



South Coast Air Quality Management District

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

TECHNOLOGY COMMITTEE MEETING HYBRID FORMAT

Committee Members

Council Member Joe Buscaino, Chair
Supervisor Lisa Bartlett
Board Member Gideon Kracov
Mayor Pro Tem Larry McCallon
Vice Mayor Rex Richardson
Mayor Pro Tem Carlos Rodriguez

November 19, 2021 ♦ 12:00 p.m.

Pursuant to Assembly Bill 361 the South Coast AQMD Technology Committee meeting will be held at 10:30 a.m. on Friday, November 19, 2021 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/or virtual attendance via videoconferencing and by telephone.

Given health and safety concerns, auditorium seating availability may be limited and the meeting format may be changed to full remote via webcast. 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>

Proof of vaccination or a negative COVID test within 72 hours prior to the start of the meeting will be required for admittance into the auditorium.

Proof of COVID-19 Vaccination includes:

- COVID-19 Vaccination Record Card (issued by the Department of Health and Human Services Centers for Disease Control & Prevention or WHO Yellow Card1) which includes name of person vaccinated, type of vaccine provided and date doses administered); OR
- A photo of a vaccination card as a separate document; OR
- A photo of the vaccine card stored on a phone or electronic device; OR
- Documentation of vaccination from a healthcare provider; OR
- [Digital record](#) that includes a QR code that when scanned by a SMART Health Card reader displays to the reader: name, date of birth, vaccine dates and vaccine type

REMINDER: Mask wearing is required indoors during the meeting.

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

Join Zoom Meeting - from PC or Laptop

<https://scaqmd.zoom.us/j/96669409722>

Zoom Webinar ID: 966 6940 9722 (applies to all)

Teleconference Dial In

+1 669 900 6833

One-Tap Mobile

+16699006833, 96669409722#

**Audience will be able to provide public comment in person or through Zoom connection or telephone.
PUBLIC COMMENT WILL STILL BE TAKEN**

Cleaning the air we breathe...

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 attending in person, please provide a Request to Address the Committee card to the Committee Secretary if you wish to address the Committee on an agenda item.

If no cards are available, please notify South Coast AQMD staff or a Board Member of your desire to speak. If on Zoom, 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 each.

CALL TO ORDER

ROLL CALL

ACTION ITEMS (1-2):

- 1. Recognize 2021 U.S. EPA Targeted Airshed Grant Program Awards for Zero-Emission Vehicles and Equipment, Issue RFPs, Transfer Funds, Execute Contracts to Demonstrate Zero-Emission Vehicles and Equipment, and Reimburse General Fund (*Motion Requested*)**
South Coast AQMD has been awarded up to \$14,339,960 from U.S. EPA 2021 Targeted Airshed Grant Program to demonstrate a zero-emission freight line-haul locomotive, long-range Class 8 fuel cell trucks, deploy zero-emission school buses, and replace commercial lawn and garden equipment. These actions are to: 1) recognize revenue, upon receipt, of up to \$14,339,960 from U.S. EPA into the Advanced Technology, Outreach and Education Fund (17); 2) transfer up to \$2,169,169 from the Air Quality Investment Fund (27) into the Advanced Technology, Outreach and Education Fund (17) for South Coast AQMD cost-share; 3) contingent upon U.S. EPA's final awards, execute three contracts in a total amount not to exceed \$12,749,000 from the Advanced Technology, Outreach, Outreach and Education Fund (17); 4) issue RFPs and execute resulting contracts for the Commercial Lawn and Garden Equipment Incentive and Exchange Program in an amount not to exceed \$3,020,000 from the Advanced Technology, Outreach and Education Fund (17); and 5) reimburse the general fund for administrative costs up to \$590,960 from the Advanced Technology, Outreach and Education Fund (17).

Mei Wang
Program Supervisor

- 2. Approve Awards for Lower-Emission School Bus Program and Transfer Funds for Development of Lower Emission School Bus Grant Management System (*Motion Requested*)**

Yuh Jiun Tan
Program Supervisor

In October 2020, the Board issued a Program Announcement to solicit applications for the replacement of pre-2001 model year diesel school buses with new alternative fuel or zero emission buses. This action is to approve awards to replace pre-2001 diesel school buses with new, near-

zero or zero emission school buses and infrastructure in an amount not to exceed \$47 million from the Carl Moyer Program AB 923 Fund (80). This action is to also appropriate up to \$81,000 from the administrative portion of the Carl Moyer Program AB 923 Fund (80) into Information Management's FY 2021-22 Budget, Professional and Special Services and/or Capital Outlays Major Objects and reimburse the General Fund (01) using administrative funds for enhancement for the Lower Emission School Bus Program grant management system.

INFORMATIONAL ITEM:

**3. Clean Fuels Program Draft 2022 Plan Update
(Written Report - No Motion Requested)**

Aaron Katzenstein
Assistant Deputy
Executive Officer

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 with particular emphasis on heavy-duty truck technologies with zero and near-zero emissions for goods movement applications as well as a continued focus on preparing for hydrogen vehicle deployments.

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, December 17, 2021 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 Chairman 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.

Technology Committee Agenda #1

BOARD MEETING DATE: December 3, 2021

AGENDA NO.

PROPOSAL: Recognize 2021 U.S. EPA Targeted Airshed Grant Program Awards for Zero-Emission Vehicles and Equipment, Issue RFPs, Transfer Funds, Execute Contracts to Demonstrate Zero-Emission Vehicles and Equipment, and Reimburse General Fund

SYNOPSIS: South Coast AQMD has been awarded up to \$14,339,960 from U.S. EPA 2021 Targeted Airshed Grant Program to demonstrate a zero-emission freight line-haul locomotive, long-range Class 8 fuel cell trucks, deploy zero-emission school buses, and replace commercial lawn and garden equipment. These actions are to: 1) recognize revenue, upon receipt, of up to \$14,339,960 from U.S. EPA into the Advanced Technology, Outreach and Education Fund (17); 2) transfer up to \$2,169,169 from the Air Quality Investment Fund (27) into the Advanced Technology, Outreach and Education Fund (17) for South Coast AQMD cost-share; 3) contingent upon U.S. EPA's final awards, execute three contracts in a total amount not to exceed \$12,749,000 from the Advanced Technology, Outreach, Outreach and Education Fund (17); 4) issue RFPs and execute resulting contracts for the Commercial Lawn and Garden Equipment Incentive and Exchange Program in an amount not to exceed \$3,020,000 from the Advanced Technology, Outreach and Education Fund (17); and 5) reimburse the general fund for administrative costs up to \$590,960 from the Advanced Technology, Outreach and Education Fund (17).

COMMITTEE: Technology, November 19, 2021; Recommended for Approval

RECOMMENDED ACTIONS:

1. Recognize revenue, upon receipt, of up to \$14,339,960 from 2021 U.S. EPA Targeted Airshed Grant Program into the Advanced Technology, Outreach and Education Fund (17), Comprised of the following grant awards:
 - a. \$4,174,000 for zero-emission freight line-haul locomotive repower with supporting charging infrastructure;
 - b. \$7,998,024 for long-range class 8 fuel cell truck demonstration (\$3,608,012) and zero-emission school bus replacement project (\$4,390,012); and

- c. \$2,167,936 for commercial lawn and garden equipment incentive and exchange program.
2. Transfer up to \$2,169,169 from the Air Quality Investment Fund (27) - Rule 1111 into the Advanced Technology, Outreach and Education Fund (17) for South Coast AQMD's cost-share for the zero-emission line-haul locomotive demonstration project (\$1,000,000) and Commercial Lawn and Garden Equipment Incentive and Exchange Program implementation (\$1,169,169);
3. Authorize the Chairman to execute the following contracts from the Advanced Technology, Outreach and Education Fund (17), contingent upon U.S. EPA's final awards:
 - a. BNSF for up to \$4,967,000 to demonstrate a zero-emission freight line-haul locomotive with supporting charging infrastructure;
 - b. Hyundai Motor Company for up to \$3,500,000 to demonstrate five long-range Class 8 fuel cell trucks; and
 - c. Moreno Valley Unified School District for up to \$4,282,000 to replace 38 diesel school buses with battery-electric buses and supporting charging infrastructure.
4. Authorize the Executive Officer to issue RFPs to solicit outreach support and vendors of commercial-grade, electric lawn and garden equipment, and based upon the results of the solicitation, execute the contract(s) from the Advanced Technology, Outreach and Education Fund (17) with qualified vendors and outreach support for the Commercial Lawn and Garden Equipment Incentive and Exchange Program, in an amount not to exceed \$3,020,000; and
5. Reimburse the General Fund up to \$590,960 from the Advanced Technology, Outreach and Education Fund (17) for administrative costs necessary to implement the above-mentioned projects.

Wayne Nastri
Executive Officer

MMM:AK:JI:WS:MW

Background

The 2016 AQMP identifies the need for NO_x reductions in meeting upcoming national ambient air quality standards. On-road heavy-duty diesel vehicles and locomotives are major contributors to NO_x emissions in the South Coast Air Basin. Significant increases in NO_x, PM, and GHG emissions from these sources are expected due to increased demand in goods movement activities. Accelerating the deployment of zero-emission long-range Class 8 fuel cell trucks, replacing diesel school buses with zero-emission buses, and repowering freight locomotives with zero-emission technology will significantly reduce NO_x, PM, and GHG emissions. The commercial lawn and garden equipment replacement with the latest zero-emission battery-electric commercial

equipment within the Coachella Valley and the urban areas of Riverside County will provide additional emission reductions.

Staff submitted five applications to U.S. EPA under the Targeted Airshed Grant Program, each for up to or close to the \$8 million limit. Three applications were preliminarily awarded, including a diesel freight line-haul locomotive repower with zero-emission technology, heavy-duty fuel cell truck demonstration, and zero-emission school bus deployment coupled with commercial lawn and garden equipment replacement.

Zero-Emission Freight Line-Haul Locomotive Repower with Supporting Charging Infrastructure

Locomotives generally utilize very large diesel combustion engines and have a long service life of over 20 years. The emissions of NO_x, PM, hydrocarbons, and GHG's are distributed throughout the South Coast Air Basin from long-distance hauling and the railyards. Developing the zero-emission solution for locomotives will significantly reduce toxic diesel exhaust and criteria pollutant emissions.

Long-Range Class 8 Fuel Cell Truck Demonstration

Long-range Class 8 trucks are designed to satisfy the need for regional and long-haul goods movement. Validating the ability of fuel cell technology to meet the real-world needs of long-haul freight is necessary to help with the commercialization of this technology. The average daily driving range per long-haul truck is approximately 360 miles. The demonstration will be conducted in a variety of routes to fully utilize up to a 500-mile range. This demonstration will provide valuable insight through real-world operations in a range of driving conditions and expands an existing demonstration project of 2 fuel-cell trucks that were previously awarded through U.S. EPA's Clean Air Technology Initiative Program.

Zero-Emission School Bus Replacement Project

Replacing older diesel emitting school buses with zero-emission school buses reduce direct diesel exhaust exposure for school children. The typical duty cycle for school buses makes battery technology an ideal candidate for the charging cycles of battery technology.

Commercial Lawn and Garden Equipment Incentive & Exchange Program

Since 2017, South Coast AQMD has implemented the Commercial Electric Lawn and Garden Equipment Incentive and Exchange Program utilizing funding provided by U.S. EPA's 2016 Targeted Air Shed Grant Program. The program replaces old gasoline- or diesel-powered commercial lawn and garden equipment with zero-emission, battery-electric equipment. A variety of makes and models of commercial-grade electric lawn and garden equipment are offered, including handheld trimmers, chainsaws, pruners, backpack and handheld blowers, and lawnmowers, including ride-on, stand-on, and

walk-behind mowers. Local governments, school districts, nonprofit organizations and commercial gardeners and landscapers have participated in the Commercial Lawn and Garden Equipment Incentive and Exchange Program, which requires the scrapping of the old equipment being replaced. To date, over 5,000 old gasoline- or diesel-powered commercial lawn and garden equipment have been replaced.

Proposal

Zero-Emission Freight Line-Haul Locomotive Repower with Supporting Charging Infrastructure

Progress Rail (P.R.), a Caterpillar Company, will replace a BNSF Tier 1+ freight line-haul locomotive engine with an 8 megawatt-hour battery-powered propulsion system. Two 1.4MW chargers with a unique pantograph design will be installed at Los Angeles and Barstow Stations to support the charging.

Long-Range Class 8 Fuel Cell Truck Demonstration

Hyundai Motor Company will demonstrate five day-cab tractors with their fleet partner and their commercial operations in existing goods movement routes to validate fuel cell technology's ability to meet the real-world needs of long-haul freight movement in the United States.

Zero-Emission School Bus Replacement Project

Replace up to thirty-eight MY 2007 and older diesel school buses in Moreno Valley Unified School District fleet with MY 2021 and newer zero-emission battery-electric school buses certified to meet the CARB Standard and provide funding for supporting charging infrastructure.

Commercial Lawn and Garden Equipment Incentive & Exchange Program

The Commercial Lawn and Garden Equipment Incentive and Exchange Program will focus on the exchange of gasoline- or diesel-powered commercial grade lawn and garden equipment for new zero-emission, battery-electric equipment for local governments, school districts, colleges, non-profit organizations, commercial landscapers/gardeners, and private entities within the Coachella Valley and surrounding urban areas of Riverside County.

In addition, RFPs would be issued to solicit outreach support and vendors of commercial-grade, electric lawn, and garden equipment. Based upon the results of the RFPs, the actions would be to execute the contract(s) in an amount not to exceed \$3,020,000 for the Commercial Lawn and Garden Equipment Incentive and Exchange Program including outreach.

Sole Source Justification

Section VIII.B.3. of the Procurement Policy and Procedure identifies four major provisions under which a sole source award may be justified for federally funded procurement. The request for sole source awards for the BNSF, Hyundai Motor Company, and Moreno Valley Unified School District contracts are made under Section VIII.B.3.c, which states the awarding federal agency or pass-through entity expressly authorizes non-competitive proposals in response to a written request from the non-federal entity.

Benefits to South Coast AQMD

The South Coast Air Basin is classified as an “extreme” nonattainment area for ozone under the Federal Clean Air Act. Projects supporting zero-emission locomotive repower, long-range Class 8 fuel cell truck demonstration, zero-emission school buses deployment, and lawn and garden equipment replacement help reduce ozone and PM2.5 air pollution. The project supports the *Technology Advancement Office Clean Fuel Program 2021 Plan Update* under the categories of “Electric/Hybrid Vehicle Technologies and Infrastructure” and “Hydrogen/Mobile Fuel Cell Technologies and Infrastructure.”

Also, the primary objective of the Commercial Lawn and Garden Equipment Incentive and Exchange Program is to reduce emissions of harmful criteria air pollutants by replacing gasoline- or diesel-powered lawn and garden equipment with zero-emission equipment in the South Coast AQMD jurisdiction, specifically in the ozone non-attainment area of Coachella Valley and the surrounding urban areas of Riverside County.

Resource Impacts

Zero-Emission Freight Line-Haul Locomotive Repower with supporting Charging Infrastructure

The contract with BNSF for repowering a diesel locomotive with zero-emission technology will not exceed \$4,967,000 from the Advanced Technology, Outreach and Education Fund (17). This includes U.S. EPA 2021 Targeted Airshed Grant funding of \$4,174,000, of which \$207,000 is for project implementation support, \$1 million cost-share from BNSF, \$533,000 from Progress Rail, and \$2.2 million in-kind from both BNSF and Progress Rail. The proposed project cost-share is shown in the table below:

Funding Source	Funding Amount	Percent
U.S. EPA FY21 Targeted Airshed Grant	\$4,174,000	46.9
BNSF	\$1,000,000	11.2
Progress Rail	\$533,000	6.0
BNSF & Progress Rail (In-Kind)	\$2,200,000	24.7
South Coast AQMD (requested)	\$1,000,000	11.2
Total	\$8,907,000	100.0

Long-Range Class 8 Fuel Cell Truck Demonstration

The contracts with Hyundai Motor Company will not exceed \$3,500,000 from Advanced Technology, Outreach and Education Fund (17). This includes U.S. EPA 2021 Targeted Airshed Grant funding of \$3,608,012, of which \$108,012 is for program implementation support. The total project cost of \$7,279,133 includes \$3,671,121 of cost-share from the fleet user FirstElement Fuel and Hyundai Motor Company. The proposed project cost-share is shown in the table below:

Funding Source	Funding Amount	Percent
U.S. EPA FY21 Targeted Airshed Grant	\$3,608,012	49.6
FirstElement Fuel (Fleet)	\$468,785	6.4
Hyundai Motor Company & FirstElement Fuel (In-Kind)	\$3,202,336	44.0
Total	\$7,279,133	100.0

Zero Emission School Bus Replacement Project

The contracts with Moreno Valley Unified School District will not exceed \$4,282,000 from the Advanced Technology, Outreach and Education Fund (17). This includes U.S. EPA 2021 Targeted Airshed Grant funding of \$4,390,012, of which \$108,012 is for program implementation support. The total project cost of \$12,952,162 includes \$8,562,150 of cost-share from Moreno Valley Unified School District. The proposed project cost-share is shown in the table below:

Funding Source	Funding Amount	Percent
U.S. EPA FY21 Targeted Airshed Grant	\$4,390,012	33.9
Moreno Valley Unified School District	\$8,562,150	66.1
Total	\$12,952,162	100.0

Commercial Lawn and Garden Equipment Incentive & Exchange Program

The total project cost of \$4,337,105 consists of the award from U.S. EPA in the amount of \$2,167,936, of which \$167,936 is for program implementation support. As part of the total project cost, \$1,000,000 is leveraged funding provided by participating equipment manufacturers in anticipated discounts for commercial-grade, electric lawn and garden equipment, and the remaining \$1,169,169 will be the cost-share for South Coast AQMD. Out of the \$1,169,169 cost-share from South Coast AQMD, \$20,000 is for program outreach and \$149,168.78 is for program implementation support.

Funding Source	Funding Amount	Percent
U.S. EPA FY21 Targeted Airshed Grant	\$2,167,936	50.0
Equipment Manufacturers	\$1,000,000	23.0
South Coast AQMD (requested)	\$1,169,169	27.0
Total	\$4,337,105	100.0

Sufficient funds will be available to execute contracts from the Advanced Technology, Outreach and Education Fund (17), once U.S. EPA 2021 Targeted Airshed grant funds are recognized. Sufficient funds are available in Air Quality Investment Fund (27) - Rule 1111 for the transfer of \$2,169,169 to the Advanced Technology, Outreach and Education Fund (17) to support the Zero-Emission Freight Line-Haul Locomotive Repower with supporting Charging Infrastructure and the Commercial Lawn and Garden Equipment Incentive & Exchange Program.

