support:

- deployment of a network of DC fast charging infrastructure (350Kw or more) and rapidly expand the existing network of public EV charging stations including energy storage systems;

[19] https://www.veloz.org/ev-market-report/. Q2 2023 data uploaded on 8/2/23.

[20] https://cleanvehiclerebate.org/eng/rebate-statistics

- deployment of DC fast charging infrastructure (500 Kw or more) in conjunction with energy storage and/or solar to support large scale deployments of 50 or more battery electric trucks (BETs) at a single fleet location;
- charging infrastructure and innovative systems (i.e. solar or battery swap) to support MD and HD vehicle and off-road equipment demonstration and deployment projects;
- regional planning for MD/HD charging;
- development of MD/HD charging infrastructure solutions that provide easier installation through reduced grid reliance and increased resiliency;
- development of ACS solutions that provide prime power for temporary solutions charging and or mobile backup power;
- investigation of fast charging impacts on battery life;
- development of intelligent transportation system strategies for cargo containers; and
- development of freight load-balancing strategies as well as to conduct market analysis for zero emission HD trucks in goods movement.

Potential Air Quality Benefits:

The 2022 AQMP identifies zero emission vehicles as a key attainment strategy. MD/HD infrastructure is currently a limiting factor to deploying BETs for many fleets. This proposed project category will reduce PM pollution along major roadways through the expansion of the public EV charging infrastructure network by allowing drivers to shift away from conventional-fueled vehicles to battery and fuel cell EVs. In addition, this project will assist in achieving improved fuel economy and lower tailpipe emissions, further helping the region to achieve NAAQS and protect public health. Expected benefits include the establishment of criteria for emission evaluations, performance requirements and customer acceptability of the technology. This will help both regulatory agencies and OEMs to expedite introduction of ZEVs in SCAB, which is a high priority of the 2022 AQMP.

Proposed Project: Develop and Demonstrate Innovative Charging Solutions for Grid Support

Expected South Coast AQMD Cost: $2,200,000

Expected Total Cost: $5,000,000

Description of Technology and Application:

The South Coast AQMD has been involved in the development and demonstration of battery electric vehicles and has transitions to pre-commercial deployment phase. Over the past few years, several OEMs have commercialized battery electric medium and heavy-duty (HD) models. As the number of battery electric vehicles increase, the site peak demand increases and often faces long delays in getting sufficient grid capacity. Development and demonstration of innovative charging solutions for providing prime power while the grid capacity is added and backup power is now in high demand. Traditional off-grid power generation using ICE generators are often not preferred and does not fit within the funding guidelines. Innovative charging solutions that combine with the advantages of renewable fuel sources could yield major benefits, including low and zero emissions.

This project category is to apply advanced and innovative power generation technologies to identify best fit low and zero emission electric generation solution for battery electric vehicle charging, and to demonstrate their viability, reliability, and durability, gauge market preparedness, evaluate costs relative to traditional grid power and ICE-based generators. The use of alternative charging solutions and generation (i.e. solar, linear generators) could support a large-scale deployment of battery electric trucks (BETs) and charging infrastructure at a single fleet location where energy storage is optimized for grid reliability and to offset electricity demand charges.

South Coast AQMD is actively pursuing development of alternative charging solutions (ACS) to support temporary power charging as well as providing power during grid outage events. These innovative charging solutions ranging from mobile battery packs, hydrogen fuel cell generators, combustion of renewable fuels, as well as temporary installations of chargers via existing electrical systems, different than permanent infrastructure, which requires long term planning as well as permitting of the site and equipment, ACS systems are mobile and can often deployed quickly and falls under backup generator category for permitting, or local building department for electrical permitting. ACS technologies can also provide power for off-road equipment which also requires mobile charging.

Linear generators were introduced in 2010s and provide an alternative technology for power generation applications. Unlike traditional internal combustion engines (ICEs), linear generators produce electricity by driving magnets through copper coils in a linear motion. A unique feature of linear generators is that the thermochemical reaction takes place at lower temperatures than ICE, which results in lower emissions without add-on control devices (e.g., selective catalytic reduction). Linear generators are modular in their design, rapidly dispatchable, and have the ability to run on fuels such as hydrogen, ammonia, natural gas, and biogas, making them a viable alternative charging solution for microgrid applications.

Similar category also includes sections of the Stationary Clean Fuel Technologies.

Potential Air Quality Benefits:

Certification of battery electric and hybrid electric vehicles and engines and their integration into SCAB's transportation sector is a high priority under the 2022 AQMP. This project is expected to further efforts to

develop innovative charging technologies that could aid in the deployment of MD and HD trucks, buses, off-road equipment, and other applications. Benefits will include proof of concept for new technologies, diversification of transportation fuels and lower emissions of criteria, toxic pollutants and greenhouse gases.

Proposed Project: CHARGE-OPT: Accelerating Electrification of Medium- and Heavy-duty Trucks in Southern California with Data-Driven Planning Platforms for Charging Networks, Truck Fleets, and Power Systems

Expected South Coast AQMD Cost: $300,000

Expected Total Cost: $600,000

Description of Technology and Application:

The proposed project will develop a holistic software platform based on the foundational optimization model to facilitate the coordinated development of an electrified ecosystem for medium duty and heavy duty (MDHD) vehicles. Named CHARGE-OPT (Charging and Grid Optimization Platform for Transportation), or simply CHARGE, this platform will enable stakeholders to share common background data across transportation, policy, charging networks, and power systems sectors. The foundation model and corresponding software functionalities will be customized for the specific needs of each stakeholder, including fleet owners, regulators, charging station developers, and electric utilities. CHARGE aims to fill a significant market gap by providing essential services required by these stakeholders, moving beyond the narrow focus of other initiatives, which primarily cater to charging station developers. The model will integrate real-world data—including truck trajectory data, existing charging station data, and power system capacity data—into a cohesive framework. The incorporation of large-scale, real-world truck trajectory data offers a higher fidelity of traffic information compared to agent-based models. Additionally, the integration of extensive power system capacity data into the model represents a novel approach not previously reported in the literature. The detailed scope of the solution in addressing each stakeholder's problems is listed in the table below. The CHARGE platform will bridge the gap between stakeholders, ensuring that all parties make decisions based on common data and the same foundation model, thereby promoting coordinated development and reducing misalignment.

No.	Stakeholder	Primary Interest	Scope of Our Solution in Addressing Challenging Problems
1	Fleet Owners	Maintain uninterrupted business with ZEVs at comparable or reduced costs.	● Assess the benefits and pace of ZEV conversion and select appropriate models. ● Decide whether to build depot chargers and onsite distributed energy resources (e.g. solar and battery storage). ● Establish reliable day-to-day joint routing and charging schedules.
2	Regulators	Achieve the ZEV policy goals.	● Provide holistic analyses considering the dynamics of all downstream parties – electric utilities, charging station developers, and fleet owners – to identify the most cost-effective strategies for achieving ZEV goals. ● Evaluate and refine policy based on the insights gained from the above analysis and the real-world trends.

No.	Stakeholder	Primary Interest	Scope of Our Solution in Addressing Challenging Problems
3	Charging Station Developers	Ensure profitable utilization rates of charging stations.	● Identify optimal locations & scales for new stations. ● Engage the right customers for conversion to electric and use the charging stations. ● Anticipate when the grid will be ready to support newly-sited charging stations while considering solar and battery storage integration.
4	Electric Utilities	Align grid capacity with state ZEV regulation goals.	● Identify the most cost-effective extent of necessary upgrades to the existing infrastructure. ● Justify the necessity of grid investment and the potential electricity price increase to regulators. ● Remain developer-agnostic while supporting long-term transportation demands.

Potential Air Quality Benefits:
Projects to support the development and demonstration of MD/HD ZEV technologies and supporting infrastructure are included in the Technology Advancement Office Clean Fuels Program 2024 Plan Update under the categories “Zero Emission Infrastructure” and “Electric / Hybrid Technologies.” The proposed tool will help improve the deployment process for the charging infrastructure by providing grid data-insight and also assist the fleet owners in more strategic infrastructure planning when electrifying the fleets and operating the battery electric trucks. The tool will address the common obstacles and challenges faced by infrastructure developers and fleet owners, helping accelerate the transition to battery electric technology in the MD/HD trucking sector. The implementation of this project is consistent with the 2022 AQMP, which relies on MD/HD ZEV technologies to achieve NAAQS for ozone and PM2.5 in SCAB.

3.4.2.5. Fueling Infrastructure and Deployment (NG and renewable fuels)

Proposed Project: Demonstrate Low-Emission Engine/Generation Technology

Expected South Coast AQMD Cost: $1,000,000

Expected Total Cost: $2,000,000

Description of Technology and Application:

Natural gas vehicles (NGVs) have been very successful in reducing emissions in SCAB due to the deployment by fleet owners and operators of HD vehicles utilizing this fuel. This technology category seeks to support the expansion of OEMs producing engines or systems certified to the lowest optional NOx standard or near-zero emission and useable in a wide variety of MD and HD applications, including Class 6 vehicles such as school buses and in passenger and goods delivery vans, Class 7 vehicles such as transit buses, waste haulers, street sweepers, sewer-vector trucks, dump trucks, concrete mixers, commercial box trucks, Class 8 tractors used in goods movement and drayage operations, and off-road equipment such as construction vehicles and yard hostlers. This category can also include advancing engine technologies to improve engine efficiencies that will help attract HD vehicle consumers to near-zero emission powertrains.

Hydrogen fueled internal combustion engines starts to gain more attentions as a few major advantages exist with this technology. Comparing with the fuel cell electric technology, hydrogen ICE can work at a lower level of fuel purity and costs significantly less upfront. It is also expected to be more reliable as it largely based on today's engine technology. The increase in hydrogen ICE can also be a drive force for the fuel cell application by increasing the consumption of hydrogen fuel in the transportation sector. Efforts have been put on to optimize tailpipe NOx and PM emissions, while greenhouse gas (GHG) emissions are nearly zero.

Potential Air Quality Benefits:

Gaseous fueled vehicles have inherently lower engine criteria pollutant emissions relative to conventionally fueled vehicles, especially older diesel-powered vehicles. The deployment of near-zero emission vehicles would significantly further emission reductions relative to the state's current regulatory requirements. Incentivizing the development and demonstration of near-zero emission vehicles in private and public fleets, goods movement applications, and transit buses will help reduce local emissions and emissions exposure to nearby residents. NG and hydrogen vehicles can also have lower GHG emissions, help address national energy security objectives and reduce biomass waste produced from such feedstocks. Deployment of additional near-zero emission vehicles is consistent with the 2022 AQMP goal to reduce criteria pollutants. When fueled by RNG and renewable hydrogen, it supports California's objectives of reducing GHGs and carbon intensity of the state's transportation fuel supply, as well as the federal government's objective of increasing domestically produced alternative transportation fuels.

Proposed Project: Develop, Maintain and Expand Renewable Fuel Infrastructure

Expected South Coast AQMD Cost: $300,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

This project supports the development, maintenance and expansion of renewable fuel fueling infrastructure in strategic locations throughout SCAB, including the Ports, and advancing technologies and station design to improve fueling and fueling efficiencies of HDVs. This category supports broader deployment of near-zero emission HD vehicles and implementation of South Coast AQMD's fleet rules. In addition, as existing NG and hydrogen fueling infrastructure begins to age or has been placed in demanding usage, components will deteriorate. This project offers facilities the opportunity to replace worn-out equipment or to upgrade existing fueling and/or garage and maintenance equipment to provide increased fueling capacity to public agencies, private fleets and school districts.

Potential Air Quality Benefits:

The 2022 AQMP identifies the use of alternative clean fuels in mobile sources as a key attainment strategy. HD NGVs have significantly lower emissions than their diesel counterparts and represent one of the cleanest ICE-powered vehicles available today. The project has the potential to significantly reduce the installation and operating costs of NGV fueling infrastructure and improve vehicle fueling times through improved fueling system designs and high-flow nozzles. New or improved NGV infrastructure helps facilitate hydrogen refueling infrastructure. Increased exposure and fleet and consumer acceptance of renewable fuel vehicles will lead to significant and direct reductions in NOx, VOC, CO, PM and toxic compound mobile source emissions. Such increased penetration of NGVs and other renewable fuel vehicles will provide direct emission reductions of NOx, VOC, CO, PM and air toxic compounds throughout SCAB.

Proposed Project: Demonstrate Renewable Transportation Fuel Production and Distribution Technologies

Expected South Coast AQMD Cost: $400,000

Expected Total Cost: $1,500,000

Description of Technology and Application:

The transportation sector represents a significant source of criteria pollution in SCAB. Clean, alternative fuel-powered transportation is a necessary component for this region to meet NAAQS. Alternative fuels produced from renewable sources such as waste biomass help further efforts associated with landfill and waste diversion, GHG reduction, energy diversity and petroleum dependency. Locally produced renewable fuels further reduce concerns associated with out-of-state production and transmission of fuel and help support the local economy. Renewable fuels recognized as a transportation fuel under the state's LCFS program and the federal government's Renewable Fuel Standard program can provide financial incentives, including reduced fuel price and operational costs, which act as incentives to purchase and deploy alternative or renewable energy powered vehicles.

This project category will consider development and demonstration of technologies for the production and use of renewable transportation fuels such as RNG, renewable diesel (RD), and renewable hydrogen (RH). These renewable fuels can be converted from various waste biomass feed stocks, including municipal solid wastes, green waste, and biosolids produced at wastewater treatment facilities generated from anaerobic digestion, gasification, and pyrolysis. Transport of fuels can include mobile refueling but also dedicated pipeline for long distance and high-volume transport. For example, at the Port of Los Angeles, a mobile hydrogen refueler is currently being demonstrated. This mobile refueler is powered by a hydrogen fueled fuel-cell truck and has the capability of hauling 247 kg of hydrogen. The purpose of this mobile hydrogen refueler is to provide hydrogen fuel to support zero emissions equipment operating at the port.

The main objectives of this project are to Investigate, develop and demonstrate:

- commercially viable methods for converting renewable feed stocks into CNG, LNG, hydrogen or diesel (e.g., production from biomass);
- economic small-scale NG and hydrogen liquefaction technologies;
- utilization of various feed stocks locally available;
- commercialize incentives for fleets to site, install and use renewable refueling facilities; and
- pipeline interconnection in the local gas grid to supply users.

Potential Air Quality Benefits:

The 2022 AQMP relies on a significant increase in the penetration of zero and near-zero emission vehicles in SCAB to attain the NAAQS by 2037. This project would help develop renewable transportation fuel production and distribution facilities to improve local production and use of renewable fuels to help reduce transportation costs and losses as well as reduce total operating costs of zero and near-zero emission vehicles to be competitive with comparable diesel fueled vehicles. Such advances in production and use are expected to lead to greater infrastructure development. Additionally, this project could support the state's goal of redirecting biomass waste for local fuel production and reduce GHGs associated with these waste biomass feedstocks.

3.4.2.6. Stationary Clean Fuel Technologies (including microgrids and renewables)

Proposed Project: Develop and Demonstrate Microgrids with Photovoltaic/Fuel Cell/Battery Storage Energy Management

Expected South Coast AQMD Cost: $1,000,000

Expected Total Cost: $4,000,000

Description of Technology and Application:

CARB has proposed the Advanced Clean Truck Regulation which is part of a holistic approach to accelerate a large-scale transition of zero emission MD and HD vehicles from Class 2B to Class 8. Manufacturers who certify Class 2B-8 chassis or complete vehicles with combustion engines would be required to sell zero emission trucks as an increasing percentage of their annual California sales from 2024 to 2030. By 2030, zero emission truck/chassis sales would need to be 50 percent of Class 4–8 straight trucks sales and 15 percent of all other truck sales.

The commercialization of zero emission HD trucks is currently under way with two of the largest manufacturers offering commercial products in California. South Coast AQMD is deploying 100 Daimler and Volvo Class 8 BETs, solar, and energy storage for the JETSI Pilot Project for drayage and regional haul applications. Ever larger deployments of zero emission trucks will be needed for the technology to impact air quality. Large deployments of zero emission Class 8 BETs each carrying 300+ kWh of battery-stored energy or fuel cell trucks (FCTs) carrying 30-50 kg of hydrogen will require costly infrastructure that creates a barrier for some fleets to adopt zero emission technologies. Many fleet operators lease their facilities, making it impossible to recoup the capital expenditure of EV or hydrogen infrastructure in a short period. To comply with existing and upcoming regulatory requirements, fleets must navigate challenges installing and maintaining charging and/or fueling infrastructure. Microgrids can be instrumental in meeting the challenge of cost-effectively providing large amounts of energy for EV charging or hydrogen generation to support zero emission vehicle charging and fueling. Additionally, suppose the microgrid equipment is owned by a third party and energy is sold to the fleet through a power purchase agreement. In that case, the financial challenge of large capital investment can be avoided by the fleets.

A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity concerning the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected and island-mode. Microgrids can work synergistically with the utility grid to provide power for zero emission vehicle fueling by managing when energy from the grid is used during off-peak hours when it is the least expensive. Then during peak demand periods, the microgrid would use energy from battery storage or onsite generation. Most technologies that make up microgrids include photovoltaic, fuel cells, battery storage, along with hardware and software for the energy management system (EMS). When grid service is interrupted, the microgrid can disconnect from and continue to operate as an energy island independent from the grid. Ensuring an uninterrupted power source is an important consideration for fleets. If the microgrid is connected to the fleet's logistics and telematics systems, additional benefits in infrastructure cost and battery life for BETs can be realized. If the EMS is fed information on the route a truck is planning to travel, it can charge the vehicle with enough energy for the trip so the truck will operate within the desired 20-80 percent state of charge (SOC) of the battery having the least amount of impact to battery life. Additionally, if the EMS is connected to the logistics system,

it can plan charging schedules with 150 Kw or lower power chargers which will have less impact on battery life than 350+ Kw chargers and lower charging costs.

Electricity demand for electric and fuel cell HD trucks is substantial. For a 100-vehicle fleet of BETs with 300 kWh batteries, 30 MW hours/day of electricity would be required to charge these BETs. The hydrogen requirement for a 100-vehicle fleet of FCTs is 2,000 kg/day. Microgrids can provide energy for EV and hydrogen infrastructure to enable large zero emission vehicle deployments and make charging and fueling economical and reliable. The staff has demonstrated several microgrid projects with the University of California Irvine and has toured a microgrid at the Prologis Charging Depot in Torrance. In May 2024, Prologis and Performance Team launched a microgrid near the ports of Los Angeles and Long Beach that is capable of charging up to 96 electric trucks simultaneously. This microgrid uses 2.75 megawatts of Mainspring Energy's linear generators, along with 18 MWh of batteries to provide up to 9MW of charging capacity. The linear generators are fueled by natural gas and can operate independently from the grid or grid-connected.

Several pilot projects are being discussed with microgrid developers and fleets that involve various configurations of microgrid technologies and different business models. Proposed projects would include development and demonstration of microgrids utilizing various types of renewable and zero and or low emitting onsite generation (fuel cell tri-generation, power to gas, photovoltaic, wind), energy storage, connectivity to logistics systems, vehicle-to-grid and vehicle-to-building technologies. Projects demonstrating different business models will be considered, such as projects involving a separate entity owning some or all the microgrid equipment and engaging in a power purchase agreement to provide energy to fleets transitioning to zero emission trucks. Proposed projects would partner with truck OEMs and their major customers, such as large- and medium-sized fleets looking at microgrid solutions for their operations in SCAB.

