South Coast
Air Quality Management District
South Coast AQMD 21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 • www.aqmd.gov

HYRBRID TECHNOLOGY COMMITTEE MEETING

Committee Members

Councilmember Carlos Rodriguez, Chair
Supervisor Andrew Do
Supervisor Curt Hagman
Mayor Patricia Lock Dawson
Mayor Larry McCallon
Board Member Veronica Padilla-Campos

October 20, 2023 ♦ 12:00 p.m.

TELECONFERENCE LOCATIONS

Yorba Linda Public Library Study Room 2 4852 Lakeview Avenue Yorba Linda, CA 92886	County Administration North 400 West Civic Center Drive First Floor Multipurpose Room 101 Santa Ana, CA 92701	Riverside City Hall 7th Floor Conference Room 3900 Main St. Riverside, CA 92522

A meeting of the South Coast Air Quality Management District Technology Committee will be held at 12:00 p.m. on Friday, October 20, 2023 through a hybrid format of in-person attendance in the Dr. William A. Burke Auditorium at the South Coast AQMD Headquarters, 21865 Copley Drive, Diamond Bar, California, and remote attendance via videoconferencing and by telephone. Please follow the instructions below to join the meeting remotely.

Please refer to South Coast AQMD's website for information regarding the format of the meeting, updates if the meeting is changed to a full remote via webcast format, and details on how to participate:

http://www.aqmd.gov/home/news-events/meeting-agendas-minutes

ELECTRONIC PARTICIPATION INFORMATION
(Instructions provided at bottom of the agenda)

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One-Tap Mobile
+16699006833, 96669409722#

Audience will be allowed to provide public comment in person or through Zoom connection or telephone.

PUBLIC COMMENT WILL STILL BE TAKEN

AGENDA

Members of the public may address this body concerning any agenda item before or during consideration of that item (Gov't. Code Section 54954.3(a)). If you wish to speak, raise your hand on Zoom or press Star 9 if participating by telephone. All agendas for regular meetings are posted at South Coast AQMD Headquarters, 21865 Copley Drive, Diamond Bar, California, at least 72 hours in advance of the regular meeting. Speakers may be limited to three (3) minutes total for all items on the agenda.

CALL TO ORDER

ROLL CALL

ACTION ITEMS (1):

1. **Execute Contract to Replace Existing Hydrogen Refueling Station at South Coast AQMD Headquarters *(Motion Requested)***
   Maryam Hajbabaei
   Program Supervisor

   For over a decade, South Coast AQMD hosted a hydrogen refueling station at its headquarters that is part of a CEC award to Air Products and Chemicals, Inc. The current station's capacity to provide hydrogen refueling is limited. Recently, FirstElement Fuel, Inc. received a CEC grant in the amount of $42.6 million to develop publicly accessible advanced hydrogen refueling stations. Additional funding is sought to clean up the site. This action is to execute a contract with FirstElement Fuel, Inc. to expand and upgrade the existing hydrogen refueling station at South Coast AQMD headquarters and clean up the site in an amount not to exceed $275,000 from the Clean Fuels Program Fund (31).

2. **Execute Contract for Regional Medium- and Heavy-Duty Zero Emission Vehicle Infrastructure Analysis *(Motion Requested)***
   Maryam Hajbabaei
   Program Supervisor

   The University of California, Riverside (UCR) was awarded $400,000 from CEC to conduct a technical planning study for Southern California's and the California-Mexico Border ZEV infrastructure deployment. The CEC Medium-Duty and Heavy-Duty (MD/HD) blueprint project focuses on ZEV infrastructure deployment planning. Consistent with CEC's blueprint and to expand the scope of the study, UCR proposes to expand the scope of the existing planning efforts to include a Medium-Duty and Heavy-Duty ZEV infrastructure deployment criteria and benefits analysis for Southern California. This action is to execute a contract with UCR in an amount not to exceed $150,000 from the Clean Fuels Program Fund (31).

INFORMATIONAL ITEM:

3. Clean Fuels Program Draft 2024 Plan Update — Vasileios Papapostolou, Planning & Rules Manager

(Written Report – No Motion Requested)

The Clean Fuels Plan Update is submitted every year with the Clean Fuels Annual Report as required by legislation. As part of that process, staff provides the Clean Fuels Program Draft Plan Update to the Technology Committee to solicit input on the proposed priority technology areas and potential projects for the upcoming year before requesting final Board approval for the Plan Update in early spring. Staff proposes continued support for a wide portfolio of technologies emphasizing zero emission technologies for vehicles, off-road equipment, and supporting infrastructure.

4. Other Business

Any member of the Committee, or its staff, on his or her own initiative or in response to questions posed by the public, may ask a question for clarification, may make a brief announcement or report on his or her own activities, provide a reference to staff regarding factual information, request staff to report back at a subsequent meeting concerning any matter, or may take action to direct staff to place a matter of business on a future agenda. (Gov't. Code Section 54954.2)

5. Public Comment Period

At the end of the regular meeting agenda, an opportunity is provided for the public to speak on any subject within the Committee's authority that is not on the agenda. Speakers may be limited to three (3) minutes each.

6. Next Meeting Date

Friday, November 17, 2023 at 12:00 p.m.

ADJOURNMENT

Document Availability

All documents (i) constituting non-exempt public records, (ii) relating to an item on an agenda for a regular meeting, and (iii) having been distributed to at least a majority of the Committee after the agenda is posted, are available by contacting Penny Shaw Cedillo at 909.396.3179, or send the request to pcedillo@aqmd.gov.

Americans with Disabilities Act and Language Accessibility
Disability and language-related accommodations can be requested to allow participation in the Technology Committee meeting. The agenda will be made available, upon request, in appropriate alternative formats to assist persons with a disability (Gov't Code Section 54954.2(a)). In addition, other documents may be requested in alternative formats and languages. Any disability or language-related accommodation must be requested as soon as practicable. Requests will be accommodated unless providing the accommodation would result in a fundamental alteration or undue burden to South Coast AQMD. Please contact Penny Shaw Cedillo at 909.396.3179 from 7:00 a.m. to 5:30 p.m., Tuesday through Friday, or send the request to pcedillo@aqmd.gov.

INSTRUCTIONS FOR ELECTRONIC PARTICIPATION

Instructions for Participating in a Virtual Meeting as an Attendee
As an attendee, you will have the opportunity to virtually raise your hand and provide public comment.

Before joining the call, please silence your other communication devices such as your cell or desk phone. This will prevent any feedback or interruptions during the meeting.

Please note: During the meeting, all participants will be placed on Mute by the host. You will not be able to mute or unmute your lines manually.

After each agenda item, the Chair will announce public comment.

Speakers may be limited to a total of 3 minutes for the entirety of the consent calendar plus board calendar, and three minutes or less for each of the other agenda items.

A countdown timer will be displayed on the screen for each public comment.

If interpretation is needed, more time will be allotted.

Once you raise your hand to provide public comment, your name will be added to the speaker list. Your name will be called when it is your turn to comment. The host will then unmute your line.

Directions for Video ZOOM on a DESKTOP/LAPTOP:

- If you would like to make a public comment, please click on the **"Raise Hand"** button on the bottom of the screen.
- This will signal to the host that you would like to provide a public comment and you will be added to the list.

Directions for Video Zoom on a SMARTPHONE:

- If you would like to make a public comment, please click on the **"Raise Hand"** button on the bottom of your screen.
- This will signal to the host that you would like to provide a public comment and you will be added to the list.

Directions for TELEPHONE line only:

- If you would like to make public comment, please **dial *9** on your keypad to signal that you would like to comment.

BOARD MEETING DATE: November 3, 2023 AGENDA NO.

PROPOSAL: Execute Contract to Replace Existing Hydrogen Refueling Station at South Coast AQMD Headquarters

SYNOPSIS For over a decade, South Coast AQMD hosted a hydrogen refueling station at its headquarters that is part of a CEC award to Air Products and Chemicals, Inc. The current station's capacity to provide hydrogen refueling is limited. Recently, FirstElement Fuel, Inc. received a CEC grant in the amount of $42.6 million to develop publicly accessible advanced hydrogen refueling stations. Additional funding is sought to clean up the site. This action is to execute a contract with FirstElement Fuel, Inc. to expand and upgrade the existing hydrogen refueling station at South Coast AQMD headquarters and clean up the site in an amount not to exceed $275,000 from the Clean Fuels Program Fund (31).

COMMITTEE: Technology, October 20, 2023; Recommended for Approval

RECOMMENDED ACTION:
Authorize the Chair, or on the Chair's behalf, the Executive Officer, to execute a contract with FirstElement Fuel, Inc. to expand, and upgrade the existing hydrogen refueling station at South Coast AQMD headquarters and clean up the site after the removal of the existing equipment in an amount not to exceed $275,000 from the Clean Fuels Program Fund (31).

Wayne Nastri
Executive Officer

AK:MW:VP:MH

Background
South Coast AQMD has been operating a hydrogen refueling station at its headquarters for close to two decades. The current station is one of eight stations in California that was established with an award from the CEC to Air Products and Chemicals, Inc. (Air

Products) over a decade ago. However, the hydrogen refueling station has limited hydrogen dispensing capacity based on demand and increased downtime largely due to aging equipment.

FirstElement Fuel, Inc. (FirstElement) was recently awarded a $42.6 million grant from the CEC to design, construct, and expand a network of 46 high-performance hydrogen fueling stations across California. The objective of this initiative is to elevate customer experience and optimize operational efficiency of hydrogen refueling stations which is crucial for the sustained success of fuel cell electric vehicles (FCEVs). The upgraded station will be integrated with a telematics software management tool to keep track of the volume of vehicles being fueled on-site and manage fuel availability and customer demand. In addition, expanding hydrogen refueling infrastructure will help with the adoption of FCEVs and reduce hydrogen dispensing costs, making these vehicles more accessible and economically viable.

Proposal

FirstElement proposes to upgrade the existing hydrogen refueling station at South Coast AQMD headquarters with four fueling stations. The upgraded station will be capable of dispensing up to 1,600 kg/day of hydrogen to support the refueling of up to 600 FCEVs daily compared to the existing station with a capacity of 250 kg/day of hydrogen capable of supporting 100 FCEVs. Once the existing equipment is removed from the current location, FirstElement will perform site clean up prior to the installation of the upgraded refueling station equipment.

South Coast AQMD funding will be used to clean up the site after the existing hydrogen refueling station equipment is removed. This action is to execute a contract with FirstElement to expand and upgrade the existing hydrogen refueling station at South Coast AQMD headquarters, in an amount not to exceed $275,000 from the Clean Fuels Program Fund (31).

Sole Source Justification

Section VIII.B.2 of the Procurement Policy and Procedure identifies four major provisions under which a sole source award may be justified. This request for a sole source award is made under provision B.2.d.: Other circumstances exist which in the determination of the Executive Officer require such a waiver in the best interest of South Coast AQMD. Specifically, these circumstances are B.2.d.(1): Project involving cost-sharing by multiple sponsors. The proposed projects will include in-kind contributions and cost-share by the CEC and FirstElement.

Benefits to South Coast AQMD

Projects to support the development and demonstration of zero-emission vehicle technologies and supporting infrastructure are included in the Technology Advancement Office Clean Fuels Program 2023 Plan Update under the category “Hydrogen and Fuel

Cell Technologies and Infrastructure." This project is to develop a higher performing hydrogen refueling station with greater capacity and capability, allowing the simultaneous fueling of four FCEVs. The upgraded refueling station will support existing customers, create a more robust hydrogen supply chain with high capacity and lower station downtime that will encourage South Coast Air Basin residents to purchase and drive FCEVs. Implementation of this project is consistent with the 2022 AQMP, which relies on zero-emission technologies to achieve National Ambient Air Quality Standards for ozone and PM2.5. This higher capacity upgraded refueling station will better serve the residents of the South Coast Air Basin and will assist in achieving California's goal in creating a more expansive and reliable hydrogen refueling network throughout the state.

Resource Impacts

The total cost for the proposed project is $3,355,000, of which South Coast AQMD's proposed contribution will not exceed $275,000 from the Clean Fuels Program Fund (31), as summarized below.

Proposed Zero Emission Demonstration Project Costs

Source	Funding Amount	% of Total Project Cost
CEC	$1,580,000	47%
FirstElement	$1,500,000	45%
South Coast AQMD (proposed)	$275,000	8%
Total	**$3,355,000**	**100%**

* Contingent to CEC approval

** South Coast AQMD proposed contribution will be used for site clean up

Sufficient funds are available in the Clean Fuels Program Fund (31) for this proposed project. The Clean Fuels Program Fund (31) is established as a special revenue fund resulting from the state mandated Cleans Fuels Program. The Clean Fuels Program, under Health and Safety Code Sections 40448.5 and 40512 and Vehicle Code Section 9250.11, establishes mechanisms to collect revenues from mobile sources to support projects to increase the utilization of clean fuels, including the development of the necessary advanced enabling technologies. Funds collected from motor vehicles are restricted, by statute, to be used for projects and program activities related to mobile sources that support the objectives of the Clean Fuels Program.

Back to Agenda

Agenda Item #1

Execute Contract to Replace Existing Hydrogen Refueling Station at South Coast AQMD Headquarters

Maryam Hajbabaei

Background

- For about two decades, South Coast AQMD has hosted hydrogen refueling stations at its Headquarters in Diamond Bar
- The current hydrogen station has limited capacity and has increasing downtime due to aging equipment along with high usage
- FirstElement Fuel, Inc. recently received a CEC award of $42.6M to develop publicly accessible advanced hydrogen refueling stations in California
- $3.1M is proposed from FirstElement and their CEC award towards the new Diamond Bar station

Proposal

- FirstElement will replace the existing hydrogen refueling station at South Coast AQMD Headquarters
- FirstElement will perform site cleanup once the existing equipment is removed from the current location and prior to installing the new station
- The upgraded station will have increased hydrogen dispensing capacity along with additional fueling stations

Resource Impacts

Source	Funding Amount $	Project Cost %
CEC*	$1,580,000	47%
FirstElement	$1,500,000	45%
*South Coast AQMD** (Proposed)*	*$275,000*	*8%*
Total Project Cost	**$3,355,000**	**100%**

** Contingent to CEC approval*

*** South Coast AQMD proposed contribution will be used for site cleanup*

Recommended Actions

Authorize the Executive Officer to execute a contract with FirstElement Fuel, Inc. to replace, and expand the existing hydrogen refueling station at the South Coast AQMD Headquarters and clean up the site after the removal of the existing equipment in an amount not to exceed $275,000 from the Clean Fuels Program Fund (31)

BOARD MEETING DATE: November 3, 2023 AGENDA NO.