Agenda Item #1

Recognize 2021 U.S. EPA Targeted Airshed Grant Program Awards for Zero-Emission Vehicles and Equipment, Issue RFPs, Transfer Funds, Execute Contracts to Demonstrate Zero-Emission Vehicles and Equipment, and Reimburse General Fund

Mei Wang

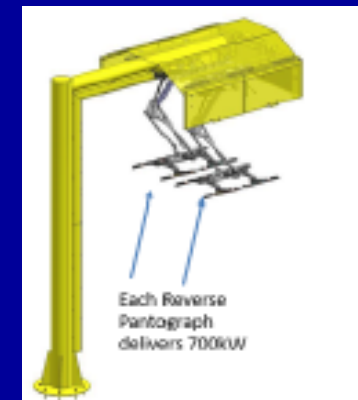
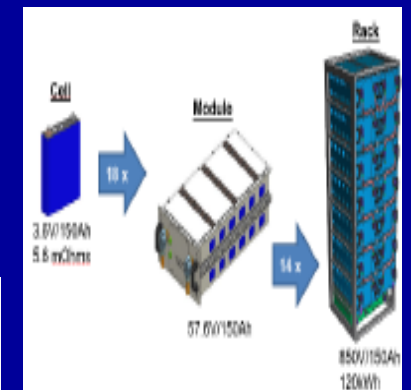
Background

- Accelerating the deployment of zero-emission vehicles and equipment are needed to reduce NOx emissions and meet national ambient air quality standards
- Five applications were submitted under 2021 U.S. EPA Targeted Airshed Grant Program and three were awarded:
 - Zero-emission freight line-haul locomotive repower with supporting infrastructure
 - Zero-emission long-range class 8 fuel cell trucks demonstration and school buses deployment
 - Commercial Lawn and Garden Equipment Incentive & Exchange Program



Proposal – Battery-Electric Freight Line-Haul Locomotive Repower & Charging Infrastructure

- BNSF and Progress Rail, a Caterpillar Company
- Repower a Tier 1+ BNSF line-haul locomotive
 - 8 megawatt-hour battery-powered propulsion system
 - Two 1.4MW chargers:
 - Los Angeles station
 - Barstow station
- U.S. EPA award: \$4,174,000



Proposal - Long-Range Class 8 Fuel-Cell Trucks Demonstration

- Hyundai Motor Company and FirstElement Fuel
- Demonstrate five day-cab tractors with 500-mile range
 - Expands the existing 2-truck demonstration previously awarded under Clean Air Technology Initiative Program
- Validate the ability of fuel cell technology to meet real-world long-haul freight trucks need
- U.S. EPA award: \$3,608,012



Proposal - Zero-Emission School Bus Replacement Project

- Moreno Valley Unified School District
- Replace up to 38 MY 2007 and older diesel school buses with battery-electric buses
- Buses equipped with 210kWh batteries, capable of 150 miles range
- Zero-Emission School Bus Replacement Project
- U.S. EPA award: \$4,390,012



Proposal - Commercial Lawn and Garden Equipment Incentive & Exchange Program

- Replace old gasoline- or diesel- powered equipment with battery-electric equipment
- Old equipment must be scrapped
- Coachella Valley and urban area of Riverside County
- Local governments, school districts, nonprofit organizations and commercial gardeners and landscapers
- Issue RFP to solicit equipment vendors and Program outreach support
- U.S. EPA award: \$2,167,936



Resource Impacts

Project Fund Source(\$)	BE Line-Haul Locomotive Repower and Charing	Long-Range Class 8 FC Truck	Electric School Buses	Commercial Lawn and Garden Equipment
EPA Award	\$4,174,000	\$3,608,012	\$4,390,012	\$2,167,936
SCAQMD Cost-Share	\$1,000,000	—	—	\$1,169,169
Partners Cost-Share	\$3,733,000	\$3,671,121	\$8,562,150	\$1,000,000
Total Project Cost	\$8,907,000	\$7,279,133	\$12,952,162	\$4,337,105

Recommended Actions

- Recognize revenue of up to \$14,339,960 from U.S. EPA into the Advanced Technology, Outreach and Education Fund (17)
- Transfer up to \$2,169,169 from the Air Quality Investment Fund (27) – Rule 1111 into Fund 17 for South Coast AQMD's cost-share
- Execute three contracts from Fund 17 with BNSF, Hyundai Motor Company and Moreno Valley Unified School District in the amounts not to exceed \$4,967,000, \$3,500,000, and \$4,282,000, respectively

Recommended Actions (cont'd)

- Issue RFPs to solicit commercial lawn and garden equipment vendors and outreach support and execute contract(s) for an amount up to \$3,020,000 from Fund 17
- Reimburse the General Fund up to \$590,960 from Fund 17 for the administrative costs necessary to implement the projects

Technology Committee Agenda #2

BOARD MEETING DATE: December 3, 2021

AGENDA NO.

PROPOSAL: Approve Awards for Lower-Emission School Bus Program and Transfer Funds for Development of Lower Emission School Bus Grant Management System

SYNOPSIS: In October 2020, the Board issued a Program Announcement to solicit applications for the replacement of pre-2001 model year diesel school buses with new alternative fuel or zero emission buses. This action is to approve awards to replace pre-2001 diesel school buses with new, near-zero or zero emission school buses and infrastructure in an amount not to exceed \$47 million from the Carl Moyer Program AB 923 Fund (80). This action is to also appropriate up to \$81,000 from the administrative portion of the Carl Moyer Program AB 923 Fund (80) into Information Management's FY 2021-22 Budget, Professional and Special Services and/or Capital Outlays Major Objects and reimburse the General Fund (01) using administrative funds for enhancement for the Lower Emission School Bus Program grant management system.

COMMITTEE: Technology, November 19, 2021; Recommended for Approval

RECOMMENDED ACTIONS:

1. Authorize the Chairman to:
 - a. Execute contracts with 46 public school districts, as listed in Table 1, to replace 178 pre-2001 diesel school buses with new alternative fuel or zero emission buses and infrastructure totaling an amount not to exceed \$47 million from the Carl Moyer Program AB 923 Special Revenue Fund (80); and
 - b. Execute contracts from the backup projects as listed in Table 2, in the event that funding amounts are reduced, not implemented, or returned from any of the Table 1 recipients approved for projects in this Board letter.

2. Appropriate up to \$81,000 from the administrative portion of the Carl Moyer Program AB 923 Fund (80) into Information Management's FY 2021-22 Budget, Professional and Special Services and/or Capital Outlays Major Objects and reimburse the General Fund (01) using administrative funds for enhancement for the Lower Emission School Bus Program Grant Management System (GMS).

Wayne Nastri
Executive Officer

MMM:AK:WS:YT

Background

Since the start of the Lower-Emission School Bus Program in 2001, South Coast AQMD has awarded nearly \$325 million in local, state and federal funds to replace over 1,800 highly polluting publicly owned diesel school buses with alternative fuel or zero emission buses and retrofit 3,400 diesel school buses with particulate traps. This program has resulted in helping thousands of school children commute in some of the cleanest school buses in the country.

On October 2, 2020, the Board issued a Program Announcement (PA) #PA2021-02 to solicit applications for replacement of pre-2001 model year diesel school buses owned by public school districts and joint power authorities with new alternative fuel or zero-emission school buses. To be eligible, the existing school buses must have a Gross Vehicle Weight Rating (GVWR) over 14,000 lbs and have continuous California Highway Patrol certification for the past three years. Public school districts and joint power authorities had the option under #PA2021-02 to purchase alternative fuel and zero-emission school buses. Alternative fuel buses purchased under this program are required to have engines certified at or below the optional low NOx standard of 0.02 g/bhp-hr.

During this process additional functionalities have been developed for the Lower-Emission School Bus Program Grant Management System (GMS) to help facilitate and streamline the application and program evaluation process. Functionalities include the development of program project tracking functionalities, authorization forms, dashboard, applications context, application review, application messages, applications tasks and the calculation and ranking modules. These developments further maximize efficiencies with the application processes, internal review and approvals.

Proposal

Under #PA2021-02, 47 public school districts applied for the replacement of 361 school buses for a total request amount of \$100,757,550. Staff determined that one school

district was not eligible as it did not meet the GVWR requirement of the Lower-Emission School Bus Program. Also, due to the high demand and limited funding available under the Lower-Emission School Bus Program, staff recommends awards and the execution of contracts with 46 public school districts not exceeding seven buses per school district in over-subscribed counties. This would result in awards for 178 pre-2001 diesel school buses as listed in the attached Table 1, in an amount not to exceed \$47 million from the Carl Moyer Program AB 923 Special Revenue Fund (80).

As the Program was heavily over-subscribed, funding of eligible school bus projects was made based on several factors, including distribution of program funds across Los Angeles, Orange, Riverside, and San Bernardino counties based on county population, school bus model year, benefits to disadvantaged and/or low-income communities, replacement technology, and project cost effectiveness. To optimize the distribution of funds for school districts, at least two school buses were awarded per school district (if requested at the time of application).

Consistent with the requirements of AB 1390, staff ensured that not less than 50 percent of the funds appropriated under the Lower-Emission School Bus Program are expended in a manner that directly reduces air contaminants and/or associated public health risks in disadvantaged and low-income communities. Utilizing CalEPA's CalEnviroScreen mapping tool, which helps identify disadvantaged and low-income communities in California, over 60 percent of the school districts that are proposed for replacement awards include disadvantaged or low-income communities.

The proposed awards will fund 89 zero emission, 83 CNG and six propane school buses for a total of 178 replacements. All school buses recommended for funding are Type C or D. The recommended awards provide up to \$370,000 for a Type C or D zero emission school bus, \$205,000 for a Type C or D CNG school bus and \$155,000 for a Type C propane school bus, including sales tax. In addition, the award will include fueling or charging infrastructure funding up to \$15,000 per CNG, \$5,000 per propane, and \$20,000 per zero emission bus for those school districts that have requested it.

School districts will have to pay for any discretionary options they choose to include on the bus. The diesel buses being replaced are required to be permanently destroyed by licensed dismantlers.

To help offset the cost of zero emission school buses, school districts may apply for funding through the California Hybrid and Zero Emission Truck and Bus Voucher Incentive Project (HVIP). The combined award amount from South Coast AQMD and HVIP cannot exceed \$400,000 for each zero emission school bus and the funding amounts may be reduced if the project also receives HVIP funding. In the event that project funding amounts are reduced, not implemented, or returned from any of the funding sources identified in this Board letter, staff recommends execution of contracts

from the backup project list in Table 2 based on project cost-effectiveness and the county where the project is located.

Lastly, this action is to appropriate up to \$81,000 from the administrative portion of the Carl Moyer Program AB 923 Fund (80) into Information Management's FY 2021-22 Budget, Professional and Special Services and/or Capital Outlays Major Objects and reimburse the General Fund (01) using administrative funds for the enhancement for the Lower Emission School Bus Program GMS. This appropriation will reimburse expenses incurred for the development of additional features for the Lower Emission School Bus Program GMS to further enhance user interface, program dashboard, staff review and approval processes.

Outreach

In accordance with South Coast AQMD's Procurement Policy and Procedure, a public notice advertising the PA and inviting bids was published in the Los Angeles Times, the Orange County Register, the San Bernardino Sun, and Riverside County's Press Enterprise newspapers to leverage the most cost-effective method of outreach to the South Coast Basin.

Notice of the PA was emailed to the Black and Latino Legislative Caucuses and various minority chambers of commerce and business associations and placed on the Internet at South Coast AQMD's website (<http://www.aqmd.gov>).

Also, staff released several email notifications to over 300 recipients, including all public school districts within South Coast AQMD jurisdiction, dealerships and school bus manufacturers, announcing the opening of #PA2021-02. Subsequent email notifications were sent in January 2021 to remind potential applicants to apply prior to the application deadline of January 26, 2021.

Benefits to South Coast AQMD

The successful implementation of the Lower-Emission School Bus Replacement Program will provide less polluting and safer transportation for school children and reduce exposure to toxic diesel particulate matter emissions. This program is also expected to reduce criteria and toxic air pollution in disadvantaged and low-income communities in the South Coast AQMD.

Resource Impacts

Sufficient funding is available in the Carl Moyer Program AB 923 Special Revenue Fund (80) for the recommended awards that will not exceed \$47 million.

Sufficient funding of \$81,000 is available in the administrative portion of the Carl Moyer Program AB 923 Fund (80) for enhancement of the Lower Emission School Bus Program GMS.

Attachments

Table 1: Recommended Awards for Pre-2001 School Bus Replacements

Table 2: Recommended List of Backup Projects

Table 1: Recommended Awards for Pre-2001 School Bus Replacements

#PA2021-02 Applicant	County	Number of Buses	Replacement School Bus Fuel Type	Maximum Bus Award AB923 Funds	Maximum Infrastructure Award AB923 Funds	Total Maximum Award
ABC Unified School District	LA	3	CNG	\$615,000	\$45,000	\$660,000
Baldwin Park Unified School District*	LA	2	Electric	\$380,000	\$40,000	\$420,000
Bonita Unified School District	LA	4	Electric	\$1,480,000	\$80,000	\$1,560,000
El Monte Union High School District	LA	1	CNG	\$205,000	\$15,000	\$220,000
Monrovia Unified School District	LA	2	Electric	\$740,000	\$40,000	\$780,000
Montebello School District	LA	6	Electric	\$2,220,000	\$120,000	\$2,340,000
Newhall School District*	LA	3	Electric	\$606,000	\$60,000	\$666,000
Norwalk - La Mirada Unified School District*	LA	8	Electric	\$1,520,000	\$160,000	\$1,680,000
Saugus Union School District	LA	2	Propane	\$310,000	\$0	\$310,000
Sulphur Springs Union School District*	LA	2	Electric	\$404,000	\$40,000	\$444,000
Torrance Unified School District	LA	5	CNG	\$1,025,000	\$75,000	\$1,100,000
Walnut Valley Unified School District	LA	1	CNG	\$205,000	\$0	\$205,000
Whittier Union High School District*	LA	4	Electric	\$760,000	\$80,000	\$840,000
William S. Hart Union High School District*	LA	14	Electric	\$2,828,000	\$280,000	\$3,108,000
Total Los Angeles County		57		\$13,298,000	\$1,035,000	\$14,333,000
Anaheim Elementary School District	OC	2	Electric	\$740,000	\$40,000	\$780,000
Anaheim Union High School District	OC	2	Electric	\$740,000	\$40,000	\$780,000
Buena Park School District	OC	1	Electric	\$370,000	\$20,000	\$390,000
Capistrano Unified School District	OC	7	CNG	\$1,435,000	\$0	\$1,435,000
Centralia School District*	OC	2	Electric	\$380,000	\$40,000	\$420,000
Fountain Valley School District	OC	2	CNG	\$410,000	\$0	\$410,000
Fullerton Joint Union High School	OC	2	CNG	\$410,000	\$30,000	\$440,000
Fullerton School District	OC	2	Propane	\$310,000	\$0.00	\$310,000
Garden Grove Unified School District	OC	3	Electric	\$1,110,000	\$60,000	\$1,170,000
Huntington Beach City School District	OC	2	CNG	\$410,000	\$0	\$410,000
Huntington Beach Union High School District	OC	7	CNG	\$1,435,000	\$105,000	\$1,540,000
La Habra City School District	OC	2	CNG	\$410,000	\$0	\$410,000

#PA2021-02 Applicant	County	Number of Buses	Replacement School Bus Fuel Type	Maximum Bus Award AB923 Funds	Maximum Infrastructure Award AB923 Funds	Total Maximum Award
Los Alamitos Unified School District	OC	2	CNG	\$410,000	\$0	\$410,000
Newport-Mesa Unified School District	OC	2	CNG	\$410,000	\$0	\$410,000
Ocean View School District	OC	4	CNG	\$820,000	\$0	\$820,000
Orange Unified School District*	OC	2	Electric	\$380,000	\$60,000	\$420,000
Placentia-Yorba Linda Unified School District	OC	7	Electric	\$2,590,000	\$140,000	\$2,730,000
Westminster School District	OC	2	Propane	\$310,000	\$10,000	\$320,000
Total Orange County		53		\$13,080,000	\$525,000	\$13,605,000
Coachella Valley Unified School District	RC	4	CNG	\$820,000	\$0	\$820,000
Coachella Valley Unified School District	RC	2	Electric	\$740,000	\$40,000	\$780,000
Desert Sands Unified School District	RC	2	CNG	\$410,000	\$0	\$410,000
Hemet Unified School District	RC	7	CNG	\$1,435,000	\$105,000	\$1,540,000
Lake Elsinore Unified School District	RC	7	CNG	\$1,435,000	\$105,000	\$1,540,000
Moreno Valley Unified School District**	RC	4	Electric	\$1,480,000	\$80,000	\$1,560,000
Murrieta Valley Unified School District	RC	7	Electric	\$2,590,000	\$140,000	\$2,730,000
Temecula Valley Unified School District	RC	2	Electric	\$740,000	\$40,000	\$780,000
Total Riverside County		35		\$9,650,000	\$510,000	\$10,160,000
Bear Valley Unified School District	SB	7	CNG	\$1,435,000	\$105,000	\$1,540,000
Chaffey Joint Union High School District	SB	5	CNG	\$1,025,000	\$0	\$1,025,000
Colton Joint Unified School District	SB	3	CNG	\$615,000	\$45,000	\$660,000
Fontana Unified School District	SB	5	CNG	\$1,025,000	\$75,000	\$1,100,000
Fontana Unified School District	SB	1	Electric	\$370,000	\$20,000	\$390,000
Ontario-Montclair School District	SB	3	Electric	\$1,110,000	\$60,000	\$1,170,000
Redlands Unified School District	SB	6	Electric	\$2,220,000	\$120,000	\$2,340,000
Rim of The World Unified School District	SB	3	CNG	\$615,000	\$45,000	\$660,000
Total San Bernardino County		33		\$8,415,000	\$470,000	\$8,885,000
Total		178		\$44,443,000	\$2,540,000	\$46,983,000

* Award amounts have been adjusted to ensure that the total award amount from South Coast AQMD and HVIP does not exceed \$400,000.