Potential Air Quality Benefits:

Microgrids can provide grid resilience and potentially support large deployments of zero emission MD and HD trucks that are necessary to meet the AQMP target of 83 percent NOx emission reductions from the 2018 level and 67 percent additional reductions in 2037 beyond already adopted regulations and programs by 2037. Both renewable and zero emitting power generation technologies that make up a microgrid can provide a well-to-wheel zero emission pathway for transporting goods. Projects could potentially reduce a significant class of NOx and CO emissions over the assumptions in the 2022 AQMP and further enhance South Coast AQMD's ability to enforce full-time compliance.

Proposed Project: Develop and Demonstrate Zero or Near-Zero Emission Energy Generation Alternatives

Expected South Coast AQMD Cost: $2,500,000

Expected Total Cost: $7,000,000

Description of Technology and Application:

This project aims to support the development and demonstration of clean energy and renewable alternatives in stationary applications. The technologies to be considered include thermal, photovoltaic and other solar energy technologies; wind energy systems; energy storage potentially including vehicle to grid or vehicle to building functionalities for alternative energy storage; biomass conversion; and other renewable energy and recycling technologies. Innovative solar technologies, such as solar thermal air conditioning and photovoltaic-integrated roof shingles, are particularly interesting. Also, in the agricultural sections of SCAB, wind technologies could potentially be applied to drive large electric motor-driven pumps to replace highly polluting diesel pumps. Besides renewable technologies, electrolyzer technology could be used to generate hydrogen as a clean fuel. Hydrogen, when used in ICEs, can potentially reduce tail-pipe emissions of NOx, while emissions in fuel cells are reduced to zero.

This project is expected to result in pilot-scale zero or near-zero emission energy production demonstrations, scale-up process design and cost analysis, overall environmental impact analysis and projections for ultimate clean fuel costs and availability. This project is expected to result in several projects addressing technological advancements in these technologies that may improve performance and efficiency, potentially reduce capital and operating costs, enhance the quality of RNG generated from renewable sources for injection into NG pipelines, improve reliability and identify markets that could expedite implementation of successful technologies. One example of a near-zero technology is the linear generator. This technology was introduced in 2019 and unlike traditional internal combustion engines, linear generators produce electricity by driving magnets through copper coils in a linear motion. This reaction takes place at much lower temperatures than ICEs, which result in lower emissions without the need for add-on emission control devices such as catalysts. In addition, linear generators are fuel agnostic and can switch between fuels like hydrogen, natural gas, ammonia, and biogas.

Potential Air Quality Benefits:

The 2022 AQMP identifies that the development and implementation of non-polluting power generation could gain maximum air quality benefits. Polluting fossil fuel-fired electric power generation needs to be replaced with clean, renewable energy resources or other advanced zero emission technologies, such as hydrogen fuel cells, particularly in a distributed generation context to help provide grid resiliency as the transportation sector becomes more reliant on electricity.

This project is expected to accelerate implementation of advanced zero and near-zero emission energy sources. Expected benefits include directly reducing emissions by displacement of fossil generation; proof-of-concept and potential viability for zero emission power generation systems; increased exposure and user acceptance of the new technology; reduced fossil fuel usage; and potential for increased use, once successfully demonstrated, with resulting emission benefits, through expedited implementation. These technologies would also have a substantial influence in reducing GHG emissions.

3.4.2.7. Fuel and Emissions Studies

Proposed Project: Conduct In-Use Emission Studies including MATES VI for Advanced Technology Vehicle Demonstrations

Expected South Coast AQMD Cost: $1,000,000

Expected Total Cost: $4,000,000

Description of Technology and Application:

Hybrid electric, plug-in electric hybrid and battery-electric and fuel cell electric vehicles will all play a role in the future of transportation. Each of these transportation technologies has attributes that could provide unique benefits to different transportation sectors. Identifying optimal placement of each transportation technology will provide the co-benefits of maximizing environmental benefit and return on investment.

As the new CARB and U.S. EPA low-NOx regulations focus on addressing the gap of in-use and certification values, staff expects the in-use emissions from new engines to perform closer to certification values, but there are still a significant population of the diesel legacy fleet expected to remain in service well into the 2030s. There is always a need to better assess real world truck emissions, fuel economy, and activity from engines, hybrid powertrain and zero carbon combustion technologies for continued technology improvements and verification of emission reductions.

This project would review and potentially coordinate application specific drive cycles for specific applications. Potential emission reductions and fossil fuel displacement for each technology in a specific application would be quantified on a full-cycle basis. This information could be used to develop a theoretical database of potential environmental benefits of different transportation technologies when deployed in specific applications. This duty-cycle requirement, often based on traditional vehicles, is used for planning purposes for building MD and HD public zero emission vehicle fueling stations, similar to the approaches provided for NREL's fleet DNA database. Furthermore, the creation and standardization of test cycles, like the chassis dyno-based cycle, can be used to evaluate efficiency of zero-emissions vehicles and direct comparisons with baseline ICE vehicles.

Another project would be characterization of intermediate volatility organic compound (IVOC) emissions, which is critical in assessing ozone and secondary organic aerosol (SOA) precursor production rates. Diesel vehicle exhaust and unburned diesel fuel are major sources and contribute to formation of urban ozone and SOA, which is an important component of PM2.5. NGVs are also a concern due to lack of particulate filters, however the actual impact based on current and projected vehicle populations needs to be further studied. Another emerging PM emissions of interest non-tailpipe emissions from brake and tire wear. CARB estimates PM from non-tailpipe sources already exceeded traditional sources and increase with VMT. CARB has introduced a series of projects to assess the emission factor for brake- and tire-wear emissions. South Coast AQMD also expects new fuels and emission studies projects to support the research needed for MATES VI study.

Potential Air Quality Benefits:

Development of an emissions reduction database for various application specific transportation technologies would assist in targeted deployment of new transportation technologies. This database coupled with application specific vehicle miles traveled and population data would assist in intelligently deploying advanced technology vehicles to attain the maximum environmental benefit. These two data streams would allow vehicle technologies to be matched to an application that is best suited to the specific technology, as well as selecting applications that are substantial enough to provide significant environmental benefits. Demonstration of a quantifiable reduction in operating cost through intelligent deployment of vehicles will also accelerate commercial adoption of various technologies. Accelerated adoption of lower emitting vehicles will further assist goals in the 2022 AQMP.

Proposed Project: Conduct Emission Studies including MATES VI on Biofuels, Alternative Fuels and Other Related Environmental Impacts

Expected South Coast AQMD Cost: $1,000,000

Expected Total Cost: $4,000,000

Description of Technology and Application:

The use of renewable fuels such as biofuels can be an important strategy to reduce petroleum dependency, air pollution and greenhouse gas (GHG) emissions and help with California's aggressive GHG reduction goals. Biofuels are receiving increased attention due to national support and state activities resulting from SB 32, AB 1007 and the Low-Carbon Fuel Standard. With an anticipated increase in renewable fuel use, it is the objective of this project to further analyze these fuels to better understand their benefits and impacts not only on GHGs but also air pollution and associated health effects.

In various diesel engine studies, replacement of petroleum diesel fuel with renewable fuel has demonstrated reduced PM, CO and air toxics emissions. Renewable fuel also has the potential to reduce GHG emissions if made from renewable feedstocks such as soy and canola. However, certain blends of biodiesel can increase NOx emissions for some engines and duty cycles, which exacerbates ozone and PM2.5 challenges faced in SCAB. In addition, despite recent advancements in toxicological research in the air pollution field, the relationship between biodiesel particle composition and associated health effects is still not completely understood.

Ethanol is another biofuel that is gaining increased national media and state regulatory attention. CARB's reformulated gasoline regulation increases ethanol content to 10 percent as a means to increase the number of renewable fuels in the state. As in the case of biodiesel, ethanol has demonstrated in various emission studies to reduce PM, CO and toxic emissions. South Coast AQMD also has been monitoring efforts in using ethanol as a primary fuel for MD and HD applications in optimized engine systems that allows both criteria and GHG reductions which could be another pathway for reducing emissions due to abundance of ethanol from the light duty sector.

CARB recently proposed a regulation on commercialization of alternative diesel fuels, including biodiesel and renewable diesel, while noting that biodiesel in older HD vehicles can increase NOx. The need for emerging alternative diesel fuels for HD trucks and transit buses is also being studied. Researchers have proposed evaluating the emissions impact of RNG and other NG blends such as renewable hydrogen or pure hydrogen.

To address these concerns on potential health effects associated with alternative fuels and fuel blends, this project will investigate physical and chemical composition and associated health effects of tailpipe PM emissions from LD to HD vehicles burning biofuels to ensure public health is not adversely impacted by broader use of these fuels. This project also supports future studies to identify mitigation measures to reduce NOx emissions from biofuels. Additionally, a study of well-to-wheel emissions from for the extraction and use of shale gas might be considered.

The Power-to-Gas concept as well as demand for additional green hydrogen supply has renewed interest in hydrogen-fossil fuel blends as well as pure hydrogen for use in both ICE and other combustion sources. Hydrogen fueled ICEs were studied heavily in the early 2000s and results have shown significant possible

criteria emission reductions with optimized engine calibration though any new hydrogen ICE will need to comply to the latest standard for MY 2024 and MY 2027

To evaluate contribution of meteorological factors to high ozone and PM2.5 episodes occurring in SCAB, mainly as a result of higher summer temperatures and increased air stagnation following droughts, a comprehensive study is necessary to evaluate trends of meteorological factors that may adversely impact air quality in SCAB to support efforts such as the MATES VI. The study will assist in better understanding potential impact of recent weather trends on criteria pollutant emissions and developing more effective strategies for improving air quality in the future.

Potential Air Quality Benefits:

If renewable diesel, biodiesel and biodiesel blends can be demonstrated to reduce air pollutant emissions with the ability to mitigate NOx impacts, this technology will become a viable strategy in meeting air pollutant standards as well as the goals of SB 32 and the Low-Carbon Fuel Standard. The use of biodiesel is an important effort for a sustainable energy future. Emission studies are critical to understanding emission benefits and any tradeoffs (NOx impacts) that may result from using this alternative fuel. With reliable information on the emissions from using biodiesel and biodiesel blends, this can ensure the use of biodiesel without creating additional NOx emissions. Additionally, understanding meteorological factors on criteria pollutant emissions may help identify mitigation strategies, possibly through targeted advanced transportation deployment.

Proposed Project: Identify and Demonstrate In-Use Fleet Emission Reduction Technologies and Opportunities

Expected South Coast AQMD Cost: $400,000

Expected Total Cost: $1,500,000

Description of Technology and Application:

New technologies, such as alternative fueled HD engines, are extremely effective at reducing emissions because they are designed to meet the most stringent emissions standards while maintaining vehicle performance. In addition, many new vehicles are now equipped with telematics enabling motorists to obtain transportation information such as road conditions to avoid excessive idling and track information about vehicle maintenance needs, repair history, tire pressure and fuel economy. Telematics have been shown to reduce emissions from new vehicles through various vehicle usage optimization strategies. Unfortunately, many in-use fleets lack telematic systems, particularly HD engines in trucks, buses, construction equipment, locomotives, commercial harbor craft and cargo handling equipment, and have fairly long working lifetimes (up to 20 years due to remanufacturing in some cases). Even LD vehicles routinely have lifetimes exceeding 200,000 miles and 10 years. The in-use fleet, especially the oldest vehicles, are responsible for the majority of emissions. In the last few years, real-time emissions and fuel economy data reporting along with telematics has been demonstrated with large fleets as fleet management tools to identify high emitters and increase operational efficiency. Similar efforts have already been proposed by CARB as part of the HD I/M regulation. Moreover, the same telematic systems are being installed on zero emission trucks where fleet and charging management are important. Cloud based fleet management concepts are being proposed by researchers to maximize range and air quality benefits of zero emission trucks.

This project category is to investigate near-term emission control technologies that can be cost-effectively applied to reduce emissions from the in-use fleet. The first part of the project is to identify and conduct proof-of-concept demonstrations of feasible candidate technologies, such as:

- remote sensing for HD vehicles including license plate recognition systems;
- annual testing or for high mileage vehicles (>100,000 miles);
- replace or upgrade emission control systems at 100,000-mile intervals;
- on-board emission diagnostics with remote notification;
- low-cost test equipment for monitoring and identifying high emitters;
- intelligent transportation system such as fleet management tools, dashboards and localized traffic policies;
- electrical auxiliary power unit replacements;
- development, deployment and demonstration of smart vehicle telematic systems;
- fleet and charger management concepts; and
- low-cost emissions sensor development.

Potential Air Quality Benefits:

Many of the technologies identified can be applied to LD and HD vehicles to identify and subsequently remedy high-emitting vehicles in the current fleet inventory. Estimates suggest that 5 percent of existing fleets account for up to 80 percent of the emissions. Identification of higher emitting vehicles would assist

with demand-side strategies, where higher emitting vehicles have correspondingly higher registration charges. Identification and replacement of high-emitting vehicles has been identified in the Community Emission Reduction Plans (CERPs) from multiple AB 617 communities as a high priority for residents living in these communities, particularly as HD trucks frequently travel on residential streets to bypass traffic on freeways surrounding these disadvantaged communities.

3.4.2.8. Emission Control Technologies

Proposed Project: Onboard Sensors for On-Road/Off-Road Vehicles

Expected South Coast AQMD Cost: $250,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

New HD on-road vehicles represent one of the largest categories in the NOx emissions inventory in SCAB. The 2022 AQMP identifies that 83 percent NOx emission reductions from the 2018 level and 67 percent additional reductions beyond already adopted regulations and programs are necessary to meet the 2015 8-hour ozone standard by 2037. Previous in-use emission studies, including studies funded by the South Coast AQMD, have shown significantly higher NOx emissions from on-road HD vehicles than the certification limit under certain in-use operations, such as low power duty cycles. In CARB's adopted HD On-Road "Omnibus" Low NOx regulation, in addition to the lower certification values, there is a low load test cycle and revisions to the not-to-exceed compliance tests. NOx sensor data reporting is also introduced where the vehicle computer is required to store a past period of emissions data to ensure real-world emission reductions are realized over various duty cycles, especially those low power duty cycles in urban areas. An alternative proposed new methodology is to continuously measure real-time emissions from trucks with onboard sensors. Both industry, government and regulators are looking to use sensors to better monitor emissions compliance and leverage the real-time data from sensors to enable advances concepts such as geofencing. CARB's newly adopted HD I/M rules address in-use emissions from the older legacy fleets and also has onboard sensors as one of the emission testing methods.

This project category is to investigate near term and long-term benefits from onboard sensors to understand in-use emissions better and reduce emissions from the advanced management concept. The first part of the project is to identify and conduct proof-of-concept demonstrations of feasible candidate technologies, such as:

- laboratory evaluation/verification of new and baseline sensors;
- development and evaluation of next generation sensors;
- development of algorithms to extract sensor information into mass-based metric;
- demonstrate feasibility to monitor emissions compliance using sensors;
- identify low-cost option for cost and benefit analysis;
- demonstrate sensors on NG and other mobile sources such as LD, off-highway and commercial harbor craft; and
- development, deployment and demonstration of smart energy/emissions management systems.

Potential Air Quality Benefits:

The proposed research projects will assist the trucking industry to monitor emissions, using sensors as one of the design platform options and identify freight routes which result in lower emissions. Reduction of NOx and PM emissions from mobile sources is imperative for SCAB to achieve NAAQS and protect public health.

Proposed Project: Integration of On-Road Technologies in Off-Road Applications

Expected South Coast AQMD Cost: $200,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

On-road HD engines have demonstrated progress in meeting increasingly stringent federal and state requirements. New HD engines have progressed from 2 g/bhp-hr NOx in 2004 to 0.2 g/bhp-hr NOx in 2010, which is an order of magnitude decrease in just six years. Off-road engines, however, have considerably higher emissions limits depending on engine size. For example, Tier 3 standards for HD engines require only 3 g/bhp-hr NOx. There are apparent opportunities to implement cleaner on-road technologies in off-road applications. There is also an opportunity to replace existing engines in both on-road and off-road applications with the cleanest available technology. Current regulations don't usually require repowering (engine replacement) or remanufacturing to meet cleaner emission standards as engines are retired. Unfortunately, this does not take advantage of recently developed clean technologies.

Exhaust gas cleanup strategies, such as EGR, SCR, DPF, electrostatic precipitators, baghouses and scrubbers, have been used successfully for many years on stationary sources. The exhaust from the combustion source is routed to the cleaning technology, which typically requires a large footprint for implementation. This large footprint has made installation of such technologies on some mobile sources prohibitive. However, in cases where the mobile source is required to idle for long periods of time, it may be more effective to route emissions from the mobile source to a stationary device to clean the exhaust stream.

Projects in this category will include utilizing proven clean technologies in novel applications, such as:

- demonstrating certified LNG and CNG on-road engines as well as other clean alternative fuels such as hydrogen in off-road applications including yard hostlers, locomotives, commercial harbor craft, gantry cranes, waste haulers and construction equipment;
- implementing lower emission engines requirement in repower applications for both on-road and off-road applications; and
- applying stationary best available control technologies, such as EGR, SCR, scrubbers, DPF, baghouses and electrostatic precipitators, to appropriate on- and off-road applications, such as idling locomotives, commercial harbor craft at dock and HD line-haul trucks at weigh stations.

Potential Air Quality Benefits:

Transfer of mature emission control technologies, such as certified engines and SCR, to the off-road and retrofit sectors offers high potential for immediate emission reductions. Further development and demonstration of these technologies will assist in regulatory efforts which could require such technologies and retrofits.

3.4.2.9. Health Impacts Studies

Proposed Project: Conduct Monitoring and Support MATES VI Program Implementation

Expected South Coast AQMD Cost: $5,000,000

Expected Total Cost: $5,000,000

Description of Technology and Application:

MATES is a Governing Board environmental justice initiative that started back in 1987 with MATES I. South Coast AQMD previously conducted five MATES campaigns to characterize the concentration of airborne toxic compounds within the South Coast AQMD jurisdiction and to determine the region-wide cancer risks associated with major airborne carcinogens. However, as each successive MATES campaign builds on the previous work, each iteration added additional goals and objectives and employed more sophisticated measurement and modeling techniques. Results of MATES are used to provide public information about air toxics and associated health risks throughout the region, evaluate progress in reducing air toxics exposure, and provide direction to future toxics control programs. Previous MATES campaigns have also identified unknown air toxics sources and have been critical in the interpretation of data from special air toxics monitoring studies in communities throughout the region. MATES continues to be the most sophisticated regional air toxics analysis conducted in the nation, taking advantage of the extensive air quality monitoring, modeling, and analysis expertise and resources at the agency.

South Coast AQMD has initiated MATES VI and will begin measurements beginning in 2025. Similar to previous MATES campaigns, South Coast AQMD staff has convened a Technical Advisory Group (TAG) to provide technical guidance in the design of the study. The group includes experts from academia, health agencies, and government. MATES VI field measurements will be conducted over a one-year period at ten fixed sites to evaluate air toxics levels. MATES VI monitoring is being extended to the Coachella Valley for the first time. In addition, two of the ten monitoring locations will be sited adjacent to freeways to capture near-road air toxics impacts. MATES VI will also include measurements of ultrafine particle (UFP) and black carbon (BC) concentrations, which can be compared to the UFP and BC levels measured in MATES IV and MATES V, continuous measurement of metals, some of which are chemical tracers for non-exhaust vehicular emissions, and measurement of ammonia, a key precursor to PM2.5 formation in the region. Currently South Coast AQMD operates only one ammonia monitor in Coachella Valley and more measurements as part of MATES VI can help better understand the sources of ammonia across South Coast AQMD's jurisdiction. While MATES VI is focused on air toxic impacts, these ammonia measurements and particle speciation measurements will provide additional information about the sources and composition of PM2.5, which will assist in the design of control strategies to attain federal PM2.5 standards.