PROPOSAL: Execute Contract for Regional Medium- and Heavy-Duty Zero Emission Vehicle Infrastructure Analysis

SYNOPSIS: The University of California, Riverside (UCR) was awarded $400,000 from CEC to conduct a technical planning study for Southern California's and the California-Mexico Border ZEV infrastructure deployment. The CEC Medium-Duty and Heavy-Duty (MD/HD) blueprint project focuses on ZEV infrastructure deployment planning. Consistent with CEC's blueprint and to expand the scope of the study, UCR proposes to expand the scope of the existing planning efforts to include a Medium-Duty and Heavy-Duty ZEV infrastructure deployment criteria and benefits analysis for Southern California. This action is to execute a contract with UCR in an amount not to exceed $150,000 from the Clean Fuels Program Fund (31).

COMMITTEE: Technology, October 20, 2023; Recommended for Approval

RECOMMENDED ACTION:
Authorize the Executive Officer to execute a contract with the University of California, Riverside (UCR), to conduct a regional Medium-Duty and Heavy-Duty Zero Emission Vehicle Infrastructure Analysis in an amount not to exceed $150,000 from the Clean Fuels Program Fund (31).

Wayne Nastri
Executive Officer

AK:MW:VP:MH

Background
The medium-duty/heavy-duty (MD/HD) transportation sector continues to be a significant source of harmful air pollutant emissions, presenting an opportunity for improving local air quality and addressing climate change. Transitioning this 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 National Ambient Air Quality Standards (NAAQS) for the South Coast Air Basin. 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.

Proposal
UCR was awarded $200,000 through CEC ARV-21-027 to develop a comprehensive blueprint that discusses a viable strategy to identify the most cost-effective technology solutions, financial incentives, infrastructure upgrades, and equipment mixes for identifying actions and milestones needed for the implementation of MD/HD ZEV and related electric charging and hydrogen refueling infrastructure in the South Coast Air Basin. This funding will expand the scope of the study to include a cost analysis of ZEV infrastructure deployment and fuel/power supply, evaluation of the technical specifications for charging and fueling stations, resource requirements, and standardization of protocols. The study will also quantify criteria pollutant, air toxics, and greenhouse gas benefits from and review potential impacts on Environmental Justice communities within the South Coast Air Basin from the installation of MD/HD charger. In addition, University of California Alianza Mexico awarded UCR $200,000 to lead an infrastructure analysis for the California-Mexico Border MD/HD ZEV that involves activities to update, improve, and optimize the models that will be used in the proposed study.

Sole Source Justification
Section VIII.B.2. of the Procurement Policy and Procedure identifies provisions under which a sole source award may be justified. The request for sole source award is made under provision B.2.d.(8): Research and development efforts with educational institutions or nonprofit organizations. UCR is an educational institution and the College of Engineering - Center for Environmental Research and Technology (CE-CERT) is its research center with multidisciplinary resources to engage in diverse environmental and transportation research programs including advanced vehicle

technologies and systems; emission measurements, analyses and control technologies; atmospheric measurements and modeling; and renewable energy.

Benefits to South Coast AQMD
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 2023 Plan Update under the category "Zero Emission Infrastructure including Hydrogen and Electric Charging Infrastructure." This study further evaluates the cost and technical specifications, quantifies the air quality benefits anticipated from MD/HD ZEV deployments, and promotes a smoother transition to providing strategic ZEV infrastructure development. Having strategic ZEV planning will help with adoption of MD/HD ZEV technologies. 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 the South Coast Air Basin.

Resource Impacts
South Coast AQMD's support of the Regional MD/HD ZEV Infrastructure Analysis, provided through an agreement with UCR CE-CERT, shall not exceed $150,000 from the Clean Fuels Program Fund (31). CEC's contribution to this project is $15,000 from the initial award of $200,000 to develop the regional blueprint and University of California Alianza in Mexico (UC Alianza MX) will contribute $135,000 towards this project for the California-Mexico Border ZEV Infrastructure Analysis for MD/HD Vehicles. Project partners and proposed funding are as follows:

Project Partners	**Funding***	**Percentage**
CEC	$15,000	5%
UC Alianza MX	$135,000	45%
South Coast AQMD (*requested)*	$150,000	50%
Total (not to exceed)	**$300,000**	100%

Sufficient funds are available from the Clean Fuels Program Fund (31). The Clean Fuels Program Fund (31) is established as a special revenue fund resulting from the state mandated Cleans Fuels Program. The Clean Fuels Program, under Health and Safety Code Sections 40448.5 and 40512 and Vehicle Code Section 9250.11, establishes mechanisms to collect revenues from mobile sources to support projects to increase the utilization of clean fuels, including the development of the necessary advanced enabling technologies. Funds collected from motor vehicles are restricted, by statute, to be used for projects and program activities related to mobile sources that support the objectives of the Clean Fuels Program.

Back to Agenda

Agenda Item #2

Execute Contract for Regional Medium- and Heavy-Duty Zero Emission Vehicle Infrastructure Analysis

Maryam Hajbabaei

Background

- Transitioning the transportation sector to Zero Emission Vehicles (ZEVs) is critical to achieving air quality attainment and climate goals
- CEC awarded UCR $400,000 to conduct a technical planning study to expand the application of ZEVs and the supporting charging infrastructure in the South Coast Air Basin and along the California Mexico Boarder

Background (con'd)

- As part of the CEC comprehensive blueprint development, UCR performs technology and resource assessment, and benefit analysis that evaluate emissions reduction and jobs creation
- UCR will provide realistic, holistic, and futuristic view of regional transportation planning at the local and regional levels

Proposal

- UCR will expand the existing study scope to provide essential information for ZEV infrastructure planning in the South Coast Air Basin
  - Identify key barriers associated with transitioning trucking to ZEV platforms
  - Conduct a cost analysis of infrastructure deployment and technical specifications for charging and fueling stations and resource requirements
  - Quantify criteria pollutants, air toxics, and greenhouse gas benefits and impact on overburden communities
  - Coordinate with regional stakeholders, including SCAG

Resource Impacts

Source	Funding Amount $	Project Cost %
CEC	$15,000	5%
UC Alianza MX*	$135,000	45%
South Coast AQMD (Proposed)	$150,000	50%
Total Project Cost	**$300,000**	**100%**

* UCR current project for the California-Mexico Border ZEV Infrastructure Analysis for MD/HD Vehicles

Recommended Actions

Authorize the Executive Officer to execute a contract with the University of California, Riverside, to conduct a regional Medium and Heavy-duty Zero Emission Vehicle Infrastructure Analysis in an amount not to exceed $150,000 from the Clean Fuels Program Fund (31)

PROPOSAL: Clean Fuels Program Draft 2024 Plan Update
[Written Report Only]

SYNOPSIS: The Clean Fuels Plan Update is submitted every year with the Clean Fuels Annual Report as required by legislation. Staff provides the Clean Fuels Program Draft Plan Update to the Technology Committee each fall to solicit input on the proposed priority technology areas and potential projects for the upcoming year before requesting final Board approval for the Plan Update and Clean Fuels Annual Report in early spring. Staff proposes continued support for a wide portfolio of technologies with particular emphasis on zero emission technologies for vehicles, off-road equipment, and supporting infrastructure.

Background
Each calendar year, as required by legislation, the Clean Fuels Program Plan Update is revised to reflect technical priorities and proposed project areas for the upcoming year. As part of this process, staff provides the Clean Fuels Program Draft Plan Update (Draft Plan Update) to the Technology Committee as a separate item to solicit input on the proposed allocation of Clean Fuels funds before requesting final approval in early spring. This has provided an opportunity for the Committee to provide input before Board approval of the final Plan Update (concurrent with approval of the Clean Fuels Annual Report).

For Calendar Year 2024, staff has prepared a Clean Fuels Program Draft 2024 Plan Update which proposes continued support for a wide portfolio of technologies with emphasis on zero emission technologies for vehicles, off-road equipment, and supporting infrastructure to create a pathway towards attainment of National Ambient Air Quality Standards for ozone. This aligns well with South Coast AQMD's FY 2023-24 Goals and Priority Objectives and assists in achieving goals outlined in the 2022 Air Quality Management Plan (AQMP), which calls for a significant reduction in NOx emissions by 2037 through economy-wide transition to zero emission technologies wherever feasible. The portfolio is also designed to leverage funds from other state and

federal programs such as the CARB Greenhouse Gas Reduction Fund Program, CEC Clean Transportation Program, EPA grants such as the Diesel Emissions Reduction Act, Targeted Airshed, and the Clean Air Technology Initiative Grants, and recent federal grants from EPA, DOE, and DOT established by the Infrastructure Investment and Jobs Act and the Inflation Reduction Act.

Proposal

The attached Draft Plan Update identifies potential projects to be considered for funding during 2024. The proposed projects reflect promising near-zero and zero emission technologies and applications that are emerging for different emission categories. This update includes several proposed projects. The actual projects to be funded in the current fiscal year will depend on the available budget and the awards received from other funding sources. Some of the proposed projects for 2024 include but are not limited to: 1) Large deployment projects of medium-duty (MD) and heavy-duty (HD) zero emission trucks and charging/fueling infrastructure, 2) Innovative micro-grid solutions to support HD truck charging and hydrogen fueling, 3) Development and deployment of advanced charging technologies, including high-power charging at the megawatt levels to increase range of battery electric trucks, 4) Development and demonstration of long range Class 8 fuel cell electric trucks and equipment, and 5) Development and demonstration of green hydrogen production pathways. Projects that will not be funded in 2024 may be considered for funding in subsequent years.

In addition to identifying proposed projects to be considered for funding, this Draft Plan Update confirms nine key technical areas of highest priority to the South Coast AQMD. The Renewal Natural Gas Infrastructure category has now been changed to Renewable Fuel Infrastructure to include other fuel types, such as hydrogen fuel blends. These high priority areas are listed below based on the proposed funding distribution shown in Figure 1:

- Zero Emission Infrastructure
- Hydrogen/Mobile Fuel Cell Technologies
- Electric/Hybrid Technologies
- Stationary Clean Fuel Technologies (including renewables) Fuel and Emissions Studies
- Renewable Fuel Infrastructure
- Health Impacts Studies
- Administrative and Technical Support
- Emission Control Technologies
- Engine Systems/Technologies (particularly in the HD vehicle sector)

It should be noted that these priorities represent the areas where South Coast AQMD funding is thought to have the greatest impact. In keeping with the diverse and flexible

"technology portfolio" approach, these priorities may shift during the year to: (1) capture opportunities such as cost-sharing by state government, federal government, or other entities, or (2) address specific technology issues which affect residents within the South Coast AQMD's jurisdiction.

Figure 1 graphically depicts potential distribution of South Coast AQMD's Clean Fuels funds, based on projected program costs of $33 million for the nine project areas discussed previously. The expected actual project expenditures for 2024 are expected to be less than the total projected program cost since not all projects will materialize. Target allocations are based on balancing technology priorities, addressing technical challenges and opportunities, and achieving near-term versus long-term benefits with the constraints on available South Coast AQMD funding. Specific contract awards throughout 2024 will be based on this proposed allocation, quality of proposals received and evaluation of projects against standardized criteria, and ultimately, Governing 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.

These technical priorities will necessarily be balanced by funding availability and availability of qualified projects. Established under H&SC Section 40448.5 and Vehicle Code Section 9250.11, the Clean Fuels Program collects revenues from mobile and stationary sources to support the program's objectives, albeit with constraints on the use of funds. Grants and cost-sharing revenue contracts from various government agencies, such as CARB, CEC, NREL, EPA, DOT, and DOE, also support technology advancement efforts and may be utilized for cost-sharing.

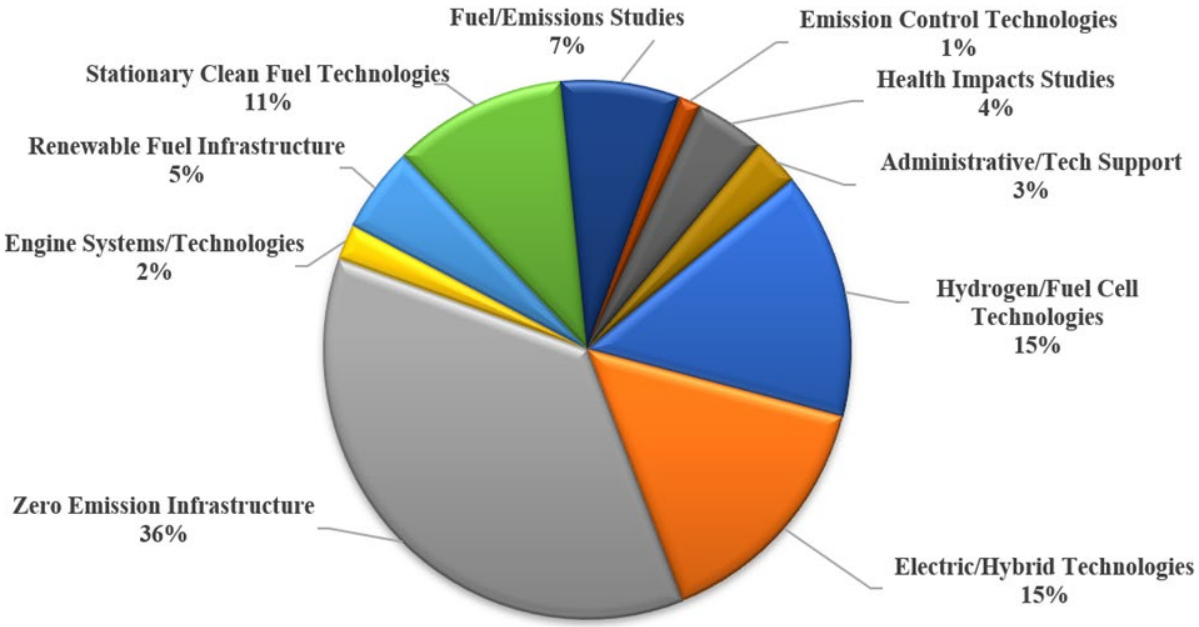

Figure 1: Projected Funding Distribution for Potential Projects in 2024 ($33M)

The proposed update is the result of historical as well as current comprehensive planning and review process, which will continue over the next few months as the Draft 2024 Plan Update is further refined before the Governing Board considers adoption in early spring. This process includes consideration of the 2022 AQMP, California Sustainable Freight Strategy, CARB 2022-2023 Funding Plan, CARB 2020 Mobile Source Strategy and new mobile source regulations, such as the Advanced Clean Trucks and Fleets regulations, as well as our adopted and proposed Indirect Source Rules. The proposed update also incorporates coordination activities involving outside organizations on federal, state and local activities, and proposed integrated solutions ranging from the Governor's Executive Orders and goals for MD and HD vehicles to EPA and CARB climate pollution reduction strategies. The Governor's Executive Order issued in January 2018 setting a target of 200 hydrogen stations by 2025 (double the original 2023 target) and 5 million ZEVs by 2030 is a good example of state and local alignment. As part of the Clean Fuels Program, staff hosted two advisory group meetings in February and September 2023 to solicit input from the Clean Fuels Advisory Group, Technology Advancement Advisory Group, and other technical experts. During these advisory meetings, participants reviewed current and proposed Technology Advancement projects as well as the proposed funding distribution for the Draft 2024 Plan Update and discussed near-term and long-term technologies as potential projects.