**School District's EPA 2021 Targeted Airshed Grant award has been factored in during the selection process.

Table 2: Recommended List of Backup Projects

#PA2021-02 Applicant	County	Replacement School Bus Fuel Type	Maximum Bus Award AB923 Funds	Maximum Infrastructure Award AB923 Funds	Total Maximum Award
Los Angeles County*					
<i>*All eligible projects located in Los Angeles County were recommended for funding. Any returned funds from projects in Los Angeles County will be reallocated to projects in the other three counties within the South Coast AQMD air basin.</i>					
Orange County					
Ocean View School District	OC	CNG	\$205,000	\$0	\$205,000
Ocean View School District	OC	CNG	\$205,000	\$0	\$205,000
Ocean View School District	OC	CNG	\$205,000	\$0	\$205,000
Westminster School District	OC	Propane	\$155,000	\$5,000	\$160,000
Centralia School District	OC	Electric	\$190,000	\$20,000	\$210,000
Fullerton Joint Union High School District	OC	CNG	\$205,000	\$15,000	\$220,000
Fullerton Joint Union High School District	OC	CNG	\$205,000	\$15,000	\$220,000
Orange Unified School District	OC	Electric	\$190,000	\$20,000	\$210,000
Orange Unified School District	OC	Electric	\$190,000	\$20,000	\$210,000
Orange Unified School District	OC	Electric	\$190,000	\$20,000	\$210,000
Orange Unified School District	OC	CNG	\$205,000	\$15,000	\$220,000
Orange Unified School District	OC	Electric	\$190,000	\$20,000	\$210,000
Garden Grove Unified District	OC	Electric	\$370,000	\$20,000	\$390,000
Garden Grove Unified District	OC	Electric	\$370,000	\$20,000	\$390,000
Garden Grove Unified District	OC	Electric	\$370,000	\$20,000	\$390,000
Anaheim Union High School District	OC	Electric	\$370,000	\$20,000	\$390,000
Newport-Mesa Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Huntington Beach City School District	OC	CNG	\$205,000	\$0	\$205,000
La Habra City School District	OC	CNG	\$205,000	\$0	\$205,000
Anaheim Elementary School District	OC	Electric	\$370,000	\$20,000	\$390,000
Anaheim Elementary School District	OC	Electric	\$370,000	\$20,000	\$390,000
Fullerton School District	OC	Propane	\$155,000	\$0	\$155,000
Fullerton School District	OC	Propane	\$155,000	\$0	\$155,000
Anaheim Elementary School District	OC	Electric	\$370,000	\$20,000	\$390,000

#PA2021-02 Applicant	County	Replacement School Bus Fuel Type	Maximum Bus Award AB923 Funds	Maximum Infrastructure Award AB923 Funds	Total Maximum Award
Anaheim Elementary School District	OC	Electric	\$370,000	\$20,000	\$390,000
Anaheim Elementary School District	OC	Electric	\$370,000	\$20,000	\$390,000
Newport-Mesa Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Ocean View School District	OC	CNG	\$205,000	\$0	\$205,000
La Habra City School District	OC	CNG	\$205,000	\$0	\$205,000
Newport-Mesa Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Fountain Valley School District	OC	CNG	\$205,000	\$0	\$205,000
Fountain Valley School District	OC	CNG	\$205,000	\$0	\$205,000
Huntington Beach City School District	OC	CNG	\$205,000	\$0	\$205,000
Westminster School District	OC	Propane	\$155,000	\$5,000	\$160,000
Garden Grove Unified District	OC	Electric	\$370,000	\$20,000	\$390,000
Anaheim Elementary School District	OC	Electric	\$370,000	\$20,000	\$390,000
Westminster School District	OC	Propane	\$155,000	\$5,000	\$160,000
Westminster School District	OC	Propane	\$155,000	\$5,000	\$160,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Huntington Beach Union High School District	OC	CNG	\$205,000	\$15,000	\$220,000
Huntington Beach Union High School District	OC	CNG	\$205,000	\$15,000	\$220,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Capistrano Unified School District	OC	CNG	\$205,000	\$0	\$205,000
Huntington Beach Union High School District	OC	CNG	\$205,000	\$15,000	\$220,000
Huntington Beach Union High School District	OC	CNG	\$205,000	\$15,000	\$220,000
Ocean View School District	OC	CNG	\$205,000	\$0	\$205,000
Ocean View School District	OC	CNG	\$205,000	\$0	\$205,000

#PA2021-02 Applicant	County	Replacement School Bus Fuel Type	Maximum Bus Award AB923 Funds	Maximum Infrastructure Award AB923 Funds	Total Maximum Award
Huntington Beach Union High School District	OC	CNG	\$205,000	\$15,000	\$220,000
Placentia-Yorba Linda Unified School District	OC	CNG	\$205,000	\$15,000	\$220,000
Placentia-Yorba Linda Unified School District	OC	CNG	\$205,000	\$15,000	\$220,000
Placentia-Yorba Linda Unified School District	OC	Electric	\$370,000	\$20,000	\$390,000
Riverside County					
Moreno Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Moreno Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Moreno Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Temecula Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Temecula Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Coachella Valley Unified School District	RC	CNG	\$205,000	\$0	\$205,000
Temecula Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Temecula Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Murrieta Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Murrieta Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Moreno Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Hemet Unified School District	RC	CNG	\$205,000	\$15,000	\$220,000
Murrieta Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Lake Elsinore Unified School District	RC	CNG	\$205,000	\$15,000	\$220,000
Lake Elsinore Unified School District	RC	CNG	\$205,000	\$15,000	\$220,000
Lake Elsinore Unified School District	RC	CNG	\$205,000	\$15,000	\$220,000
Hemet Unified School District	RC	CNG	\$205,000	\$15,000	\$220,000
Murrieta Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Hemet Unified School District	RC	CNG	\$205,000	\$15,000	\$220,000
Coachella Valley Unified School District	RC	CNG	\$205,000	\$0	\$205,000
Coachella Valley Unified School District	RC	CNG	\$205,000	\$0	\$205,000
Lake Elsinore Unified School District	RC	CNG	\$205,000	\$15,000	\$220,000
Murrieta Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
Lake Elsinore Unified School District	RC	CNG	\$205,000	\$15,000	\$220,000
Murrieta Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000

#PA2021-02 Applicant	County	Replacement School Bus Fuel Type	Maximum Bus Award AB923 Funds	Maximum Infrastructure Award AB923 Funds	Total Maximum Award
Murrieta Valley Unified School District	RC	Electric	\$370,000	\$20,000	\$390,000
San Bernardino County					
Ontario-Montclair School District	SB	Electric	\$370,000	\$20,000	\$390,000
Ontario-Montclair School District	SB	Electric	\$370,000	\$20,000	\$390,000
Ontario-Montclair School District	SB	Electric	\$370,000	\$20,000	\$390,000
Bear Valley Unified School District	SB	CNG	\$205,000	\$15,000	\$220,000
Bear Valley Unified School District	SB	CNG	\$205,000	\$15,000	\$220,000

Agenda Item #2

Approve Awards for Lower Emission School
Bus Program and Transfer Funds
for Development of Lower Emission School
Bus Grant Management System

Yuh Jiun Tan

Background

Since 2001, South Coast AQMD has spent over \$325 million to:

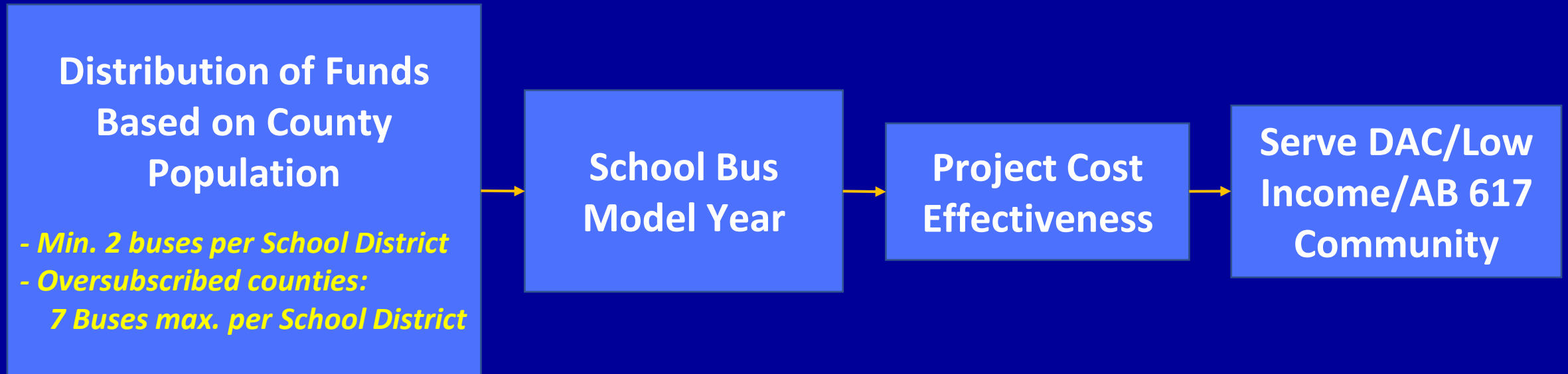
- Replace over 1,800 diesel school buses
- Retrofit 3,400 diesel school buses with PM traps



Background (cont'd)

- In October 2020, the Board issued a Program Announcement (#PA2021-02) to solicit applications for replacement of pre-2001 diesel school buses with new alternative fuel or zero emission school buses
- Additional functionalities developed for the Lower Emission School Bus Grant Management System which helped facilitate and streamline evaluation process

Selection Prioritization



Proposal

Award and execute contracts not to exceed \$47M:

- 46 public school districts
- 178 pre-2001 diesel school bus replacements and supporting infrastructure



New School Bus Type	Number of Buses
Zero-Emission	89
CNG	83
Propane	6
Total	178

Proposed Award Distribution

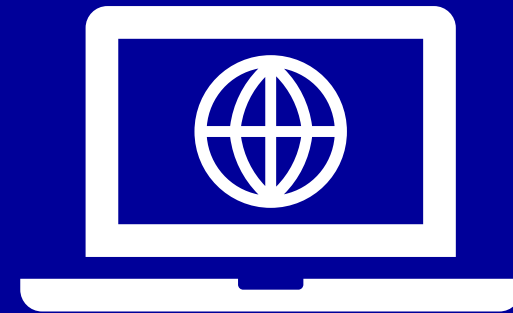
County	# of School Districts	# of Buses	Funding Amount	% of Total Funds
Los Angeles*	14	57	\$14,333,000	31%
Orange	18	53	\$13,605,000	29%
Riverside	7	35	\$10,160,000	22%
San Bernardino	7	33	\$8,885,000	19%
Totals	46	178	\$46,983,000	100%

** All eligible projects in Los Angeles County are recommended for funding.*

Proposal (cont'd)

Appropriate up to \$81,000 to reimburse for expenses incurred for enhancement of the Lower Emission School Bus Program GMS

- Dashboard
- Project tracking
- Application review
- Message and assign tasks



Recommended Actions

- Execute contracts with 46 public schools to replace 178 school buses and infrastructure in an amount not to exceed \$47M from the Carl Moyer Program AB 923 Fund (80)
- Execute contracts for project on the backup list if additional funds become available
- Appropriate up to \$81,000 from administrative portion of the Carl Moyer Program AB 923 Fund (80) into Information Management FY 21-22 Budget, Professional and Special Services and/or Capital Outlays Major Objects and reimburse the General Fund using administrative funds for the Lower Emission School Bus GMS

PROPOSAL: Clean Fuels Program Draft 2022 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. 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 with particular emphasis on heavy-duty truck technologies with zero and near-zero emissions for goods movement applications as well as a continued focus on preparing for hydrogen vehicle deployments.

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) before the Technology Committee as a separate item to solicit input on the proposed allocation of potential project funds before requesting final approval each year 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 2022, staff has prepared a 2022 Draft Plan Update which proposes continued support for a wide portfolio of technologies. This Draft Plan Update continues to have particular emphasis on heavy-duty (HD) truck technologies with zero and near-zero emissions for goods movement applications, as well as a continued focus on preparing for hydrogen vehicle deployments, to create a pathway towards achieving 2031 attainment. This aligns well with South Coast AQMD's FY 2021-22 Goals and Priority Objectives and assists in achieving goals outlined in the 2016 Air Quality Management Plan (AQMP), which calls for a significant reduction in NOx emissions by 2031. The portfolio is also designed to leverage funds from other state and federal

programs such as the Greenhouse Gas Reduction Fund Program and the EPA Targeted Airshed Grants.

Proposal

The attached Draft Plan Update identifies potential projects to be considered for funding during 2022. The proposed projects reflect promising low, near-zero and zero emissions technologies and applications that are emerging in different source categories. This update includes a number of proposed projects, not all of which are expected to be funded in the current fiscal year given the available budget. Some of the proposed projects for 2022 include but are not limited to: 1) Large deployment projects of HD zero emission battery electric trucks and infrastructure, 2) Continue microgrid demonstrations to support large HD truck deployment projects, 3) Support advanced high power quick charge infrastructure to support HD battery electric trucks, 4) Development and demonstration for long range fuel cell electric trucks, 5) Develop pathways and demonstrate green hydrogen production and 6) HD diesel truck replacements with near-zero emissions natural gas trucks. Projects not funded in 2022 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. These high priority areas are listed below based on the proposed funding distribution shown in Figure 1:

- Hydrogen and Fuel Cell Technologies and Infrastructure
- Electric and Hybrid Vehicle Technologies (including charging infrastructure)
- Engine Systems (particularly in the HD vehicle sector)
- Infrastructure and Deployment (compressed and liquid natural gas)
- Fuel and Emissions Studies
- Stationary Clean Fuels Technologies (including renewables)
- Emissions Control Technologies
- Health Impacts Studies
- Technology Transfer/Assessment and Outreach

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 the state government, the 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 the potential distribution of South Coast AQMD’s Clean Fuels funds, based on projected program costs of \$21.8 million for the nine project areas

discussed previously. The expected actual project expenditures for 2022 will be less than the total projected program cost since not all projects will materialize. The 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 2022 will be based on this proposed allocation, the 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, the specific scope of work, the project team capabilities, and the project cost-sharing.

These technical priorities will necessarily be balanced by funding availability and the availability of qualified projects. Revenues from several sources support the South Coast AQMD’s Technology Advancement program. The principal revenue source is the Clean Fuels Program, which under H&SC Section 40448.5 and Vehicle Code Section 9250.11 establishes mechanisms to collect revenues from mobile and stationary sources to support the program’s objectives, albeit with constraints on the use of the funds. Grants and cost-sharing revenue contracts from various government agencies, such as CARB, CEC, NREL, U.S. EPA and DOE, also support technology advancement efforts and may be approached for cost-sharing.

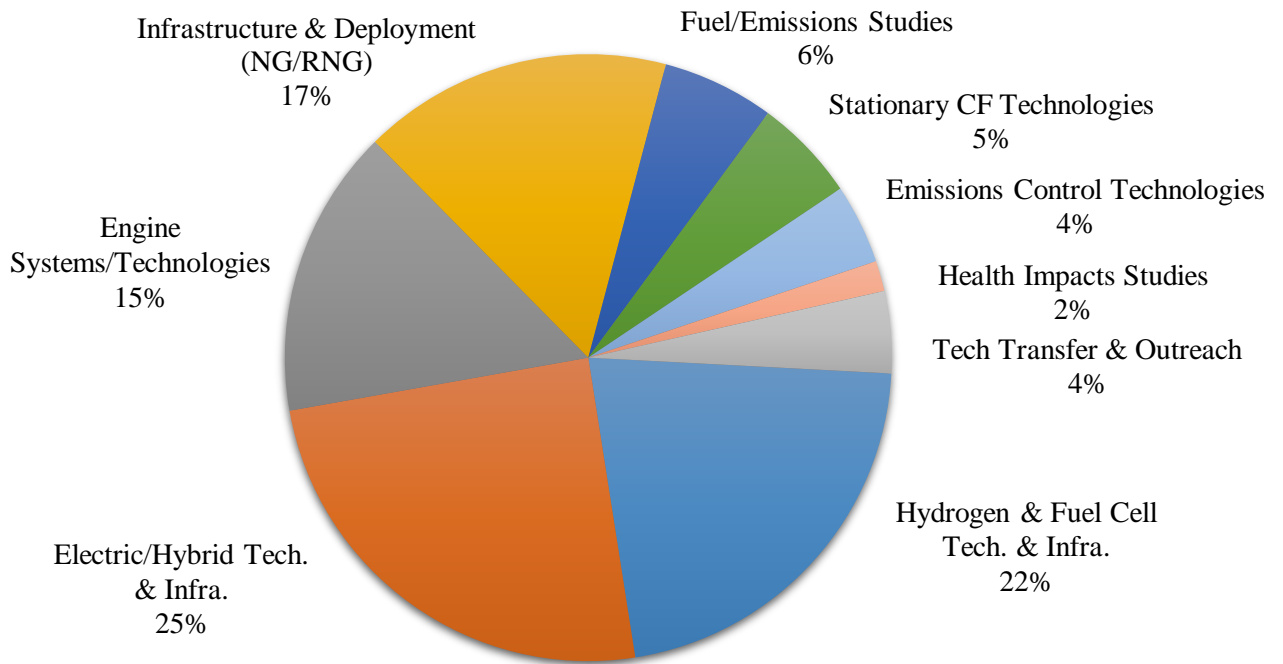


Figure 1: Projected Funding Distribution for Potential Projects in 2022 (\$21.8M)

The proposed update is the result of a historical as well as current comprehensive planning and review process, which will continue over the next few months as the Draft Plan Update is further refined before the Board considers adoption in early spring. This process includes consideration of the 2016 AQMP, the Ports' Clean Air Action Plan, California Sustainable Freight Strategy, CARB's 2021-2022 Funding Plan and proposed rules, such as the innovative clean transit rule, as well as our own Indirect Source Rules. The proposed update also incorporates coordination activities involving outside organizations including consideration of federal, state and local activities and proposed integrated solutions ranging from the Governor's Executive Orders and goals for medium- and heavy-duty vehicles and beyond to CARB's climate strategies. The Governor's Executive Officer 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 January and September 2021 to solicit input from the Clean Fuels Advisory Group, the Technology Advancement Advisory Group and other technical experts. During these advisory meetings, the participants reviewed current and proposed Technology Advancement projects as well as the proposed funding distribution for the 2022 Draft 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, the California Natural Gas Vehicle Partnership, the California Fuel Cell Partnership, 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:

- Focus priorities on large demonstrations of zero emissions drayage trucks to test and validate OEM readiness and infrastructure viability;
- Define technology pathways via special projects - the Ultra-Low Emissions Engine Program;
- Develop near-zero emission (gaseous and liquid fuel) engine systems, with a focus on high horsepower HD engine technology;
- Develop and demonstrate long range fuel cell electric trucks; and
- Demonstrate hydrogen production, dispensing and mobile refueling for HD applications.