In addition to the fixed site monitoring, MATES VI will include a special study to characterize emissions of ethylene oxide (EtO) in ambient air and at the near-road sites to assess the contribution of vehicular emissions to background EtO concentration levels. The TAG will assist with the overall design of this study, and a scope and project plan for this part of the MATES VI campaign will be developed through the TAG meetings.

South Coast AQMD already possesses some of the monitoring and laboratory equipment needed for MATES VI. However, additional instrumentation and replacement, repair, and calibration of some older equipment is required to complete all the proposed measurements and can be used after MATES VI for additional studies,

special investigations, or community monitoring. Laboratory and field supplies are also needed to conduct MATES VI. In addition to equipment and supply needs, temporary staffing is necessary to meet the additional workload associated with MATES VI, as well as contractor support services for conducting tire-wear marker study, and to support study design, data analysis, and review.

The total program cost for MATE VI is around $5M to over FY 2023-24 through FY 2027-28 to purchase the necessary equipment and supplies and retain temporary staff for the MATES VI program. That include Solicitation for Tire and Brake Wear Study, Purchase Orders for Condensation Particle Counters, Aethalometers, Xact 625i Multi-Metal Monitor, Xact 625i Switching Inlet Systems, Continuous Monitors for Ethylene Oxide , Continuous Monitors for Ammonia, Gas Chromatograph Mass Spectrometer Instruments, GC-MS Canister Autosamplers, Monitoring Shelters, Vehicles, Zero Air Generators , GC-MS Thermal Desorption System, Air Toxics Samplers, Gas Dilution Systems and Linux Computational Server System and so-on.

Potential Air Quality Benefits:

The MATES studies conducted by South Coast AQMD provide essential information on air toxics levels in the South Coast AQMD's jurisdiction and present a unique opportunity to evaluate long-term trends in air toxics and their health impacts. South Coast AQMD continues to work toward reducing air toxics emissions through supporting cleaner technologies (including cleaner diesel technologies), rulemaking to address toxic emissions from mobile and stationary sources, and implementing air toxics monitoring and enforcement initiatives. The MATES VI program complements these efforts and provides information to track progress on reducing air toxics in the region along with the identification of sources contributing to the air pollution health risk.

3.4.2.10. Technology Assessment and Transfer/Outreach

Proposed Project: Assess and Support Advanced Technologies, Disseminate Information and Support Workforce Training

Expected South Coast AQMD Cost: $750,000

Expected Total Cost: $2,000,000

Description of Project:

This project supports assessment of clean fuels and advanced technologies, progress towards commercialization and dissemination of information on demonstrated technologies. The objective of this project is to expedite transfer of technology developed from Technology Advancement Office projects to the public domain, industry, regulatory agencies and the scientific community. This project is a fundamental element in South Coast AQMD's outreach efforts by coordinating activities with other organizations to expedite implementation of advanced engines and clean fuels technologies.

This project may include the following:

- technical review and assessment of technologies, projects and proposals;
- support for alternative charging solutions and zero emission charging and fueling infrastructure;
- advanced technology curriculum development, mentoring and outreach to local schools;
- emission studies and assessments of near-zero and zero emission alternatives;
- preparation of reports, presentations at conferences for technical and non-technical audiences, meet funding agency/grant requirements and improve public relations by conducting public outreach on successful clean technology demonstration and deployment projects;
- participation in and coordination of workshops and various meetings;
- support for training programs related to fleet operation, maintenance and fueling of alternative fuel vehicles and equipment;
- publication of technical papers as well as reports and bulletins; and
- dissemination of information, including websites development and updates.

These objectives will be achieved by consulting with industry, scientific, health, medical and regulatory experts and co-sponsoring related conferences and organizations, resulting in multiple contracts. In addition, an ongoing outreach campaign will be conducted to encourage decision-makers to voluntarily switch to alternatively fueled vehicles and train operators to purchase, operate and maintain these vehicles/equipment and associated infrastructure.

Potential Air Quality Benefits:

As the Clean Fuels Program transitions increasingly to zero emission vehicle, equipment and infrastructure technologies, there will continue to be challenges in assisting fleets and others to successfully make this transition. The benefits of highlighting challenges, lessons learned, and success stories in the use of zero emission and near-zero emission vehicles, equipment and infrastructure can expedite acceptance and

commercialization of these technologies. In addition, projects that support workforce training and professional development will prepare and train the next generation of engineers and technicians to handle the increased demand of EVs. The emission reduction benefits will contribute to the goals of the 2022 AQMP.

Proposed Project: Support Implementation of Clean Fuels Incentives and Demonstration Projects

Expected South Coast AQMD Cost: $350,000

Expected Total Cost: $400,000

Description of Project:

This project supports implementation of incentive programs, including state and federal grant programs, Carl Moyer, Prop 1B, VW, VIP, CAPP, lower emission school bus, Replace Your Ride, and South Coast AQMD residential EV charger rebate program. Implementation support includes application review, funds allocation, equipment owner reports collection, documentation to CARB, verification of vehicle operation, and other support as needed. Information dissemination is critical to successfully implementing coordinated and comprehensive incentive programs. Outreach will be directed to vehicle OEMs, dealers, individuals and fleets.

Potential Air Quality Benefits:

South Coast AQMD will provide matching funds to implement several key incentive programs to reduce emissions in SCAB. The benefit of highlighting zero emission vehicle, equipment and infrastructure incentives is to expedite acceptance and commercialization of advanced technologies. Future emission reduction benefits will contribute to the goals of the 2022 AQMP. Carl Moyer, Prop 1B, VW, VIP, CAPP, and lower emission school bus incentive programs can reduce large amounts of NOx and PM emissions, and toxic air contaminants in SCAB.

Appendix A

South Coast AQMD Advisory Groups

[This Page Intentionally Left Blank]

Technology Advancement Advisory Group[1]

Dr. Aaron Katzenstein, Chair	South Coast AQMD
Sam Wilson	Union of Concerned Scientists
Jacob Goldberg	Port of Los Angeles
Dr. Bill Robertson	California Air Resources Board
Dr. Michael Kleinman	University of California Irvine
Yuri Freedman	Southern California Gas Company
George Payba	Los Angeles Department of Water and Power
Dr. Laura Verduzco	Chevron Corporation
Elizabeth John	California Energy Commission
David Pettit	Natural Resources Defense Council
Dr. Matt Miyasato	FirstElement Fuel
*Dr. Leela Rao	Port of Long Beach
Rosalie Barcinas	Southern California Edison

*Newly appointed member

[1] Members as of February 21, 2025

SB 98 Clean Fuels Advisory Group[2]

Dr. Aaron Katzenstein, Chair	South Coast AQMD
Keith Brandis	Volvo Group
Brett Stevens	Daimler Truck North America
Dr. John Wall	Independent Consultant in Combustion Technology
Marcus Alexander	Electric Power Research Institute
Dr. Mridul Gautam	West Virginia University, Adjunct Professor, & University of Nevada-Reno
Dr. Wayne Miller	University of California, Riverside, College of Engineering, Center for Environmental Research and Technology
Dr. Petros Ioannou	University of Southern California Director of the Center for Advanced Transportation Technologies
Dr. Scott Samuelsen	University of California, Irvine, Combustion Laboratory/National Fuel Cell Research Center
David Park	Hydrogen Fuel Cell Partnership
Tom Swenson	Cummins, Inc.
Ken Kelly	National Renewable Energy Laboratory
*Dr. Gordon Abas Goodarzi	Magmotor Technologies, Inc.
*Yassamin Kavezade	California Building Decarbonization Coalition

*Newly appointed member

[2] Members as of March 7, 2025

Appendix B

Open Clean Fuels Contracts as of January 1, 2025

[This Page Intentionally Left Blank]

Contract	Contractor	Project Title	Start Term	End Term	South Coast AQMD $	Project Total $
Electric / Hybrid Electric Technologies and Infrastructure						
18232	Hyster-Yale Group Inc	Electric Top-Pick Development, Integration & Demonstration	09/14/18	02/28/25	367,801	3,678,008
18287	Evgo Services LLC	Charging Station and Premises Agreement for Installation of One DCFC at SCAQMD Headquarters	06/27/18	06/26/28	0	0
19166	Phoenix Cars LLC dba Phoenix Motorcars	Battery Electric Shuttle Bus Replacement Project	01/31/19	04/30/25	0	7,311,456
19464	West Basin Container Terminal LLC	Battery Electric Yard Tractor Replacement Project	10/29/20	02/28/25	442,750	3,300,000
20296	Daimler Trucks North America LLC	Deploy Zero Emission Electric Delivery Trucks	05/27/21	03/31/26	0	12,310,000
21153	Volvo Group North America LLC	Switch-On: Develop and Deploy Seventy Heavy-Duty Battery Electric Vehicles	06/10/21	11/30/25	2,000,000	31,540,000
22036	University of California Riverside	Energy-Efficient Routing for Electric Trucks	09/06/22	04/30/25	99,500	99,500
22120	Los Angeles Cleantech Incubator	Conduct Stakeholder Outreach and ZEV Workforce Plan	03/24/22	03/31/25	95,000	155,000
22177	Daimler Trucks North America LLC	Deploy Class 8 Battery Electric Trucks and Charging Infrastructure	06/16/22	04/30/25	447,638	27,073,593
22247	NFI Interactive Logistics LLC	Deploy Class 8 Battery Electric Trucks, Charging Infrastructure and Distributed Energy Resource Technologies	12/15/22	04/30/25	4,547,126	35,078,329
23072	CALSTART	Charging Related Data Collection, Fleet Analysis and Reporting for Deployment of 100 Commercial Class 8 Battery Electric Trucks	03/08/23	03/31/25	98,582	197,582
23090	Electric Power Research Institute	Deployment of 100 Commercial Class 8 Battery Electric Trucks	03/19/24	03/31/25	209,588	209,588
23103	San Bernardino County DBA Arrowhead Regional Medical Center	Deployment of Zero Emission Mobile Clinics	03/22/23	04/30/25	500,000	2,200,000
24101	Odyne Systems LLC	Development and Demonstration an Electric Power Take-Off System on a Zero-Emission Battery Electric Medium-Duty Truck Chassis	01/03/23	12/31/25	250,000	1,050,000
24123	Range Energy Inc	Development and Demonstration of Electric Powered Trailer for Heavy-Duty Vehicles	06/03/24	06/02/25	500,000	4,242,000
24318	University of California Riverside	Evaluation of Electric Powered Trailer for Heavy-Duty Vehicles	12/11/24	12/10/25	50,000	50,000

Contract	Contractor	Project Title	Start Term	End Term	South Coast AQMD $	Project Total $
Emissions Control Technologies						
23059	University of California Riverside	Study of Emissions and Air Quality Impact from Goods Movement Operations in Southern California Communities	12/27/22	12/26/25	500,000	3,610,000
Fueling Infrastructure and Deployment (NG / RNG)						
18336	ABC Unified School District	FY2017-18 Alternative Fuel School Bus Replacement Program (3 CNG Buses)	10/05/18	11/30/34	117,900	676,500
18337	Alta Loma School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (2 CNG Buses)	10/05/18	11/30/34	78,600	423,000
18344	Bellflower Unified School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (1 CNG Bus)	09/07/18	11/30/34	39,300	225,500
18346	Chaffey Joint Union High School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (6 CNG Buses)	10/05/18	11/30/34	235,800	1,269,000
18348	Cypress School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (1 CNG Bus)	09/07/18	11/30/34	39,300	211,500
18349	Downey Unified School District	FY 2017-18 alternative Fuel School Bus Replacement Program (4 CNG Buses)	09/14/18	11/30/36	157,200	902,000
18350	Fountain Valley School District	FY2017-18 Alternative Fuel School Bus Replacement Program (1 CNG Bus)	09/07/18	11/30/34	39,300	211,500
18351	Fullerton Joint Union High School District	FY2017-18 Alternative Fuel School Bus Replacement Program (4 CNG Buses)	10/05/18	11/30/34	157,200	846,000
18354	Hemet Unified School District	FY2017-18 Alternative Fuel School Bus Replacement Program (5 CNG Buses)	10/05/18	11/30/34	196,500	1,127,500
18355	Huntington Beach Union High School District	FY2017-18 Alternative Fuel School Bus Replacement Program (15 CNG Buses)	10/05/18	11/30/34	589,500	3,382,500
18363	Orange Unified School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (1 CNG Bus)	09/14/18	11/30/34	39,300	225,500
18364	Placentia-Yorba Linda Unified School District	FY2017-18 Alternative Fuel School Bus Replacement Program (6 CNG Buses)	10/05/18	11/30/34	235,800	1,353,000
18365	Pupil Transportation Cooperative	FY 2017-18 Alternative Fuel School Bus Replacement Program (5 CNG Buses)	10/05/18	11/30/34	196,500	1,127,500
18367	Rialto Unified School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (13 CNG Buses)	10/05/18	11/30/34	510,900	2,931,500
18368	Rim Of The World Unified School District	FY2017-18 Alternative Fuel School Bus Replacement Program (3 CNG Buses)	10/05/18	11/30/34	117,900	676,500
18369	Rowland Unified School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (3 CNG Buses & 1 Propane Bus)	11/02/18	11/30/34	117,900	770,000

Contract	Contractor	Project Title	Start Term	End Term	South Coast AQMD $	Project Total $
Fueling Infrastructure and Deployment (NG / RNG) (cont'd)						
18370	San Jacinto Unified School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (2 CNG Buses)	09/14/18	11/30/34	78,600	451,000
18374	Upland Unified School District	FY 2017-18 Alternative Fuel School Bus Replacement Program (4 CNG Buses)	10/12/18	11/30/34	157,200	902,000
20178	Whittier Union High School District	FY 2017-18 Alternative Fuel School Bus Replacement Program	02/21/20	11/30/34	196,500	1,052,500
Hydrogen and Mobile Fuel Cell Technologies and Infrastructure						
15150	Air Products and Chemicals Inc	Install/Upgrade Eight H2 Fueling Stations throughout SCAG (including SCAQMD's HQs H2 station)	10/10/14	01/09/25	643,750	16,979,189
15611	Ontario CNG Station Inc	Installation of Ontario Renewable Hydrogen Fueling Station	07/10/15	07/09/25	200,000	2,510,000
20033	Port of Long Beach	Sustainable Terminals Accelerating Regional Transportation (START) Phase I	06/04/21	06/30/26	500,000	105,013,765
20038	University of California Irvine	Expansion of the UCI Hydrogen Refueling Station	10/18/19	02/17/27	400,000	1,800,000
21313	Sunline Transit Agency	Deployment of 5 Zero-Emission Fuel Cell Transit Buses	08/27/21	12/31/25	204,921	6,759,910
21372	University of California Davis	California Hydrogen Systems Analysis	03/29/22	06/29/25	50,000	550,000
22084	A-1 Alternative Fuel Systems	Develop and Demonstrate Hydrogen Fuel Cell Medium-Duty Buses	01/19/22	04/18/24	531,166	2,086,608
24166	Zero Emission Industries Inc	Development of a Portable Liquid Hydrogen Fueling System	06/27/24	04/30/26	1,175,000	7,168,750
24235	Air Products and Chemicals Inc	License Agreement to Operate and Maintain Publicly Accessible Hydrogen Fueling Station at SCAQMD's Diamond Bar HQs	04/10/24	01/09/25	0	0
Stationary Sources - Clean Fuels						
24035	RockeTruck Inc	Develop and Demonstrate Hydrogen Fuel Cell Mobile Power Generation System	05/10/24	06/30/25	200,000	4,617,067
Zero Emission Infrastructure						
24131	University of California Riverside	Regional Medium- and Heavy-Duty Zero Emission Vehicle Infrastructure Analysis	08/20/23	03/31//25	150,000	300,000
Technology Assessments and Transfer / Outreach						
09252	JWM Consulting Service	Technical Assistance with Review and Assessment of Advanced Technologies, Heavy-Duty Engines and Conventional and Alternative Fuels	12/20/08	06/30/26	30,000	30,000

12376	University of California Riverside	Technical Assistance with Alternative Fuels, Biofuels, Emissions Testing, and Zero-Emission Transportation Technology	06/01/14	05/31/26	300,000	300,000
19302	Hydrogen Ventures	Technical Assistance with Hydrogen Infrastructure and Related Projects	04/24/19	04/23/25	50,0000	50,000
20085	CALSTART Inc	Technical Assistance for Development & Demonstration of Infrastructure and Mobile Source Applications	11/08/19	11/07/25	250,000	250,000
20265	Eastern Research Group	Technical Assistance with Heavy-Duty Vehicle Emissions Testing, Analyses & Engine Development & Applications	06/17/20	06/30/26	50,000	50,000
22096	AEE Solutions LLC	Technical Assistance with Heavy-Duty Vehicle Emission Testing, Test Methods and Analysis of Real-World Activity Data	11/08/21	11/07/25	100,000	100,000
22273	Green Paradigm Consulting Inc	Technical Assistance with Alternative Fuels, Evs, Charging & Infrastructure and Renewable Energy	04/22/22	04/02/26	200,000	200,000
22274	Gladstein, Neandross & Associates LLC	Technical Assistance with Alternative Fuels & Fueling Infrastructure, Emissions Analysis & On-Road Sources	05/05/22	04/02/26	300,000	300,000
24173	Integra Environmental Consulting Services Inc	Technical Assistance to Support Technology Advancement Office Mobile Source Incentive and Technology Demonstration Programs	05/01/24	04/30/26	75,000	75,000
25077	Coordinating Research Council Inc	Cosponsor the 35th Real World Emissions Workshop	10/01/24	07/31/25	5,000	100,000

Appendix C

Final Reports for 2024

[This Page Intentionally Left Blank]

South Coast AQMD Contract #18194 **December 2024**

Class 8 Heavy-Duty Opposed-Piston Engine Demonstration

Contractor

CALSTART, Achates Power, Peterbilt, Aramco Services Company, Southwest Research Institute, Delphi, Eaton, Faurecia, Corning, BASF, Federal Mogul, Tyson Foods, Walmart

Cosponsors

California Air Resources Board, San Joaquin Valley APCD, South Coast AQMD

Project Officer

Joseph Lopat

Background

The movement of freight within and through California's regional centers relies predominantly on the use of heavy-duty (HD) diesel-fueled trucks. These trucks are a large source of greenhouse gas (GHG), criteria pollutant, and toxic air-contaminant emissions. Since these vehicles tend to frequent ports, railyards, and warehouse districts as part of their normal activities, large amounts of nitrous oxide (NOx) and diesel particulate matter (PM) emissions significantly impact nearby communities. Reducing emissions from these trucks is not only necessary to meet federally imposed clean-air standards but also to reduce adverse health effects from their emissions—especially in disadvantaged communities.

The continued development and demonstration of advanced technologies (zero-emission and near zero-emission) is necessary to meet California's long-term GHG emissions reduction goals, protect public health, and reach attainment with increasingly stringent federal air quality standards. Therefore, as part of the 2016-2017 Funding Plan for Low Carbon Transportation Investments and the Air Quality Improvement Program (AQIP), CARB announced funding for the On-Road Advanced Technology Demonstrations and Pilot Projects. The primary aim of these projects was to incentivize advanced technology within the freight sector that reduces GHG, criteria pollutant, and toxic air contaminant emissions to disadvantaged communities.