Discussions from the review process and advisory meetings, where appropriate, have been and will continue to be fashioned into project areas and included in this year's Plan Update as it is finalized. Additionally, staff regularly interacts with CARB, CEC, DOE, DOT, EPA, Hydrogen Fuel Cell Partnership, Veloz, and other entities to solicit and incorporate technical areas for potential leveraged funding. Overall, the Draft Plan Update attempts to maintain flexibility to address dynamically evolving technologies and incorporate new research and data.

The major areas of focus are proposed in the following areas:

- Large deployments of MD and HD zero emission drayage trucks;
- HD zero emission infrastructure development, demonstration, deployment, and planning;
- Onboard sensor development for emissions monitoring and improved efficiency;
- Innovative solutions to support zero emission infrastructure;
- Battery and fuel cell electric transit and school bus fleet charging/fueling infrastructure;
- HD diesel truck replacements with zero emission trucks through incentive programs; and

- Fuel and emissions studies, such as conducting non-tailpipe PM studies and support of the MATES VI study.

Maintain other areas of emphasis

While some categories, such as hydrogen fuel cell or electric/hybrid technologies, have lower percentages in 2024, the Clean Fuels Fund allocations and total project cost will be higher. As shown in Figure 2, the Draft 2024 Plan Update has a particular focus on zero emission infrastructure for large-scale charging and fueling stations necessary to support medium- and heavy-duty battery electric and fuel cell vehicles. There remains an urgent need to develop, demonstrate, and deploy zero emission technologies for HD vehicles and equipment, especially for goods movement applications, including supporting infrastructure. The emphasis on zero emission technologies continues to pave a technological pathway towards achieving the 2037 federal ozone National Ambient Air Quality Standard.

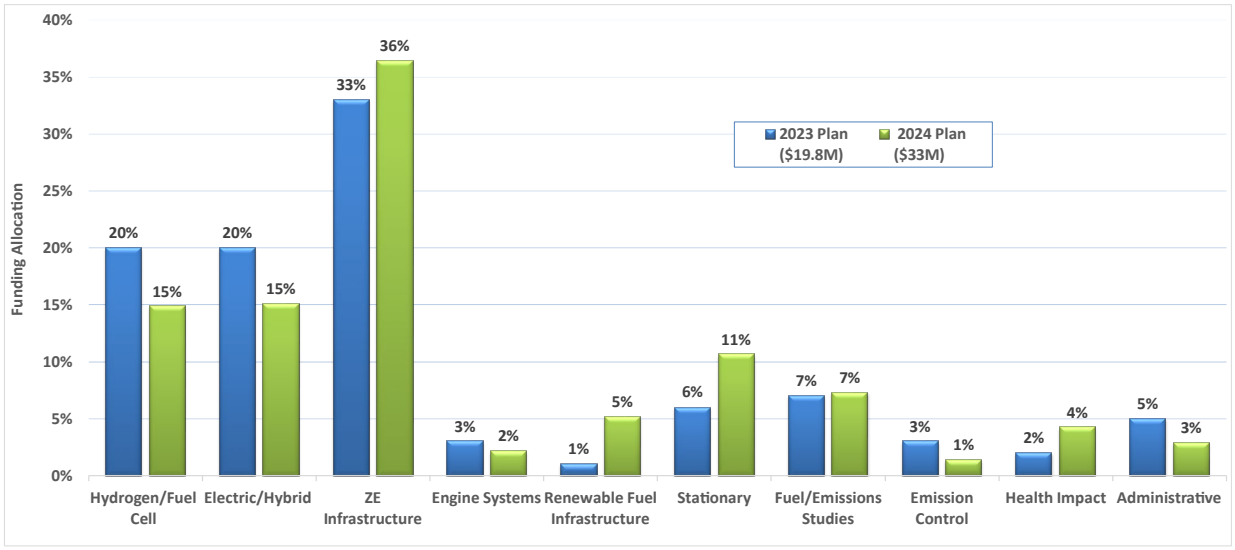

Figure 2: 2023 and 2024 Clean Fuels Plan Update Comparison

Based on communications with organizations specified in H&SC Section 40448.5.1 and review of their programs, the projects proposed in this update do not appear to duplicate any past or present projects. As each individual project is recommended to the Governing Board for funding, staff will continue to coordinate with these organizations to ensure that duplication is avoided and optimal expenditure of Clean Fuels Program funds.

Attachment

Clean Fuels Program Draft 2024 Plan Update

Back to Agenda

TECHNOLOGY ADVANCEMENT OFFICE
DRAFT 2024 PLAN UPDATE

South Coast Air Quality Management District
October 2023

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EXECUTIVE SUMMARY

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 (Basin) 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 the natural geographic and atmospheric conditions of the region, coupled with the high population density and associated mobile and stationary source emissions.

In 1988, 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 oxides (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 hydrogen fuel cells, advanced natural gas (NG) technologies, alternative fuel engines, battery electric vehicles, plug-in hybrid electric vehicles and related fueling infrastructure including 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 $267.9 million into $1.7 billion in 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 source of funding for mobile source emission reduction projects. The MSRC develops an annual Work Program to define the categories of projects for funding. Each year, approximately $15 million, collected from motor vehicle registration, is allocated to the discretionary fund and is an importance 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 has been able to partner 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 brand names that are trusted. This is the type of scale needed to achieve emission reductions to attain national ambient air quality standards (NAAQS).

South Coast AQMD plays a leadership role in technology development and commercialization, along with its partners, to accelerate criteria pollutant and greenhouse gas (GHG) reductions. The Clean Fuels Program has traditionally supported a portfolio of technologies at different technology readiness levels. This helps with the development of new technologies across many different mobile sectors in need of 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, and 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 Clean Fuels Plan Update looks ahead at proposed projects for the next CY, re-calibrating technical emphasis of the Program.

Deploying charging infrastructure for Class 8 HD BETs for the Joint Electric Truck Scaling Initiative (JETSI) Pilot Project required significant effort. Schneider successfully deployed sixteen 350 kW DC fast chargers to support its 50 Daimler Class 8 BETs in June 2023. NFI will deploy its charging infrastructure in two phases under temporary power charging completed in September 2023 and permanent power charging to be completed in summer 2024. Solar and battery storage will also be deployed by summer 2024 to offset demand charges at NFI's Ontario site. Due to utility requirements and regulations which do not support microgrid technologies in combination with infrastructure, NFI's infrastructure deployment is subject to significantly increased equipment and installation costs which are not covered under existing utility infrastructure incentive programs.

By working together with Hyundai Motor Company Hyundai Motor Company (HMC), long-range Class 8 FCTs are currently under development, which are scheduled to start demonstration in Q4 2023. This demonstration will validate the fuel cell technology's capacity to fulfill the practical requirements of long-haul freight transportation, offering a range of up to 500 miles. Hydrogen fuel cell technology emerges as an exceptionally appealing solution for heavy-duty goods movement due to hydrogen's remarkable energy density and its ability to facilitate rapid refueling. This, in turn, allows for extended driving ranges and increased vehicle utilization. Through this collaboration, South Coast AQMD aims to overcome existing barriers such as economic competitiveness of fuel cell electric vehicles (FCEVs) and limited deployment of hydrogen infrastructure.

In March 2023, the final report of the 200 Heavy-Duty Vehicle Emissions Testing Program was published and made available to the public on the California Energy Commission's website. The report outlines the findings of the largest in-use testing program to date, collecting real world activity data and validating both under real-world and lab conditions. The University of California, Riverside and West Virginia University collaborated with four industry and government agency cosponsors to test more than 200 heavy-duty vehicles in this comprehensive, multi-year, four-phase program. Measured emission levels varied widely across different duty cycles, test methods, engine/fuel technologies, and vocations. This extensive test program has also successfully provided new data to improve air quality modeling and planning. Program findings are informing follow-up work, policy decisions, and program development.

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 the Basin. 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). CARB's 2022 State SIP Strategy included a revised mobile source strategy required for the Basin to meet the 2015 8-hour ozone standard of 70 ppb by 2037. The CARB 2022 State SIP Strategy for both mobile and stationary sources require rapid deployment of zero emission technologies to achieve air quality targets.

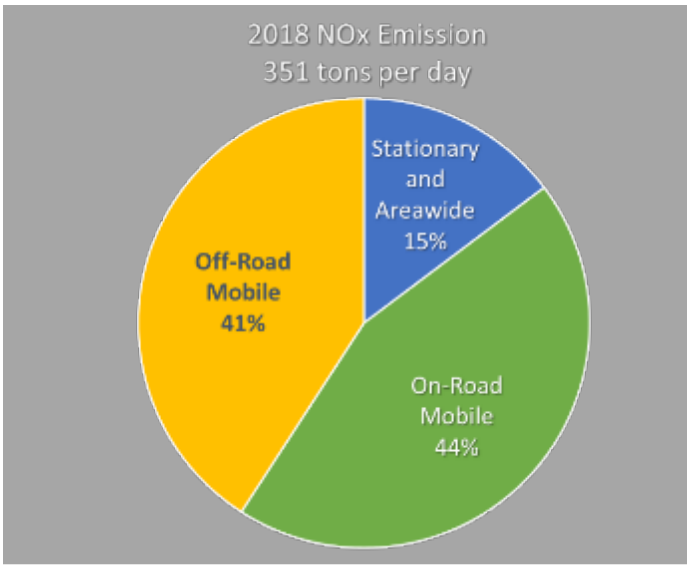


Figure 1: NOx Emissions by Source Category

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 improve ozone air quality and attain the ozone NAAQS in the Basin. Approximately 85 percent of NOx emissions are from mobile sources in 2018, as shown in Figure 1[1]. Furthermore, NOx emissions, along with VOC emissions, also lead to the secondary formation of PM2.5 in the atmosphere (particulate matter measuring 2.5 micrometer or less in size).

The emission reductions and control measures in the 2022 AQMP rely on commercial adoption of a mix of currently available technologies as well as the expedited development and commercialization of clean fuel mobile and stationary advanced technologies in the Basin 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 the Basin by source category. The majority of NOx reductions must come from mobile sources, both on-road and off-road categories. 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).

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

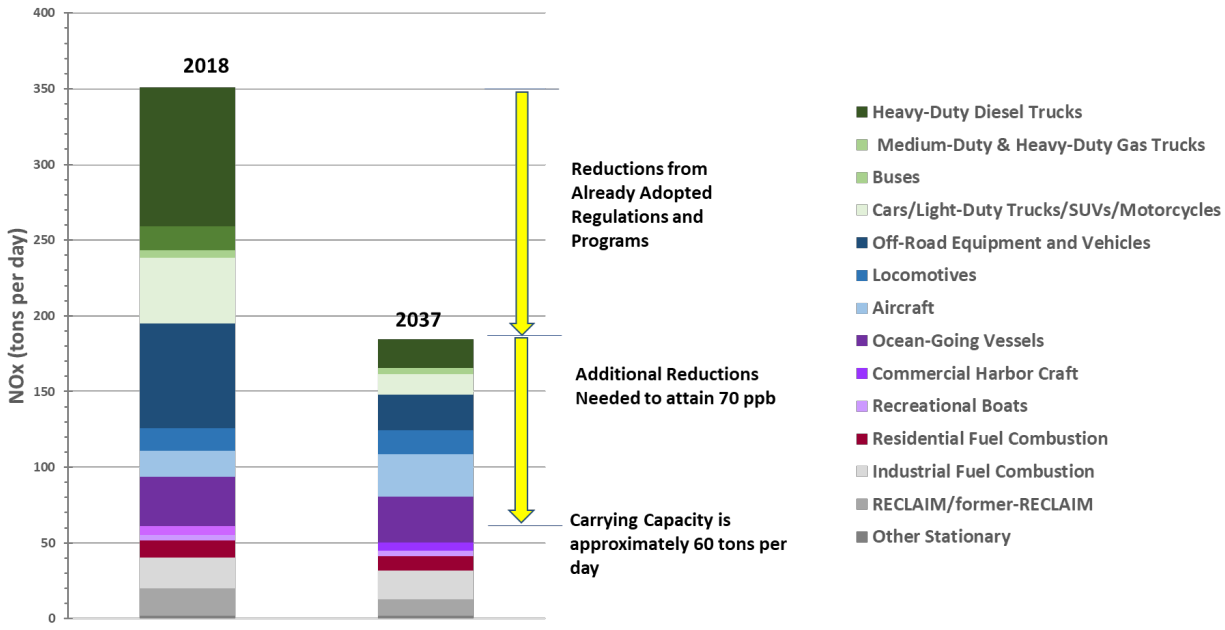


Figure 2: NOx Emissions and Reductions Required to Attain 2015 Standard

The 2022 AQMP shows the need for economy-wide transition to zero emission technologies where feasible along with the CARB 2020 Mobile Source Strategy, and low NOx technologies in other applications.