Maintain other areas of emphasis

The relative changes in funding allocation are a result of recent and anticipated opportunities to partner with other agencies on projects and studies. For example, the 2022 Draft Plan Update increased the allocation for electric and hybrid technologies and infrastructure, which is in line with the \$27.8 million Greenhouse Gas Reduction Fund grant the South Coast AQMD and its partners were awarded by CARB in April 2021 for 100 Heavy Duty Truck and Infrastructure Pilot Project. As shown in Figure 2, the 2022 Draft Plan Update has a particular focus on infrastructure for large-scale fueling stations necessary to support medium- and heavy-duty fuel cell vehicles anticipated to be in demonstration service over the next few years. There remains an urgent need to develop and demonstrate near-zero and zero emissions HD technologies, especially for goods movement applications, including the infrastructure for such technologies. While this Draft Plan Update reflects a modest decrease in anticipated funding for hydrogen and fuel cells and for electric/hybrid technologies in 2022, the emphasis on heavy-duty truck technologies with zero and near-zero emissions for goods movement applications continues to pave a technological pathway towards achieving the 2031 federal attainment goals. Emphasis will continue on near-zero, larger displacement engine system development, demonstration and deployment to ensure a broad portfolio of technologies and leverage state and federal efforts.

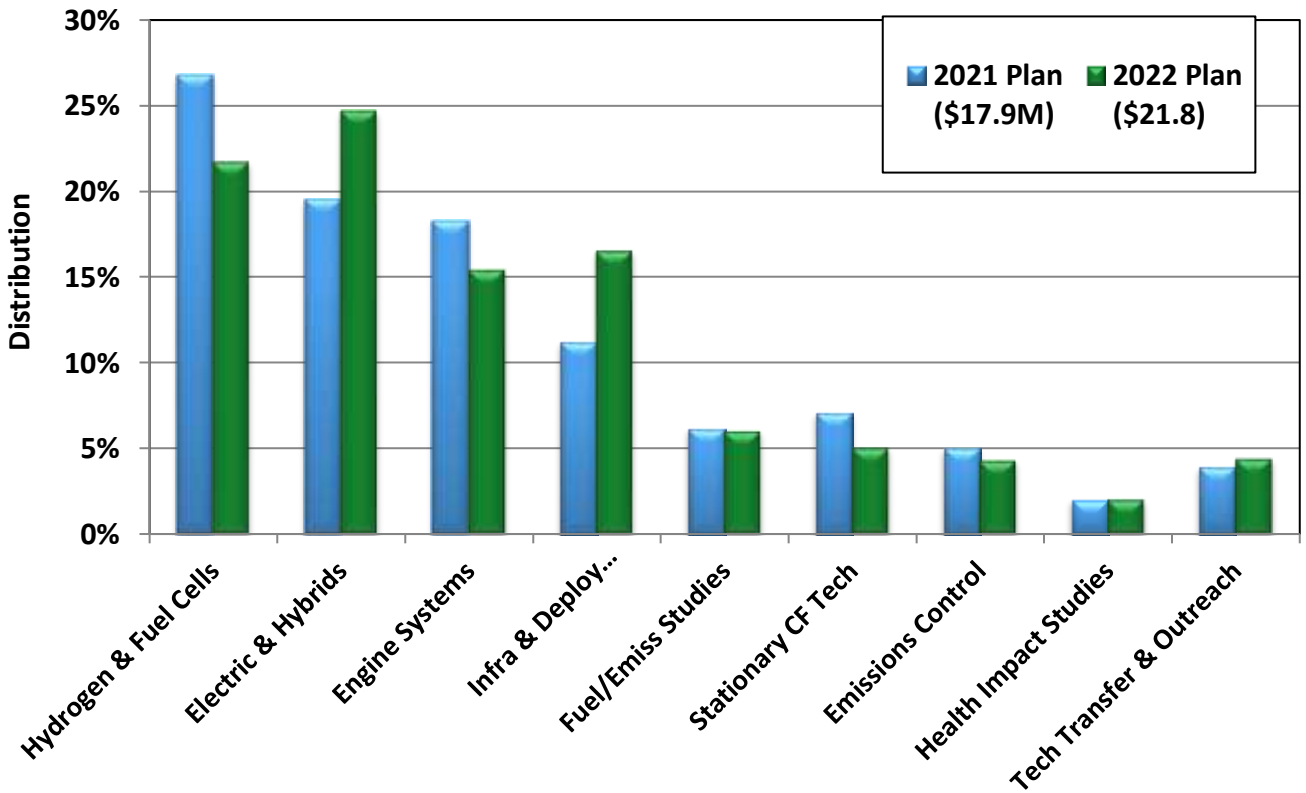


Figure 2: Plan Update Comparison

Based on communications with the 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 Board for funding, staff will continue to coordinate with these organizations to ensure that duplication is avoided and ensure optimal expenditure of Clean Fuels Program funds.

Attachment

Clean Fuels Program 2022 Draft Plan Update

TECHNOLOGY ADVANCEMENT OFFICE DRAFT 2022 PLAN UPDATE

**South Coast Air Quality Management District
November 2021**

[This Page Intentionally Left Blank]

EXECUTIVE SUMMARY

Introduction

The South Coast Air Quality Management District (South Coast AQMD) is the air pollution control agency for all of 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 eventually 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 TAO Clean Fuels Program is an integral part of the South Coast AQMD’s effort to achieve the significant nitrogen oxides (NOx) emission reductions called for in the 2016 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 received through a \$1 motor vehicle registration fee, the Clean Fuels Program encourages, fosters and supports clean fuels and transportation technologies, such as hydrogen powered fuel cells, advanced natural gas 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 \$231.6 million into over \$1.14 billion in projects.

As technologies move towards commercialization, such as battery and fuel cell electric trucks, 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 in larger numbers. 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 needed to attain federal and state ambient air quality standards.

While South Coast AQMD aggressively seeks to leverage funds, it plays a leadership role in technology development and commercialization, along with its partners, to accelerate the reduction of criteria pollutants. The TAO 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 reductions and health benefits. This approach enhances the region’s chances of achieving the National Ambient Air Quality Standards (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 determined to be relevant by the South Coast AQMD. The Legislature recognized the need for flexibility, allowing focus on a broad range of technology areas, including cleaner fuels, vehicles and infrastructure, which helps the South Coast AQMD continue to make progress toward achieving its clean air goals.

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

Setting the Stage

The overall strategy of TAO’s Clean Fuels Program is largely based on emission reduction technology needs identified in the AQMP and the South Coast AQMD Board directives to protect the health of almost 18 million residents (nearly half the population of California) in the Basin. The AQMP, which will be updated in 2022, is the long-term regional “blueprint” that identifies the fair-share emission reductions from all jurisdictional levels (e.g., federal, state and local). The 2016 AQMP, which was adopted by the South Coast AQMD Board in March 2017, 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). South Coast AQMD recently initiated efforts for updating the AQMP and is coordinating the efforts with the California Air Resources Board’s (CARB) revised 2020 Mobile Source Strategy.

Ground level ozone (a key component of photochemical smog) is created by a chemical reaction between NO_x and volatile organic compound (VOC) emissions in sunlight. The primary driver for ozone formation in the Basin is NO_x emissions, and mobile sources contribute approximately 88 percent of the NO_x emissions in this region, as shown in Figure 1. Furthermore, NO_x emissions, along with VOC emissions, also lead to the secondary formation of PM_{2.5} [particulate matter measuring 2.5 microns or less in size, expressed as micrograms per cubic meter (µg/m³)].

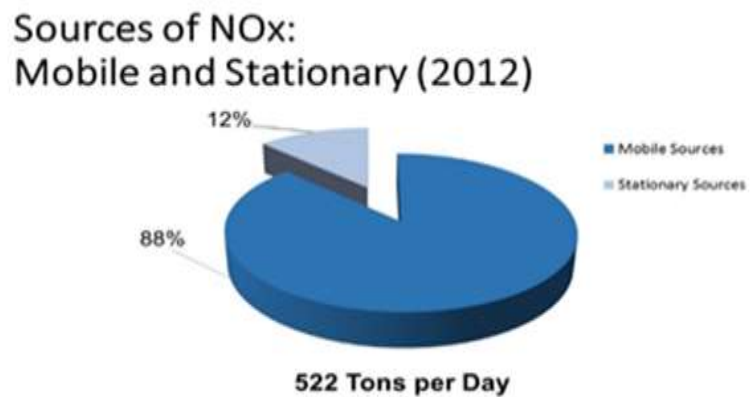
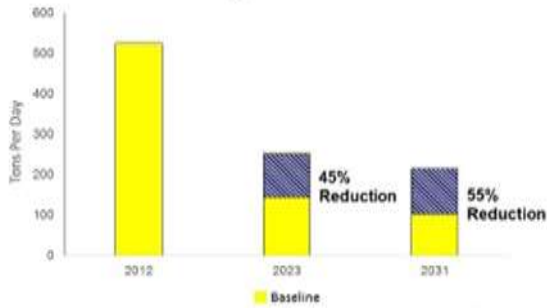


Figure 1: Sources of NO_x 2012 Base Year

The emission reductions and control measures in the 2016 AQMP rely on a mix of currently available technologies as well as the expedited development and commercialization of clean fuel mobile and stationary advanced technologies to achieve health-based air quality standards. The 2016 AQMP identifies a 45 percent reduction in NO_x is required by 2023 and an additional 55 percent reduction by 2031 to achieve national ambient air quality standards (NAAQS) for (8-hour) ozone of 80 parts per billion (ppb) and 75 ppb, respectively. Figure 2 illustrates these needed NO_x reductions in the Basin. The majority of NO_x reductions must come from mobile sources, both on-road and off-road. Notably, the South Coast AQMD is currently only one of two regions in the nation designated as an extreme nonattainment area (the other region is California’s San Joaquin (Central) Valley).

Basin Total NO_x Emissions



8-hour Ozone strategy targeting 2023 will ensure 1-hour attainment in 2022 as well as 24-hour and annual attainment in 2019 and 2025, respectively

Figure 2: Total NO_x Reductions Needed

For the first time, the 2016 AQMP identified a means to achieving the NAAQS through regulations and incentives for near-zero and zero emission mobile source technologies that are commercial or nearing commercialization. This strategy requires a significantly lower state and national heavy-duty truck engine emissions standard with the earliest feasible implementation date, significant additional financial resources, and accelerated fleet turnover on a massive scale.

Current state and federal efforts in developing regulations for on- and off-road vehicles and equipment are expected to significantly reduce NO_x emissions, but are insufficient to achieve the 2023 and 2031 ozone attainment deadlines.

Clean Fuels Program

The Clean Fuels Program, established in California Health And Safety Code 40448.5, is an important mechanism to encourage and accelerate the advancement and commercialization of clean fuels in both stationary and transportation 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 not only to provide a portfolio of technology choices but to achieve near-term and long-term emission reduction benefits. South Coast AQMD's 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 2021 Clean Fuels Annual Report and Draft 2022 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 typically attend and provide feedback. Preliminary review and comment are also provided by South Coast AQMD's Board and other interested parties and stakeholders, as deemed appropriate.

2022 Plan Update

The Clean Fuels Program is re-evaluated annually to develop the annual Plan Update based on a reassessment of the 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 reduction potential and co-funding opportunities. For several years, the state has focused a great deal of attention on climate change and petroleum reduction goals, but the South Coast AQMD has remained committed to developing, demonstrating and commercializing technologies that reduce criteria pollutants, specifically NO_x and toxic air contaminants (TACs). Most of these technologies address the Basin's need for NO_x and TAC reductions and also garner reductions in greenhouse gases (GHG) 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 extensively.

To identify technology and project opportunities where funding can make a significant difference in deploying cleaner technologies in the Basin, the 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 various 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 conceptually within the Draft 2022 Plan Update. Assembly Bill (AB) 617¹ requires reduced exposure to communities most 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 deployment of cleaner technologies. Cleaner technologies such as zero emission heavy-duty trucks are now included in the Community Emission Reduction Plans (CERPs) for these AB 617 communities, and an RFP for zero emission heavy-duty truck incentive funding will be released in 2022. CARB adopted two critical milestone regulations for reducing emissions from on-road heavy-duty mobile sources in 2020, the Advanced Clean Truck (ACT) regulation which mandates increasingly higher percentage of zero emission truck sales starting in 2024 and the Omnibus Low NO_x regulation which requires lower exhaust NO_x standards on heavy-duty engines starting in 2024. CARB is also working on the Heavy-Duty Vehicle Inspection and Maintenance Program as well as the Advanced Clean Fleets regulation for Board consideration in 2022. Despite these major efforts, NO_x emission reductions in the South Coast AQMD are still expected to fall short of the levels necessary to meet 2023 and 2031 ozone attainment targets.

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 emission reductions identified in the 2016 AQMP. Given the need for significant emission reductions over the next five to ten years, near-zero and zero emission technologies are emphasized. Areas of focus include:

- developing and demonstrating technologies to reduce emissions from goods movement and port-related activities, including near-zero and zero emission drayage trucks and infrastructure;
- developing and demonstrating ultra-low NO_x, gaseous and liquid renewable fueled, large displacement/high efficiency engines and heavy-duty zero emission engine technologies;
- developing, demonstrating and deploying advanced, low-NO_x natural gas and propane engines as well as near-zero and zero emission technologies for high horsepower applications;

¹ <https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program/about>

- mitigating criteria pollutant emissions from the production of renewable fuels, such as renewable natural gas, diesel and hydrogen as well as other renewable 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 light-, medium- and heavy-duty platforms;
- establishing large-scale hydrogen refueling and electric vehicle (EV) charging infrastructure to support light-, medium- and heavy-duty zero emission vehicles;
- ultra-fast charging for heavy duty battery electric vehicles and
- developing and demonstrating zero emission microgrids that utilize electric energy storage systems and onsite clean power generation to support transportation electrification demands associated with goods movement and freight handling activities.

Table 1 (page 20) lists potential projects across nine core technologies by funding priority:

1. Hydrogen/Mobile Fuel Cell Technologies and Infrastructure (especially large-scale refueling and production facilities) and stations that support medium and heavy-duty vehicles;
2. Engine Systems/Technologies (emphasizing alternative and renewable fuels for truck and rail applications);
3. Electric/Hybrid Vehicle Technologies and Infrastructure (emphasizing electric and hybrid electric trucks and container transport technologies with zero emission operations);
4. Fueling Infrastructure and Deployment (predominantly renewable natural gas and renewable fuels);
5. Stationary Clean Fuel Technologies (including microgrids that support EV and Hydrogen infrastructure and renewables);
6. Fuel and Emission Studies;
7. Emission Control Technologies that support low emitting diesel engines;
8. Health Impact Studies within disadvantaged communities; and
9. Technology Transfer/Assessment and Outreach.

These potential projects for 2022 total \$21.8 million of Clean Fuels funding, with the anticipation of total project costs of \$167.5 million, leveraging more than \$4 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 Community Air Protection (CAP) funding, Volkswagen Mitigation and Carl Moyer VOC, and NOx mitigation funds.

CLEAN FUELS PROGRAM

2022 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 Technology Advancement Program (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 2022 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 AQMP, which will be updated in 2022, is the long-term regional "blueprint" that relies on fair-share emission reductions from all jurisdictional levels (e.g., federal, state and local). The 2016 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).

The emission reductions and control measures in the 2016 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 2016 AQMP identifies a 45 percent reduction in NO_x required by 2023 and an additional 55 percent reduction by 2031 to achieve 8-hour ozone standards of 80 ppb and 75 ppb, respectively. The majority of NO_x reductions must come from mobile sources, including both on- and off-road vehicle and equipment. Notably, South Coast AQMD is currently only one of two regions in the nation designated as an extreme nonattainment area (the other region is California's San Joaquin Valley). Furthermore, in April 2019, South Coast AQMD requested a voluntary re-classification from U.S. EPA of the 1997 8-hour federal ozone standard for the Coachella Valley region of the South Coast AQMD to "extreme" status. Hotter temperatures and other meteorological changes impacted by climate change in this region have presented challenges that require additional time to reach attainment.

While current state efforts in developing regulations for on- and off-road vehicles and stationary equipment are expected to reduce NO_x emissions significantly, they will be insufficient to meet South Coast AQMD needs, particularly in terms of timing. The 2016 AQMP identified a means to achieving the NAAQS through regulations and incentives for near-zero and zero emission technologies that are commercial or nearing commercialization. This strategy requires a significantly lower state and national heavy-duty truck engine emissions standard with the earliest feasible implementation date, significant

additional financial resources, and accelerated fleet turnover on a massive scale. To support the fleet turnover the Clean Fuels Program's emphasis continues on commercialization of larger HD low NOx engines and large deployment projects of zero emission HD trucks like the JETSI Pilot Project.²

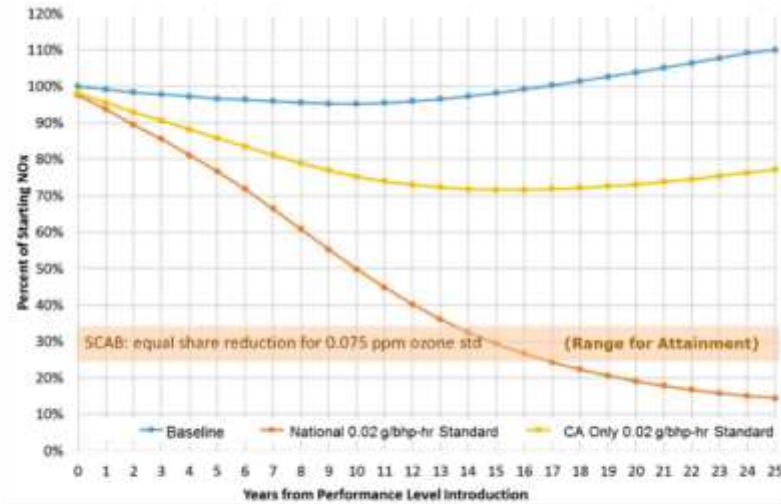
On June 3, 2016, South Coast AQMD petitioned the U.S. EPA to initiate rulemaking for a lower national NOx standard for on-road heavy-duty engines to achieve additional mobile source emission reductions. A national NOx standard (as opposed to a California standard) for on-road heavy-duty vehicles is estimated 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 heavy-duty vehicle miles traveled in the Basin are from vehicles purchased outside of California, which points to the need for a more stringent federal as well as state standard for on-road heavy-duty vehicles.