Project Objective

The Opposed-Piston Engine (OPE) Class 8 Demonstration Project deployed and validated with major truck, engine and fleet partners is a world-leading engine design that will meet California's ultra-low NOx requirement (0.02 g / bhp-hr), while simultaneously meeting the 2027 EPA GHG requirements. This was the first demonstration in the United States of a high-efficiency AND low NOx engine / powertrain vehicle in Classes 7-8. The project combined two proven solutions – the OPE, largely developed by Achates Power, Inc., and the ultra-low NOx aftertreatment system developed by Southwest Research Institute.

The successful completion of this project supports the commercialization and widespread adoption of this technology in Class 7-8 trucks, thereby supporting South Coast AQMD's goals of reducing emissions needed to meet air quality standards and reducing carbon dioxide (CO2) emissions from larger trucks for which there is a shortage of other available options.

Technology Description

The OPE promises a practical and economically viable solution for the reduction of NOx emissions and CO2 as mandated by the California Air Resources Board (CARB) Heavy-Duty Engine and Vehicle Omnibus Regulation. The OPE resolves one of the conundrums of emissions reduction: achieving ultra-low NOx emissions without

increasing CO2 and without costly additional emissions technology. Conventional four-stroke engines induct a full cylinder of air during the intake stroke that dilutes the engine's exhaust heat. High exhaust enthalpy is necessary to enable rapid catalyst light-off and maintain the catalyst temperature required to achieve lower NOx and CO2 emissions. OPEs, by contrast, utilize scavenging to reduce the amount of additional exhaust enthalpy required to maintain catalyst temperature while undertaking less gas exchange work to achieve simultaneous reductions in NOx and CO2 emissions.

OPE Specifications	
Swept Displacement	10.6 L
Number of cylinders	3
Total Stroke	312 mm
Bore	120 mm
Stroke/Bore	2.6
Peak Power	300 kW (400 hp) @ 1700 rpm
Peak Torque	2237 Nm (1650 lb-ft) @ 950-1300 rpm
Emissions Level	California ultra-low NO_x: 0.02 g/bhp-hr
EGR	Yes

Results

Though the Class 8 HD OPE Demonstration project ended prematurely due to truck engine and diesel particulate filter failures, the results from this project have shown that a Class 8 OPE HD truck could perform similar duty cycles of a conventional HD truck used in large-scale, commercial operations while meeting the most stringent enacted and proposed tailpipe and CO2 emissions regulations in the world. Furthermore, the demonstration showed the potential of the OPE to meet these regulations through at least 2027 in a cost-effective, robust, and practical manner. In addition to its inherent advantages in high-efficiency, low-emissions, and low-complexity, the OPE also has advantages in fuel flexibility, including carbon-free hydrogen combustion and low-carbon combustion of alcohols like ethanol and methanol.

The final report on the entire project was delivered on January 29, 2024, and is on file.

Benefits

The OPE advantages in low tailpipe emissions and improved fuel efficiency scale into larger and smaller engines and can be applied to off-road applications as well. Class 8 truck engines represent the first beachhead for the clean, efficient OPE. It is a logical starting place, considering that HD vehicles emit 26% of all NOx emissions in California. Combined, off-road and MHD engines emit 67% of all NOx in California. If the OPE, capable of reducing NOx emissions by 90%, were put in place in all these applications, California-based NOx emissions could be reduced by more than 90%.

Project Costs

GRANT AMOUNT	
CARB	$6,994,601
COST-SHARE	
SOUTH COAST AQMD	$1,000,000
SJVAPCD	$1,000,000
PARTNER MATCH	$7,705,267
TOTAL	$16,699,868

Commercialization and Applications

At least two paths to market exist. Commercial vehicle engine manufacturers already have all the necessary capability to develop, manufacture, distribute, and service OPEs. Achates can work with these firms during the development and industrialization process and will earn a royalty for a license to its OPE technology, including designs, control software, development tools, test tools, and patents.

Another path to market is for Achates to assemble a team of established organizations to undertake the development, certification, manufacturing, integration, distribution, and support for diesel, HD OPEs. Achates believes sufficient capacity and capital exists for this pathway.

South Coast AQMD Contract #20092 **April 2024**

Development of a Pent-Roof Medium-Duty Spark-Ignited Natural Gas Engine in an Optimized Hybrid Vehicle System

Contractor
Southwest Research Institute

Cosponsors
National Renewable Energy Lab (NREL)
South Coast AQMD

Project Officer
Sam Cao

Background
Regulated emissions output for medium-duty diesel engines are set to be significantly reduced over the coming decade. The 2027 MY NO_X standard will be reduced by an order of magnitude (0.2 to 0.02 g/bhp-hr NOx emissions) while diesel greenhouse gas (GHG) standards are simultaneously reduced ~7.6%. There are significant concerns that diesel engines will have difficulty meeting future NOx and GHG emission standards with reasonable aftertreatment costs.

As an alternative fuel, natural gas (NG) is an abundant resource across the United States, and new discoveries and extraction methods have led to a dramatic rise in shale gas development, making the United States the world's leading natural gas producer while changing the dynamics of the global energy mix. Advances in the ability to capture methane to produce renewable natural gas (RNG) further increase the interest in and motivation for expanding the use of natural gas in the transportation sector.

Project Objective
The project objective was to develop a pent-roof cylinder head version of a medium duty (MD) diesel engine for operation on natural gas and integrate it into an MD truck chassis, in combination with a hybrid drivetrain system (Figure 1) to provide a demonstration of a highly optimized low GHG emission medium-duty truck.

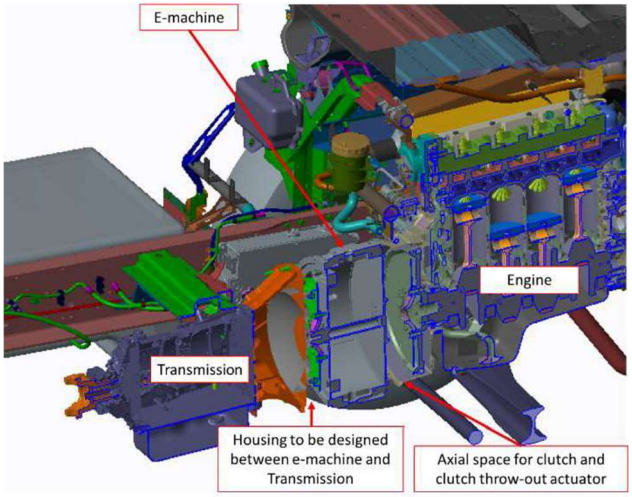


Figure 1. Hybrid Powertrain Integration Cutaway

Technology Description
Spark Ignition (SI) engines operating with stoichiometric combustion can use simple three-way catalysts to achieve low tailpipe emissions. However, most SI engines are a compromised design for medium- and heavy-duty applications. They are either derived from an automotive application in which the engine is de-rated to provide for more durability or from a medium- or heavy-duty flat head diesel in which the flow field is compromised for SI combustion.

New technologies, such as cooled exhaust gas recirculation (EGR), have recently been developed for stoichiometric SI engines which enable high efficiency and BMEP at low engine speeds. This enables torque curves comparable to diesel engines and therefore comparable operating conditions in vehicle, which enables diesel-like durability in an SI engine. An optimized hybrid system was used in combination with the high BMEP natural gas engine to further increase the efficiency gains and demonstrate the potential for a low NO_X, low GHG medium-duty truck applicable to real world applications.

Status

The Pentroof EGR natural gas engine was built up and installed in an engine dynamometer test cell for calibration of the engine control system. The efficiency and emissions were then verified before it was combined with the PHEV driveline and integrated into an Isuzu F Series class 8 truck. The truck was then installed on a heavy-duty chassis dyno to demonstrate the efficiency gains and emissions performance in a complete vehicle. The project was completed in December of 2023.

Results

The NG hybrid vehicle successfully demonstrated the targeted 25% reduction in CO_2 and met the 0.02 NOx emissions requirement over the city and multi-use GEM certification cycles, while maintaining performance equal to or better than the diesel baseline. Real world cycles were developed from Isuzu supplied durability cycles to show the practical capability of the hybrid powertrain. The hybrid vehicle was shown to be capable of matching the vehicle speed and acceleration rates expected of a diesel vehicle at full gross vehicle weight rating. The sizing of the electric motor, battery, and internal combustion engine have all been shown to be sufficient for the speed, acceleration, and emissions requirements. In addition, the integration of the systems only had a minor effect on the vehicle cargo load capacity with a reduction of less than 5% (0.5 ton reduction) of GVWR. The projected initial vehicle cost is estimated to be similar to the cost of a 2027 compliant diesel version with reduced total cost of ownership ofover 15% during the first 3 years.

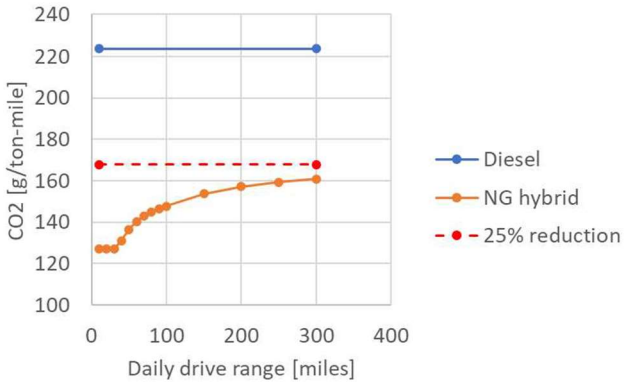


Figure 2. CO_2 Emissions in G/Ton-Mile Based on GEM Calculations for the Diesel Baseline and NG Hybrid Vehicles in the Multipurpose Category

Benefits

The technology demonstrated in this program is ready for a production intent application. The sizing of the electric motor, battery, and internal combustion engine have all been shown to be sufficient for the speed, acceleration, and emissions requirements. The potential CO_2 emission reduction from the technologies utilized in this build, on average, easily meet the 25% GHG reduction target, and in higher kinetic energy duty cycles far exceeds it.

Project Costs

The $2,525,000 in NREL and $475,000 in South Coast AQMD funding was fully utilized during the project. An additional $3,180,525 in price participation was supplied by SwRI and other partners to complete the project.

Commercialization and Applications

The technology to develop a product based on this program exists on the market and would only require a standard product design and development program commercialization. With the initial purchase cost for a Class 8 vehicle projected to be on par with the projected 2027 compliant diesel costs, and with a significantly lower total cost of ownership over the first three years, there would be a positive business case with consumers, especially fleet owners. In addition, this technology could be applied across the range of heavy- duty commercial vehicle classes.

South Coast AQMD Contract #20316 **June 2024**

Natural Gas Engine & Vehicles Research & Development - Plug-In Hybrid CNG Drayage Truck (PHET)

Contractor

US Hybrid

Cosponsors

DOE/ National Renewable Energy Laboratory
California Energy Commission
South Coast AQMD

Project Officer

Phil Barroca, Sam Cao

Background

Building on a strong history of working collaboratively with the U.S. Department of Energy Vehicle Technologies Office, the California Energy Commission Energy (CEC) Research and Development Division, and the South Coast Air Quality Management District (South Coast AQMD), the National Renewable Energy Laboratory (NREL) formed and led a Natural Gas Research and Development Consortium to encourage innovation in medium-duty and heavy-duty natural gas vehicles (NGVs). This Consortium is working to develop and identify improvements that will benefit the NGV industry and other stakeholders. NREL successfully leveraged funding from the three agencies in alignment with each agency's goals to fund and manage research and development projects through a competitive request for proposals selection process. This effort aims to advance the medium-duty and heavy-duty NGV transportation sector in terms of NGV total cost of ownership, emissions, and efficiency. NREL worked with the funding agencies during project selection and awarded a portfolio of eight research and development project awards.

Project Objective

US Hybrid Corporation and its partners will address (total cost of ownership) TCO by developing and demonstrating a fully integrated and optimized natural gas, plug-in hybrid electric truck (PHET) Class 8 vehicle using the Cummins 9-liter near-zero emission engine, a commercialized parallel hybrid powertrain with 240 horsepower rating, and a 40 kilowatt-hour liquid-cooled high-power density lithium-ion battery pack. The project includes a 24-month demonstration in port drayage operations to quantify emission and performance improvements and will implement a global positioning system-based predictive geofencing hybrid control architecture to ensure zero emission operation at the port.

Technology Description

The optimization was applied to Commercialized Truck chassis (Freightliner,) utilizing the EPA certified Cummins L9N Near-Zero Emission Engine and commercialized parallel hybrid powertrain, with 320hp rating and most efficient performance for motoring and regeneration, and an 89kWh, liquid cooled high power density lithium-ion battery pack, and all electric drive accessories. The hybrid vehicle control was optimized to operate the L9N engine with the lowest NOx emission and most efficient brake specific fuel consumption (BSFC) operation. Effectively the PHET truck will reduce NOx emission by half of near-zero emission values of certified below 0.02 g/bhp-hr. NOx, when evaluated based on NOx emission g/mile or g/ton-mile performance.

The electric motor supplements the internal combustion engine (ICE) power by (1) providing superior acceleration and energy recovery during regenerative braking with a total power of 640 hp, providing performance exceeding that of ISX12 NG and 13-L diesel engines, (2) dramatically reducing emissions with doubling fuel economy, and (3) enabling 500+ miles per standard CNG tank racks with no interference to trailer movement and need to extend the wheelbase impacting turning radius. The truck will be able to operate in battery electric-only (20 miles drive, 1 hr. during port queuing and maneuvering operation) with electric power accessories (steering, air system and HVAC) and plug-in charging capability to maximize EV-only range

and utilize engine start-stop technology to minimize idling. Using results from simulation models developed in the past 4 years, the project's advanced controllers for the engine and electrical systems and optimized electrical components were designed specifically to optimize vehicle performance and drivability for drayage applications. This minimized emissions and maximized fuel economy. The PHET includes a 20kW, on-board isolated, UL rated AC charger with SAEJ1772 and EN61851, charging protocol that is comparable to existing port charging infrastructure feeding from 480V, 3-Phase directly.

Status/Results

The project was completed February 2024, and the Final Report is on file with complete technical details of the project.

The PHET truck was driven for 5,313 miles and 1,012 Diesel Gallon Equivalent (DGE) was consumed, therefore, the fuel consumption for the CNG PHET is 5.25 mpgDGE by the La Mirada Transport Drayage operation. The CNG PHET range would be 913 miles with 174 DGE tank on board.

The CNG PHET fuel consumption improves 33% better than the CNG truck (3.95 mpgDGE) and 130% better than LNG truck (2.24 mpgDGE).

The test report from the University of California, Riverside, Center for Environmental Research and Technology (UCR/CE-CERT) evaluation showed that under the Urban Dynamometer Driving Schedule (UDDS) cycle, the achieved fuel consumption was 4.32mpgDGE, while the port and regional cycle (DTP_3) showed 5.22 mpgDGE. The latter is consistent with the results observed by the operator, who operates under those port/regional drive cycles.

The dyno testing also verified the gradeability of the vehicle. In the past, operators have complained of the CNG/LNG vehicles lack of performance on inclines. The dyno testing showed a maximum speed of 20mph on a 6% grade for CNG only operation, and a maximum of 40mph on a similar grade in hybrid mode.

The NOx emissions results were not conclusive, and additional re-test was recommended. NOx peak of emissions was observed in various vehicles by UCR. Preliminary analysis from other projects indicates that a modification of the vehicle algorithm would drastically lower the peak. Other peaks observed are potentially due to leak in the exhaust system OR to the measurement equipment. UCR proposed to retest the vehicle to verify the achievements that could be attained.

Figure 1. US Hybrid PHET Vehicle

Benefits

The PHET truck can offer both zero and near-zero emission operation while maintain performances.

Zero-emissions travel: PHET trucks offer 20 miles of emission-free operation within the port, significantly reducing air pollution in already disadvantaged communities surrounding port facilities.

Near-zero regional operation: With a 500-mile+ range and performance exceeding traditional diesel engines, PHET trucks seamlessly transition to near-zero emissions during regional operations, slashing GHG and criteria air pollutant emissions.

Project Costs

US Hybrid received $2.8 million to build and deploy three project trucks. The South Coast AQMD's cost-share was $500,000 with other cost-share totaling over $2.3 million.

Commercialization and Applications

US Hybrid built three trucks and demonstrated the fuel efficiency as well the emission benefit potential of the PHET technology. However, with the adoption of various California Air Resources Board zero emission regulations, PHET truck, as its existing configuration, will not meet the requirements of zero emission vehicle. The emissions benefit of the PHET truck still needs to be further verified and refined.

South Coast AQMD Contract #21083 **September 2024**

Effects of Hydrogen/Natural Gas Blends on a Heavy-Duty Natural Gas Engine

Contractor

University of California Riverside, Center for Environmental Research and Technology

Cosponsors

South Coast AQMD
Southern California Gas Company
Pacific Gas & Electric Company

Project Officer

Sam Cao

Background

The internal combustion engine remains a critical propulsion system, especially in heavy-duty freight transportation. However, the traditional internal combustion engine is also a major contributor to anthropogenic greenhouse gas (GHG) emissions and criteria air pollutants. The use of alternative fuels such as renewable natural gas and hydrogen can help reduce life-cycle greenhouse gas emissions and improve the sustainability of the transportation sector immediately. Renewable natural gas is produced from a variety of feedstocks and is compatible with existing pipeline infrastructure. Hydrogen can be produced from renewable energy via electrolysis and injected and stored in small volumetric fractions in the existing natural gas pipeline infrastructure. Studies also have shown that hydrogen, when used in internal combustion engines, can increase efficiency and reduce particulate emissions. The characterization of criteria air pollutants such as nitrogen oxides (NOx), particulate matter (PM), and carbon monoxide (CO) as well as the engine performance are not yet fully understood for low blends of hydrogen up to 5% in natural gas engines.

Project Objective

The purpose of this study was to test how different blends of hydrogen in renewable natural gas at low concentrations (1-5% by volume) affect engine efficiency and criteria pollutants without any modification to the engine or engine control unit. The study was executed in two phases. Phase 1 was supported by South Coast AQMD and focused on the emissions and engine performance of low hydrogen blends. Phase 2 was supported by Southern California Gas Company (SoCalGas) and Pacific Gas & Electric Company (PG&E) and focused on durability testing.

Technology Description

For this program, a heavy-duty Cummins six-cylinder L9N 8.9 liter near-zero natural gas engine was used. The engine utilized port injection and spark ignition and was equipped with a three-way catalyst. The engine is certified to 0.02 NOx [g/bhp-hr]. Engine-out NOx, CO, CO2, and THC emissions were made with a 1065-certified gaseous portable emissions measurement system (PEMS). Solid particle number (SPN) emissions were measured with an AVL particle counter (APC) with a 23 nm diameter cut point. A TSI Condensation Particle Counter (CPC) 3022 with a 7 nm diameter cutoff and a TSI Engine Exhaust Particle Sizer (EEPS) 3090 with a measuring size distribution from 5.6 to 560 nm were placed after the APC to measure SPN at smaller sizes. A pressure transducer was installed in the engine head directly above one of the cylinders to measure in-cylinder pressure. A spark plug based AVL VisioKnock sensor was also installed in the spark plug port of the same cylinder. The VisioKnock spark plug sensor uses fiber optic cables attached to eight radially oriented optical observation cones to transfer light intensity signals from the combustion chamber to photodiode sensors. This enables the possibility of locating events of diffusion-controlled flames due to their higher light radiation.