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 the relationship with incentive programs. Various stages of technology projects are funded to provide a portfolio of technologies as well as 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.

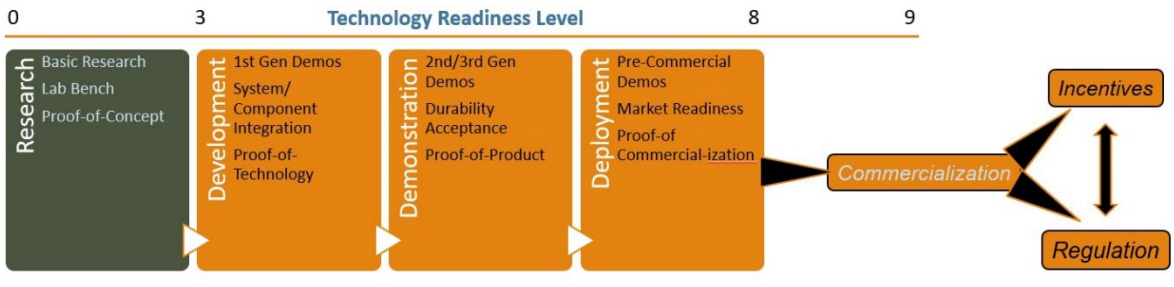


Figure 3: Stages of Clean Fuels Program Funding

Below is a summary of the 2024 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 Board in 1990. These stakeholder groups review and assess the overall direction of the 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 working in the fields of the Program's core technologies also attend and provide feedback. Preliminary review and comment are also provided by South Coast AQMD's Board and other interested parties and stakeholders.

2024 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 the development and deployment of 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 the Basin's need for NOx and TAC reductions and garner GHG reductions and petroleum use. Due to these co-benefits, South Coast AQMD has been successful in partnering with the state and public/private partnerships to leverage its Clean Fuels funding.

To identify technology and project opportunities where funding can make a significant difference in deploying cleaner technologies in the Basin, South Coast AQMD engages in outreach and networking efforts. 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, and Requests for Information (RFIs) to determine the current state of technologies and their 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 2024 Clean Fuels Plan Update.

Assembly Bill (AB) 617[2] 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 deployment of cleaner technologies. Cleaner technologies such as zero emission HD trucks are in the Community Emission Reduction Plans (CERPs) for these AB 617 communities, and a zero emission HD truck loaner program is being launched in 2023. This program will allow smaller fleets and independent owner operators to learn about zero emission trucks by trying them out in their business operations. This program is being funded through Community Air Protection Program (CAPP) funds but utilizes zero emission truck technologies developed under the Clean Fuels Program.

Since 2020, CARB has adopted several critical milestone regulations for reducing emissions from on-road HD mobile sources. These regulations include: 1) Advanced Clean Trucks (ACT) regulation which mandates an increasingly higher percentage of zero emission truck sales starting in 2024, 2) Omnibus Low NOx regulation which requires lower exhaust NOx standards on HD engines starting in 2024, 3) HD Vehicle Inspection and Maintenance Program for removing high emitters from legacy trucks, and 4) Advanced Clean Fleets (ACF) regulation which requires fleets to transit to zero-emission trucks starting in 2024. CARB also finalized the 2022 State Implementation Plan (SIP) Strategy pending U.S. EPA approval.

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

On the federal level, U.S. EPA has adopted a national low NOx truck rule in December 2022. The "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards," sets more stringent emissions from HD vehicles starting in model year 2027. This regulation is one of three rulemakings planned under the EPA Clean Trucks Plan. Two additional rulemakings include Phase 3 heavy-duty GHG standards and light-duty (LD) and medium-duty (MD) vehicle muti-pollutant standards for model years 2027 will be finalized by end of 2023.[3] These EPA regulations have are some slight differences when compared to CARB counterparts. In August 2023, CARB announced proposed amendments to the Omnibus regulation aligning with the adopted US EPA rule in MY2027 and provisions for allowing sale of legacy engines starting MY 2024. Both federal and state regulations will together bring much needed mobile source NOx reductions to the South Coast Air Basin.

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 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 for achieving the goal of zero emission drayage trucks by 2035. Despite all these major efforts, per the 2022 AQMP, additional NOx emission reductions in the South Coast Air Basin are needed to meet ozone attainment target deadlines.

The Plan Update includes projects to develop, demonstrate and commercialize a variety of 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-related activities, including zero emission drayage trucks, equipment and infrastructure;
- demonstrating ultra-low NOx, gaseous and liquid alternative/renewable fueled, large displacement/high efficiency engines and HD zero emission engine technologies;
- mitigating criteria pollutant emissions from the production of renewable fuels, such as renewable natural gas, diesel and hydrogen 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 MW) for HD 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 hydrogen refueling and advance these technologies ;
- developing and demonstrating green hydrogen production pathways and hydrogen ecosystem to reduce the cost of hydrogen and improve state-wide hydrogen station reliability and availability;
- developing and demonstrating low and zero emission alternative charging solution (ACS) technologies to support delay in deploying permanent EV charging infrastructure or to provide temporary and/or backup power generation;

[3] Final Rule and Related Materials for Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards | US EPA

- 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.

Table 1 (page 27) lists potential projects across ten core technologies by funding priority:

- Zero Emission Infrastructure (especially large-scale fueling and production facilities and private and public stations as well as ACS that support MD and HD vehicles);
- Hydrogen / Mobile Fuel Cell Technologies;
- Electric / Hybrid Technologies (battery electric and hybrid electric trucks and container transport technologies with zero emission operations);
- Stationary Clean Fuel Technologies (microgrids and stationary clean fuel technology projects, but not in combination with EV and Hydrogen infrastructure);
- Fuel and Emission Studies;
- Renewable Fuel Infrastructure;
- Health Impact Studies within disadvantaged communities;
- Administrative and Technical Support;
- Engine Systems / Technologies (alternative and renewable fuels for truck and rail applications); and
- Emission Control Technologies

These potential projects for 2024 total $33 million of Clean Fuels funding, with the anticipation of total project costs of $556.8 million, leveraging almost $17 for every $1 of Clean Fuel funds spent. Some proposed projects may also be funded by other funding sources, such as state and federal grants for clean fuel technologies, incentive programs such as AB 617 CAPP funding, Volkswagen Mitigation, and Carl Moyer, and other mitigation funds.

CLEAN FUELS PROGRAM

2024 Plan Update

In 1988, SB 2297 (Rosenthal) was signed into law (Chapter 1546) establishing South Coast AQMD's Clean Fuels Program and reaffirming the existence of the TAO to administer the Clean Fuels Program. The funding source for the Clean Fuels Program is a $1 motor vehicle registration surcharge that was originally approved for a limited five-year period, but legislation eventually extended both the Program and surcharge indefinitely. 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 capitalize on the latest progress in technologies, research areas and data.

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 Board. This Plan Update for CY 2024 targets several projects to achieve near-term emission reductions needed for the South Coast to meet health-based NAAQS.

Overall Strategy

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 Board directives to protect the health of the approximately 18 million residents (nearly half the population of California) in the Basin. 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 State SIP Strategy included a revised mobile source strategy required for the Basin to meet the 2015 8-hour ozone standard of 70 ppb by 2037. The adopted 2022 State SIP Strategy for both mobile and stationary sources requires rapid deployment of zero emission technologies to achieve air quality targets.

The emission reductions and control measures in the 2022 AQMP rely on commercial adoption of a mix of currently available technologies as well as the expedited development and commercialization of clean fuel mobile and stationary advanced technologies in the Basin 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. The majority of NOx 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). The 2022 AQMP shows the need for economy-wide transition to zero emission technologies where feasible, and low NOx emission technologies in other applications.

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 will emphasize on commercialization and deployment of zero emission HD trucks, like the large scale

deployment by the Joint Electric Truck Scaling Initiative (JETSI) Pilot Project and supporting zero emission infrastructure, and solar and energy storage.[4]

While zero emission technologies, the number of BETs and FCTs needed to meet the 2031 and 2037 ozone standards will be difficult to achieve. To enable widespread deployments of BETs and price reductions on these trucks from at scale production, several challenges must be addressed. These challenges include providing an easier process for fleets and independent owner operators to purchase BETs and overcoming obstacles with installing charging infrastructure, increasing grid capacity at their sites to coincide with truck deliveries, and managing charging and matching duty cycles with diesel trucks in drayage, short regional haul, and last mile freight applications. Projects, such as the JETSI 100 BET deployment and Electric Power Research Institute (EPRI) Electric Truck Research and Utilization Center (eTRUC) project to develop and demonstrate 1 MW chargers. The eTRUC project will implement two up to 1 MW charging sites while the JETSI project will focus on addressing the complexity of integrating 50 BETs at two fleets. On June 7, 2023, JETSI partner Schneider hosted a ribbon cutting event to celebrate the scaled deployment of BETs and charging infrastructure at their South El Monte intermodal site. The site features sixteen 350 kW dual-corded dispensers to allow Schneider to charge 32 trucks simultaneously. By year end, the site will support up to 100 BETs, including 50 funded through the JETSI project.

Within the South Coast Basin, other large fleets are purchasing BETs with near term delivery dates. Several fleets had trucks being delivered in 2022-2023 but unfortunately the installation of infrastructure lagged the delivery of the trucks. The difficulty of installing infrastructure to charge BETs is often a hindrance that many fleets have chosen not to tackle and simply have reverted to purchasing new diesel trucks. Even for large fleets who are interested in deploying charging, the lack of grid capacity and challenges in deploying solar, storage, or other technologies to offset grid demand makes it challenging to deploy infrastructure without significant lead times of 2-4 years, which does not coincide with the availability of truck and infrastructure incentives and truck delivery schedules. Public truck charging is needed for small fleets and owner operators who do not have the sites or funding to host their own charging. Additional technology solutions to provide energy generation which are not grid tied assets and the need to comply with multiple complex interconnection requirements are sorely needed to mitigate the frustrations with purchasing BETs. Unfortunately, in the South Coast Air Basin, the infrastructure for public truck charging is extremely limited[5]. South Coast AQMD, partnering with other entities, is seeking State and Federal funding opportunities to install HD public charging infrastructure. Meanwhile, South Coast AQMD had been strongly engaged in development and demonstration of low and zero emission alternative charging solutions (ACS). The availability of reliable ACS will help fill the void of infrastructure delays as well as provide a backup generation option during grid outages and public safety power shutoff events due to wildfires.

Today, diesel truck emissions are still the largest NOx emission category in the South Coast Air Basin. While CARB has the ACT, ACF, and HD Engine and Vehicle Omnibus regulations in place, there is still a need to tackle interstate truck emissions. On June 3, 2016, South Coast AQMD petitioned U.S. EPA to initiate rulemaking for a lower national NOx standard for on-road HD engines to achieve additional mobile source emission reductions. The national NOx standard for on-road HD vehicles is estimated to result in 70 to 90 percent NOx emission reductions from this source category in 14 to 25 years, respectively. CARB estimates that 60 percent of total on-road HD vehicle miles traveled in the Basin are from vehicles

[4] The project, known as Joint Electric Truck Scaling Initiative, or JETSI, will be one the largest commercial deployment of battery-electric trucks in North America to date, helping to significantly increase the number of zero-emission HD trucks available for goods movement while achieving necessary emission reductions. This is the first battery-electric truck project jointly financed by CARB and the CEC, and the largest investment of its kind.

[5] WattEV opened a public HD truck charging site at the Port of Long Beach in May 2023 which is capable of charging 26 trucks concurrently. It is currently equipped with 60 kW chargers but can be expanded to provide additional capacity. WattEV has other public HD charging sites in San Bernardino and Gardena that should be operational in December 2023.

purchased outside of California, which points to the need for a more stringent federal as well as state standard for on-road HD vehicles. U.S. EPA has acknowledged the need for additional NOx reductions through a harmonized and comprehensive national NOx 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. Two additional EPA rules are under consideration, including the proposed Phase 3 HD GHG standards and the proposed LD and MD vehicle multi-pollutant standards for model year 2027. Both of these proposed rules include significant emphasis on large adoption of zero-emission LD, MD, and HD vehicles.

South Coast AQMD completed MATES V in August 2021 to update the emissions inventory of toxic air contaminants, as well as modeling to characterize risks, including measurements and analysis of ultrafine particle concentrations typically emitted or subsequently formed from vehicle exhaust. Findings from the MATES V report showed that air toxics cancer risk based on modeling data has decreased by 40% since 2015 MATES IV, with an average multi-pathway air toxics cancer risk at 454-in-a-million. The highest risk locations are at Los Angeles Airport (LAX), the San Pedro Bay Ports, and along major goods movement and transportation corridors. In MATES V, diesel PM is the largest contributor accounting for approximately 50% of the overall air toxics cancer risk. For the first time, chronic non-cancer risk was estimated with chronic hazard indices of 5 to 9 among the 10 stations in the MATES V study. MATES VI is in the planning stages with monitoring scheduled to start in mid 2025.

A key strategy of the Clean Fuels Program, which allows significant leveraging of Clean Fuels funding (historically $4 to every $1 of Clean Fuels funds), is its public-private partnerships with private industry, technology developers, academic institutions, research institutions and government agencies. Since 1988, the Clean Fuels Program provided more than $267.9 million toward projects nearing $1.7 billion. 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 reduction of criteria pollutants. Since the Carl Moyer Program began, South Coast AQMD has begun 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[6]. 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 further accelerate emission reductions.

Despite several current California incentive programs to deploy cleaner technologies and offset the higher procurement costs of cleaner technologies, significant additional resources and technology development is needed to achieve the NAAQS for this region. There are several key technologies that are discussed in detail later that will provide NOx and GHG co-benefits while requiring less vehicle purchase incentives.

The Clean Fuels Program has partnered with large OEMs, such as Daimler and Volvo to deploy HD BETs. 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

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

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 in large quantities, and utilize their distribution networks to support sales across the state.