U.S. EPA has since acknowledged the need for additional NOx reductions through a harmonized and comprehensive national NOx reduction program for heavy-duty on-highway engines and vehicles. On November 13, 2018, U.S. EPA announced the Cleaner Truck Initiative, and on January 6, 2020, they issued an Advance Notice of Proposed Rule to reduce NOx emissions from on-road heavy-duty trucks. The progress was stalled in 2020 but EPA recently confirmed the deadline given by the president's Executive Order to finalize low NOx rulemaking by the end of 2022 for lower NOx standard with model year 2027. In the summer of 2020 CARB adopted its own Low NOx Omnibus rule. The new regulation imposes lower NOx standards starting in model year 2024, that will harmonize with U.S. EPA's Cleaner Truck Initiative's national NOx standard of 0.02 g/bhp-hr in 2027, 90% below today's NOx standard. Although both regulations are welcome news, their implementation and effectiveness are too late to help the South Coast AQMD meet its 2023 federal ozone attainment deadline. So, despite the milestone progress, commercialization and deployment of cost-effective near-zero engines are still needed to meet near-term goals.

Given that the Basin must attain the 75-ppb ozone NAAQS by 2031, a new on-road heavy-duty engine NOx emission standard is critical given the time needed for OEMs to develop and produce compliant vehicles, and for national fleet turnover to occur.

Figure 4 shows the difference in NOx reductions from on-road heavy-duty trucks under three scenarios: baseline (no change in the low NOx standard) in blue, a low NOx standard adopted only in California in yellow, and lastly, a federal low NOx standard in orange.

² The project, known as Joint Electric Truck Scaling Initiative, or JETSI, is the largest commercial deployment of battery-electric trucks in North America to date, helping to significantly increase the number of zero-emission heavy-duty 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.



Source: Presentation by Mr. Cory Palmer, ARB at the Symposium on California's Development of its Phase 2 Greenhouse Gas Emission Standards for On-Road Heavy-Duty Vehicles (April 22, 2015)

Figure 4: NOx Reduction Comparison: No New Regulations vs Low NOx Standard in California only vs National Standard

In mid-2017, South Coast AQMD initiated MATES V 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, finalized in June 2021, showed that air toxics cancer risk based on modeling data has decreased by over 50% since MATES IV, with an 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. In the meantime, U.S. EPA approved the use of the CARB EMFAC 2017 model for on-road vehicles for use in the State Implementation Plan and transportation conformity analyses, which assesses emissions from on-road vehicles including cars, trucks and buses. The off-road model, which assesses emissions from off-road equipment such as yard tractors, top handlers, and rubber tire gantry cranes, is being replaced by category-specific methods and inventory models developed for specific regulatory support projects.

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 \$231.6 million toward projects exceeding \$1.14 billion. 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 technologies 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 in 1998, South Coast AQMD has implemented other incentive programs (i.e., Volkswagen Mitigation, Proposition 1B-Goods Movement, and Community Air Protection Program), with cumulative funding of \$250 million annually. Starting in 2022, there will also be AB 617 incentive funding reserved for zero emission trucks in AB 617 communities which was identified as a funding priority in their CERPs. The 2016 AQMP also included control measures to develop indirect source regulations and strengthen the 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 are still needed for the scale necessary to achieve the NAAQS for this region. Meanwhile, South Coast AQMD is seeking to commercialize alternative low-NOx technologies that do not rely on incentives by providing customer fuel savings with low payback periods. There are several emerging key technologies that are discussed in detail later that will provide the NOx and GHG co-benefit which might no longer require vehicle purchase incentives.

As technologies move towards commercialization, such as heavy-duty battery electric trucks, the Clean Fuels Program has been able to partner with large OEMs, such as Daimler and Volvo to deploy these vehicles in large numbers. These OEM partnerships allow the Program to leverage their research, design, engineering, manufacturing, sales and service, and financial resources that are needed to move advanced technologies from the laboratories to the field and into customers' hands. The OEMs have the resources to develop advanced technology vehicles such as battery electric and hydrogen fuel cells, manufacture in large quantities and distribution network to support sales across the state. To obtain the emission reductions needed to meet NAAQS, large numbers of advanced technology clean-fueled vehicles must be deployed across our region and state.

Figure 5 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 South Coast AQMD's 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 to achieve near-term and long-term emission reduction benefits.



Figure 5: Technology Readiness Levels

Many of the technologies that address the Basin's needed NOx reductions align with the state's GHG reduction efforts. U.S. EPA (2021)³ noted that the transportation sector contributed 29 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 2022 Plan Update includes projects to research, develop, demonstrate and advance deployment (RD3) a variety of technologies, from near-term to long-term, that are intended to address the following challenges:

- 1) implementation of new and changing 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 by including accelerated development of technologies

³ U.S. Greenhouse Gas Emissions and Sinks 1990-2019. 2021. <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

- nearing commercialization and deploying commercially ready technologies; and
- 3) continued development of near-term cost-effective approaches and long-term technology development.

The overall scope of projects in the 2022 Plan Update needs to remain sufficiently flexible to address new technologies and control measures identified in the 2016 AQMP, dynamically evolving technologies, and new research and data. The latter includes findings from MATES V and revised emission inventories from the recently released EMFAC 2021.

Within the core technology areas defined later in this section, project objectives range from near term to long term. The South Coast AQMD 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. These are expected to result in commercially available products as early as 2021, including obtaining required certifications from CARB and U.S. EPA. It is often difficult to transition users to non-traditional technologies or fuels due to higher incremental costs or required changes to user behavior, even if these technologies or fuels offer significant benefits. In addition to government's role to reduce risk by funding technology development and testing, it is also necessary to offset incremental costs through incentives to accelerate the use of cleaner technologies. The increased use of these clean fuel technologies also depend on efforts to increase stakeholder confidence that these technologies are viable and cost-effective in the long term.
- Technologies ready to begin field *demonstration* in 2022 are expected to result in commercially available products in the 2023-2025 timeframe, and technologies being demonstrated generally are in the process of being verified or certified by CARB and U.S. EPA. 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 the technologies. Field demonstrations provide real-world evidence of performance to allay any concerns by early adopters.
- Finally, successful technology *development* projects are expected to begin during 2022 with duration of 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. Development projects identified in this plan may result in technologies ready for commercial introduction as soon as 2022-2026. Projects may involve the development of emerging technologies that are considered long-term and higher risk, but with significant emission reductions potential. Commercial introduction of such long-term technologies would not be expected until 2027 or later.

Core Technologies

The following technologies have been identified as having the greatest potential to enable the emission reductions needed to achieve 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 2022 due to funding limitations, and the focus will remain on control measures identified in the 2016 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 is significant opportunity 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 heavy-duty 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 operating on an alternative fuel as a range extender. Elements of the core hybrid electric system 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, AB 617, signed by the Governor in mid-2017, will implement actions and provide incentive funding for priorities designated in CERPs by six AB 617 communities within the South Coast region, and additional flexibility will be needed to develop new strategies and technologies for those disadvantaged communities.

The following nine core technology areas are listed by current South Coast AQMD priorities based on the goals for 2022.

Hydrogen/Mobile Fuel Cell Technologies and Infrastructure

The South Coast AQMD supports hydrogen infrastructure and fuel cell technologies as one option in the technology portfolio; the agency is dedicated to assisting federal and state government programs to deploy light-, medium-, and heavy-duty fuel cell electric vehicles (FCEV) by supporting the required hydrogen fueling infrastructure.

Calendar Years 2015-2019 were a critical timeframe for the introduction of hydrogen fueling infrastructure. In 2014, Hyundai introduced the Tucson FCV for lease. In 2015, Toyota commercialized the Mirai, the first FCV available to consumers for purchase. In December 2016, Honda started commercial lease of its 2017 Honda Clarity FCV. The 2019 Hyundai Nexo was the second FCV offered for sale and lease in California. 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. Changes to CARB’s Low Carbon Fuel Standard (LCFS) regulation to provide credit for low carbon fuel capacity in addition to throughput is enabling station operators to remain solvent during the early years until vehicle numbers ramp up. 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 refueling reliability matching those of existing gasoline and diesel fueling stations. The current network of hydrogen fueling stations to support the current number of light-duty FCVs on the road is insufficient, and supply of hydrogen and additional hydrogen production continue to be challenges that need to be addressed.

In 2018, Former Governor Brown issued Executive Order (EO) B-48-18. Among other provisions, the order sets an additional hydrogen station network development target of 200 stations by 2025. Meeting this new ambitious target clearly requires accelerated effort on the part of the State to ensure its achievement. The EO additionally sets a target for 5 million ZEVs by 2030; FCVs are expected to comprise a significant portion of this future ZEV fleet. In September 2019, Governor Newsom issued EO N-19-19 on Climate Change, which directs CARB to push OEMs to produce even more clean vehicles, and to find ways for more Californians, including residents in disadvantaged communities, to purchase these vehicles on the new and used markets. CARB is tasked with developing new grant criteria for clean vehicle programs to encourage OEMs to produce clean, affordable cars and propose new strategies to increase demand in the

primary and secondary markets for ZEVs. Finally, CARB is taking steps to strengthen existing or adopt new regulations to achieve GHG reductions within the transportation sector.

Fuel cells can play a role in medium- and heavy-duty applications where battery recharge time, although improving, is insufficient to meet fleet operational requirements. The California Fuel Cell Partnership's (CaFCP's) *2030 Vision*⁴ released in July 2018 provides a broader framework for the earlier *Medium- and Heavy-Duty 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 *Heavy-Duty Vision* released in July 2021 describes 70,000 fuel cell electric trucks supported by 200 heavy-duty hydrogen stations operating in California and beyond.

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 heavy-duty hydrogen fueling station using hydrogen produced by a new tri-generation fuel cell on Port of Long Beach property leased by Toyota. As part of the \$83 million Shore-to-Store project led by the Port of Los Angeles, for which the Clean Fuels Program committed \$1 million, Toyota and Kenworth deployed 10 Class 8 fuel cell trucks and Equilon (Shell) built two large capacity hydrogen fueling stations in Wilmington and Ontario. Kenworth leveraged the development 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.

Another player in the heavy-duty fuel cell truck space is Cummins who recently purchased Hydrogenics and EDI to develop fuel cell power trains. Cummins is currently working on the ZECT 2 and a CEC/South Coast AQMD supported project that will develop and demonstrate fuel cell drayage trucks with next generation fuel cell module - easy to package system design and other innovative integration strategies. Also, Volvo and Daimler this year announced a joint venture to develop fuel cell powered trucks. 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 heavy-duty fuel cell trucks. 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 500miles for regional and long-haul operations.

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. As part of the \$46 million Fuel Cell Electric Bus Commercialization Consortium project, for which the Clean Fuels Fund contributed \$1 million, the Center for Transportation and Environment (CTE), in partnership with New Flyer, Trillium, and Orange County Transportation Authority (OCTA), deployed 10 40-foot New Flyer XHE40 fuel cell transit buses and installed a liquid storage hydrogen station capable of fueling up to 50 fuel cell transit buses at OCTA. This project also deployed 10 fuel cell transit buses and a hydrogen station upgrade at Alameda-Contra Costa Transit District (AC Transit). SunLine Transit Agency was the recipient of a U.S. EPA Targeted Airshed grant in June 2020 to deploy five fuel cell transit buses, in addition to their existing fleet of 21 fuel cell (in process to accept 5 fuel cell buses) 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. In August 2021, the Clean Fuels Program committed \$531,166 to a \$2 million project to develop and demonstrate two medium-duty fuel cell buses at Sunline.

The 2022 Plan Update identifies key opportunities while clearly leading the way for pre-commercial demonstrations of OEM vehicles. 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 hydrogen co-production and higher pressure (10,000 psi) hydrogen dispensing and scalable/higher throughput;

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

- 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 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 FCVs in controlled fleet applications in the Basin;
- 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 investing as well as critical assessments of market risks to guide and protect this investment;
- coordination with FCV OEMs to develop an understanding of their progress in overcoming barriers to economically competitive FCVs and develop realistic scenarios for large scale introduction; and
- repurpose of 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.

Engine Systems/Technologies

To achieve the emissions reductions required for the Basin, internal combustion engines (ICEs) used in the heavy-duty sector will require emissions that are 90 percent lower than the 2010 standards as outlined in CARB's recently adopted Heavy-Duty On-Road "Omnibus" Low NOx regulation and EPA's Cleaner Trucks Initiative. In 2016, Cummins Westport, Inc. (CWI) achieved a new ultra-low NOx threshold by commercializing the first on-road heavy-duty 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; and powering these vehicles with low Carbon Intensity renewable fuels or biomethane, to help address greenhouse gas (GHG) objectives, became a game changer for the heavy-duty transportation sector. The 8.9L engine works well in refuse and other vocational trucks as well as transit and school buses. In 2017, CWI, with South Coast AQMD and other project partners, also achieved certification of the 12L natural gas engine. The 12L engine in Class 8 drayage trucks and 60-foot articulated transit buses expanded the scope of this near-zero technology. CARB and U.S. EPA certified both engines at 0.02 g/bhp-hr for NOx. New for 2020, Cummins certified its 6.7L natural gas engine to 0.02 g/bhp-hr NOx for the first time, further ensuring the viability of near-zero engine options for all market segments. For trucks that cannot utilize the Cummins near-zero emission engines, the 2022 Plan Update includes potential projects to develop, demonstrate and certify natural gas and propane engines in the 6-8L range, several options has been made available for medium-duty truck and bus platforms. Although no near-zero emission diesel technology is commercially available today, South Coast AQMD has been working closely with CARB, U.S. EPA and others on defining technology pathways via several projects, including the Ultra-Low Emissions Diesel Engine Program at Southwest Research Institute (SwRI), opposed piston engine development with Achates Power Inc., and Thermal Management using Cylinder Deactivation (CDA) with West Virginia University. The 2022 Plan Update includes on-road truck demonstrations for the SwRI as well as the Achates projects, these demonstration efforts are considered key milestones in driving up the TRL level toward full commercialization. CDA has proven to be a key engine enabling technology for controlling exhaust temperature and increasing efficiency. These demonstration projects, although not yet complete, show that near-zero emission diesel technologies using renewable fuel sources are feasible via advanced engine and aftertreatment or optimized engine design and calibration. At the same time, applications that require high power/torque levels are also the applications where zero emission technologies and supporting infrastructures will take longer to become commercially available, and development of near-zero emission

technologies would be critical to support those applications. The Plan Update continues to incorporate pursuit of cleaner engines and hybrid powertrains for the heavy-duty sector. Future projects will support the development, demonstration and certification of engines and powertrains that can achieve these massive near-term emission reductions using an optimized powertrain systems approach. At the same time, the aggressive GHG emissions reduction targets set forth by both CARB and EPA have invigorated interest in revisiting low- and zero carbon alternative fuels for those high power/torque applications as well as off-road applications. While the GHG benefit is easy to assess, it is important to understand the criteria emissions impact where optimized engine systems are required from earlier learnings to ensure reduction of both criteria and GHG can be met. In December 2018, South Coast AQMD participated in the Natural Gas Engine & Vehicle R&D Source Review Panel meeting in Sacramento to review, discuss and prioritize several natural gas engine and vehicle technology projects that increase efficiencies using advanced engines or hybrid drive trains.

The 2022 Plan includes potential projects that the South Coast AQMD might participate in with federal and state agencies towards these efforts. Specifically, these projects are expected to target the following:

- development of ultra-low emissions and improved higher efficiency natural gas engines for heavy-duty vehicles and high horsepower applications projects that move these technologies to a higher technology readiness level and commercialization;
- continued development and demonstration of gaseous- and liquid-fueled, advanced fuels or alternative fuel medium-duty and heavy-duty engines and vehicles;
- development and demonstration of CNG hybrid vehicle technology;
- development and demonstration of diesel hybrid vehicle technology;
- development and demonstration of alternative fuel engines for on- and off-road applications;
- evaluation of alternative engine systems such as plug-in hybrid vehicles;
- development and demonstration of engine systems that employ advanced engine design features, CDA, improved exhaust or recirculation systems, and aftertreatment devices.
- further development of robust aftertreatment systems which can maintain certified emissions levels throughout useful life.

U.S. EPA's recent initiation to create a new national low NOx standard for on-highway heavy-duty engines starting in 2027 will further motivate manufacturers to develop lower-NOx emitting technologies expected to result in greater NOx emission reductions than a "California only" low NOx standard for on-road heavy-duty engines.

Electric/Hybrid Technologies and Infrastructure

To meet federal standards for PM2.5 and ozone, a primary focus must be on zero and near-zero emission technologies. A key strategy to achieve these goals is the wide-scale electrification of transportation. South Coast AQMD supports projects to address concerns regarding cost, battery life, all-electric range, charging infrastructure 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. Additionally, the challenges of installing infrastructure both in terms of costs and construction impacts needs to be better understood.

There are separate challenges associated with light-duty EVs vs. medium- and heavy-duty EVs, which are on opposite ends of the commercialization spectrum. Light-duty EVs and charging infrastructure have long been commercially available and availability of public charging and costs to deploy infrastructure are the main challenges. Medium- and heavy-duty EVs are becoming more commercially available, with Daimler and Volvo obtaining CARB certification of their Class 6 and/or 8 battery electric trucks in 2020. Standards for charging infrastructure to support medium- and heavy-duty EVs has generally been with the Combined

Charging System Combo 1 (CCS1) connector in North America. Although Volvo and ABB obtained UL certification of the Combined Charging System Combo 2 (CCS2) connector in 2020, which is a connector standard predominantly used in Europe and other parts of the world, the CCS1 connector continues to be the standard connector for charging up to 350 kW DC. A Megawatt Charging System connector is under development by the Charging Interface Initiative (CharIN) for Class 6 -8 EVs for charging up to 4.5 MW DC, although there are no EVs which are currently 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. The challenges and costs of installing medium- and heavy-duty charging infrastructure increase exponentially compared to light-duty infrastructure. Each year there are more commercially available options for medium- and heavy-duty on-road EVs and off-road equipment, charging infrastructure to support these EVs and equipment, and an ability to fund larger scale deployment projects for medium- and heavy-duty EVs, equipment, and infrastructure.

The 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. The 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/infrastructure (battery and/or fuel cell), or plug-in hybrid powertrains, locomotives with hydrogen fuel cells, hybrid and, battery electric technologies, , and linear synchronous motors for locomotives and 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 City of Los Angeles *Zero Emission 2028 Roadmap 2.0* in preparation for the 2028 Olympics corroborates this effort, calling for an additional 25% GHG and criteria pollutant reductions. The San Pedro Bay Ports *Clean Air Action Plan* (2017) calls for zero emissions cargo handling equipment by 2030 and zero emission drayage trucks by 2035, respectively.