Status

This project (Phase 1) was successfully completed in January 2024. Comprehensive data analysis was completed in November 2024.

Results

Results showed higher tailpipe NOx emissions for the 5% blend. However, the tailpipe emission factors for all blends were very near zero. The engine-out NOx emission factors showed a trend where the 1% and 3% blends were generally lower than the baseline and 5% fuel blends, with the 5% blend close to the baseline.

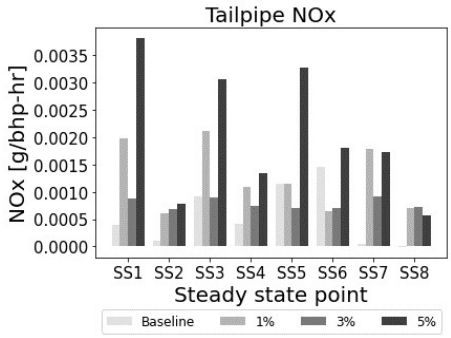


Figure 1. Tailpipe NOx emissions

Tailpipe NOx emissions over the entire federal test procedure (FTP) cycle were measured to be slightly higher than the certification levels for this engine (0.02 g/bhp-hr), even for the baseline fuel. Hot-start tailpipe NOx emissions were lower than cold-start conditions for all fuel blends except for the 3% blend, as shown in Figure 2, due to lower average aftertreatment temperatures. The hot-start NOx emission factors for the baseline renewable natural gas (RNG) and 1% fuel blends were approximately 50% higher than the standard at 0.03 g/bhp-hr. The 5% fuel blend exhibited an increase of about 100% in NOx emissions compared to the baseline RNG fuel. Two additional fuel blends, 9% and 11% hydrogen, were tested and analyzed for tailpipe emissions and exhibited over 4 and 6 times as much NOx emissions, respectively, compared to the baseline condition.

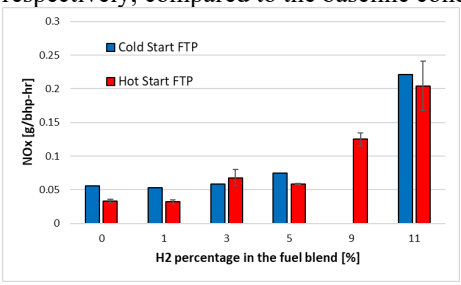


Figure 2. Tailpipe NOx emissions over the FTP

Generally, the highest number of particles were measured at the steady-state points near peak torque for all fuel blends as shown in Figure 3. There is no strong correlation between fuel blend and particle number. The particle size distribution was dominated by nucleation mode particles.

Peak cylinder pressure was shown to be highest for the 5% blend, followed by the baseline fuel. This follows the trend observed with NOx emissions where the 1% and 3% blends were lower than the baseline.

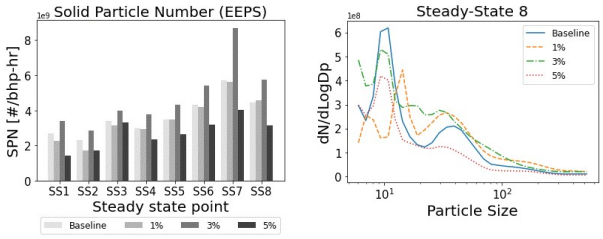


Figure 3. Solid particle number and size distributions

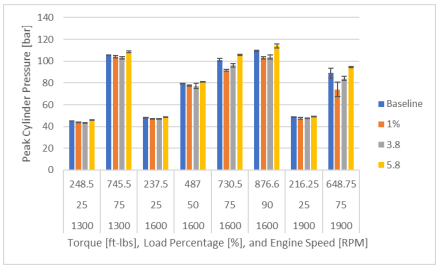


Figure 4. In-cylinder peak pressure measurements

Benefits

In this study, we assessed the emissions and performance of low-level hydrogen blends in RNG using a heavy-duty natural gas highway engine. This work evaluates readily available solutions to (a) reduce the carbon intensity of transportation fuels by adding a zero-carbon fuel to pipeline gas, and (b) mitigate pollutant emissions and GHGs from heavy-duty vehicles. It is important to understand the environmental and combustion performance of low-level hydrogen blends in the existing natural gas fleet. Overall, our findings suggest that low hydrogen blends can provide a strong pathway for tailpipe emissions reductions from heavy-duty vehicles in the South Coast Air Basin. More research work is necessary to better control NOx emissions with hydrogen addition by recalibrating existing engines and also better control particulates with the use of particulate filters.

Project Costs

South Coast AQMD contributed $533,021 towards this project.

Commercialization and Applications

It is expected that hydrogen fuel will likely play a major role in heavy-duty ground and marine transportation and off-road applications. The use of hydrogen will contribute to the complete decarbonization of the transport sector and to reductions of harmful pollutants and GHG emissions.

SCAQMD Contract #21386 **December 2024**

CA Hydrogen Heavy-Duty Infrastructure Research Consortium H2@Scale Initiative

Contractor

National Renewable Energy Laboratory (NREL)

Cosponsors

CARB
California Governor's Office of Business and Economic Development (GO-Biz)
California Energy Commission (CEC)

Project Officer

Dr. Maryam Hajbabaei

Background

A team of California public agencies, including CARB, CEC, Governor's Office of Business and Economic Development (GO-Biz), South Coast AQMD, and national laboratories formed a research partnership in 2017 focused on near-term hydrogen infrastructure development, deployment, and operation needs in California and was awarded DOE H2@Scale CRADA (Cooperative Research and Development Agreement) funds that year. Many of these partnerships had been in place for years through individual CRADA agreements and work scopes. The research partnership framework was intended to continue beyond that project for a long-lasting strategic partnership with the DOE, agencies, and national laboratories. As California begins to expand its light-duty (LD) fuel cell refueling network to include the medium- and heavy-duty (HD) fuel cell EV market, the research partnership jointly submitted a project proposal (and was awarded) to DOE's H2@Scale to 1) build upon existing momentum and 2) advance the H2@Scale vision and the goals of California, by developing an HD hydrogen reference station, fueling performance test device concepts, and HD hydrogen station capacity model.

Project Objective

The purpose of this project is to continue the research partnership between national laboratories, DOE, and California public agencies for the advancement of hydrogen fueling infrastructure for HD vehicles. This research partnership will provide design considerations and risk analysis for HD hydrogen fueling stations, design concepts for a HD fueling performance test device, and a model to evaluate the dispensing capacity of HD hydrogen stations. This cooperative work directly reflects California's transition to Zero Emission Trucks as spelled out in CARB's 2020 Advanced Clean Truck Regulation and Governor Gavin Newsom's zero-emission vehicle Executive Order (N-79-20).

Technology Description

A hydrogen fueling infrastructure is necessary to support the emerging LD and HD fuel cell electric vehicle market (FCEV), including both a network of fueling stations and the availability of hydrogen fuel that meets required fuel quality specifications. Fuel quality verification is mandated before a fueling station is certified for commercial hydrogen dispensing and periodically thereafter for the operational life of the fueling station. This infrastructure would benefit by the on-site hydrogen contaminant detectors (HCDs) for near-real-time verification of fuel quality, preferably at the nozzle just before dispensing of the hydrogen into the FCEV.

Status

This project was successfully completed in January 2025. A report was submitted in February 2025 for final approval.

Results

Task 1- Reference station design for HD stations: Two separately published reports were developed as outputs for this task. The first report on reference station design for HD vehicles describes the type of equipment needed along with the required footprint and costs for several configurations of HD hydrogen stations. The second report on reference station risk assessment discusses the quantitative risk assessment based on the HD equipment needed for the different station configurations and identifies gaps in NFPA code for HD stations. The tasks were completed with input from project partners and external stakeholders. Example tables and figures from the reports are included below for reference.

Table 1. Reference station data showing a summary of resource consumption along with design cases

Case	Description	Elec Energy Use (MWh/day)	Peak Demand (MW)	Water Use (m3/day)	LiquidH2 (kg/day)
1	Electrolyzer on-demand	230	63.5	20	-
2	Electrolyzer off-peak	228	17.8	20	-
3	LiquidH2 small compressor	12.7	6.5	-	4186
4	LiquidH2 large compressor	15.8	10.8	-	4186
5	LiquidH2 cryopump	2.9	1.6	-	4186

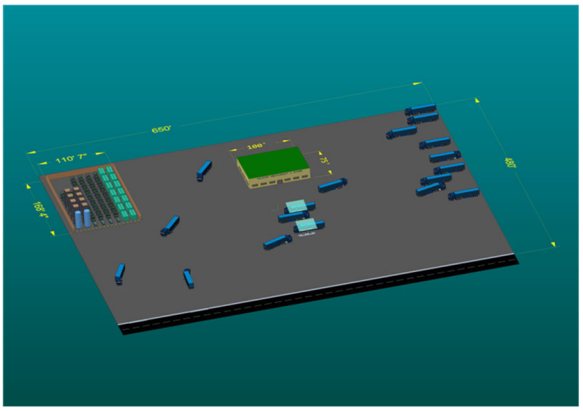


Figure. 1: Layout for one of the design cases where hydrogen is delivered as a liquid, flashed to a vapor in a low-pressure vaporizer and compressed on-demand for direct-fill.

Task 2- Hydrogen fueling/performance testing device: This task created design documents that would aid in the final design and build of a hydrogen fueling performance test device for HD hydrogen station dispensers with high flowrates of up to 300 g/s. This device specification is like the Hydrogen Station Equipment Performance (HyStEP) device built for LD hydrogen stations but with larger tank volumes and hardware that supports higher flowrates for HD stations.

Task 3- HD H2 station capacity tool: This task developed the HD Hydrogen station Capacity tool (HyCap 1.0), which is available from the NREL website. Users of the tool provide their major hydrogen station equipment specifications in a spreadsheet input file, and the model provides the number of trucks and amount of hydrogen that the equipment could dispense in a day based on the selected station demand profile. The tool is intended for gaseous dispensing from the station to the HD vehicle at nominal pressures up to 70MPa. It also works for LD stations.

Benefits

In this study, the CRADA continued the research partnership between national laboratories, DOE, and California public agencies for the advancement of hydrogen fueling infrastructure for HD vehicles. The output included published reports, models, and specification documents useful to the HD hydrogen community going forward.

Project Costs

Project Partner	Cost
U.S. DOE	$999,000
CEC	$25,000
GO-Biz	$25,000
CARB	$40,000
South Coast AQMD	$25,000
Total	**$1,114,000**

Commercialization and Applications

The CRADA benefits to DOE, Participant, and US Taxpayers include: 1) assisting laboratory in achieving programmatic scope, 2) adding new capability to the laboratory's core competencies, 3) enhancing the laboratory's core competencies, 4) using the laboratory's core competencies, and 5) enhancing U.S. competitiveness by utilizing DOE-developed intellectual property and capabilities.

This project provided valuable information on reference station design, exploration of design concepts for a fueling performance test device, and modeling of station capacity. The work applies to HD hydrogen fueling stations with large dispensing capacity and high flowrates servicing HD hydrogen trucks such as class 8 trucks in long-haul applications. The work leverages national lab capabilities including staff and equipment at SNL, NREL, and ANL with collaboration and funding cost share from California agencies (CEC, SCAQMD, and GO-Biz). This project will provide tools and information that lead to more efficient design, acceptance and commissioning of these larger capacity, higher flowrate stations serving HD applications. The HCD work will benefit both LD and HD stations.

SCAQMD Contract #22082 **August 2024**

High Flow Bus Fueling Protocol Development

Contractor
Frontier Energy, Inc.

Cosponsors
DOE, Industry partners, South Coast AQMD

Project Officer
Maryam Hajbabaei

Background
Industry and government initiatives/regulations are advancing rapidly toward zero emission medium-duty (MD) and heavy-duty (HD) vehicles to reduce pollutant emissions and to meet greenhouse gas reduction goals. Although a mix of powertrain architectures may be used to meet these targets, hydrogen fuel cell vehicles are expected to play an important role, especially for H35 MD/HD vehicles with duty cycles that require long range, ability to climb steep grades, and/or short refueling times.

Transit agencies such as AC Transit and SunLine Transit have been fueling heavy-duty hydrogen fuel cell buses for about 20 years with 350 bar hydrogen fuel (H35), and since 2010 have been able to fill buses in the equivalent time of fueling a diesel or compressed natural gas (CNG) bus (5-10 minutes). Heavy-duty hydrogen fueling infrastructure technology has progressed considerably since 2010, and compressors and liquid H_2 pumps to compress the fuel have become more reliable and more efficient. During the last 15 years, transit agencies have relied on the expertise of hydrogen infrastructure providers or expertise developed with CNG to develop custom fueling protocols that fit within the safety boundaries presented in the SAE International (SAE) Technical Information Report (TIR) J2601-2. These fueling protocols needed significant fine tuning and verification to meet the needs of specific "return-to-base" fleet vehicles and to achieve full fills. During these years, SunLine Transit and their bus development partners voluntarily performed early summer fueling tests to provide the baseline data sets that led to the development of SAE TIR J2601-2 as a performance fueling standard with safety boundaries for pressure and temperature to fill for HD H_2 vehicles.

Project Objective
The project's goal is to support SAE J2601-5 for the development of a verified H35HF MC Formula fueling protocol for MD/HD vehicles.

Technology Description
The National Renewable Energy Laboratory (NREL) owns a one-dimensional thermodynamic hydrogen filling simulation model (H2FillS), but its use was designed specifically for light-duty fueling. Therefore, the project team upgraded the H2FillS model to accommodate H35HF fueling for vehicles with large onboard storage systems, as well as to have the capability to derive t-final fueling tables that will be installed in commercial station dispensers. To derive all t-final fueling tables, many fueling simulations are required. Thus, the project team integrated the H2FillS model with the NREL high-performance computing system, as shown in Fig. 1. The developed t-final fueling tables are validated with real-world H35HF fueling data before those tables are published as in the J2601-5 fueling protocol TIR.

Status
The project is complete, and the project-team-reviewed final report has been issued.

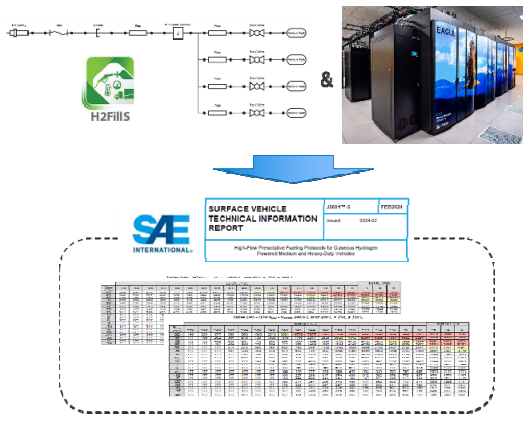


Figure 1 Process of t-final table generation

Results

The project team successfully upgraded the H2FillS model to accommodate H35HF fueling and the t-final fueling table generation capability. The team generated all the necessary t-final tables in the H2FillS model integrated with the NREL High-Performance Computing center. To confirm the reliability of the t-final tables, the team leveraged the Zentrum für BrennstoffzellenTechnik (ZBT) station (https://www.zbt-duisburg.de/en/the-zbt/) because the ZBT H35HF dispenser is equipped with the same hardware as that expected to be used at future commercial stations. The generated t-final tables were implemented in the ZBT H35HF dispenser and used for a total of 11 fueling tests under various conditions, as shown in Table 1. Through the tests, the project team confirmed that the fueling process with the tables never caused the vehicle storage systems to experience overheating and overfilling, even under ambient temperature fueling conditions. Thus, the project team confirmed that the safety of the fueling process with the tables is sufficiently assured and that the tables are well prepared to be installed in commercial station dispensers. All the t-final tables generated under the project were published in the SAE J2601-5 TIR.

Table 1 Test matrices at ZBT station

Test ID	CHSS	T_{amb}	$T_{precool}$	$P_{initial}$	Fueling time	Maximum CHSS H2 press.	Maximum CHSS H2 temp.
1	244-L type IV	28.1°C	-16°C	3.0 MPa	332 s (5.5 min)	40.0 MPa	76.7°C
2	244-L type IV	20.2°C	0°C	3.0 MPa	677 s (11.3 min)	40.9 MPa	74.6°C
3	244-L type IV	15.0°C	No precooling	3.0 MPa	1337 s (22.3 min)	41.2 MPa	69.8°C
4	244-L type IV	19.6°C	-16°C	1.0 MPa	278 s (4.6 min)	40.1 MPa	77.0°C
5	244-L type IV	18.6°C	0°C	1.0 MPa	750 s (12.5 min)	41.3 MPa	72.9°C
6	244-L type IV	19.4°C	No precooling	1.0 MPa	2200 s (36.7 min)	41.2 MPa	68.8°C
7	322-L type III	23.3°C	No precooling	1.0 MPa	2816 s (50.0 min)	40.0 MPa	68.2°C
8	322-L type III	23.3°C	-20°C	1.0 MPa	2300 s (38.3 min)	39.1 MPa	44.0°C
9	350-L type IV	3.8°C	-16°C	3.0 MPa	282 s (4 min)	38.9 MPa	68.2°C
10	350-L type IV	10.4°C	0°C	3.0 MPa	600 s (10 min)	40.9 MPa	79.3°C
11	350-L type IV	1.4°C	No precooling	3.0 MPa	740 s (12.3 min)	41.1 MPa	80.2°C

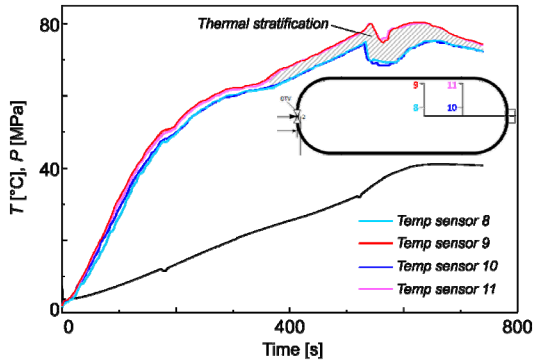


Figure 2 Hydrogen temperatures and pressure measured in vehicle storage tank during slow (ambient temperature) fueling

Benefits

The project team and SAE J2601-5 developed, tested, and validated H35HF MC Formula fueling protocol for MD/HD vehicles, which will help:

- Provide guidelines to the design H35 stations and vehicles
- Enable other manufacturers and vehicle original equipment manufacturers to also participate in technology/protocol advancement, which should accelerate to grow the market.

Accordingly, this project's outcome should facilitate adoption of H35 MD/HD stations and vehicles to reduce greenhouse gas and pollutant emissions from the transportation sector.

Project Costs

The budget for the project breaks down as follows:
Total budget: $699,000
DOE: $545,000
Industry partners: $154,000
South Coast AQMD: $25,000

Commercialization and Applications

The H35HF MC Formula fueling protocol for MD/HD vehicles has been made available to the public. As described in Benefits, this should help fleet manufacturers develop hydrogen-powered 350 bar vehicles as well as help station providers build fueling stations to support 350 bar vehicles. The issuance of the fueling protocol could spur other manufacturers to enter the hydrogen market, supporting users' efforts to achieve greenhouse gas reduction goals.