Figure 4 outlines a developmental progression for technology demonstration and deployment projects funded by the Clean Fuels Program and the relationship incentive programs administered by TAO play in that progression. 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 4: Stages of Clean Fuels Program Funding

Many technologies that address the Basin's needed NOx reductions align with the state's GHG reduction efforts. U.S. EPA (2023)[7] noted that the transportation sector contributed 28 percent of overall GHG emissions. Due to these co-benefits, South Coast AQMD has been successful in partnering with the state and public/private partnerships to leverage its Clean Fuels funding extensively.

Program and Funding Scope

This Draft 2024 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 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 readiness of existing power grid; and development of alternative charging solutions;
4) necessity to improve hydrogen refueling station network reliability and availability, 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 2024 Plan Update remains sufficiently flexible to address new technologies and control measures identified in the 2022 AQMP, dynamically evolving technologies, and

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

new research and data. The latter includes findings from MATES V and emission inventories periodically updated by CARB.

Within the core technology areas defined later in this section, project objectives range from near term to long term. 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 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 to reduce 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 prior to the commercial introduction of technologies. Field demonstrations provide real-world evidence of performance to allay any concerns by early adopters as well as preliminary emissions reduction potential.
- Technology development projects are typically more advanced and require two or more years. Additionally, field demonstrations to gain long term verification of performance may also be needed prior to 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 reductions potential. Additionally, field demonstrations to gain long term verification of performance may also be needed prior to commercialization. In additional to field demonstrations, large scale pilot deployments are key to full certification and commercialization.

Core Technologies

The following technologies have been identified as having the greatest potential to enable the emission reductions needed to achieve the NAAQS and thus form the core of the Clean Fuels Program.

The goal is to fund viable projects in all categories. However, not all project categories will be funded in 2024 due to funding limitations, and the focus will remain on control measures identified in the 2022 AQMP, with consideration for availability of suitable projects. The project categories identified below are appropriate within the context of the current air quality challenges and opportunities for technology advancement.

Within these 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 the Basin. A concerted effort is continually made to form public-private partnerships to maximize leveraging of Clean Fuels funds.

Several of the core technologies discussed below are synergistic. For example, a 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 a natural gas HD vehicle that also combusts gaseous fuel and requires a compressed tank storage system; components of the similar combustion and fuel storage 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 which 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 disadvantaged communities.

The following ten core technology areas are listed by current South Coast AQMD priorities based on the goals for 2024.

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.

Hydrogen Infrastructure

With lead times on retail level hydrogen fueling stations requiring 18-36 months for permitting, construction and commissioning, plans for future stations need to 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 FCVs is insufficient, and supply of hydrogen and additional hydrogen production, specifically the 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 POLB property leased by Toyota. The station was commissioned in July 2021 and Shell continues to operate and maintain this station to consumer including Toyota and other fleet operators that commit to use FCEVs. As part of the $83 million Shore-to-Store project led by the POLA, 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 on 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, the Ontario and Wilmington stations are commissioned and completed site acceptance testing by November 2022, moving to 24-hour unstaffed operations. . 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.

New, ongoing, and recently completed hydrogen infrastructure projects include: 1) POLA Shore to Store project with 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, and 3) Equilon (Shell) project to develop a new 1000 kg/day HD hydrogen fueling station in POLB.

There are numerous fuel cell applications for off-road equipment; however, one of the primary challenges is the lack of 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. To address this issue, the development and demonstration of a fuel cell-powered mobile hydrogen refueler is proposed. This mobile refueler aims to provide the necessary hydrogen for fuel cell-powered cargo handling equipment (CHE). By conducting this demonstration, valuable insights into the technical requirements of mobile hydrogen fueling and the economic viability of this approach within a port complex can be gained.

Electric Charging Infrastructure

The challenges of installing charging infrastructure include costs, permitting, 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 are requiring 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 development of corresponding codes and standards for MD and HD infrastructure including adoption of a Megawatt Charging Standard (MCS) standard for high power megawatt charging. Additionally, SCE's Charge Ready Transport Program and Los Angeles Department of Water and Power's (LADWP) Commercial EV Charging Station Rebate Program includes funding for charging infrastructure.

LD EV charging infrastructure is commercially available, and the market is aligning towards the North American Combined Charging Standard (CCS1) while MD and HD charging infrastructure using CCS1 connectors are commercially available in an early deployment stage. The CCS1 connector continues to be the standard connector 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 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. Challenges and costs of installing MD and HD charging infrastructure increases exponentially compared to LD infrastructure due to higher power requirements.

South Coast AQMD is seeking both 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. In a related effort, Metro has committed $50 million of its funding 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 DOT to support the BETs and equipment at the Ports and facilitate electrifying long-haul transportation. There are also additional state and federal funding opportunities under CARB, CEC, and U.S. EPA for HD electrification and climate pollution reduction.

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 battery electric trucks 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.

The Draft 2024 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 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 load-shifting, energy resilience, and lower operating energy costs;
- demonstration and installation 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.

Hydrogen / Mobile Fuel Cell Technologies

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.

Fuel cells can play a role in MD and HD applications where battery recharge time and vehicle range, although improving, is insufficient to meet fleet operational requirements. The Hydrogen Fuel Cell Partnership's (H2FCP, previously known as California Fuel Cell Partnership or CaFCP) 2030 Vision[8] 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 CaFCP'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 with these OEMs 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 currently working on the ZECT 2 and a CEC/South Coast AQMD project to develop and demonstrate fuel cell drayage trucks with next generation fuel cell module - easy to package system design and other innovative integration strategies. In June 2021, South Coast AQMD recognized $500k from 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. In 2022, Volvo and Daimler also announced a joint venture to develop fuel cell powered trucks. In 2023, South Coast AQMD was awarded $5,000,000 from US. EPA Targeted Airshed Program to demonstrate and deploy six Daimler (Freightliner) Class 8 hydrogen fuel cell trucks with the partnership of Cummins that will be leased through Penske to various Southern California fleet operators.

The CaFCP Fuel Cell Electric Bus Road Map released in September 2019 supports implementation of 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.

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

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 the expansion of 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.

The Draft 2024 Plan Update identifies key opportunities while clearly 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 the Air Basin;
- coordination with FCEV OEMs to establish a roadmap to commercialization by overcoming barriers to economically competitive FCEVs and develop 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.

Electric / Hybrid Technologies

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.

Development and deployment of 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 as well as freight/logistics facilities throughout the Basin. 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), or plug-in hybrid powertrains, and linear synchronous motors for trucks. Additionally, the California Sustainable Freight Action Plan 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 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.

HD hybrid vehicles have historically been optimized for fuel economy, under the adopted CARB and EPA regulation, new hybrid powertrains must co-optimize for both criteria emissions and fuel economy by either by meeting the criteria standard by engine itself or as a combined system. These hybrid systems could be both plug-in and non-plug-in configurations, by focusing on electrifying key engine subsystems and energy recovery to provide engine assistance during transient operations. 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 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 Mobile Source Air Pollution Reduction Review Committee (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 the Basin 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 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 battery technologies for use in 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 metals; 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.

Stationary Clean Fuel Technologies

Although stationary source NOx emissions are small compared to mobile sources in the Basin, there are applications where clean fuel technologies or processes can be applied to reduce NOx, VOC and PM emissions. As discussed in engine systems, the use of 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, 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 installation of infrastructure. UCR's Sustainable Integrated Grid Initiative and UCI's Advanced Energy and Power Program, funded in part by the South Coast AQMD, for example, could assist in evaluation of these technologies.

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 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.

Fuel and Emissions Studies

Monitoring of pollutants in the Basin 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 few years, 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 air quality impacts from these vehicles. South Coast AQMD has funded studies to investigate both 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 natural gas and diesel HD vehicles. The results from these studies suggest the addition of a particulate filter for controlling particulate emissions from GDI vehicles. On April 12, 2023, the U.S. Environmental Protection Agency (EPA) announced new multi-pollutant standard for Light-Duty and medium-duty vehicles starting with model year 2027 which lowered the PM standard further that will require the use of particulate filter.

In 2017, South Coast AQMD initiated a basin wide in-use real-world emissions study, including fuel usage profile characterization and an assessment of the impacts of current technology and alternative fuels. The study was concluded in late 2022 with results suggest real-world emissions vary greatly between applications and fuel types; but alternative fueled technologies such as natural gas fueled vehicles, especially ones certified to near-zero emission levels, are significantly lower in emissions compared to diesel baseline. The results of the study also contributed to the new EMFAC 2021 emissions model.

In recent years, non-exhaust PM emissions has 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 have not been regulated because they are difficult to measure and control. Model predictions suggest that traffic-related emissions of both PM2.5 and PM10 will eventually be dominated by non-exhaust sources. SCAQMD has been engaging in researching effort to control these emissions by having a greater understanding of their physical and compositional characteristics and to support MATE VI efforts.Based on higher average summer temperatures over the past few years, there is interest on 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 the Basin. These types of studies may be beneficial to support 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 to support MATES VI;

- in-use emission studies using biofuels, including renewable diesel and other alternative fuels;
- in-use emission studies to determine 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;
- 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 impact of higher ambient temperatures on emissions of primary and secondary air pollutants.

Renewable Fuel Infrastructure

The Clean Fuels Program has provided funding for significant demonstration and commercialization efforts as well as other local, state and federal agencies: 1) upgrade and buildup of public and private infrastructure projects, 2) expansion of the network of public access and fleet fueling 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 natural gas refueling stations throughout Southern California with a certain percentage of renewable gas in the pipeline. Additionally, incentive funds have been made available for RNG infrastructure. South Coast AQMD has funded several RNG refueling projects through the Carl Moyer Program. The Clean Fuels program expects minimum funding allocated for RNG infrastructure.

Health Impacts Studies

Assessment of potential health risks linked to exposure to pollution is extremely important. Studies indicate that ultrafine particulate matter (PM) can produce irreversible damage to children's lungs, which highlights the need for further studies to identify health impacts resulting from these technologies.

Previous studies of ambient levels of toxic air contaminants, such as the MATES studies, have found that diesel exhaust is the major contributor to cancer risk from air toxics. South Coast AQMD completed MATES V in August 2021 to update the emissions inventory of toxic air contaminants, as well as modeling to characterize risks, including measurements and analysis of ultrafine particle concentrations typically emitted or subsequently formed from vehicle exhaust. Findings from the MATES V report showed that air toxics cancer risk has decreased 40% since MATES IV, with average multi-pathway air toxics cancer risk at 454 in a million. The highest risk locations are at LAX and the Ports along goods movement and transportation corridors. Diesel PM continues to be the major contributor accounting for over 60% of the overall air toxics cancer risk. For the first time, chronic non-cancer risk was estimated with chronic hazard indices of 5 to 9 among the 10 stations in the MATES V study. MATES VI is in the planning stages with monitoring scheduled to start in mid 2025.

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, natural gas 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 compare to baseline, due to excess lube oil consumption, ammonia emissions and lack of particulate filters.

Administrative and Technical Support

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[9] 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.

Engine Systems/Technologies

To achieve the emission reductions required for the Basin, 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% zero emission trucking sector will take time Meanwhile, with the recent CARB announcement, ICE engines will slowly transitioning to ultra-low NOx level starting MY 2027.

The effort with low emission ICE engines started back in 2016, with Cummins Westport, Inc. (CWI) 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. The 8.9 liter (8.9L) ISL-G natural gas engine demonstrated that an ICE could achieve NOx exhaust emission levels 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. The 8.9L engine works well in refuse and other vocational trucks as well as transit and school buses. Later, Cummins also certified the different displacement version of the engine for more market sectors including a more powerful 15L natural gas 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. South Coast AQMD has been working closely with CARB, U.S. EPA and others on defining low NOx diesel technology pathways via several projects. 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 EPA and CARB regulations.

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

More recently, Cummins announced a hydrogen powered ICE with near-zero NOx capabilities ready for implementation 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 2024 Plan Update includes on-road truck demonstrations and real-world emissions benefit analysis using hydrogen as a fuel for internal combustion.

The Draft 2024 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 2024 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.

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. South Coast AQMD will continue to fund studies to help mitigate emissions concerns for gasoline and natural gas fueled engines. Onboard emissions sensors have been identified by CARB and other agencies as a reliable method for assessing in-use emissions compliance. At the same time, 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, evaluate, and demonstrate cloud-based emissions and energy management system.

Target Allocations to Core Technology Areas

Figure 5 presents the potential allocation of available Clean Fuels Program funding, based on South Coast AQMD projected program costs of $33 million for all potential projects. The actual project expenditures for 2024 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 cost effectiveness of emission reductions as one of several factors in determining which technologies to fund the Legislature allows for flexibility in prioritizing technologies with a higher cost effectiveness if it is deemed necessary for South Coast AQMD to meet its NAAQS. The 2022 AQMP specifically calls for accelerated deployment of zero emission technologies wherever feasible to achieve the 2015 8-hour ozone standard and the associated CARB 2020 Mobile Source Strategy shows the need for rapid implementation of zero-emission transportation. Specific contract awards throughout 2024 will be based on this proposed allocation, quality of proposals received, and evaluation of projects against standardized criteria and ultimately South Coast AQMD 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.