New zero emission battery electric technology projects include: 1) Pilot Project with deployment of 100 Daimler and Volvo Class 8 battery electric trucks for drayage and regional haul at NFI and Schneider funded by \$16M from CARB and \$11M from CEC; 2) Switch-On Project with deployment of 70 Volvo Class 8 battery electric drayage/freight trucks at up to five fleets in the Inland Empire and San Fernando Valley in Los Angeles funded by a \$20 million U.S. EPA Targeted Airshed grant, 3) deployment of two additional Class 8 battery electric drayage trucks as part of the CARB funded Volvo LIGHTS project through a \$500,000 U.S. EPA Clean Air Technology Initiative grant, 4) deployment of two Volvo Class 8 battery electric trucks and 150 kW DC fast chargers at Producers Dairy in Fresno as part of the CARB funded GGRF Zero Emission Drayage Truck Project, 5) Daimler Commercial Experience project to demonstrate eight Class 6 and 8 battery electric trucks and fast charging infrastructure funded with \$1 million by the South Coast AQMD Clean Fuels Fund.

Continued technology advancements in light-duty infrastructure have facilitated the development of corresponding codes and standards for medium- and heavy-duty infrastructure including the UL certification of the CCS2 connector for the Volvo LIGHTS battery electric truck demonstration project. Additionally, SCE's Charge Ready Transport Program and LADWP include funding for medium- and heavy-duty vehicles and infrastructure.

Heavy-duty hybrid vehicles have historically been optimized for fuel economy, new generation hybrid powertrains that use a systems approach for co-optimizing both criteria emissions and fuel economy could provide another technology pathway to meet the air quality goals of the Basin. These hybrid systems in both plug-in and non-plug-in configurations, will focus on electrifying key engine subsystems and energy recovery to provide engine assistance during transient operations. Furthermore, the availability of additional

electrical power such as 48-volt systems could allow for electric aftertreatment heaters for better transient control through thermo-management and therefore better NO_x control. CARB adopted new test procedures for medium-duty and heavy-duty hybrid powertrains to certify to engine standards in CARB's proposed Heavy-Duty On-Road "Omnibus" Low NO_x regulation. The new hybrid powertrain test procedures will properly credit for the fuel and emission benefits of hybrid vehicles via vehicle simulation on vehicle-based cycles and allow the entire powertrain system to certify to potentially lower emissions standards than traditional engine only tests. South Coast AQMD views these next generation hybrid powertrains as capable of being deployed without the need for incentives, by providing fuel economy benefits which could provide another potential cost-effective pathway for reducing NO_x emissions in the near term. Furthermore, CARB's Advance Clean Trucks and Advance Clean Fleets regulations both allow sales of plug-in hybrid vehicle that's capable of zero-emission operation as a compliance pathway for meeting the zero emission mandate.

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 and fuel cell electric technologies for cargo handling and container transport operations, e.g., heavy-duty battery electric or plug-in electric drayage trucks with all electric range;
- large scale deployments of commercial battery electric vehicles and infrastructure (i.e. 50 or more vehicles) to prove feasibility and develop tools for fleets to assist in successful operation for drayage and short regional haul operations;
- demonstration of medium-duty battery electric and fuel cell electric vehicles in package delivery operations, e.g., battery electric walk-in vans with fuel cell or CNG range extender;
- development and demonstration of battery and fuel cell electric off-road equipment; e.g. battery electric off-road construction equipment, yard tractors, or top-handler with wireless charger;
- development and demonstration of CNG hybrid vehicle technology;
- development and demonstration of diesel hybrid vehicle technology;
- development of hybrid vehicles and technologies for off-road equipment;
- demonstration of niche application battery and fuel cell electric medium- and heavy-duty vehicles, including school and transit buses 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 by operating in zero emission mode 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 heavy-duty trucks;
- demonstration and installation of infrastructure to support battery electric and fuel cell electric vehicle light-, medium- and heavy-duty 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);
- development of higher density battery technologies for use in heavy-duty vehicles;

- repurpose 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;
- 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; and
- deployment of infrastructure corresponding to codes and standards specific to light-, medium- and heavy-duty vehicles, including standardized connectors, fuel quality, communication protocols, and open standards and demand response protocols for EV chargers to communicate across charging networks.

Fueling Infrastructure and Deployment (Natural Gas/Renewable Fuels)

Significant demonstration and commercialization efforts funded by the Clean Fuels Program as well as other local, state and federal agencies are underway to: 1) support the upgrade and buildup of public and private infrastructure projects, 2) expand the network of public-access and fleet fueling stations based on the population of existing and anticipated vehicles, 3) put in place infrastructure that will ultimately be needed to accommodate transportation fuels with very low gaseous and GHG emissions, and 4) support local production of clean, low carbon intensity, renewable transportation fuels.

Compressed and liquefied natural gas (CNG and LNG) refueling stations continue to be positioned to support both public and private fleet applications. Funding has been applied to provide refueling at key points for all classes of vehicles, with an emphasis on heavy-duty natural gas vehicle users travelling on major goods movement corridors, including local ports, and along I-15 and The Greater Interstate Clean Transportation Corridor (ICTC) Network. Upgrades and expansions are also needed to refurbish or increase capacity for some of the stations installed five or more years ago as well as standardize fueling station design, especially to ensure growth of alternative fuels throughout the Basin and beyond. There is also a continuing and growing interest for partial or complete transition to renewable fuels, particularly natural gas delivered through existing natural gas pipelines. Funding has been provided to support local production and use of renewable natural gas to incentivize turnover to near-zero natural gas-powered heavy-duty vehicles. The growing interest in low carbon, renewable transportation fuels that also power ultra-low to zero emission vehicles will expand the scope of this category to provide support of local production and distribution of such fuels and help accelerate fleet turnover. SB 350 (De León) further established a target to double the energy efficiency in electricity and natural gas end uses by 2030.

Some of the projects expected to be developed and co-funded for infrastructure development are:

- development and demonstration of low carbon intensity renewable transportation fuels including renewable natural gas, renewable hydrogen, and renewable electricity from zero emission sources and from renewable feedstocks, such as biomass and biowaste;
- development and demonstration of advanced, cost-effective methods for manufacturing synthesis gas for conversion to renewable natural gas and renewable (biomass-based) hydrogen;
- enhancement of safety and emissions reductions from natural gas refueling equipment;
- expansion of fueling infrastructure, fueling stations, and equipment, with an emphasis on renewable energy sources; and
- expansion of infrastructure connected with existing fleets, public transit, and transportation corridors, including demonstration and deployment of closed loop systems for dispensing and storage.

Stationary Clean Fuel Technologies

Although stationary source NOx emissions are small compared to mobile sources in the Basin, there are applications where cleaner fuel technologies or processes can be applied to reduce NOx, VOC and PM emissions. For example, a recent demonstration project funded in part by the South Coast AQMD at a local sanitation district consisted of retrofitting an existing biogas engine with a digester gas cleanup system and catalytic exhaust emission control. The retrofit system resulted in significant reductions in NOx, VOC and CO emissions. This project demonstrated that cleaner, more robust renewable distributed generation technologies exist that not only improve air quality but enhance power quality and reduce electricity distribution congestion.

Selective Catalytic Reduction (SCR) has been used as aftertreatment for combustion equipment for NOx reduction. SCR requires the injection of ammonia or urea that is reacted over a catalyst bed to reduce the NOx formation during the combustion process. Challenges arise if ammonia distribution within the flue gas or operating temperature is not optimal resulting in ammonia emissions leaving the SCR in a process referred to as “ammonia slip.” The ammonia slip may also lead to the formation of particulate matter in the form of ammonium sulfates. An ongoing demonstration project funded in part by the South Coast AQMD consists of retrofitting a Low NOx ceramic burner on an oil heater without the use of reagents such as ammonia nor urea which is anticipated to achieve SCR NOx emissions or lower. Based on the successful deployment of this project, further emission reductions may be achieved by other combustion sources such as boilers by the continued development of specialized low NOx burners without the use of reagents. 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 potentially stranded renewable electricity to be stored as hydrogen fuel. 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 the 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.

The development, demonstration, deployment and commercialization of advanced stationary clean fuel technologies will support control measures in the 2016 AQMP in that they reduce emissions of NOx and VOCs from traditional combustion sources by replacement or retrofits with zero and near-zero emission technologies.

Health Impacts, Fuel and Emissions Studies

The monitoring of pollutants in the Basin is extremely important, especially when linked to (1) a particular sector of the emissions inventory (to identify the responsible source or technology) and/or (2) exposure to pollution (to assess potential health risks). In fact, studies indicate that ultrafine particulate matter (PM) can produce irreversible damage to children's lungs. This information highlights the need for further emission and health studies to identify emissions from high polluting sectors as well as the health effects 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 NO_x emissions while reducing other criteria pollutant emissions. South Coast AQMD has participated in several renewable diesel and ethanol-blend gasoline studies led by CARB in an effort to approve these fuels in California, the results of these studies are expected in 2022. 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, 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 are due to be published in 2022. In addition, as the market share for gasoline direct injection (GDI) vehicles has rapidly increased from 4 percent of all vehicle sales in the U.S. to an estimated 60 percent between 2009 and 2016, it is important to understand the air quality impacts 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 heavy-duty vehicles. The results from these studies suggest the addition of a particulate filter for controlling particulate emissions from GDI vehicles. 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. Preliminary results suggest real-world emissions vary greatly between applications and fuel types; the NO_x reduction from natural gas fueled vehicles, especially ones certified to near-zero emission levels, are significant compared to diesel baseline. The results of the study also contributed to the new EMFAC 2021 emissions model. In 2020, CARB adopted Omnibus regulation to the next lower level NO_x standard, particularly highlighting the need to address the gap between certification values and in-use emissions. The new regulation included a new low-load cycle, new in-use emissions testing metric based on 3-Bin Moving Average Windows (3B-MAW), and new concept to assess NO_x across the entire vehicle population via onboard emission sensors. The 3B-MAW will be a game changer for future combustion technologies, as it address the short-falls of previous in-use testing methods and should address the issue of gap between in-use emissions and certification standard, an issue commonly seen in the South Coast Air Basin where many heavy-duty vehicles operate in low-speed, low load modes. The current and future real-world emissions study could help stakeholders better understand the impacts of emissions in real time to a specific geographic area.

Senate Bill 210 was signed in the law in 2019 which directs CARB to develop and implement a new comprehensive heavy-duty inspection and maintenance (HD I/M) program to support higher emitter and issues with mal-maintenance to ensure trucks maintain their emissions for their intended useful life. The HD I/M program includes a measurement emission from a large population of trucks which is critical for success of this program. Remote sensing technology, which can be setup near road side and on freeway over passes has gained the spot light for enabling a new suite of technology for assess emissions in-use. In August 2021, CARB staff shared findings from the pilot program. OBD and Roadside Emissions Monitoring Device (REMD) testing would likely be the best combination of technologies for a future

statewide vehicle compliance and enforcement program as OBD testing technologies have proven to be capable of reliably collecting OBD parameters of interest and diagnosing emissions related vehicle issues. REMD testing has good inter-system correlation and repeatability for NO_x, and repairs for identified emissions related issues were found to be feasible and effective at reducing emissions. Automated License Plate Recognition (ALPR) camera technologies were also able to capture 80% of license plates to assist in enforcement efforts. A statewide vehicle compliance program would likely be phased in with vehicle screening starting in January 2023, enforcement of compliance certificate requirements in July 2023, and periodic testing and certified devices for OBD submissions in 2024. CARB would take a HD I/M Proposed Regulation for a statewide vehicle compliance program to their Board for consideration in December 2021. The new HD I/M rule should address the concerns of high emitters in the legacy fleet which are expected to remain service well into 2030s, further reducing emissions in our region.

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. In mid-2017, South Coast AQMD initiated MATES V 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 finalized in August 2021 showed that air toxics cancer risk based on modeling data has decreased over 50% since MATES IV, with average multi-pathway air toxics cancer risk at 454-in-a-million. Highest risk locations are at LAX and the Ports along goods movement and transportation corridors. Diesel PM continues to be the major contributor to 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.

In recent years, there has also been an increased interest at the state and federal level on the use of alternative fuels to reduce petroleum oil dependency, GHG emissions and air pollution. In order to sustain and increase biofuel utilization, it is essential to identify feedstocks that can be processed in a more efficient, cost-effective and sustainable manner. More recently, the various low and zero carbon initiatives have stirred up a new round of interest in alternative fuel combustions such as ethanol, hydrogen and other engineered bio/renewable fuels. In 2019, South Coast AQMD, along with SoCalGas, UCR/CE-CERT launched a study to assess emissions of hydrogen-natural gas blends on near-zero emission natural gas engines, the study was impacted by Covid-19 shut downs but recently has resumed testing with results available in early 2022. Moreover, based on higher average summer temperatures noted over the past few years, there is interest on how the higher temperatures impact ozone formation. In line with this, a project 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.

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;
- in-use emission studies using biofuels, including renewable diesel and other alternative fuels, to evaluate in-use emission composition;
- in-use emission studies to determine impact of new technologies, in particular EVs on local air quality as well as benefit of telematics on emission reduction strategies;
- 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 hydrogen-fossil fuel blends on latest technology engines; and

- evaluation of impact of higher ambient temperatures on emissions of primary and secondary air pollutants.

Emissions Control Technologies

Although engine technology and engine systems research are required to reduce the emissions at the combustion source, dual fuel technologies and post-combustion cleanup methods are also needed to address on-road and off-road equipment emissions. Existing diesel emissions can be greatly reduced with introduction of natural gas RNG, biofuels, synthetic and low carbon fuels into the engine or via aftertreatment controls such as PM traps, advanced SCR and DPF catalysts coupled with electrically heated diesel exhaust fluid (DEF) dosers and electrical heaters that increase the aftertreatment temperature utilizing the 48V battery system from diesel-hybrid powertrain, as well as using low sulfur fuel. Gas-to-Liquid (GTL) fuels, formed from natural gas or other hydrocarbons rather than petroleum feedstock and emulsified diesel, provide low emission fuels for use in diesel engines. As emissions from engines become lower and lower, the lubricant contributions to VOC and PM emissions become increasingly important. Recently, particulate matter (PM and PN) emissions from GDI fueled light-duty vehicles, natural gas fueled medium- and heavy-duty vehicle have gathered attention due to lack of a particulate filter. While relative PM level are low and below the applicable standard, concerns on ultra-fine emissions needs to be assessed. South Coast AQMD have been and will continue to fund studies to help mitigate particulate matter related concerns to gasoline and natural gas fueled engines.

Recently, onboard emissions sensors have been identified by CARB and other agencies as a new 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, to enable advanced concepts like Geofencing, Eco-routing, and more. The most promising of these technologies will be considered for funding, specifically:

- evaluation and demonstration of new emerging liquid fuels, including alternative and renewable diesel and GTL fuels;
- development and demonstration of renewable-diesel engines and advanced aftertreatment technologies for mobile applications (including heated dosing technologies, close coupled catalysts, electronically heated catalysts and other advanced selective catalytic reduction systems) as well as non-thermal regen technology;
- development and demonstration of low-VOC and PM lubricants for diesel and natural gas engines;
- develop, evaluate, and demonstrate onboard sensor-based emissions monitoring methodology; and
- develop, evaluate, and demonstrate cloud-based emissions and energy management system.

Technology Assessment and Transfer/Outreach

Since the value of the Clean Fuels Program depends on the deployment and adoption of the demonstrated technologies, outreach and technology transfer efforts are essential to its success. This core area encompasses assessment of advanced technologies, including retaining outside technical assistance to expedite the 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). As part of AB 617⁵, which requires reduce exposure to communities most 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.

⁵ <https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program/about>

Incentivizing the deployment of zero emission heavy-duty trucks has been included in the CERPs and an RFP for zero emission heavy-duty truck incentive funding will be released in 2022 for these AB 617 communities.

Target Allocations to Core Technology Areas

The figure below presents the potential allocation of available funding, based on South Coast AQMD projected program costs of \$21.8 million for all potential projects. The actual project expenditures for 2022 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. Specific contract awards throughout 2022 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.

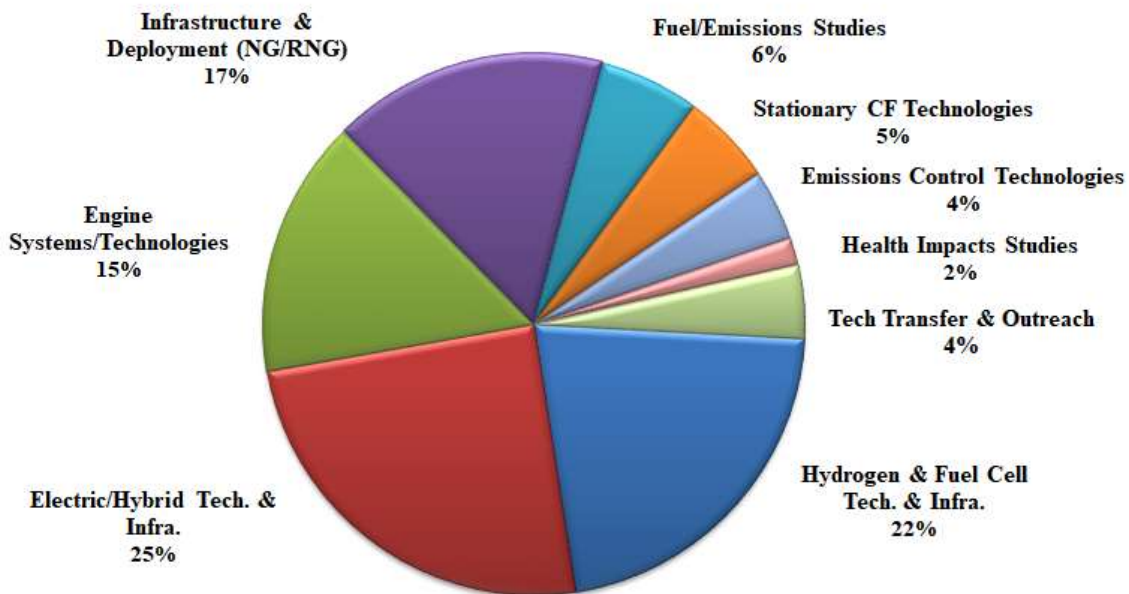


Figure 6: Projected Cost Distribution for Potential South Coast AQMD Projects in 2022 (\$21.8M)

CLEAN FUELS PROGRAM Program Plan Update for 2022

This section presents the Clean Fuels Program Plan Update for 2022. 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 (CAP) funding, Volkswagen Mitigation and Carl Moyer, and VOC and NOx mitigation.