Under this project, the team conducted a limited number of protocol validation experiments and could not fully validate the protocol. This is because the protocol covers a wide range of ambient temperatures, precooling temperatures, and onboard vehicle storage system sizes. Thus, the protocol was published as a technical information report. However, SAE J2601-5 hopes to make it a standard fueling protocol in the coming years. To do so, the protocol in the technical information report will need to be fully validated. Accordingly, NREL has proposed a follow-on project to fully validate the protocol and help SAE J2601-5 publish the protocol as a standard.

South Coast AQMD Contract #21266 **February 2024**

Air Quality Assessment of Microgrid Deployment in the South Coast Air Basin

Contractor

University of California, Irvine

Cosponsors

Port of Long Beach

Project Officer

Seungbum Ha

Background

Microgrids are gaining attention as a means of increasing the resilience and reliability of the electricity system, increasing the deployment of renewable power generation resources in serving the electric load demand, replacing backup generators, and serving as a hub for the merging of the electricity and transportation sectors.

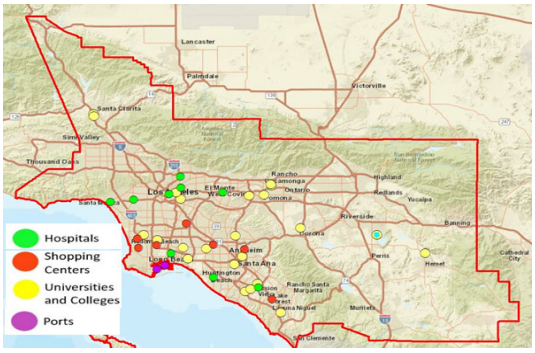
As microgrids become prevalent, electricity generation within the Basin will increase concomitant with a potential increase in the emission of criteria pollutants. At this nascent stage of a shift to a mass deployment of microgrids in South Coast Air Basin (SCAB), it is prudent to inform the regulatory framework and guide the design and deployment of microgrids that map to the air quality goals for the Basin. In the absence of a regulatory framework, an opportunity to reach a future of zero-emission from the electricity and transportation sectors in the emerging era of microgrid deployment will be lost.

This project addressed two areas: (1) the impact on air quality stemming from both a near-term and long-term mass deployment of microgrids in SCAB, and (2) the policy to assure that microgrids are designed and deployed consistent with air quality goals for the basin.

Project Objectives

The goal of this project was to assess the air quality impacts associated with a mass deployment of microgrids in the SCAB by evaluating (1) the population and location of microgrids in the Basin in both the near-term and long-term, (2) the generation technology selected to power the microgrids, (3) the role of microgrids in supporting the future of zero-emission vehicles, and (4) the impact of microgrid deployment on disadvantaged communities.

Approach



To assess the mass deployment of microgrids in SCAB, the following four categories of microgrids were considered: university campuses, shopping centers, hospitals, and ports. Lists of microgrid candidates in the Basin were developed for both the near-term and long-term deployment based on the size of the microgrids, access of the microgrids to transmission and distribution resources, and vicinity of the microgrids to critical facilities and other microgrids. For each category, a representative microgrid was characterized, evaluated, and assessed to determine the suitable mix of distributed energy resources (DERs) required to serve the microgrid.

For both the near-term and long-term mass deployments, scenarios were developed for combustion gas turbine generator (CGT)-based microgrids and zero-emission-based microgrids (equipped with photovoltaic and fuel cell generation, and battery energy storage and supply) to assess the impact on air quality and public health. The results for each scenario were compared to a Baseline Scenario (the California Air Resources Board 2022 Scoping Plan scenario) which did not consider microgrid deployment. The impacts on both the region and on disadvantaged communities were considered, and the outcomes were used to inform policy recommendations and to develop a scoring strategy for future proposed microgrids.

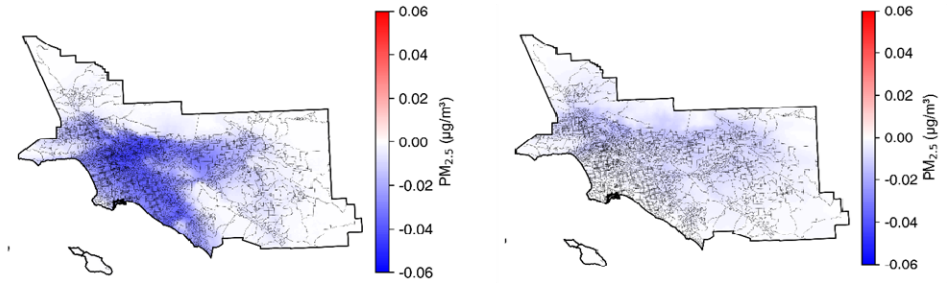
Results

Total health impacts ($) and the ratio of health impacts within DAC

Month	Scenario	Health ($)		DAC %
		Disadvantaged	Non-Disadvantaged	
Summer	S3*	-9,465,631	-14,733,392	-39.1%
	S4**	17,480,057	18,520,467	48.6%
Winter	S3	-4,292,536	-4,289,778	-50.0%
	S4	17,483,632	18,958,102	47.9%

*Long-term NG turbine-based microgrids
**Long-term zero-emission microgrids

For both the near-term and the long-term mass deployment of microgrids in SoCAB, the results of the study established the number by category of microgrid candidates likely to be deployed, the impact on NO_x emissions, the impact on air quality (ozone and $PM_{2.5}$), and the associated impact on public health regionally and within disadvantaged communities. Overall, the results show that, to minimize negative health effects, microgrids need to be designed with (1) 24/7 zero-emission power generation, (2) a systematic specification (depending on size and application) of supporting DER including battery and thermal storage resources, and (3) an orderly accommodation of the emerging electrified transportation sector with services to charge battery-electric vehicles and to fuel fuel-cell electric vehicles, and infrastructure to implement plug-in vehicle-to-microgrid services.



Difference in PM2.5 concentrations between S4 and S3

Conclusions

The major findings of the project are:

- While a mass deployment of CGT-based microgrids results in a relatively small increase in NO_x emissions and a relatively small negative impact on air quality, the impact on public health is significant regionally and disproportionally high in disadvantaged communities..
- The mass deployment of zero-emission based microgrids results in improved air quality and a reduction in NO_x emissions, thereby precluding public health costs both regionally and within disadvantaged communities.
- A regulatory framework will be prudent to assure that the evolution of microgrids within SCAB are powered 24/7 by zero-emission generation and equipped with resources to support charging and fueling zero-emission vehicles and, as appropriate, plug-in vehicle to microgrid services.

Benefits

Microgrids offer the benefits of enhanced integration of renewable resources, facilitation of charging and fueling zero-emission vehicles, and higher reliability and resiliency in serving critical loads in the case of outages, emergencies, weather events, and other unforeseen occurrences. A potential detriment associated with a mass deployment of microgrids is the degradation of air quality given that microgrids must have, by definition, an on-site source of electrical power. This study assessed the air quality and public health impacts associated with a mass deployment of microgrids in SCAB with the goal to inform policy associated with managing the air quality and public health impacts regionally and within disadvantaged communities.

Project Costs

The cost of the project was $370,000, of which $290,000 was funded by South Coast AQMD with $80,000 of match funding associated with a UCI APEP Port of Long Beach microgrid research contract.

South Coast AQMD Contract #22262 **September 2024**

Microgrid Backup Air Quality Attributes

Contractor

University of California, Irvine

Cosponsors

South Coast AQMD
SunPower
Port of Long Beach

Project Officer

Maryam Hajbabaei

Background

Climate change has resulted in an increased frequency of extreme weather events such as winter storms and wildfires. These events result in more frequent and longer grid outages, and this increasing trend is expected to continue as the impacts of climate change become more pronounced. Thus, it is expected that the population of backup generators (BUGs) will increase significantly as businesses, industries and residences try to adapt to this new reality.

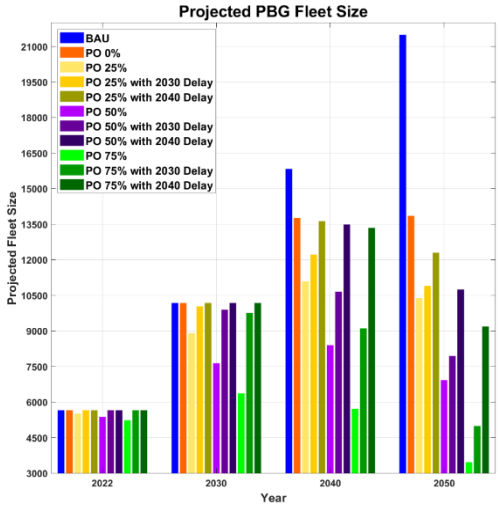
In the absence of any regulatory change, mostly diesel and gasoline BUGs will be deployed, negatively impacting the urban air quality and health of the South Coast Air Basin (SCAB) popoluation. Thus, it is important to assess the impacts of future BUG fleets as well as zero-emission alternatives for deployemnt in lieu of BUGs and the associated impact in mitigating some or all of the negative impacts.

Project Objectives

The objectives of this project were to: (1) assess the emissions from BUGs as a result of their operation and maintenance, (2) estimate future emissions from diesel backup generators with increased deployment and use of these resources due to more frequent outages, (3) identify alternative technologies that can replace diesel backup generators with a focus on renewable resources, hydrogen and fuel cells, and (4) estimate the emissions reduction and resultant air quality and health impacts associated with microgrids associated with the alternatives to gasoline and diesel backup generators.

Approach

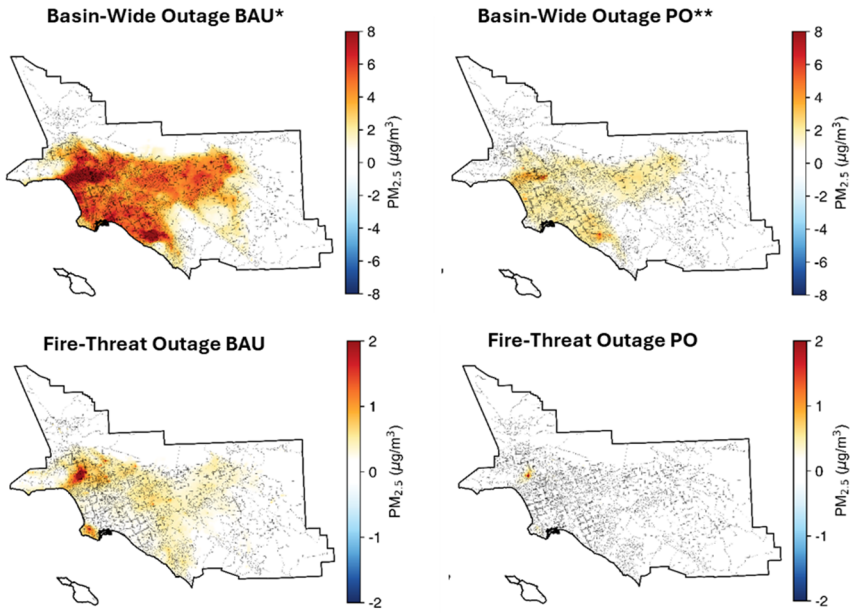
Impacts of BUGs were determined by first developing an inventory for existing BUGs. This was addressed through public record requests for permitted backup generators (PBG) and developing a Design of Experiment (DOEx) model for unpermitted residential backup generators (RBG). Thirty-seven future scenarios were developed and modeled for PBGs based on different growth rates for PBGs and different rates of replacing them with zero-emission alternatives. Scenarios also included delays in action to start the transition. The scenarios spanned from worst case (a scenario with an uncontrolled increase in diesel PBGs) to a best case (a scenario with aggressive retirement of existing PBGs and aggressive deployment of zero-emission alternatives). Several scenarios were also modeled for a future fleet of RBGs based on population growth and increased frequency and duration of outages, resulting in a higher percentage of households opting in to purchase a BUG. Emissions associated with each scenario were



determined. For a select number of scenarios, the emissions associated with a basin-wide outage or an outage only impacting fire-threat areas were used as inputs for air quality modeling and a health impact assessment.

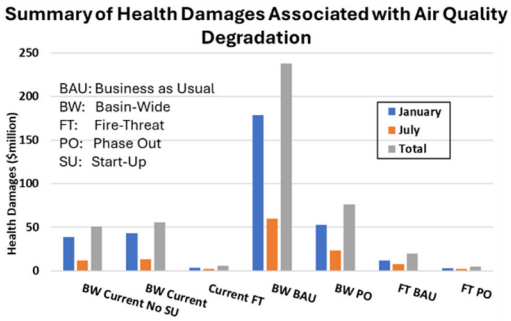
Results

The size of the BUG fleet increases in all scenarios studied except for the Phase-Out (PO) scenario where 75% of retired BUGs are replaced with zero-emission options and correspondingly the rate of adding new BUGs is decreased. The operation of BUGs for 12 hours results in air quality impacts that are most pronounced the day of the episode and generally disappear by the third day. Air quality impacts include increases in ozone over 4 ppb in sensitive locations associated with the most degraded ozone, and increases in $PM_{2.5}$ from 2 µg/m3 in July and over 8 µg/m3 in January.



Difference in January $PM_{2.5}$ Concentrations Between the 2045 Scenarios and the Baseline Scenario

BAU*: Business as Usual
PO**: Phase Out



Conclusions

The major findings of the project are:

- Though rare, for an outage impacting all fire-threat areas, emissions from the 2022 BUG fleet are estimated to be 0.281 ton/hr for NO_x and 0.08 ton/hr for PM. These emissions are comparable to 0.283 ton/hr of NO_x and 0.075 ton/hr of PM associated with all refineries operating in SCAB, conveying that BUGs represent a major source of emissions when operating in an emergency.
- Backup generators negatively impact urban air quality in all scenerios examined, the extent to which depends on the outage duration, location, and the technologies used for backup power.
- Using zero-emission technologies in place of BUGs could avoid 1 incidence of premature mortality and a wide range of other air pollution-related illnesses per 12 hour outage.
- Regulations that incentivize replacement of BUGs with zero-emission alternatives will result in significant and immediate benefits to the public health. Future work should also consider local impacts.

Benefits

Replacing BUGs with zero-emission alternatives will significantly reduce emissions per outage event and substantially reduce adverse health impacts. Additionally, deploying zero-emission alternatives increases reliability and resiliency for the customer along with financial benefits.

Project Costs

The cost of the project was $220,000, with $185,000 funded by South Coast AQMD and $35,000 of match funding associated with an in-kind contribution from parallel microgrid projects funded by SunPower Corporation and the Port of Long Beach.

South Coast AQMD Contract #22262 **September 2024**

Microgrid Transit Air Quality Attributes

Contractor
University of California, Irvine

Cosponsors
South Coast AQMD
SunPower
UCI Anteater Express
Port of Long Beach

Project Officer
Maryam Hajbabaei

Background

To improve air quality in urban areas, the public transport sector is of particular interest, in part due to reducing environmental impacts through reducing overall vehicles miles traveled (VMT), VMT per capita, deploying alternative low to non-carbon technologies replacing diesel (or CNG) buses, and reducing local emissions in disadvantaged communities. Zero-emission buses (ZEBs) can be deployed in microgrid communities (e.g., University campuses) and public transit hubs to reduce emissions, reduce fossil fuel usage, improve air quality and health benefits, and enhance resiliency in operations.

Project Objectives

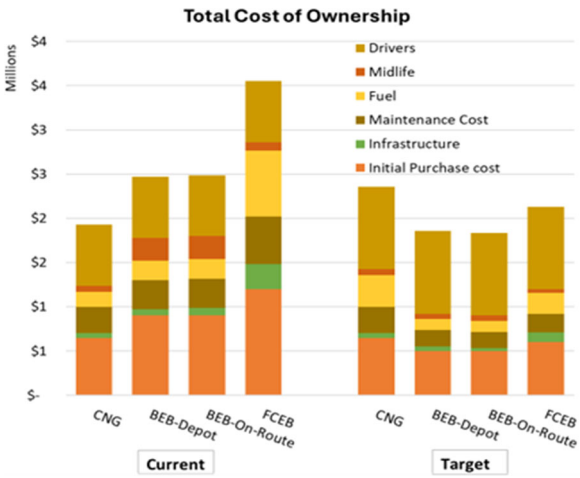
The project objectives were to (1) develop a benefit-cost analysis for zero-emission bus rollout, (2) develop a rollout strategy to transition to a zero-emission bus fleet, (3) address charging/hydrogen fueling infrastructure hubs, and (4) assess the feasibility of using plug-in electric buses as a resiliency resource for operations. The rollout strategy was based on the costs and benefits associated with each bus technology, the annual and overall budget of the transit agency to purchase buses, and the cost to install the requisite charging/fueling ZEB infrastructure.

Approach

A benefit cost analysis for ZEBs, including battery electric buses (BEBs) and hydrogen fuel cell electric buses (FCEBs), was conducted comparing the total cost of ownership (TCO) of these technologies to conventional diesel and CNG buses for different fuel pathways. Based on forecasts and targets set for the price of fuel cells, batteries, charging/fueling infrastructure, and hydrogen, a future scenario was developed and assessed as well. The benefit cost analysis was used to develop and assess several rollout strategies to achieve a zero-emission bus fleet. Next, the charging and hydrogen fueling infrastructure to support a zero-emission ZEV fleet was determined along with charging management strategies and deployment of distributed energy resources to mitigate negative impacts on the electric grid. An optimized rollout analysis was conducted using a multi-objective optimization based on costs and environmental impact, and a model was developed to assess the effectiveness of plug-in ZEBs as a grid resiliency resource.

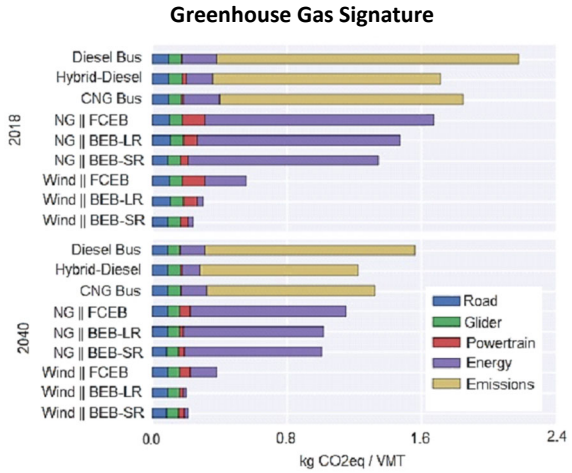
Results

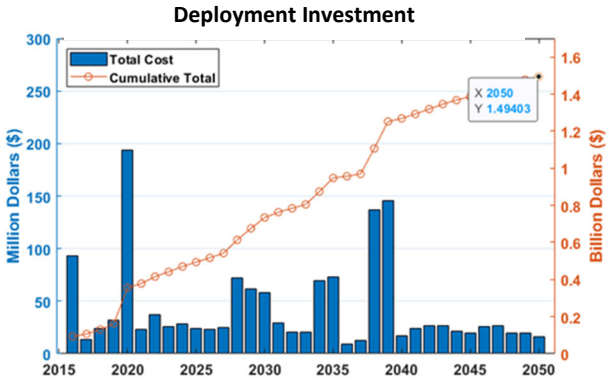
Results show that the TCO of ZEBs can be lower than CNG buses if cost targets (especially for fuel cells, batteries and hydrogen) are met. Both techologies studied, BEBs and FCEBs, play an important role in achieving a zero-emissiom fleet in transit agencies depending on the route lengths, budget, and priorities. Using an optimzied rollout can reduce the required investment.



The projected investment of a typical transit agency for the purchase of ZEBs and the supporting infrastructure will vary annually as new or expanded infrastructure is deployed.