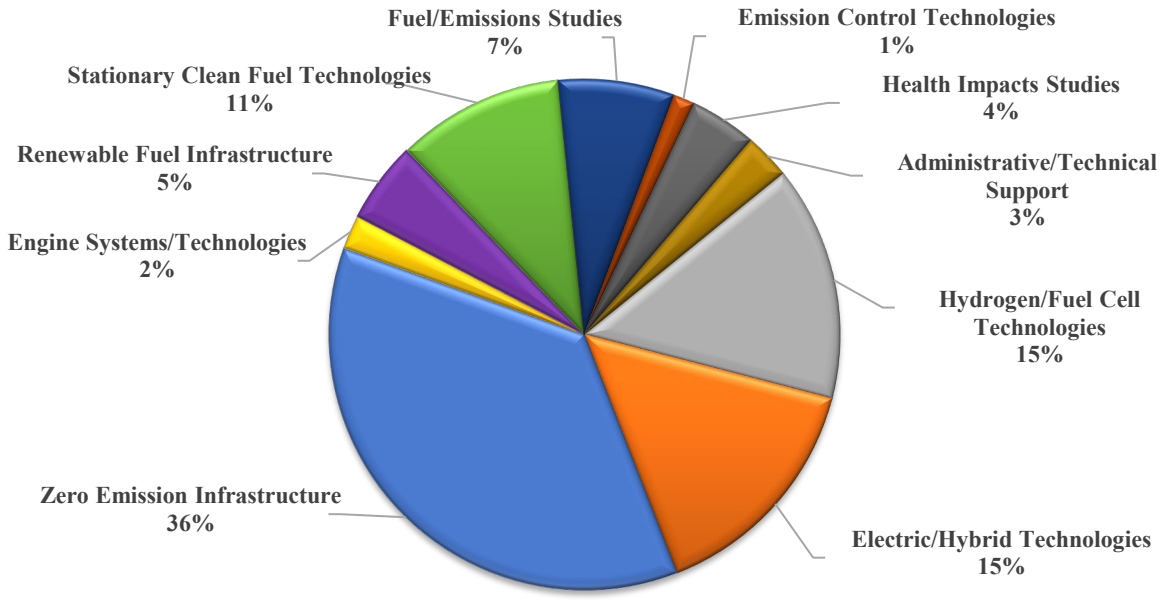


Figure 5: Projected Cost Distribution for Potential South Coast AQMD Projects in 2024 ($33M)

CLEAN FUELS PROGRAM

Program Plan Update for 2024

This section presents the Clean Fuels Program Plan Update for 2024. 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 1 summarizes potential projects for 2024 as well as the distribution of South Coast AQMD costs in some areas as compared to 2023. 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 2024 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 2024, including:

- HD zero emission battery electric and fuel cell trucks;
- HD zero emission infrastructure development, demonstration, deployment and planning, including ACS solutions;
- Onboard sensor development for emissions monitoring and improved efficiency;
- Microgrid demonstrations to support zero emission infrastructure;
- 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 2023-24 Goals and Priority Objectives, which includes supporting 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 in a synergistic manner.

Each of the proposed projects described in this Plan, once fully developed, will be presented to the South Coast AQMD Governing Board for approval prior to 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, proposed scope of work, and capabilities of 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

review of their programs, projects proposed in this Plan do not appear to duplicate any past or present projects.

Funding Summary of Potential Projects

The remainder of this section contains the following information for each of the potential projects summarized in Table 1.

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: Estimated total project cost including South Coast AQMD cost-share and cost-share of outside organizations expected to be required to complete the proposed project. This is an indication of how much South Coast AQMD public funds are leveraged through its cooperative efforts.

Description of Technology and Application: Brief summary of 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 proposed project, including expected 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 1: Summary of Potential Projects for 2024

Proposed Project	Expected SCAQMD Cost $	Expected Total Cost $
Zero Emission Infrastructure		
Develop and Demonstrate Hydrogen Production and Fueling Stations	2,000,000	6,500,000
Develop and Demonstrate Permanent Electric Charging Infrastructure	7,000,000	232,000,000
Develop and Demonstrate Innovative Charging Solutions for Grid Support	3,000,000	7,000,000
Subtotal	$12,000,000	$245,500,000
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	4,800,000	20,000,000
Subtotal	$4,900,000	$20,900,000
Electric/Hybrid Technologies		
Develop and Demonstrate MD and HD On-Road Battery Electric Vehicles and Equipment	4,800,000	255,500,000
Demonstrate Light-Duty Battery Electric Vehicles and Plug-In Hybrid Vehicles	160,000	160,000
Subtotal	$4,960,000	$255,660,000
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
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
Renewable Fuel Infrastructure		
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

Table 1: Summary of Potential Projects for 2024 (cont'd)

Proposed Project	Expected SCAQMD Cost $	Expected Total Cost $
Health Impacts Studies		
Source Specific Particulate Matter Impacts for MATES VI	1,000,000	1,250,000
Conduct Monitoring to Assess Environmental Impacts including MATES VI	200,000	800,000
Assess Sources and Health Impacts of Particulate Matter including MATES VI	200,000	800,000
Subtotal	$1,400,000	$2,850,000
Administrative and Technical Support		
Assess and Support Advanced Technologies and Disseminate Information	600,000	1,000,000
Support Implementation of Clean Fuels Incentives and Demonstration Projects	350,000	400,000
Subtotal	$950,000	$1,400,000
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
Emission Control Technologies		
Develop Methodology and Evaluate and Demonstrate Onboard Sensors for On-Road/Off-Road Vehicles	250,000	1,000,000
Demonstrate On-Road Technologies in Off-Road and Retrofit Applications	200,000	1,000,000
Subtotal	$450,000	$2,000,000
TOTALS FOR POTENTIAL PROJECTS	$32,960,000	$556,810,000

Technical Summaries of Potential Projects

Zero Emission Infrastructure

Proposed Project: Develop and Demonstrate Hydrogen Production and Fueling Stations

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

Expected Total Cost: $6,500,000

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 resulting 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 the development and demonstration of 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 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 and compatibility with existing CNG stations may be considered.

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 and to produce power and hydrogen from renewable feedstocks (e.g., biomass, digester gas) and store hydrogen in larger scale.

Innovative Fueling Appliances: Home or small scale fueling/charging or portable refueling solutions is 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.

CARB projections for on-road FCEVs counts are now 30,800 in 2024 and 61,000 in 2027 in California[10] and the majority of these do not include MD and HD vehicles deployed in the Basin. 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 operate hydrogen fueling stations and take advantage of funding opportunities that may arise soon with the California hydrogen hub application and others such as anticipated adoption of the Advanced Clean Fleets Regulation.

Potential Air Quality Benefits:

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

The 2022 AQMP identifies the use of alternative clean fuels in mobile sources as a key attainment strategy. Pursuant to 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 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 the 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: $7,000,000

Expected Total Cost: $232,000,000

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[11] EVs sold in the U.S. since 2010 were in California, and of those sales in California, almost half (44 percent) of CVRP[12] rebates issued as of July 2023 were for vehicles in the South Coast AQMD. 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 vs. 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. Availability and costs to deploy infrastructure remain the main challenges for LD EVs.

MD and HD EVs are becoming more commercially available, with multiple OEMs obtaining CARB certification for Class 4 though Class 8 battery and fuel cell electric vehicles. Standards for charging infrastructure to support MD and HD EVs has generally been with the CCS1 connector in North America. Although Tesla have adopted a different connector for their semi-trucks, the CCS1 connector continues to be the standard connector for charging up to 350 kW DC. 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. Each year there are commercially available options emerging for MD and HD on-road EVs and off-road equipment, charging infrastructure to HD EVs, equipment, and infrastructure. As the deployment of MD and HD EVs and off-road equipment has increased, there is an increasing reliance on the use of standardized charging connectors that are UL or Nationally Recognized Testing Laboratory (NRTL) certified charging infrastructure, as opposed to proprietary charging infrastructure and connectors which can only be used with EVs and equipment manufactured by that OEM or equipment manufacturer. Further, for off-road mobile applications where a fixed charging solution is not feasible, innovative solutions must be explored and demonstrated. There is significant funding provided by the Bipartisan Infrastructure Law and the Inflation Reduction Act that can support overcoming the challenges we expect wide-spreadly EVSE project to be funded within the next decade. Other federal, state and local funding opportunities have been recently announced or are expected to fund MD/HD public charging infrastructure. South Coast AQMD has partnered with private entities to submit proposals to DOT to support battery electric vehicles and equipment at the Ports and facilitate electrifying long-haul transportation.

This project category is one of South Coast AQMD's continued efforts to:

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

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

- deploy 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;
- deploy 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 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;
- develop MD/HD charging infrastructure solutions that provide easier installation through reduced grid reliance and increased resiliency;
- develop ACS solutions that provide temporary solutions charging and or mobile backup power;
- support investigation of fast charging impacts on battery life;
- develop intelligent transportation system strategies for cargo containers; and
- develop 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 battery electric trucks 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 the Basin, 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: $3,000,000

Expected Total Cost: $7,000,000

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, serval OEMs have commercialized battery electric medium and heavy-duty 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) could support a large scale deployment of battery electric trucks 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 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 batteries packs, hydrogen fuel cell generators, combustion of renewable fuels, as well as temporary installation of charger 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. Today, ACS systems are relatively new but rapidly becoming commercially available for smaller capacity solutions. Larger systems which often require onboard generation are currently being developed and demonstrated.

Potential Air Quality Benefits:

Certification of battery electric and hybrid electric vehicles and engines and their integration into the Basin's transportation sector is a high priority under the 2022 AQMP. This project is expected to further efforts to develop innovation charging technologies that could be aid in 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.

Hydrogen / Mobile Fuel Cell Technologies

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% 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 in the world 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 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 as such additional hydrogen research studies and projects are foreseen in 2023.

The California Hydrogen Infrastructure Research Consortium focuses on top research needs and priorities to address near-term problems to support California's continued leadership in innovative hydrogen technology solutions needed for fueling FCEVs. These tasks also provide significant contributions 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 polices and their impact on a 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 natural gas (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 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: $4,800,000

Expected Total Cost: $20,000,000

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 to reduce costs and potentially 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 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 being charged 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 Technology Readiness Level (TRL) of hybrid, battery electric and fuel cell HD trucks on the overall vehicle design and architecture. Especially, the fuel cell drayage truck's TRL prior to this project was at a strong Level 4 with several proof-of-concept vehicles constructed and it has advanced the TRL to a 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 2023 the U.S. EPA Targeted Airshed Grant Program awarded South Coast AQMD with development and deployement of six 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 • Shuttle Buses • MD & HD Trucks	• Vehicle Auxiliary Power Units • Construction Equipment • Lawn and Garden Equipment • Cargo Handling Equipment

Potential Air Quality Benefits:

The 2022 AQMP identifies the need to implement ZEVs. South Coast AQMD adopted fleet regulations require public and some private fleets within the Basin to acquire alternatively fueled vehicles when making new purchases. CARB is revising the Advanced Clean Fleets for adoption in 2022 to impose 100% 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 the Basin. 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 range of 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 demonstrate improvements in reliability and durability of powertrain systems 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.

Electric / Hybrid Technologies

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

Expected South Coast AQMD Cost: $4,800,000

Expected Total Cost: $255,500,000

Description of Technology and Application:

The South Coast AQMD has long been a leader in promoting 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[13] percent of vehicles in the U.S. and drive 11[14] percent of all vehicle miles traveled each year and yet are responsible for more than 30[15] percent of all the fuel burned annually. Moreover, the 2022 AQMP identified MD and HD vehicles as the largest source of NOx emissions in the Basin. 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.

South Coast AQMD has investigated the use of electric and hybrid technologies to achieve similar performance as conventional-fueled counterparts while achieving emission reductions and improved fuel economy. Multiple natural gas and diesel hybrid vehicles have been developed and demonstrated under the DOE funded Zero Emissions Cargo Transport (ZECT), CARB Greenhouse Gas Reduction Fund (GGRF) and NREL's Natural Gas Vehicle Research Consortium. These hybrid trucks all share plug-in capability and ability to operate in zero emission mode, and some leveraging advanced concepts such as geofencing and EcoDrive to maximize emission reductions in disadvantaged communities. CARB ACT and ACF regulations further provided additional compliance flexibility for plug-in hybrids with zero emission range. Battery electric-powered trailers is under development, which can integrate with existing diesel and zero-emission tractors. The electric-powered trailer can provide propulsion assistance and/or regenerative braking, and thus results in immediate emission reductions for diesel tractors and range extension of new zero-emission tractors. Vehicle based hybrid systems continue to progress for additional emission reductions and efficiency improvements. Engine powertrain based hybrid systems also began to emerge.

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

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

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

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

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.

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 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 just 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) which have been seeing great success in 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 that will require alternative charging solutions (ACS).

This project category will develop and demonstrate:

- various electric vehicles and equipment;
- studies for anticipated costs for electric vehicles and equipment;
- customer interest and preferences for these alternatives;
- integration of technologies into prototype vehicles and fleets;
- 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);
- 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; and
- development and demonstration of hybrid and plug-in hybrid vehicle technology.

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 emission 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 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 zero and near-zero emission vehicles in the Basin, 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:

Zero Emission Infrastructure South Coast AQMD has included BEVs and PHEVs as part of its demonstration fleet since the development of early conversion vehicles. South Coast AQMD installed 92 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 education outreach regarding BEV and PHEV technology. Thirty networked Level 2 fleet chargers were added through the Southern California Edison Charge Ready Fleet program in 2020, which will help South Coast AQMD acquire 8,500 GVW and over ZEVs like LD trucks and vans to comply with the upcoming CARB Advanced Clean Fleet regulation.

LD BEVs and PHEVs are available from most established OEMs and several new OEMs. Current legislation extends solo carpool lane access only for MY 2019 and later vehicles, with all Clean Air Vehicle decals expiring between 2023 - 2025, unless legislation is adopted to continue.

Potential Air Quality Benefits:

The 2022 AQMP identifies the need to implement LD EVs. South Coast AQMD adopted fleet regulations require public and some private fleets within the Basin to acquire alternatively fueled vehicles when making new purchases. In the future, such vehicles could be powered by BEVs. The proposed projects have the potential to accelerate 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 the Basin. 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.

Stationary Clean Fuel Technologies

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% of Class 4–8 straight trucks sales and 15% 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. Both Daimler and Volvo obtained CARB certification of their Class 6 and/or 8 battery electric trucks in 2020, with these trucks eligible for HVIP and other incentives and commercially available for sale. South Coast AQMD also received $16M in CARB and $11M in CEC funding, as well as $34M in co-funding from project partners for the deployment of 100 Daimler and Volvo Class 8 battery electric trucks, 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 have an impact on air quality.

Large deployments of zero emission Class 8 battery electric trucks (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 the capital expenditure of EV or hydrogen infrastructure impossible to recoup in a short period of time. To comply with existing and upcoming regulatory requirements, fleets are having to navigate challenges in installing and maintaining charging and/or fueling infrastructure. Microgrids can be instrumental in meeting the challenge of providing large amounts of energy cost-effectively for EV charging or hydrogen generation to support zero emission vehicle charging and fueling. Additionally, if the microgrid equipment is owned by a third party and energy is sold to the fleet through a power purchase agreement, 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 with respect to 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. Having assurance of 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 terms of 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% 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 of 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. For a 100-vehicle fleet of FCTs the hydrogen requirement 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. Staff has demonstrated several microgrid projects with University of California Irvine and has toured the microgrid at University of California San Diego. Currently, 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 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 that demonstrate 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 the Basin.