Table 1 summarizes potential projects for 2022 as well as the distribution of South Coast AQMD costs in some areas as compared to 2021. The funding allocation continues the focus on development and demonstration of zero and near-zero emission technologies including infrastructure to support these vehicles and off-road equipment. For the 2022 Draft Plan Update, the same four funding categories remain at the top but with reduced funding for electric/hybrid technologies in light of large electric/hybrid projects recently funded and with additional funding to Stationary Clean Fuel Technologies and Emissions Control Technologies for planned projects in 2022, including:

- Heavy-duty zero emission battery electric and fuel cell trucks and infrastructure;
- 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;
- Heavy-duty diesel truck replacements with near-zero emissions natural gas trucks; and
- Fuel and emissions studies, such as conducting airborne measurements and analysis of NOx emissions and assessing emissions impacts of hydrogen-natural gas fuel blends on near-zero emissions heavy-duty natural gas engines.

As in prior years, the funding allocations again align well with the South Coast AQMD's FY 2021-22 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 the projects, participating host sites and fleets, and securing sufficient cost-sharing to complete the project, and other necessary factors. Recommendations to the South Coast AQMD Governing Board will include descriptions of the technologies to be demonstrated or deployed, their applications, proposed scope of work, and capabilities of the selected contractor(s) and project team, in addition to the expected costs and benefits of the projects as required by H&SC 40448.5.1.(a)(1). Based on communications with all of the organizations specified in H&SC 40448.5.1.(a)(2) and review of their programs, the 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: A descriptive title and a designation for future reference.

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

Expected Total Cost: The estimated total project cost including the South Coast AQMD cost-share and the 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: A brief summary of the proposed technology to be developed and demonstrated, including the expected vehicles, equipment, fuels, or processes that could benefit.

Potential Air Quality Benefits: A brief discussion of the expected benefits of the proposed project, including the expected contribution towards meeting the goals of the 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, the 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 2022

Proposed Project	Expected SCAQMD Cost \$	Expected Total Cost \$
-------------------------	--------------------------------	-------------------------------

Hydrogen/Mobile Fuel Cell Technologies and Infrastructure

Develop and Demonstrate Hydrogen Research to Support Innovative Technology Solutions for Fueling Fuel Cell Vehicles	50,000	800,000
Develop and Demonstrate Hydrogen Production and Fueling Stations	2,000,000	6,500,000
Develop and Demonstrate Medium- and Heavy-Duty Fuel Cell Vehicles	2,644,500	12,000,000
Demonstrate Light-Duty Fuel Cell Vehicles	30,000	75,000
Subtotal	\$4,724,500	\$19,375,000

Engine Systems/Technologies

Develop and Demonstrate Advanced Gaseous- and Liquid-Fueled Medium- and Heavy-Duty Engines & Vehicle Technologies to Achieve Ultra-Low Emissions	3,000,000	21,000,000
Develop and Demonstrate Alternative Fuel and Clean Conventional Fueled Light-Duty Vehicles	176,300	1,000,000
Develop and Demonstrate Low Emissions Locomotive Technologies and After Treatment Systems	176,300	1,000,000
Subtotal	\$3,352,600	\$23,000,000

Electric/Hybrid Technologies and Infrastructure

Develop and Demonstrate Medium- and Heavy-Duty On-Road and Off-Road Battery Electric and Hybrid Vehicles and Equipment	2,400,000	22,800,000
Develop and Demonstrate Electric Charging Infrastructure	2,600,000	52,090,000
Demonstrate Alternative Energy Storage	300,000	2,000,000
Demonstrate Light-Duty Battery Electric Vehicles and Plug-In Hybrid Vehicles	75,000	200,000
Subtotal	\$5,375,000	\$77,090,000

Fueling Infrastructure and Deployment (Natural Gas/Renewable Fuels)

Demonstrate Near-Zero Emission Natural Gas Vehicles in Various Applications	1,400,000	19,000,000
Develop, Maintain and Expand Renewable Fuel Infrastructure	200,000	2,100,000
Demonstrate Renewable Transportation Fuel Manufacturing and Distribution Technologies	2,000,000	10,000,000
Subtotal	\$3,600,000	\$31,100,000

Stationary Clean Fuel Technologies

Develop and Demonstrate Microgrids with Photovoltaic/Fuel Cell/Battery Storage/EV Chargers and Energy Management	1,000,000	4,500,000
Develop and Demonstrate Zero or Near-Zero Emission Energy Generation Alternatives	200,000	500,000
Subtotal	\$1,200,000	\$5,000,000

Table 1: Summary of Potential Projects for 2022 (cont'd)

Proposed Project	Expected SCAQMD Cost \$	Expected Total Cost \$
Fuel/Emissions Studies		
Conduct In-Use Emissions Studies for Advanced Technology Vehicle Demonstrations	500,000	2,000,000
Conduct Emissions Studies on Biofuels, Alternative Fuels and Other Related Environmental Impacts	400,000	1,500,000
Identify and Demonstrate In-Use Fleet Emissions Reduction Technologies and Opportunities	400,000	1,500,000
Subtotal	\$1,300,000	\$5,000,000
Emissions Control Technologies		
Develop and Demonstrate Advanced Aftertreatment Technologies On Highways	500,000	2,000,000
Develop Methodology and Evaluate and Demonstrate Onboard Sensors for On-Road Heavy-Duty Vehicles	250,000	1,000,000
Demonstrate On-Road Technologies in Off-Road and Retrofit Applications	176,300	800,000
Subtotal	\$926,300	\$3,800,000
Health Impacts Studies		
Evaluate Ultrafine Particle Health Effects	88,150	1,000,000
Conduct Monitoring to Assess Environmental Impacts	132,225	500,000
Assess Sources and Health Impacts of Particulate Matter	132,225	300,000
Subtotal	\$352,600	\$1,800,000
Technology Assessment/Transfer and Outreach		
Assess and Support Advanced Technologies and Disseminate Information	600,000	1,000,000
Support Implementation of Various Clean Fuels Vehicle Incentive Programs	350,000	400,000
Subtotal	950,000	\$1,400,000
TOTALS FOR POTENTIAL PROJECTS	\$21,781,000	\$167,565,000

Technical Summaries of Potential Projects

Hydrogen/Mobile Fuel Cell Technologies and Infrastructure

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

Expected South Coast AQMD Cost: \$50,000

Expected Total Cost: \$800,000

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 light-duty 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.

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 FCVs. 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 medium- and heavy-duty applications and ensuring hydrogen quality is maintained. DOE awarded new H2@Scale funding in 2021 to focus on heavy-duty tasks to develop heavy-duty reference station design, model heavy-duty 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 light-duty (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.

These efforts are complemented by projects undertaken and supported by the CaFCP 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 refueling 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 cofunding support for additional or follow on mutually agreed technical tasks with the California Hydrogen Infrastructure Research Consortium members, the CaFCP as well as other collaborative efforts that may be undertaken to advance hydrogen infrastructure technologies.

Potential Air Quality Benefits:

The 2016 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 FCVs 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 FCVs are available but require optimization to achieve broad market scale. The deployment of large numbers of FCVs, which is one strategy to attain air quality goals, requires a well-planned and robust hydrogen fueling infrastructure network. This South Coast AQMD project, with significant additional funding from other governmental and private entities, will work towards providing the necessary hydrogen fueling infrastructure network.

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 FCVs, 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 refueling 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 refueling and production sites. This project would support the development and demonstration of hydrogen refueling technologies. Proposed projects would address:

Fleet and Commercial Refueling Stations: Further expansion of the hydrogen fueling network based on retail models, providing renewable generation, adoption of standardized measurements for hydrogen refueling, other strategic refueling 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 Refueling Appliances: Home or small scale refueling/recharging 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 FCVs counts are now 30,800 in 2024 and 61,000 in 2027 in California⁶ and the majority of these do not include medium- and heavy-duty vehicles deployed in the Basin. To meet demand, number of hydrogen fueling infrastructures need 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 be realized by the Governor's 2018 Executive Order to establish 200 light-duty stations by 2025, increase investment in heavy-duty hydrogen stations to support CARB's Advanced Clean Truck Regulation, and anticipated adoption of the Advanced Clean Fleets Regulation in 2022.

Potential Air Quality Benefits:

The 2016 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. FCVs constitute some of the cleanest alternative-fuel vehicles today. Since hydrogen is a key fuel for FCVs, this project would address some of the barriers faced by hydrogen as a fuel 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.

⁶ California Air Resources Board. *2021 Annual Evaluation of Fuel Cell Vehicle Deployment & Hydrogen Fuel Station Network Development* (AB 8 Report). September 2021.

Proposed Project: Develop and Demonstrate Medium- and Heavy-Duty Fuel Cell Vehicles

Expected South Coast AQMD Cost: \$2,644,500

Expected Total Cost: \$12,000,000

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 FCVs.

The California *ZEV Action Plan* specifies actions to help deploy an increasing number of ZEVs, including medium- and heavy-duty ZEVs. CARB’s Advanced Clean Truck and Fleet and Innovative Clean Transit Bus Regulations will also increase deployment of medium- and heavy-duty FCVs. Fleets are useful demonstration sites because economies of scale exist in central refueling, training skilled personnel to operate and maintain FCVs, monitoring and collecting data on vehicle performance, and OEM technical and customer support. In some cases, medium- and heavy-duty FCVs could leverage the growing network of hydrogen stations and provide an early base load of fuel consumption until the number of passenger 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 heavy-duty 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, US EPA Targeted Airshed Grant Program awarded South Coast AQMD five fuel cell transit buses to be deployed at SunLine Transit which was also cost-shared by the Clean Fuels Program.

This category may include projects in the following applications:

<p>On-Road:</p> <ul style="list-style-type: none"> • Transit Buses • Shuttle Buses • Medium- & Heavy-Duty Trucks 	<p>Off-Road:</p> <ul style="list-style-type: none"> • Vehicle Auxiliary Power Units • Construction Equipment • Lawn and Garden Equipment • Cargo Handling Equipment
--	--

Potential Air Quality Benefits:

The 2016 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 FCVs. 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 FCVs 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.

Proposed Project: Demonstrate Light-Duty Fuel Cell Vehicles

Expected South Coast AQMD Cost: \$30,000

Expected Total Cost: \$75,000

Description of Technology and Application:

This proposed project would support the demonstration of limited production and early commercial light-duty FCVs using gaseous hydrogen with PEM fuel cell technology, mainly through showcasing this technology. Recent designs of light-duty FCVs include hybrid batteries to recapture regenerative braking and improve overall system efficiency.

Fleets are useful demonstration sites because economies of scale exist in central refueling, training skilled personnel to operate and maintain FCVs, monitoring and collecting data on vehicle performance, and OEM technical and customer support. South Coast AQMD has included FCVs as part of its demonstration fleet since it started the Five Cities Program in 2005 with the Cities of Burbank, Ontario, Riverside, Santa Ana, and Santa Monica to deploy 30 hydrogen ICE vehicles and five hydrogen stations. As part of this effort, South Coast AQMD has provided support, education, and outreach regarding FCV technology on an ongoing basis. In addition, demonstration vehicles could include hybrid-electric vehicles powered by fuel cells and equipped with larger batteries capable of being charged from the grid and even supplying power to the grid.

Hyundai, Toyota and Honda have commercial FCVs in California, and Toyota redesigned the 2020 Mirai as a five-passenger sedan. The first commercial FCV leases are ending, and solo carpool lane access extends only for vehicles with MY 2019 and later, with all Clean Air Vehicle decals expiring between 2023 – 2025, unless legislation is adopted to continue. Innovative strategies and demonstration of dual fuel, ZEVs could expand the acceptance of BEVs and accelerate the introduction of fuel cells in vehicle propulsion. As hydrogen production dedicated to transportation increases from multiple providers in the next few years, and station throughput increases, dispensed hydrogen cost should start to decrease, which would encourage more model development and enable more demonstration and deployment.

Potential Air Quality Benefits:

The 2016 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, with acquisition requirements proposed to start in 2024. 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 FCVs. Expected immediate benefits include the deployment of zero emission vehicles 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 AQMP.

Engine Systems/Technologies

Proposed Project: Develop and Demonstrate Advanced Gaseous- and Liquid-Fueled Medium- and Heavy-Duty Engines and Vehicles Technologies to Achieve Ultra-Low Emissions

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

Expected Total Cost: \$21,000,000

Description of Technology and Application:

The objective of this proposed project would be to support development and certification of near-commercial prototype low emission medium- and heavy-duty 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. Recent development of low-NOx diesel or natural gas engine hybrid powertrain also shown potential for achieving lower NOx as a combined system. To achieve these 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:

- development and demonstration of advanced engines in medium- and heavy-duty vehicles and high horsepower (HP) applications;
- development of durable and reliable retrofit technologies to significantly reduce NOx emissions.;
- field demonstrations of advanced technologies in various fleets operating with different classes of vehicles; and
- development and demonstration of CNG, propane and diesel hybrid powertrain technology.
- development and demonstration of optimized engine systems for use with low- and zero carbon alternative fuels

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 laboratory 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 EPA CTI regulations, we expect these new generation of low-emission engines to comply with the low emissions standard for their full useful life.

The use of alternative fuel in heavy-duty trucking applications has been demonstrated in certain local fleets within the Basin. These vehicles typically require 200-400 HP engines. Higher HP alternative fuel engines for long-haul applications are beginning to be introduced. 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 have made it difficult for more fleets to adopt and deeply larger quantity of alternative fuel vehicles. For example, in recent years, several large trucking fleets have expressed interest in using alternative fuels but requires higher horsepower engines that able to fulfill the full range of needs. However, at this time the choice of engines over 400 HP or more was not available. Continued development of cleaner dedicated alternative gaseous-

or diesel-fueled engines over 400 HP with lower NO_x emissions, would increase availability to end-users and provide additional emission reductions for long-haul applications. The applications that require high power/torque levels such as long haul are also the applications where zero emission technologies and supporting infrastructures will take longer to become commercially available. South Coast has been supporting effort for developing high power natural gas engines that address that gap. Moreover, as incentive funding shifts away as clean combustion technologies reaches full commercial readiness, development of cost-effective technologies that do not rely on incentives are key to drive additional market penetration and emissions reduction. South Coast AQMD has investigated the emergence of cost-effective mild hybrid powertrain technologies to achieve targeted lower-NO_x emission standard and improved fuel economy. Cost-effective hybrid technologies that offers reasonable payback period could potentially offer a faster commercialization pathway for reducing both NO_x and GHG in the near term by strategically utilizing the existing internal combustion engines and electric components that assists engine operation and maintain aftertreatment temperature and efficiency. Simulation results shown that these newly integrated hybrid powertrains could achieve the CARB 2024-2026 NO_x standard of 0.05 g/bhp-hr while maintain reasonable cost and a feasible pathway to 0.02 g/bhp-hr. Even though lower NO_x engines are due to arrive in 2024 and 2027, due to the slow turn over, the legacy 2010+ diesel fleet will remain in service well into the 2030s. Thus, continued development of cost-effective low emission engine technologies are 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 medium- and heavy-duty engine technology both in the Basin and in intrastate operation. The emissions reduction benefits of replacing one 4.0 g/bhp-hr heavy-duty engine with a 0.2 g/bhp-hr engine in a vehicle that consumes 10,000 gallons of fuel per year is about 1,400 lb/yr of NO_x. A heavy-duty 8.9L and 11.9L engines using natural gas achieving NO_x emissions of 0.02 g/bhp-hr have been certified and commercialized, with larger displacement and advanced technology (e.g., opposed piston) engines undergoing development. Further, renewable or blended alternative fuels can also reduce heavy-duty engine particulate emissions by over 90 percent compared to current diesel technology. The key to future engine system project success is cost-effectiveness and availability of future incentives. This project is expected to lead to increased availability of low emission alternative fuel heavy-duty 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 2016 AQMP control measures as well as future CARB and EPA low NO_x regulations.

Proposed Project: Develop and Demonstrate Alternative Fuel and Clean Conventional Fueled Light-Duty Vehicles

Expected South Coast AQMD Cost: \$176,300

Expected Total Cost: \$1,000,000

Description of Technology and Application:

Although new conventionally fueled vehicles are much cleaner than their predecessors, not all match the lowest emissions standards often achieved by alternative fuel vehicles. This project would assist in the development, demonstration and certification of both alternative-fueled and conventional-fueled vehicles to meet the strictest emissions requirements by the state, e.g., SULEV for light-duty vehicles. The candidate fuels include CNG, LPG, ethanol, GTL, renewable diesel and hydrogen, and other novel technologies including electric hybrids. The potential vehicle projects may include:

- certification of CNG light-duty sedans and pickup trucks used in fleet services;
- assessment of “clean diesel” vehicles, including hybrids and their ability to attain SULEV standards;
- assessment of other clean technologies; and
- other fuel and technology combinations may also be considered under this category.

Potential Air Quality Benefits:

The 2016 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 in effect several fleet rules that require public and certain private fleets to purchase clean-burning alternative-fueled vehicles when adding or replacing vehicles to their vehicle fleets. This project is expected to lead to increased availability of low emission alternative-and conventional-fueled vehicles for fleets as well as consumer purchase.

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

Expected South Coast AQMD Cost: \$176,300

Expected Total Cost: \$1,000,000

Description of Technology and Application:

This project aims to support the development and demonstration of gaseous and liquid-fueled locomotive engines. With the upcoming revision of locomotive regulations and the plan to establish Tier 5 or cleaner locomotive emission standards, 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 be needed to provide a sufficient amount of 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 in early-stage of commercialization, especially in the marine sector. The development of engines and systems to fill this need is currently on-going in the locomotive sector. Engines emissions are expected to be below the current 0.2g/bhp-hr NO_x standard. The adaptation of alternative fueled locomotives in coordination with required infrastructure improvement 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, aftertreatmenets 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 NO_x emissions and methane slip. Similar low and zero carbon fuelled engines could migrate as a retrofit option.

Potential Air Quality Benefits:

This project is expected to reduce emissions of around 97 tons per year of NO_x for each locomotive. The reduction of PM and GHG emissions also shows great potential mitigation in environmental justice communities.

Electric/Hybrid Technologies and Infrastructure

Proposed Project: Develop and Demonstrate Medium- and Heavy-Duty On-Road and Off-Road Electric and Hybrid Vehicles and Equipment

Expected South Coast AQMD Cost: \$2,400,000

Expected Total Cost: \$22,800,000

Description of Technology and Application:

The significance of transportation in overall carbon emissions is increasing as energy utilities move toward cleaner and more sustainable ways to generate electricity. U.S. EPA (2021)⁷ estimated that transportation was responsible for 29 percent of the nation's carbon emissions, while the electricity sector emissions accounted for 25 percent.

The South Coast AQMD has long been a leader in promoting early demonstrations of next generation light-duty vehicle propulsion technologies (and fuels). However, given the commercial availability of light-duty EVs, priorities have shifted. South Coast AQMD will continue to evaluate market offerings and proposed technologies in light-duty vehicles to determine if any future support is required.