Results show that BEBs, both short range (SR) and long range (LR), and FECBs operating with electricity and hydrogen derived from renewable energy resources (“WIND”) have a substantially lower greenhouse gas signature.





Conclusions

The major findings of the project are:

- While TCO for ZEBs are currently higher than that of CNG buses, ZEBs have the potential to achieve a lower TCO when targets for the technology are met.
- While the extent of greenhouse gas emission reduction from ZEB deployment depends on the fuel pathways, all pathways result in an overall reduction in greenhouse gas emissions.
- Distributed energy resources (DERs) and charging/fueling management at transit fleet hubs can reduce barriers to infrastructure planning and deployment by (1) reducing the electrical demand from the grid and thereby reducing grid infrastructure upgrades, and (2) generating on-site hydrogen and thereby eliminating the transport of hydrogen.
- Given the high energy density of ZEB batteries and predictable schedules, ZEBs can serve as a valuable distributed energy resource when plugged-in by (1) load leveling during grid-tied operation and (2) supporting critical loads during a grid outage.

Benefits

Accounting for emissions associated with fuel production and delivery, ZEBs result in the reduction of both greenhouse gases and criteria pollutant emission which is a direct benefit to the reduction of carbon in the atmosphere but also the improvement of urban air quality and the reduction of air pollutant burdens in disadvantaged communities. Additionally, the use of ZEBs as a distributed energy resource increases community resiliency.

Project Costs

The cost of the project was $290,000, with $185,000 funded by South Coast AQMD and $105,000 of match funding associated with an in-kind contribution from UCI Anteater Express, and parallel microgrid projects funded by SunPower Corporation and the Port of Long Beach.

Appendix D

List of Acronyms

[This Page Intentionally Left Blank]

LIST OF ACRONYMS

3B-MAW—3-bin moving average windows
A-1—A-1 Alternative Fuel Systems
AB—Assembly Bill
AC—absorption chiller
ACS—alternative charging solution
ACF—Advanced Clean Fleets Regulation
ACFR—Annual Comprehensive Financial Report
ACT—advanced clean transportation / American Clean Truck regulation
ADA—American with Disabilities Act
AER—all-electric range
AFRC—air/fuel ratio control
AFVs—alternative fuel vehicles
AGL—Academy of Global Logistics
ALPR—automated license plate recognition
APCD—Air Pollution Control District
AQMD—Air Quality Management District
AQMP—Air Quality Management Plan
ARB—Air Resources Board
ARM—advanced RISC machine
ARRA—American Recovery & Reinvestment Act
AWMA—Air & Waste Management Association
BACT—best available control technology
BATS—blended aftertreatment system
BEB—battery electric bus
BESS— battery energy storage system
BET—battery electric tractor / battery electric truck
BEV—battery electric vehicle
BMEP—brake mean effective pressure
BMS—battery management system
BSNOx—brake specific NOx
BTC—Broadband Telecom Power, Inc.
BTE—brake thermal efficiency
CAE— computer aided engineering
CAMFC—Commercial Advancement of Mobile Fuel Cells
CAN—controller area networks
CAP—Clean Air Protection
CAAP—Clean Air Action Plan
CaFCP—California Fuel Cell Partnership
CAPP— Community Air Protection Program
CARB—California Air Resources Board
CATI—Clean Air Technology Initiative
CBD—Central Business District (cycle) - a Dyno test cycle for buses
CCE—closed cycle efficiency
CCF—California Clean Fuels
CCHP—combined cooling, heat and power
CCI—California Climate Investments
CCV—closed crankcase ventilation
CDA—cylinder deactivation
CDFA/DMS—California Department of Food &Agriculture/Division of Measurement Standards
CE—construction equipment
CEC—California Energy Commission
CE-CERT—College of Engineering – Center for Environmental Research and Technology
CEMS—continuous emission monitoring system
CERP—Community Emission Reduction Plan
CEQA—The California Environmental Quality Act
CFD—computational fluid dynamic
CFR—Code of Federal Regulations
CHBC—California Hydrogen Business Council
CHE—cargo handling equipment
C-ITS—connected intelligent transportation system
CMAQ—community multi-scale air quality
CNG—compressed natural gas
CNGVP—California Natural Gas Vehicle Partnership
CO_2—carbon dioxide
CO—carbon monoxide
COG—council of governments
ComZEV—Commercial Zero-Emission Vehicle
CPA—Certified Public Accountant
C-PORT—Commercialization of POLB Off-Road Technology
CPRG— Climate Pollution Reduction Grants
CPUC—California Public Utilities Commission
CRADA—Cooperative Research and Development Agreement
CRDS—cavity ring-down spectroscopy
CRP—Charge Ready Program
CRT—Charge Ready Transport / continuously regenerating technology
CSC—city suburban cycle
CTE—Center for Transportation and the Environment
CTF—Clean Truck Fund
CVAG—Coachella Valley Association of Governments
CWI—Cummins Westport, Inc.
CX—Customer Experience
CX Fleet Project—Customer Experience of Zero Emission Trucks and Mobile Electric Vehicle Infrastructure Project
CY—calendar year
DAC—disadvantaged community
DC—direct connection / direct current
DCFC—direct connection fast charger
DCM—dichloromethane
DEF—diesel exhaust fluid
DEG—diesel equivalent gallons
DER—distributed energy resource

LIST OF ACRONYMS (cont'd)

DERA—Diesel Emissions Reduction Act
DGE—diesel gallon equivalents
DF—deterioration factor
DHE—Dependable Highway Express
DME—dimethyl ether
DMS—Division of Measurement Standards
DMV—Department of Motor Vehicles
DOC—diesel oxidation catalysts
DOE—Department of Energy
DOT—Department of Transportation
DPF—diesel particulate filters
D-PMag—dual permanent magnet motor
DPT3—Local Drayage Port Truck (cycle) - where 3=local (whereas 2=near-dock, etc.)
DRC—Desert Resource Center
DRI—Desert Research Institute
DT—delivery truck
DTNA—Daimler Trucks North America LLC
EATS—emissions aftertreatment system
ECM—emission control monitoring / engine control module
EDD—electric drayage demonstration
EDTA—Electric Drive Transportation Association
EERE—Energy Efficiency and Renewable Energy
EGR—exhaust gas recirculation
EIA—Energy Information Administration
EIN—Energy Independence Now
EMFAC—Emission FACtors
EPRI—Electric Power Research Institute
E-rEV—extended-range electric vehicles
ESD—emergency shut down
ESS—energy storage system
EV—electric vehicle
EVITP—electric vehicle infrastructure training program
EVSE—electric vehicle supply equipment
FCEB—fuel cell electric bus
FCET—fuel cell electric truck
FCEBCC—Fuel Cell Electric Bus Commercialization Consortium
FCEV—fuel cell electric vehicle
FCTO—Fuel Cell Technologies Office
FCV—fuel cell vehicle
FCXRDT—fuel cell extended range delivery truck
FS—feasibility study
FTA—Federal Transit Administration
FTP—federal test procedures
FY—fiscal year
G2V—grid-to-vehicle
g/bhp-hr—grams per brake horsepower hour
GC/MS—gas chromatography/mass spectrometry
GCW—gross combination weight
GCVW—gross container vehicle weight
GDI—gasoline direct injection
GGE—gasoline gallon equivalents
GGRF—Greenhouse Gas Reduction Relief Fund
GH2—green hydrogen
GHG—greenhouse gas
GM—goods movement
GNA—Gladstein, Neandross & Associates, LLC
GNSS—global navigation satellite system
Go-Biz—Governor's Office of Business and Economic Development
GPCI—Green Paradigm Consulting, Inc.
GPS—global positioning system
GPU—gas processing unit
GREET—Greenhouse Gasses, Regulated Emissions and Energy Use in Transportation
GTI—Gas Technology Institute
GTL—gas to liquid
GVW—gross vehicle weight
GVWR—gross vehicle weight rating
H2—hydrogen
H2NIP—Hydrogen Network Investment Plan
H&SC—California Health and Safety Code
HCCI—Homogeneous Charge Combustion Ignition
HCD—hydrogen contaminant detector
HCHO—formaldehyde
HCNG—hydrogen-compressed natural gas (blend)
HD—heavy duty
HDD—heavy-duty diesel
HDDT—highway dynamometer driving schedule
HD-FTP—Heavy-Duty Federal Test Procedure
HD I/M—heavy-duty inspection and maintenance
HD-OBD—heavy-duty on-board diagnostics
HDV—heavy-duty vehicle
HEV— hybrid electric vehicle
HEVI-LOAD—heavy-duty electric vehicle infrastructure load, operations and deployment
HHDDT—heavy heavy-duty diesel truck schedule
HMI—Human Machine Interface
HPLC—high-performance liquid chromatography
HRSC—heat recovery steam cycle
HT—high throughput
HTFCs—high-temperature fuel cells
HTPH—high throughput pretreatment and enzymatic hydrolysis
HV—high voltage
HVIP— Hybrid and Zero-Emission Trucks and Bus Voucher Program
HyPPO—Hydrogen Progress, Priorities and Opportunities report
Hz—Hertz
IBT—Intermodal Bridge Transport
ICE—internal combustion engine

LIST OF ACRONYMS (cont'd)

ICEPAG—International Colloquium on Environmentally Preferred Advanced Generation
ICEV—internal combustion engine vehicle
ICT—Innovative Clean Transit Regulation
ICU—inverter-charger unit
ICTC—Interstate Clean Transportation Corridor
INVEST CLEAN—Infrastructure, Vehicles, and Equipment Strategy for Climate, Equity, Air Quality, and National Competitiveness
ISX12N—11.9-liter NZE engine
ITS—intelligent transportation system
IVOC—intermediate volatility organic compound
JETSI—Joint Electric Truck Scaling Initiative
kg—kilogram
kW—kilowatt
kWh—kilowatt-hour
L—liter
L9N—8.9-liter natural gas engine
LADOT—City of Los Angeles Dept. of Transportation
LADWP—Los Angeles Department of Water and Power
LAEDC—Los Angeles Economic Development Corporation
LA Metro—Los Angeles County Metropolitan Transportation Authority
LAX—Los Angeles Airport
LBCT—Long Beach Container Terminal
LC—lane change
LCA—life cycle assessment
LCFS—Low Carbon Fuel Standard
LD—light-duty
LED—low emission diesel
LFP—lithium iron phosphate
Li—lithium ion
LIGHTS—Low Impact Green Heavy Transport Solutions
LIMS—Laboratory Information Management System
LLC—low load cycle
LLNL—Lawrence Livermore National Laboratory
LNG—liquefied natural gas
LO-SCR—light-off selective catalytic reduction
LPG—liquefied petroleum gas or propane
LRUSA—Landi Renzo USA Corporation
LSM—linear synchronous motor
LSV—low-speed vehicle
LUV—local-use vehicle
LVP—low vapor pressure
M&HD— medium- and heavy-duty
MATES—Multiple Air Toxics Exposure Study
MC—mass compensated
MCE—multi cylinder engine
MCS—megawatt charging standard
MCFC—molten carbonate fuel cells
MD—medium duty
MDHD— medium- and heavy-duty
MECA—Manufacturers of Emission Controls Association
MFCG—mobile fuel cell generatorMOA—Memorandum of Agreement
MOVES—Motor Vehicle Emission Simulator
MPa—MegaPascal
MPFI—Multi-Port Fuel Injection
MPG—miles per gallon
MPGde—miles per gallon diesel equivalent
MSRC—Mobile Source Air Pollution Reduction Review Committee
MSW—municipal solid wastes
MTA—Metropolitan Transportation Authority (Los Angeles County "Metro")
MW—megawatt
MWh—megawatt hour
MY—model year
NAAQS—national ambient air quality standards
NAFA—National Association of Fleet Administrators
NAICS—North American Industry Classification System
NFPA—National Fire Protection Association
NCP—nonconformance penalty
NEV—neighborhood electric vehicles
NextSTEPS—Next Sustainable Transportation Energy Pathways
NG/NGV—natural gas/natural gas vehicle
NGO—non-governmental organization
NH3—ammonia
Nitro-PAHs—nitrated polycyclic aromatic hydrocarbons
NHTSA—Natural Highway Traffic Safety Administration
NMC—nickel manganese cobalt
NMHC—non-methane hydrocarbon
NO—nitrogen monoxide
NO_2—nitrogen dioxide
NO + NO_2—nitrous oxide
NOPA—Notice of Proposed Award
NOx—oxides of nitrogen
NRC—National Research Council
NREL—National Renewables Energy Laboratory
NRTC—non-road-tested cycle
NSPS—new source performance standard
NSR—new source review
NTE—not-to-exceed
NZ—near zero
NZE – near zero emission
O3—ozone
OBD—on-board diagnostics

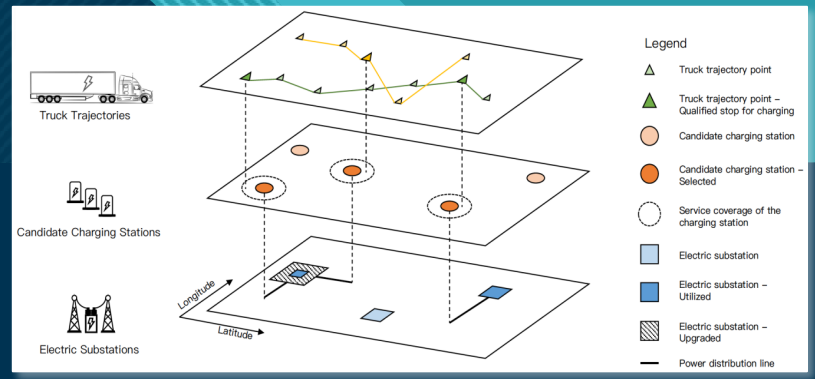
LIST OF ACRONYMS (cont'd)

OCS—overhead catenary system
OCTA—Orange County Transit Authority
OEHHA—Office of Environmental Health Hazard Assessment
OEM—original equipment manufacturer
One-off—industry term for prototype or concept vehicle
OP—opposed piston
OSAR—Onboard Sensoring and Reporting
PAH—polycyclic aromatic hydrocarbons
PAMS—portable activity measurement systems
PbA—lead acid
PCM—powertrain control module
PEMFC—proton exchange membrane fuel cell
PEMS—portable emissions measurement system
PEV—plug-in electric vehicle
PFI—port fuel injection
PHET—plug in hybrid electric tractor / plug-in hybrid electric truck
PHEV—plug-in hybrid vehicle
PM—particulate matter / permanent magnet
PM2.5—particulate matter ≤ 2.5 microns
PM10—particulate matter ≤ 10 microns
POH—Port of Hueneme
POLA—Port of Los Angeles
POLB—Port of Long Beach
PON—Program Opportunity Notice
POS—point of sale
ppb—parts per billion
ppm—parts per million
PSI—Power Solutions International
PTR-MS—proton transfer reaction-mass spectrometry
QCD—Quality Custom Distribution
QVM—qualified vehicle modifiers
R&D—research and development
RD&D—research, development and demonstration
RDD&D (or RD3)—research, development, demonstration and deployment
REAL—Real Emissions Assessment Logging
REMD—roadside emissions monitoring device
RFA—Renewable Fuels Association
RFI—Request for Information
RFP—Request for Proposal
RFS—renewable fuel standards
RH—refuse hauler
RI—reactive intermediates
RISC—reduced instruction set computer
RM—ramp metering
RMC—ramped modal cycle
RMC-SET— ramped modal cycle supplemental emissions test
RNG—renewable natural gas
ROG—reactive organic gases
ROI—return on investment
RPS—Rail Propulsion Systems
RTP/SCS—Regional Transportation Plan/Sustainable Communities Strategy
S2S—Shore to Store
SAE—Society of Automotive Engineers
SB—school bus / Senate Bill
SCAB—South Coast Air Basin or "Basin"
SCAG—Southern California Association of Governments
SCAQMD—South Coast Air Quality Management District
SCFM—standard cubic feet per minute
SCE—single cylinder engine / Southern California Edison Company / Southern Counties Express
SCR—selective catalytic reduction
SCRT—Selective Catalytic Regenerating Technology
SCCRT—Selective Catalytic Continuously Regenerating Technology
SDG&E—San Diego Gas & Electric Company
SHR—steam hydrogasification reaction
SI—spark ignited
SI-EGR—spark-ignited, stoichiometric, cooled exhaust gas recirculation
SIP—State Implementation Plan
SJVAPCD—San Joaquin Valley Air Pollution Control District
SMR—steam methane reforming
SNG—synthetic natural gas
SOAs—secondary organic aerosols
SOC—state-of-charge
SoCalGas—Southern California Gas Company (A Sempra Energy Utility)
SOFC—solid oxide fuel cells
SPaT—single phase and timing
START—Sustainable Terminals Accelerating Regional Transportation
STEPS3— Sustainable Transportation Energy Pathways 3
STTR—Small Business Technology Transfer
SULEV—super ultra-low emission vehicle
SUV—sports utility vehicle
SwRI—Southwest Research Institute
TAC—toxic air contaminants
TAO—Technology Advancement Office
TAP—(Ports') Technology Advancement Program
TB—transit bus
TC—total carbon
TCO—total cost of ownership
TEMS—transportable emissions measurement system

LIST OF ACRONYMS (cont'd)

THC—total hydrocarbons
TLS—Toyota Logistics Services
TO—task order
tpd—tons per day
TRB—Transportation Research Board
TRL—technology readiness level
TRU—transportation refrigeration unit
TSI—Three Squares, Inc.
TOU—time-of-use
TT—Turtle Top Bus
TTSI—Total Transportation Services, Inc.
TWC—three-way catalyst
UCI—University of California, Irvine
UCLA— University of California, Los Angeles
UCR—University of California, Riverside
UCR/CE-CERT—UCR/College of Engineering/Center for Environmental Research & Technology
UDDS—urban dynamometer driving schedule
$\mu g/m^3$—microgram per cubic meter
ULEV—ultra low emission vehicle
ULSD—ultra low sulfur diesel
UPS—United Postal Service
U.S.—United States
U.S. EPA—United States Environmental Protection Agency
USTS—United States Training Ship
V2B—vehicle-to-building
V2G—vehicle-to-grid
V2G/B—vehicle-to-building functionality
VLS—variable speed limit
VMT—vehicle miles traveled
VOC—volatile organic compounds
V-PER—vessel performance management package
VPP—virtual power plant
WAIRE—Warehouse Actions and Investments to Reduce Emissions Program
WGS—water gas shift
WVU—West Virginia University
ZANZEFF—Zero and Near Zero Emission Freight Facilities
ZE—zero emission
ZEB—zero-emission bus
ZECT—Zero Emission Cargo Transport
ZEDT—Zero Emission Drayage Truck
ZET—zero emission truck
ZEV—zero emissions vehicle