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 in excess of 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:

The objective of this project is to support development and demonstration of clean energy, 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 of particular interest. Also, in the agricultural sections of the Basin, 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 in fuel cells emissions are reduced to zero.

This project is expected to result in pilot-scale 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 natural gas generated from renewable sources for injection into natural gas pipelines, improve reliability and identify markets that could expedite implementation of successful technologies.

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 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.

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, hybrid hydraulic, 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.

In the past two decades, South Coast AQMD has been supporting rapid deployment of near-zero emission natural gas technologies since 2015. As more near-zero emission natural gas, propane and other alternative fuel technologies penetrate different segments, in-use assessment of real-world benefit is needed to monitor the impact of these vehicles.

The CARB EMFAC 2017 model that the 2022 AQMP is has a relatively limited data set for alternative fuel vehicles. For the latest EMFAC 2021, more complete natural gas engine modules have been included for the first time with emissions data gathered recently completed 200 vehicle in-use emissions study. In additional to the natural data, the 200-vehicle data also provided key inputs for the activity updates from the EMFAC model in the region. 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, I but there are still a significant population of the MY 2010+ 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 emission 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 also expects new 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: $1,00,000

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 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 the Basin. 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% as a means to increase the amount 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 natural gas 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 the Basin, 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 the Basin. 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 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;
- test cycle development for different class vehicles (e.g. four-wheel drive SUVs);
- electrical auxiliary power unit replacements;
- development, deployment and demonstration of smart vehicle telematic systems;
- fleet and charger management concepts; and
- low cost NOx 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.

Renewable Fuel Infrastructure

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 the Basin due to the deployment by fleet owners and operators of HD vehicles utilizing this fuel. Currently, an increasing number of on-road HD natural gas engines are being certified to CARB's optional low-NOx standards which are significantly lower in NOx emissions than the current on-road HD standard. 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 NGVs. Under Engine Systems, South Coast AQMD supports efforts for development of high-powered NGVs to support long-haul applications. Increasing natural gas engine availability for the full range of applications would increase NGV deployment in long-haul applications where diesel engines have been the only feasible option.

Hydrogen fueled internal combustion engines starts to gain more attentions as a few advantages exist with this technology. Comparing with the fuel cell electric technology, hydrogen ICE can work at a lower level of purity and costs less. It can also be a drive force for the fuel cell battery application by increasing the consumption of hydrogen fuel in the transportation sector. Hydrogen ICE shares similarities with traditional ICE. The development cycle is relatively short. Efforts have been put on to optimize tailpipe NOx emissions, while greenhouse gas emissions are zero.

Potential Air Quality Benefits:

NGVs have inherently lower engine criteria pollutant emissions relative to conventionally fueled vehicles, especially older diesel-powered vehicles. Recently, on-road HD engines have been certified to near-zero emission levels that are 90% lower in NOx than the current on-road HDV standard. California's On-Road Truck and Bus Regulation requires all on-road HDVs to meet the current standard by January 1, 2023. 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 NGVs in private and public fleets, goods movement applications, and transit buses will help reduce local emissions and emissions exposure to nearby residents. NGVs can also have lower GHG emissions and increase energy diversity, help address national energy security objectives, and reduce biomass waste produced from such feedstocks. Deployment of additional NGVs is consistent with the 2022 AQMP goal to reduce criteria pollutants. When fueled by RNG, 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 natural gas fueling infrastructure in strategic locations throughout the Basin, including the Ports, and advancing technologies and station design to improve fueling and fueling efficiencies of HD NGVs. This category supports broader deployment of near-zero emission HD vehicles and implementation of South Coast AQMD's fleet rules. In addition, as natural gas 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 near-zero emission NGVs in private and public fleets. It is expected that the lower fuel cost of natural gas relative to diesel and added financial incentives of RNG under the state's Low Carbon Fuel Standard (LCFS) program attract fleets and consumers to this technology. Increased exposure and fleet and consumer acceptance of NGVs will lead to significant and direct reductions in NOx, VOC, CO, PM and toxic compound mobile source emissions. Such increased penetration of NGVs will provide direct emission reductions of NOx, VOC, CO, PM and air toxic compounds throughout the Basin.

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 the Basin. 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.

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 natural gas liquefaction technologies;
- utilization of various gaseous feed stocks locally available;
- commercialize incentives for fleets to site, install and use RNG 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 the Basin 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.

Health Impacts Studies

Proposed Project: Source Specific Particulate Matter Impacts for MATES VI

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

Expected Total Cost: $1,250,000

Description of Technology and Application:

Reducing diesel exhaust from vehicles has become a high priority in the Basin since CARB identified the particulate phase of diesel exhaust as a surrogate for all toxic air contaminants emitted from diesel exhaust. Additionally, health studies indicate that ultrafine particulate matter (UPM) may be more toxic on a per-mass basis than other fractions. Several control technologies have been introduced and others are under development. Recent studies have shown that control technologies applied to mobile sources have been effective in reducing the mass of particulates emitted. However, there is also evidence that UPM on and near roadways has increased, even while the mass of particulates has decreased. To have a better understanding of changes in ultrafine particulate emissions from the application of new technologies and health effects of these emissions, an evaluation and comparison of UPM and potential impacts on community exposure, particularly in disadvantaged communities, is needed.

In this project, measurements and chemical composition of UPM will be done, as well as studies conducted from HD vehicles to measure, evaluate and compare UPM, PAH and other relevant toxic emissions from different types of fuels such as gasoline, CNG, low-sulfur diesel, biofuels and others. This project needs to be closely coordinated with development of technologies for alternative fuels, aftertreatment technologies, and new engine development to determine health benefits of such technologies.

Furthermore, gasoline direct injection (GDI) vehicles are known for higher efficiency and power output but the PM emissions profile is not well understood especially on secondary organic aerosol (SOA) formation potential. As manufacturers introduce more GDI models in the market to meet new fuel economy standards, it is important to understand SOA potential from these vehicles as it could further impact ambient PM concentration in our region. In 2015 a project with UCR CE-CERT to investigate the physical and chemical composition of aerosols from GDI vehicles using a mobile environmental chamber was designed and constructed to characterize secondary emissions. Based on initial results indicating an increase in particle numbers, follow-up in-use studies to assess PM emissions including with and without particle filters will be beneficial. Similar studies should also be conducted on natural gas MD and HD vehicles to understand potential emissions impacts are being considered.

Potential Air Quality Benefits:

The 2022 AQMP for the Basin relies on significant penetration of low emission vehicles to attain federal clean air standards. Reduction of PM emissions from combustion of diesel and other fuels is a major priority in achieving these standards. This project would help to better understand the nature and number of UPM generated by different types of fuels and advanced control technologies as well as provide information on potential health effects of UPM. Such an understanding is important to assess the emission reduction potentials and health benefits of these technologies. In turn, this will have a direct effect on the policy and regulatory actions for commercial implementation of alternative fuel vehicles in the Basin.

Proposed Project: Conduct Monitoring to Assess Environmental Impacts including MATES VI

Expected South Coast AQMD Cost: $200,000

Expected Total Cost: $800,000

Description of Technology and Application:

Facilities, buildings, structures, or highways which attract mobile sources of pollution are considered "indirect" sources. Ambient and saturation air monitoring near sources such as ports, airports, rail yards, freight/logistics distribution centers and freeways is important to identify emissions exposure to surrounding communities and provide data to assess health impacts. This could include the study of indirect sources such as warehouses which are impacted by South Coast AQMD's Indirect Source Regulations. This project category would identify areas of interest and conduct ambient air monitoring, emissions monitoring, analyze data and assess potential health impacts from mobile sources. These projects would need to be at least one year in duration to properly assess air quality impacts in surrounding communities.

Potential Air Quality Benefits:

The proposed project will assist in evaluation of adverse public health impacts associated with mobile sources. The information will be useful in (a) determining whether indirect sources have a relatively higher impact on residents living in close proximity, particularly in disadvantaged communities; and (b) providing guidance to develop some area-specific control strategies in the future should it be necessary.

Proposed Project: Assess Sources and Health Impacts of Particulate Matter including MATES VI

Expected South Coast AQMD Cost: $200,000

Expected Total Cost: $800,000

Description of Technology and Application:

Previous studies of ambient levels of toxic air contaminants, such as the MATES studies, have found that diesel exhaust is the major contributor to health risk from air toxics. Analyses of diesel particulate matter (DPM) in ambient samples have been based on measurements of elemental carbon. While the bulk of particulate elemental carbon in the Basin is thought to be from combustion of diesel fuels, it is not a unique tracer for diesel exhaust.

The MATES III study collected particulate samples at ten locations in the Basin. Analysis of particulate bound organic compounds was utilized as tracers to estimate levels of ambient DPM as well as estimate levels of PM from other major sources. Other major sources that were taken into consideration include automobile exhaust, meat charbroiling, road dust, wood smoke and fuel oil combustion. Analyzing for organic compounds and metals in conjunction with elemental carbon upon collected particulate samples was used to determine contributing sources.

MATES IV, completed in 2015, included an air monitoring program and updated emissions inventory of toxic air contaminants. MATES IV also measured UPM concentrations and black carbon at monitoring sites as well as near sources such as airports, freeways, rail yards, busy intersections and freight/logistics warehouse operations.

South Coast AQMD completed MATES V in August 2021 to update the emissions inventory of toxic air contaminants, as well as modeling to characterize risks, including measurements and analysis of ultrafine particle concentrations typically emitted or subsequently formed from vehicle exhaust. Findings from the MATES V report showed that air toxics cancer risk based on modeling data has decreased by about 50% since MATES IV, with average multi-pathway air toxics cancer risk at 454-in-a-million. The highest risk locations are at LAX and the Ports along goods movement and transportation corridors. Diesel PM continues to be the major contributor accounting for over 60% of the overall air toxics cancer risk. For the first time, chronic non-cancer risk was estimated with a chronic hazard index of 5.9 across the 10 stations in the MATES V study. The MATES VI study is in the planning stages with monitoring scheduled to start in summer 2025.

This project category would include other related factors, such as toxicity assessment based on age, source (HD, LD engines) and composition (semi-volatile or non-volatile fractions) to better understand health effects and potential community exposure, particularly in disadvantaged communities. Additionally, early identification of new health issues could be of considerable value and could be undertaken in this project category.

Potential Air Quality Benefits:

Results of this work will provide a more robust, scientifically sound estimate of ambient levels of DPM as well as levels of PM from other significant combustion sources, including gasoline and diesel generated VOCs. This will allow a better estimation of potential exposure and health effects from toxic air contaminants from diesel exhaust in the Basin. This information in turn can be used to determine health benefits of promoting clean fuel technologies.

Administrative and Technical Support

Proposed Project: Assess and Support Advanced Technologies and Disseminate Information

Expected South Coast AQMD Cost: $600,000

Expected Total Cost: $1,000,000

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. 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.

Air Quality Benefits:

South Coast AQMD will provide matching funds to implement several key incentive programs to reduce emissions in the Basin. 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 the Basin.

Engine Systems / Technologies

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: $500,000

Expected Total Cost: $2,000,000

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 development of low-NOx diesel or natural gas engine hybrid/plug-in hybrid powertrains have also shown the potential for achieving lower NOx as a combined system. More importantly, the release of EPA HD GHG Phase 3 National Proposed Rulemaking further promoted developed of internal combustion engines using non-carbon containing fuels such as hydrogen. To achieve the lower NOx and PM targets, an effective emissions control strategy must employ advanced fuel system and engine design features such as CDA, aggressive engine calibration and improved thermal management, improved exhaust gas recirculation (EGR) systems, and aftertreatment devices that are optimized using a system approach. 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.

In the past two decades, the use of alternative fuel in HD trucking applications has been demonstrated in certain local fleets within the Basin, resulted in wide-spread deployment of natural gas MD and HD vehicles. These vehicles typically require 200-400 HP engines. Higher HP alternative fuel engines for long-haul

applications are beginning to be introduced with Cummins announced the availability of the 15 liter natural gas engine in MY 2024. However, vehicle range, lack or limited accessible public infrastructure, lack of experience with alternative fuel engine technologies, limited selection of appropriate alternative fuel engine products, and high initial cost are still barriers for more fleets to adopt and deploy larger quantity of alternative fuel vehicles given diminishing incentives for ICEs.

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 proposed amendments to the already adopted Omnibus Regulation, proposing alignment with the adopted EPA Clean Truck Plan NOx rule in MY2027 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 the Basin 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 natural gas 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: $200,000

Expected Total Cost: $1,500,000

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, 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 natural gas 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 marine sector. The development of engines and systems to fill this need is currently on-going 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.

Emission Control Technologies

Proposed Project: Develop Methodology and Evaluate and Demonstrate 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 the Basin. 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 addresses 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 natural gas 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 the Basin to achieve NAAQS and protect public health.

Proposed Project: Demonstrate On-Road Technologies in Off-Road and Retrofit 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 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.

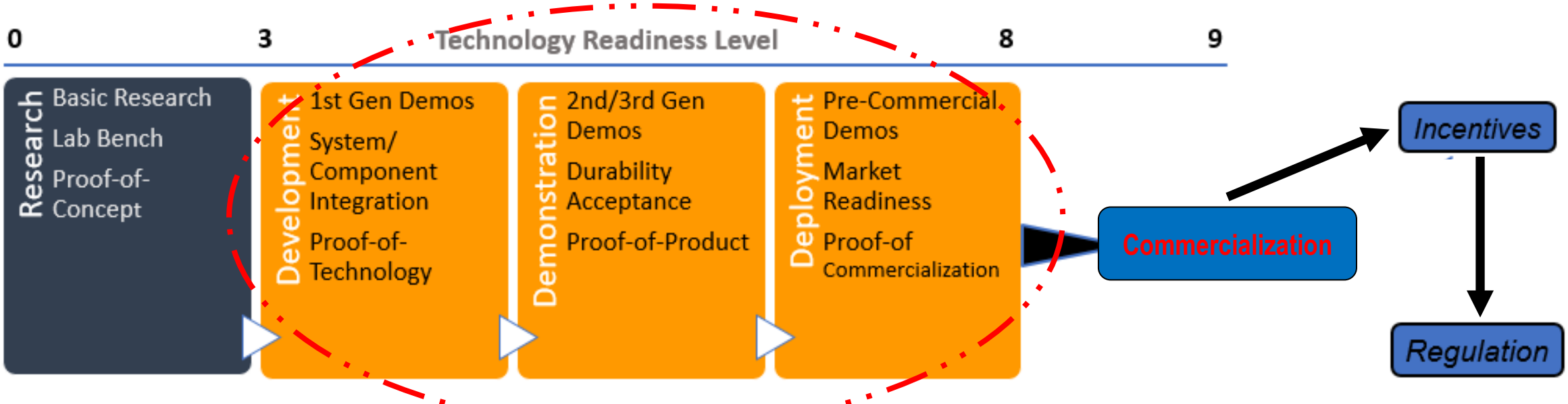
South Coast Air Quality Management District

Clean Fuels 2024 Plan Update

Agenda Item #3
Vasileios Papapostolou
Technology Demonstration Manager

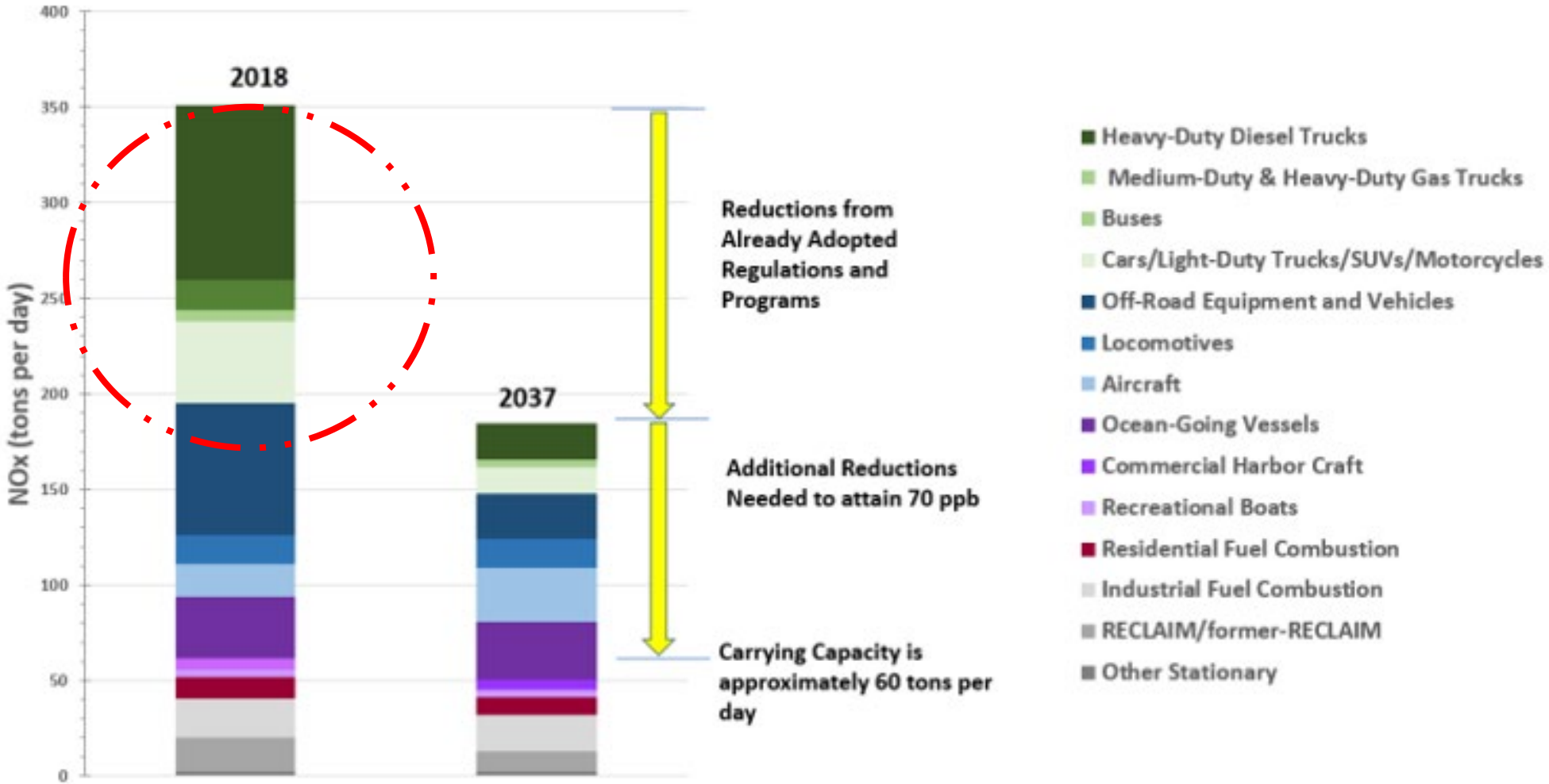
Clean Fuels Fund Program

- Established in 1988
- $1 fee on DMV registrations ($~12M/year)
- Stationary source fee (~$400k/year)
- Research, develop, demonstrate, and deploy clean technologies
- Revised to reflect technical priorities and proposed project areas



NOx Reductions Needed

83%



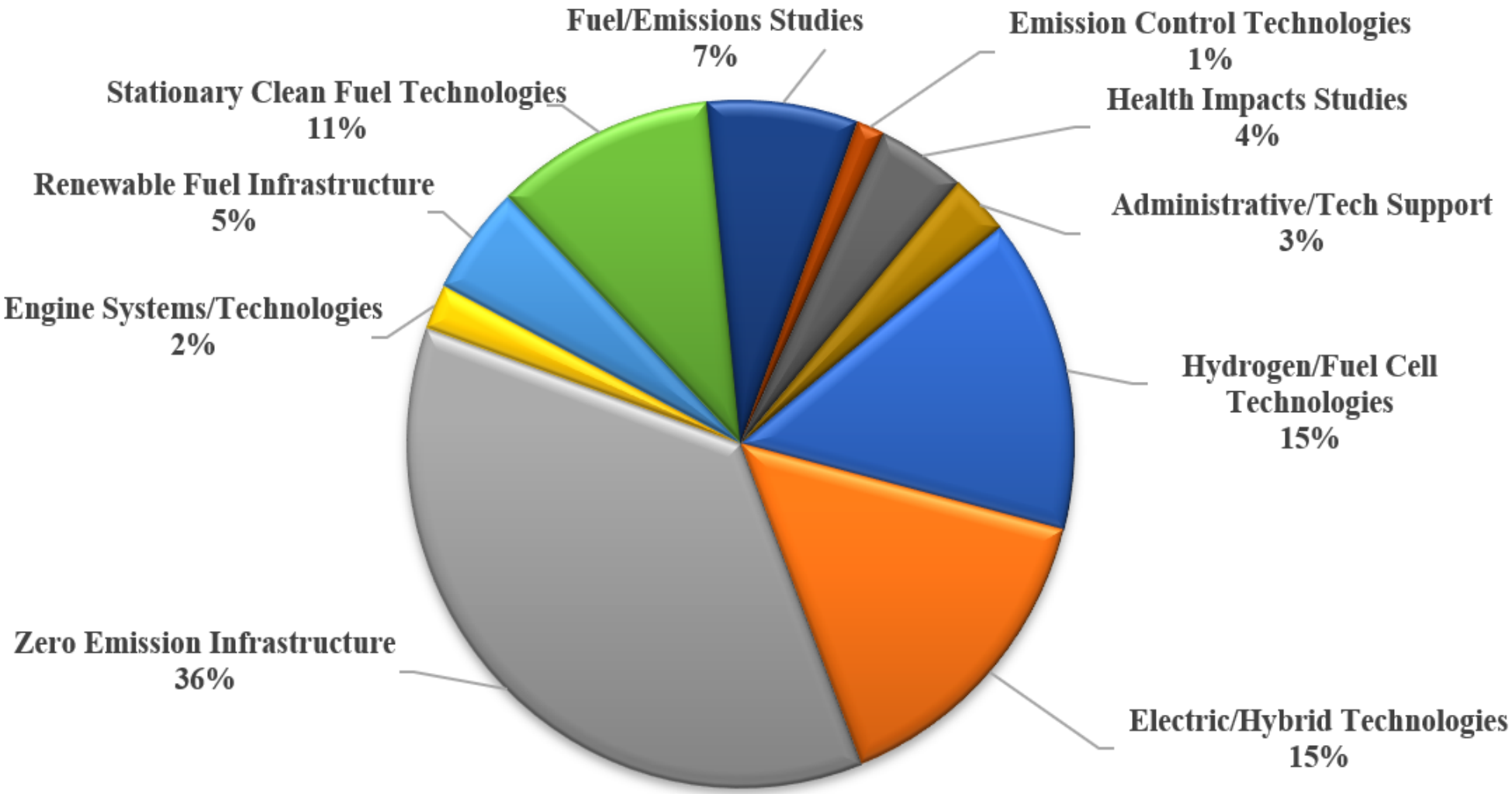
Draft 2024 Plan Update (Key Technical Areas)

- Medium and heavy-duty zero emission vehicles, and charging infrastructure
- Alternative charging infrastructure solutions to deploy ZEV
- Zero emission microgrid technologies
- Ultra-low NOx and heavy-duty zero emission engine technologies
- Fuel and NOx emission studies from hydrogen internal combustion engines
- Non-tailpipe PM emissions studies such as tire and brake wear

Draft 2024 Plan Update
Proposed Projects

- Large deployments of medium and heavy zero emission trucks and infrastructure
- Innovative solutions to support heavy duty truck charging and hydrogen fueling
- High-power charging (Megawatt) to reduce battery electric truck charging times
- Develop and demonstrate long range Class 8 fuel cell electric trucks and equipment
- Develop and demonstrate green hydrogen production pathways

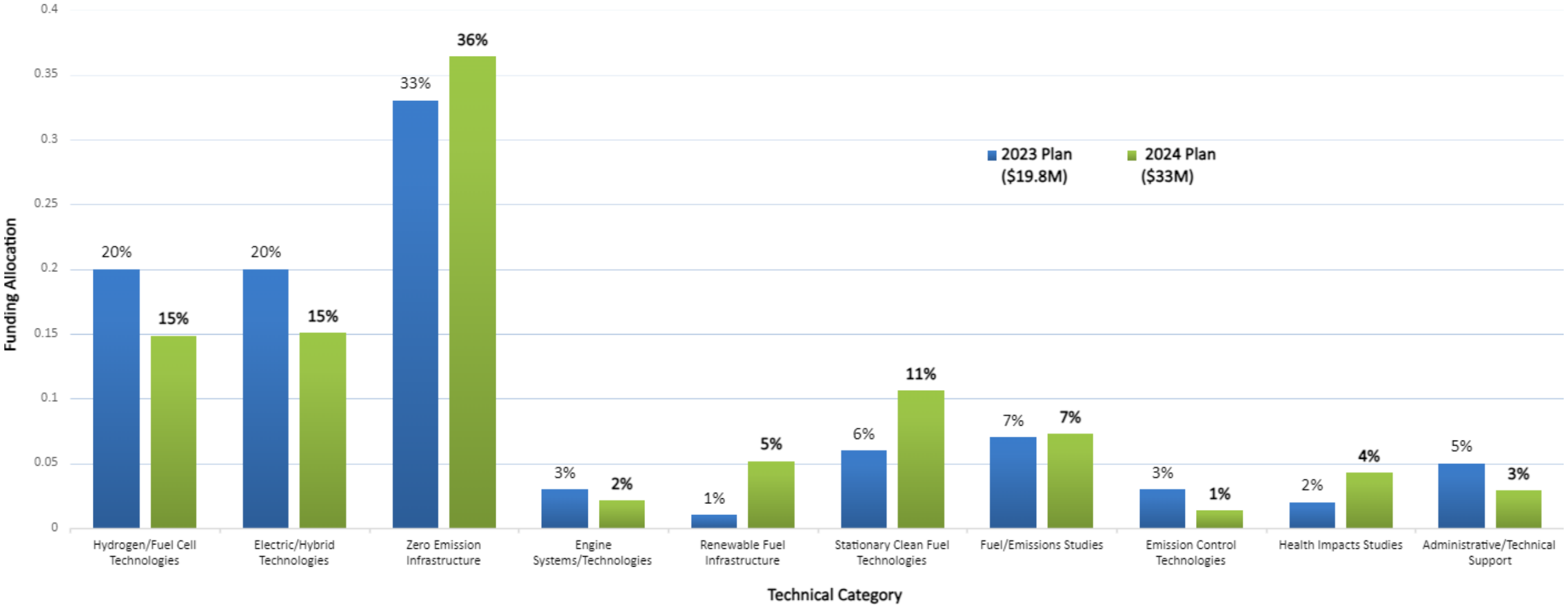
Proposed 2024 Plan Distribution*



$33 million

*Estimated

Plan Update Comparison



Increased AQMD Funding Support

- **Zero Emission Infrastructure:**
  - Hydrogen Production and Fueling Stations
  - HD and Public Access Electric Charging Infrastructure
  - Innovative Charging Solutions for Grid Support
- **Renewable Fuel Infrastructure (New category!):**
  - Low-Emission Engine/Generation Technologies
  - Renewable Fuel Infrastructure
  - Renewable Transportation Fuel Production and Distribution Technologies
- **Stationary Clean Fuel Technologies:**
  - Microgrids with Photovoltaic/Fuel Cell/Battery Storage/Energy Management
  - Zero/Near-Zero Emission Energy Generation Alternatives
- **Health Impact Studies (e.g., MATES VI):**
  - Source Specific Particulate Matter Impacts
  - Conduct Monitoring to Assess Environmental Impacts
  - Assess Sources and Health Impacts of Particulate Matter

Next Steps

- Continue to apply for State and Federal funding opportunities
- Focus on off-road ZEV and equipment solutions
- Pursue alternative solutions to support deployment of ZEV charging and fueling infrastructure