CLEAN FUELS 2024 ANNUAL REPORT & 2025 PLAN UPDATE



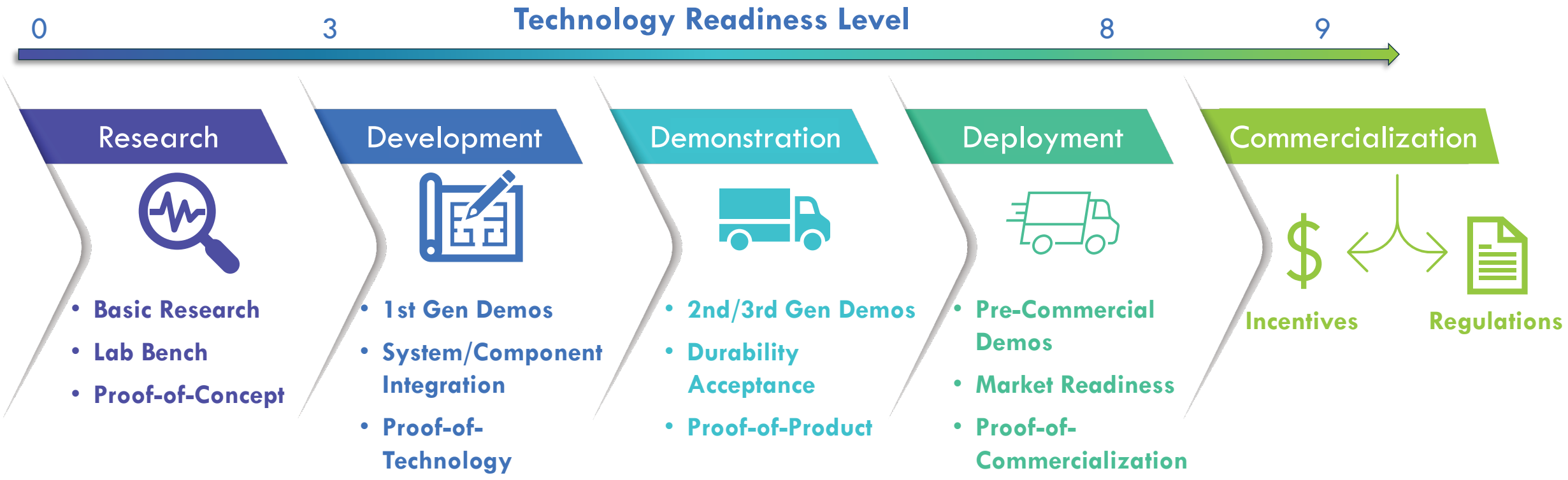
Background

State law requirements:

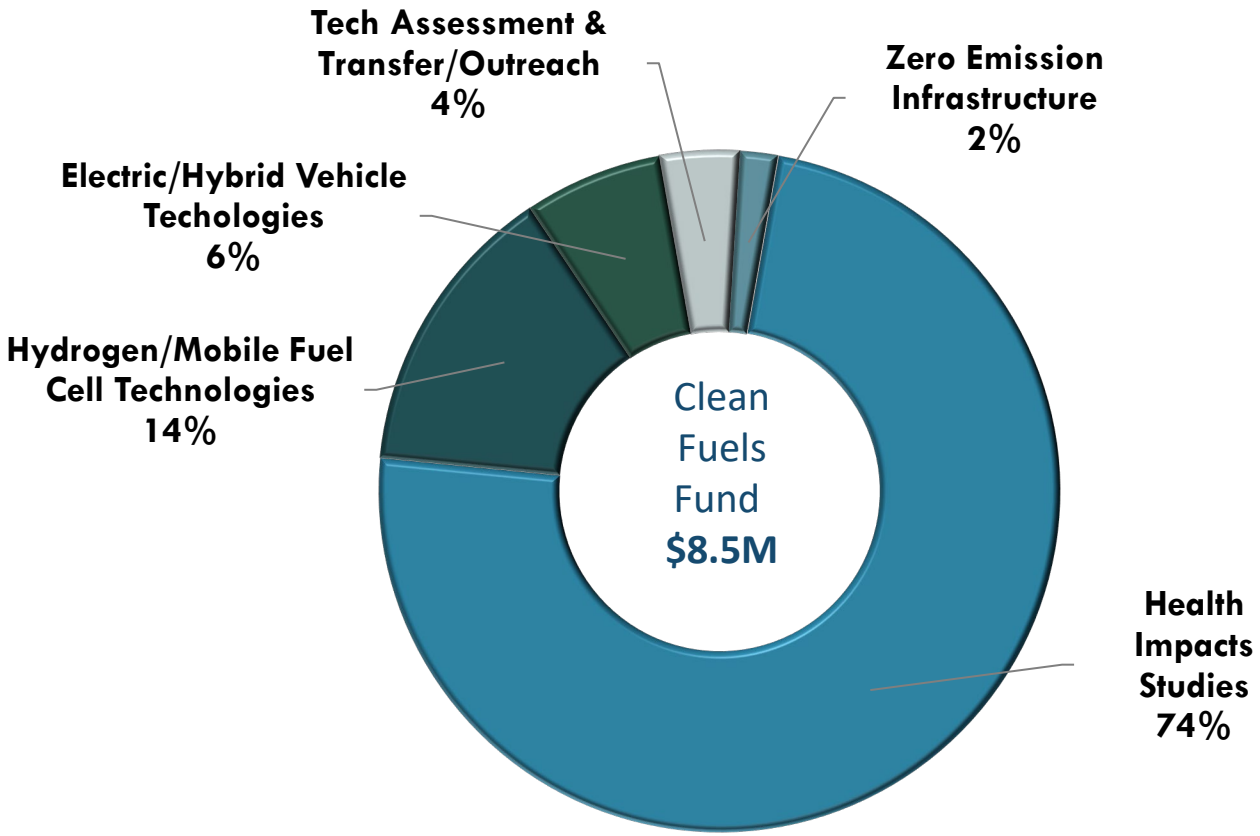
- Annual Report on Clean Fuels Program and Technology Advancement Plan Update (H&SC 40448.5.1)
- 2025 Plan Update (draft) submitted to Technology Committee October 18, 2024
- Submit to Legislature by March 31 every year

Reports: https://www.aqmd.gov/home/technology/reports

Clean Fuels Program - Overview



Clean Fuels Spending in 2024

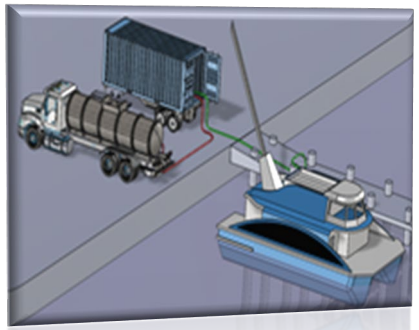


Health Impacts Studies:

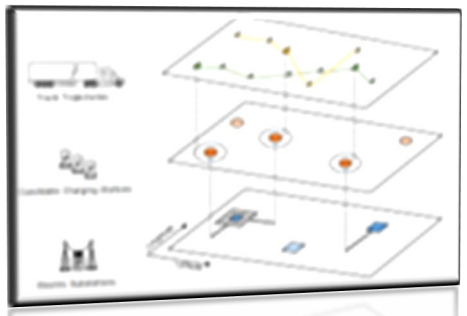
- MATES VI Study
- Brake, Road, and Tire Wear Emissions Study
- EtO Source Characterization Study
- Secondary EtO Formation Study

Highlighted Projects in 2024

- Electrification of Balboa Island Ferries and Installation of Supporting Charging Infrastructure (Balboa Island Ferry) (**Initiated**)



- Development of a Portable Liquid Hydrogen Fueling System (Zero Emission Industries, Inc.) (**Initiated**)



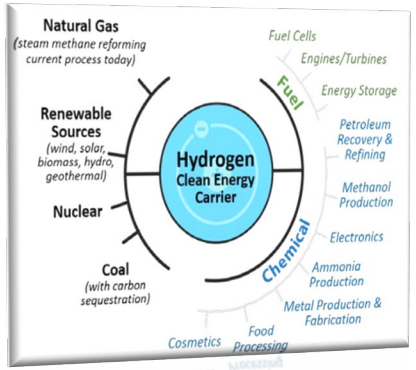
- Development of Data-Driven Planning Platforms for Charging Networks, Medium- and Heavy-Duty Truck Fleets, and Power Systems (UC Riverside) (**Initiated**)

- Determine Brake and Tire Wear Exposure Concentrations in South Coast Air Basin and Coachella Valley (MATES VI) (Emissions Analytics, Ltd. and UC Irvine) (**Initiated**)

Highlighted Projects in 2024 (Cont'd)

- Development and Demonstration of Electric Powered Trailer for HD Vehicles (Range Energy, Inc.) (**On-Going**)

- Deployment of Zero Emission Mobile Clinics with Arrowhead Regional Medical Center (San Bernardino County) (**On-going**)

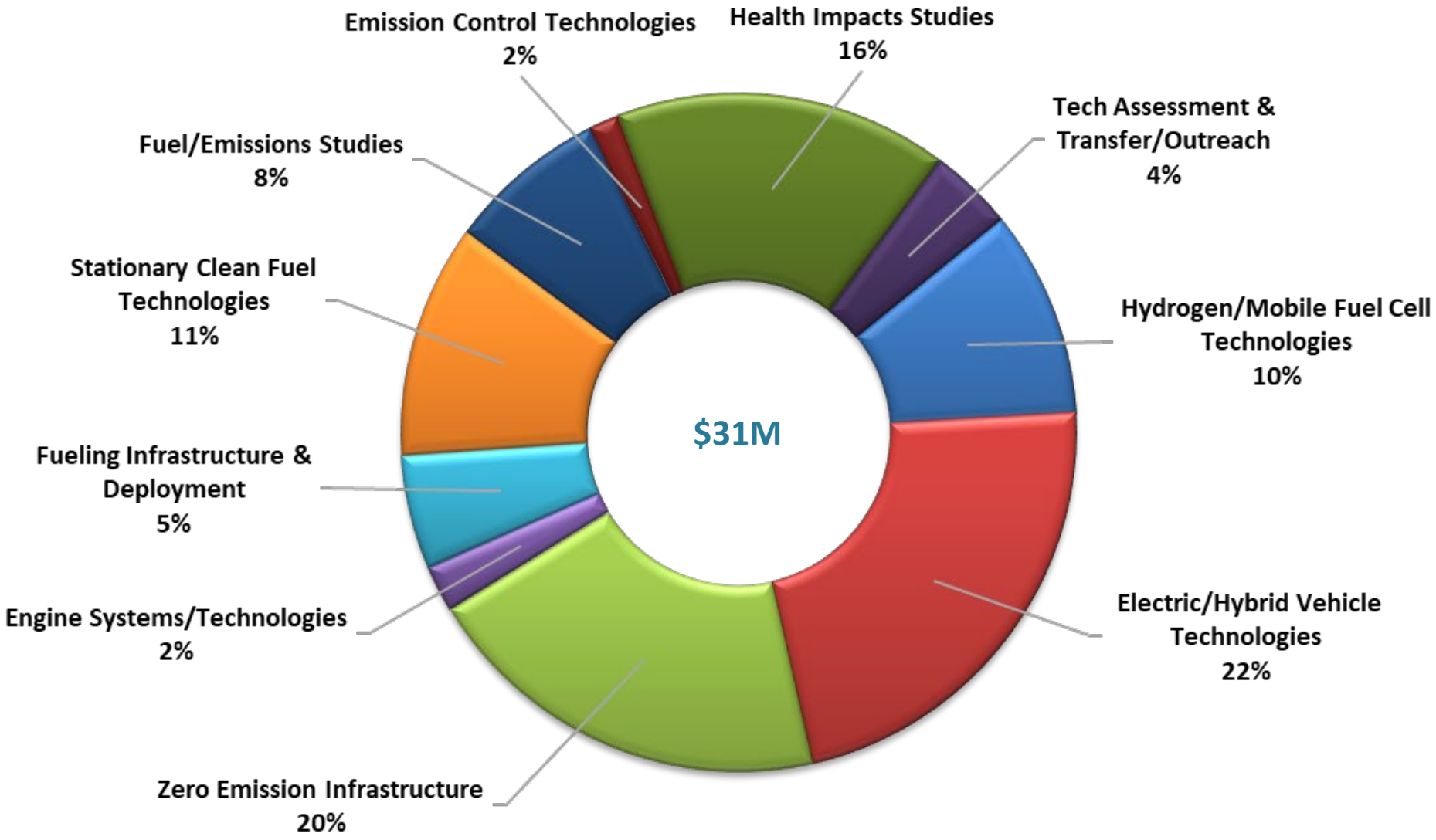


- Research on California Hydrogen Refueling Infrastructure for HD Fuel Cell trucks (DOE H2@Scale CRADA) (**Completed**)

- Assessment of Emission Impact of Hydrogen-Natural Gas Blend in Near-Zero Emission Engines (UC Riverside) (**Completed**)

- Development and Demonstration of Near-Zero Emission Opposed Piston Engine (CALSTART) (**Completed)**

Potential Clean Fuels Funding for 2025



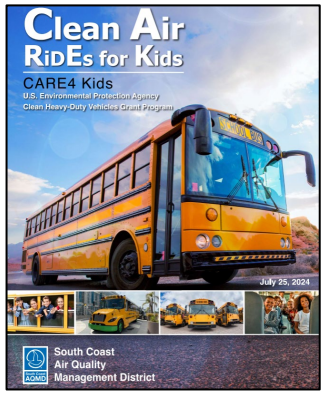
2024 Competitive Technology Grant Awards to South Coast AQMD

Over $640M Awarded

$500M
US EPA
INVEST CLEAN
ZE Freight, Infrastructure, Workforce Training

$48M
US EPA
ELECTRIC
Battery Electric Class 6&7

$40M
US EPA
CARE4KIDS
ZE School Buses



$4.5M
US EPA
DERA
ZE Trucks

$42M*
CARB & CEC
SPEED
ZE Trucks & Infrastructure

$8M
CARB
Balboa Ferry

*Award has not yet been approved by the South Coast AQMD Governing Board

2024 Incentive Program Highlights

Commercial & Residential Lawn & Garden Equipment Programs

$4.5M incentivized over 3,700 pieces of L&G equipment

VW Mitigation

$19M awarded for approximately 90 ZE trucks

School Air Filtration

$7.9M for air filtration in 234 schools

Residential Air Filtration

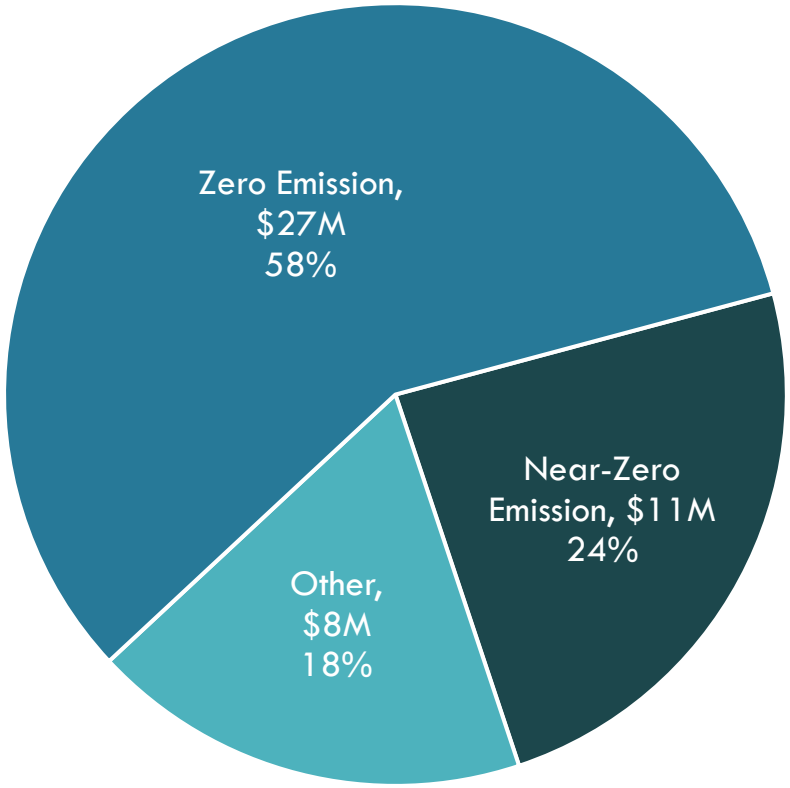
$1.8M awarded 1,700 units

Carl Moyer Program & Clean Air Protection

$153M awarded for approximately 1,300 Heavy Duty Charging Plugs and 10 H2 stations, 60 ZE trucks

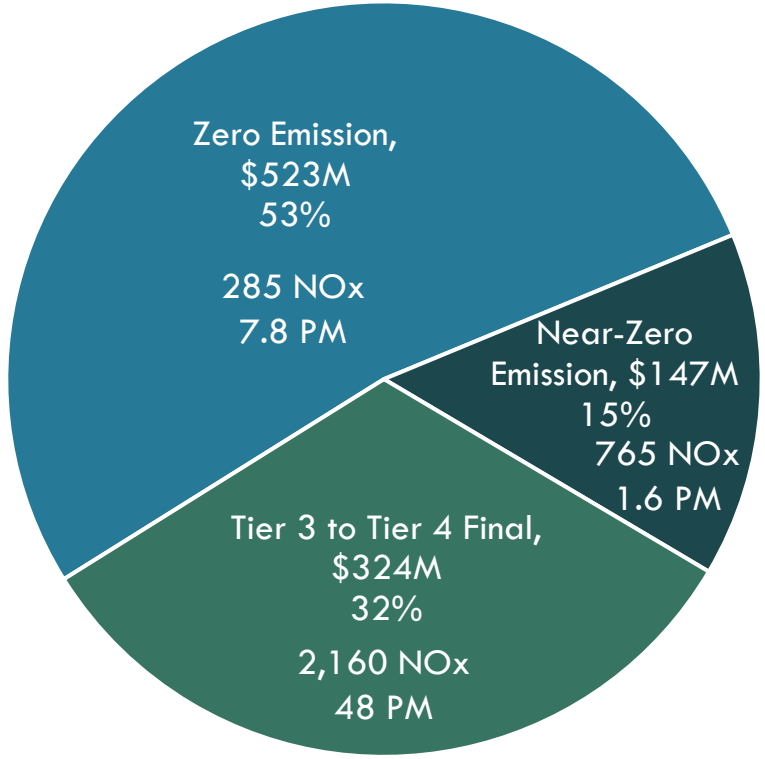
TAO Zero and Near-Zero Projects 2019 – 2024

Clean Fuels Funding, $46.4M* (Total Project Cost $871M)



*Includes projected totals from 2024 approved projects

Incentive Program Funding*,**, $994M



*Moyer, Prop 1B, VW, VIP, and other programs
**Emission Reductions in tons/year

FOCUS AREAS IN 2025

- Implementation of awarded grants and existing programs
- Start of Truck Loaner Program
- In Person Residential Lawn and Garden Exchange Programs

Proposed New Clean Fuels Advisory Group Members

Technology Advancement Advisory Group:

Dr. Leela Rao, Port of Long Beach

Clean Fuels Advisory Group:

Dr. Gordon Abas Goodarzi, Magmotor Technologies, Inc.

Yassamin Kavezade, California Building Decarbonization Coalition

Recommended Actions

- **Approve** Clean Fuels Program 2024 Annual Report
- **Adopt** Clean Fuels Program 2025 Plan Update
- **Adopt** Resolution finding no duplicate projects or programs funded by other state/local agencies
- **Approve and adopt** Clean Fuels Advisory Group membership changes
- **Receive and file** Technology Advancement Advisory Group membership changes

South Coast AQMD Technology Showcase

Today!

- Over 20 technology partners (Battery Electric/Fuel Cell Vehicles and Equipment):
  - Evolectric
  - Ford
  - GreenPower Motor
  - Hino
  - Hyundai
  - Lion Electric
  - Meritor
  - Nikola
  - Range Energy
  - RockeTruck
  - Schneider
  - Voltu Motor
  - Volvo

- Other Clean Air Technologies:
  - Mobile Monitoring Laboratory Platforms
  - Commercial Electric Lawn & Garden Equipment
  - Air Filtration Systems