Meanwhile, medium- and heavy-duty vehicles make up 5⁸ percent of vehicles in the U.S. and drive 9⁹ percent of all vehicle miles traveled each year yet are responsible for more than 25¹⁰ percent of all the fuel burned annually. Moreover, the 2016 AQMP identified medium- and heavy-duty vehicles as the largest source of NOx emissions in the Basin. Electric and hybrid technologies have gained momentum in the light-duty sector with commercial offerings by most of the automobile manufacturers. Unfortunately, there are significant emission reductions needed for medium- and heavy-duty vehicles and off-road equipment, exacerbated by low turnover of these vehicles by fleets and high incremental costs for battery electric vehicles and equipment compared to conventional-fueled vehicles and equipment.

The 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 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. Vehicle based hybrid systems continue to progress for additional emission reductions and efficiency improvements. Engine powertrain based hybrid systems began to emerge since the introduction of optional hybrid powertrain test procedures. Hybrid powertrain based projects are further described under the Engine Systems section.

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 hybrid systems utilizing off-peak charging, with advanced battery technologies including alternative chemistries, design, and management systems. Alternative fuels are preferred in these projects, e.g., natural gas, especially from renewable sources, LPG, hydrogen, gas-to-liquid (GTL) and hydrogen-natural gas blends, but conventional fuels such as gasoline, renewable diesel, or even modified biodiesel may be considered if

⁷ U.S. Greenhouse Gas Emissions and Sinks 1990-2019. 2021. <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

⁸ <https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances>

⁹ <https://www.bts.gov/content/us-vehicle-miles>

¹⁰ <https://www.bts.gov/content/fuel-consumption-mode-transportation-physical-units>

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 include cargo handling and construction equipment. The Volvo LIGHTS project included the demonstration of a zero emission freight handling system including 29 battery electric yard tractors and forklifts at fleets DHE and NFI. Volvo Construction Equipment just recently finished demonstrating small battery electric compact excavator and wheel loader in California which are now ready for commercial release in 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 switch locomotives. The most recent funding plan suggested CORE will be including off-road construction equipment in the future. Since the applications are more diverse in this sector, continued development and incentives are needed to accelerate progress in this sector.

This project category will develop and demonstrate:

- various electric vehicles and equipment;
- 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 medium- and heavy-duty 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 such as excavators and wheel loaders);
- development and demonstration of CNG hybrid vehicle technology; and
- development and demonstration of diesel hybrid vehicle technology.

Potential Air Quality Benefits:

The 2016 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 2016 AQMP.

Proposed Project: Develop and Demonstrate Electric Charging Infrastructure

Expected South Coast AQMD Cost: \$2,600,000

Expected Total Cost: \$52,090,000

Description of Technology and Application:

There is a critical need to address gaps in EV charging infrastructure availability. Almost half (44 percent) of the 2,084,118¹¹ EVs sold in the U.S. since 2010 were in California, and of those sales in California, almost half (44 percent) of CVRP¹² rebates issued as of April 2021 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 light-duty EVs vs. medium- and heavy-duty EVs, which are on opposite ends of the commercialization spectrum. Light-duty EVs and charging infrastructure have long been commercially available with an SAE J1772 connector standard for Level 1 and Level 2 charging. 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 are the main challenges for light-duty EVs.

Medium- and heavy-duty EVs are becoming more commercially available, with Daimler and Volvo obtaining CARB certification of their Class 6 and/or 8 battery electric trucks in 2020. Standards for charging infrastructure to support medium- and heavy-duty EVs has generally been with the CCS1 connector in North America. Although Volvo and ABB obtained UL certification of the CCS2 connector in 2020, which is a connector standard predominantly used in Europe and other parts of the world, the CCS1 connector continues to be the standard connector for charging up to 350 kW DC. A Megawatt Charging System connector is under development by the Charging Interface Initiative (CharIN) for Class 6 -8 EVs for charging up to 4.5 MW DC, although there are no EVs which are currently 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. The challenges and costs of installing medium- and heavy-duty charging infrastructure are exponentially increased compared to light-duty infrastructure. Each year there are more commercially available options for medium- and heavy-duty on-road EVs and off-road equipment, charging infrastructure to support these EVs and equipment, and an ability to fund larger scale deployment projects for medium- and heavy-duty EVs, equipment, and infrastructure. As the deployment of medium- and heavy-duty 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.

The South Coast AQMD is actively pursuing development of intelligent transportation systems, such as Volvo's EcoDrive 2.0 software platform being utilized for the GGRF Zero Emission Drayage Truck (ZEDT) and Volvo LIGHTS projects, to improve traffic efficiency of battery electric and fuel cell electric drayage/freight trucks. This system provides truck drivers real-time vehicle operation feedback based on changing traffic and road conditions where trucks can dynamically change their speed to better flow through intersections. EcoDrive also uses geofencing capabilities to operate in zero emissions mode while traveling through disadvantaged communities. A truck eco-routing system can provide the eco-friendliest travel route based on truck engine/emission control characteristics, loaded weight, road grade and real-time traffic conditions. Integrated programs can interconnect fleets of electric drive vehicles with mass transit via web-based reservation systems that allow multiple users. These integrated programs can match the features of EVs (zero emissions, zero start-up emissions, short range) to typical consumer demands for mobility in a

¹¹ California Energy Commission *Zero Emission Vehicle and Charger Statistics. Q2 2021 Data Update* (posted August 5, 2021). <http://www.energy.ca.gov/zevstats>

¹² <https://cleanvehiclerebate.org/eng/rebate-statistics>

way that significantly reduces emissions of pollutants and greenhouse gases. As part of the demonstration of the Volvo diesel plug-in hybrid electric truck for the ZEDT project, this truck will be demonstrated in California for six months starting in November 2020 and data will be collected on the performance of EcoDrive 2.0 through the connector vehicle corridor in Carson that was set up as part of the CEC funded Eco FRATIS¹³ freight transportation connected truck project.

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

- 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 (up to 350 kW) 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 to support medium- and heavy-duty vehicle and off-road equipment demonstration and deployment projects;
- 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 heavy-duty trucks in goods movement.

Potential Air Quality Benefits:

The 2016 AQMP identifies zero emission vehicles as a key attainment strategy. 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 2016 AQMP.

¹³ <https://www.aapa-ports.org/files/PDFs/ITS%20POLA%204.24.2019.pdf>

Proposed Project: Demonstrate Alternative Energy Storage

Expected South Coast AQMD Cost: \$300,000

Expected Total Cost: \$2,000,000

Description of Technology and Application:

The South Coast AQMD has been involved in the development and demonstration of energy storage systems for electric and hybrid-electric vehicles, mainly lithium ion chemistry battery packs. Over the past few years, new technologies, especially lithium-ion batteries have shown robust performance. Other technology manufacturers have also developed energy storage devices including beyond lithium-ion batteries, flywheels, hydraulic systems and ultracapacitors. Energy storage systems optimized to combine the advantages of ultracapacitors and high-energy but low-power advanced batteries could yield benefits. Beyond lithium-ion batteries (e.g., lithium-sulfur, lithium-oxygen, sodium-ion, flow, and solid-state batteries) also have opportunities to achieve higher energy density, longer cycle life, and lower cost.

This project category is to apply these advanced storage technologies in vehicle platforms to identify best fit applications, demonstrate their viability (reliability, maintainance and durability), gauge market preparedness, evaluate costs relative to current lithium-ion batteries and provide a pathway to commercialization. The use of alternative energy storage and generation (i.e. solar) could also be in combination with a large scale deployment of 50 or more battery electric trucks and charging infrastructure at a single fleet location for energy storage optimization for grid reliability and offset electricity demand charges.

The long-term objective of this project is to decrease fuel consumption and resulting emissions without any changes in performance compared to conventional-fueled vehicles. This effort will support several projects for development and demonstration of battery electric and hybrid electric vehicles using advanced energy storage strategies and conventional or alternative fuels. The overall net emissions and fuel consumption of these types of vehicles are expected to be much lower than traditional engine systems. Both new and retrofit technologies will be considered.

Additionally, this project will also assess potential for second life uses of electric vehicle batteries for storage as well as the longer term more cost-effective recycling approaches currently in a nascent “pilot” stage, especially for metals such as lithium and cobalt.

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 2016 AQMP. This project is expected to further efforts to develop alternative energy storage technologies that could be implemented in medium- and heavy-duty trucks, buses, off-road equipment, and other applications. Benefits will include proof of concept for new technologies, diversification of transportation fuels and lower emissions of criteria, toxic pollutants and greenhouse gases.

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

Expected South Coast AQMD Cost: \$75,000

Expected Total Cost: \$200,000

Description of Technology and Application:

This proposed project would support the demonstration of limited production and early commercial light-duty BEVs and PHEVs using advanced technology, mainly through showcasing this technology. Recent designs of light-duty BEVs and PHEVs provide increased electric range, improved efficiency and recharge times, and other advanced safety, energy, autonomous and performance features in new platforms and applications that can accelerate EV adoption.

South Coast AQMD has included BEVs and PHEVs as part of its demonstration fleet since the development of early conversion vehicles. South Coast AQMD also 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 supporting education and outreach regarding BEV and PHEV technology. Thirty networked Level 2 chargers were added through the Southern California Edison Charge Ready Fleet program in 2020, which will help South Coast AQMD acquire 8500 GVW and over ZEVs like light-duty trucks and vans to comply with the proposed CARB Advanced Clean Fleet regulation.

Light-duty 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 2016 AQMP identifies the need to implement light-duty 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 2016 AQMP.

Fueling Infrastructure and Deployment (Natural Gas/Renewable Fuels)

Proposed Project: Demonstrate Near-Zero emission Natural Gas Vehicles in Various Applications

Expected South Coast AQMD Cost: \$1,400,000

Expected Total Cost: \$19,000,000

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 heavy-duty vehicles utilizing this clean fuel. Currently, increasing number of on-road heavy-duty 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 heavy-duty 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 emissions and useable in a wide variety of medium- and heavy-duty applications, such as Class 6 vehicles used in 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, and 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 heavy-duty vehicle consumers to NGVs. Under Engine Systems, South Coast AQMD is support efforts for development high-powered natural gas vehicles 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 engine has been the only option.

Potential Air Quality Benefits:

Natural gas-powered vehicles have inherently lower engine criteria pollutant emissions relative to conventionally fueled vehicles, especially older diesel-powered vehicles. Recently, on-road heavy-duty 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, transit buses will help reduce local emissions and emissions exposure to nearby residents. Natural gas vehicles can also have lower greenhouse gas emissions and can increase energy diversity, help address national energy security objectives, and can reduce biomass waste when produced from such feedstocks. Deployment of additional NGVs is consistent with South Coast AQMD's AQMP to reduce criteria pollutants, and when fueled by RNG supports California's objectives of reducing GHGs and the 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 & Expand Renewable Fuel Infrastructure

Expected South Coast AQMD Cost: \$200,000

Expected Total Cost: \$2,100,000

Description of Technology and Application:

This project supports the development, maintenance and expansion of natural gas fueling stations in strategic locations throughout the Basin, including the Ports, and advancing technologies and station design to improve fueling and refueling efficiencies of heavy-duty NGVs. This category supports the broader deployment of near-zero emission heavy-duty vehicles and the implementation of South Coast AQMD's fleet rules. In addition, as natural gas fueling equipment begins to age or has been placed in demanding usage, components will deteriorate. This project offers facilities to replace worn-out equipment or to upgrade existing fueling and/or garage and maintenance equipment to offer increased fueling capacity to public agencies, private fleets and school districts.

Potential Air Quality Benefits:

The AQMP identifies the use of alternative clean fuels in mobile sources as a key attainment strategy. Heavy-duty NGVs have significantly lower emissions than their diesel counterparts and represent the cleanest internal combustion engine-powered vehicles available today. The project has the potential to significantly reduce the installation and operating costs of NGV refueling stations, and improving vehicle refueling times through improved refueling systems designs and high-flow nozzles. While new or improved NGV stations have an indirect emissions reduction benefit, they help facilitate the introduction of near-zero emission NGVs in private and public fleets in the area, which have a direct emissions reduction benefit. It is expected that natural gas' lower fuel cost relative to diesel and the added financial incentives of renewable natural gas (RNG) under the state's Low Carbon Fuel Standard program and the federal Renewable Fuel Standard program will significantly reduce operating costs of high fuel volume heavy-duty NGVs and attract consumers to this technology. The increased exposure and fleet and consumer acceptance of NGVs would lead to significant and direct reductions in NO_x, VOC, CO, PM and toxic compound emissions from mobile sources. Such increased penetration of NGVs will provide direct emissions reductions of NO_x, VOC, CO, PM and air toxic compounds throughout the Basin.

Proposed Project: Demonstrate Renewable Transportation Fuel Manufacturing and Distribution Technologies

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

Expected Total Cost: \$10,000,000

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 federal clean air standards. Alternative fuels produced from renewable sources such as waste biomass help further efforts associated with landfill and waste diversion, greenhouse gas reduction, energy diversity and petroleum dependency. Locally produced renewable fuels further reduce concerns associated with out-of-state production and transmission of fuel as well as helps support the local economy. Renewable fuels recognized as a transportation fuel under the state's Low Carbon Fuel Standard program and the federal government's Renewable Fuel Standard program can provide financial incentives, including the reduced fuel price and operational costs, the incentives to purchase and deploy alternative or renewable energy powered vehicles.

The project category will consider the development and demonstration of technologies for the production and use of renewable transportation fuels such as renewable natural gas (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 waste water 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 South Coast AQMD relies on a significant increase in the penetration of zero and near-zero emission vehicles in the Basin to attain federal clean air standards by 2023 and 2032. This project would help develop a number of renewable transportation fuel production and distribution facilities to improve local production and use of renewable fuels to help reduce transportation costs and losses that can 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 greenhouse gases associated with these waste biomass feedstocks.

Stationary Clean Fuel Technologies

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

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

Expected Total Cost: \$4,500,000

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 medium-and heavy-duty 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 heavy-duty trucks is currently under way with two of the largest manufacturers announcing plans for commercial products in Southern 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 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+ kW hours 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 platforms. Many fleet operators do not own but lease their facilities making the capital expenditure of EV or hydrogen infrastructure impossible to recoup in a short period of time. Like the diesel vehicles they presently operate, fleets purchase fuel for their trucks, not the fueling station. 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 refueling. Additionally, if the microgrid equipment is owned by a third party and the energy is sold to the fleet through a power purchase agreement, the financial challenge of large capital investment can be avoided by the fleet operator.

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 refueling 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 all the technologies that make up microgrids already exist including 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 it and continue to operate as an energy island independent from the grid. Having assurance of an uninterrupted fueling source is an important consideration for a fleet operator. Also, if the microgrid is connected to the fleet operator’s logistics system, 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 going to travel, it can charge the vehicle with enough energy for the trip so the truck will operate within 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 the charging schedules with 150 kW or less powerful chargers which again will have less impact on battery life than the planned higher powered 300+ kW chargers and lower the costs for the charging infrastructure.

The energy demand of electric and fuel cell heavy-duty trucks is substantial; for a 100-vehicle fleet of BETs with 300 kWh the batteries would require 30 MW hours/day of energy. For a 100-vehicle fleet of FCTs the hydrogen requirement is 2,000 kg/day. Microgrids can provide energy for hydrogen and EV infrastructure and can serve to enable large zero emission vehicle deployments and make refueling economical and reliable. Staff has demonstrated several microgrid projects with the 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 fleet operators 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. Also, 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 that are 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 here in the Basin.

Potential Air Quality Benefits:

Microgrids can provide grid resilience and potentially support large deployments of zero emission medium- and heavy-duty trucks that are necessary to meet the AQMP target of a 45 percent reduction in NOx required by 2023 and an additional 55 percent reduction by 2031. 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 that are in excess of the assumptions in the 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: \$200,000

Expected Total Cost: \$500,000

Description of Technology and Application:

The objective of this proposed project is to support the 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, a clean fuel. Hydrogen, when used in internal combustion engines, can potentially reduce tail-pipe emissions of NO_x, while in fuel cells the emissions are reduced to zero.

The 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 the implementation of successful technologies.

Potential Air Quality Benefits:

The 2016 AQMP identifies the development and ultimately the implementation of non-polluting power generation could gain the maximum air quality benefit. 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, especially as the transportation sector becomes more reliant on the electrical grid.

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

Fuel/Emissions Studies

Proposed Project: Conduct In-Use Emissions Studies for Advanced Technology Vehicle Demonstrations

Expected South Coast AQMD Cost: \$500,000

Expected Total Cost: \$2,000,000

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 the optimal placement of each transportation technology will provide the co-benefits of maximizing the environmental benefit and return on investment for the operator.

In addition, South Coast AQMD has been supporting rapid deployment of near-zero emission natural gas technologies ever since the first heavy-duty engine is commercially available in 2015. As more near-zero emission natural gas (and propane) technology penetrates the different segments, in-use assessment of real-world benefit is needed especially now CARB has introduced a new in-use testing metric.

The CARB EMFAC model that the 2016 AQMP is based on uses emissions data from in-use emissions studies for calculating emission factors for heavy-duty trucks rather than the certification data but it's limited and outdated. For the upcoming EMFAC 2021, more complete natural gas engine modules have been included for the first time with emissions data gathered from the current South Coast AQMD funded in-use emissions characterization effort. CARB and EPA low-NOx regulations focused on addressing the gap of in-use and certification values by introducing a new methodology that includes emissions from all operations. While staff expects the in-use emissions from new engines to perform closer to certification values, there is still a significant population of the MY 2010+ legacy fleet is expected to remain in service well over 2030s. There is always a need to better assess real world truck emissions, fuel economy, and their activity from both engines, hybrid powertrain and zero emission technologies for continued technology improvements.

The environmental benefit for each technology class is duty-cycle and application specific. Identifying the attributes of a specific application or drive cycle that would take best advantage of a specific transportation technology would speed the adoption and make optimal use of financial resources in the demonstration and deployment of a technology. The adoption rates would be accelerated since the intelligent deployment of a certain technology would ensure that a high percentage of the demonstration vehicles showed positive results, which would spur the adoption of this technology in similar applications, as opposed to negative results derailing the further development or deployment of a certain technology.

The proposed project would review and potentially coordinate application specific drive cycles for specific applications. The potential emissions 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 are used for planning purposes for building medium- and heavy-duty public refueling stations. Furthermore, some of the standardized test cycle, like the chassis dyno based cycle, can be used to evaluate the efficiency of the zero-emissions vehicles and compare directly with the diesel and natural gas vehicle.

Another proposed project would be the 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 of and contribute to the formation of urban ozone and SOA, which is an important component of PM2.5. Natural-gas vehicles are

also a concern due to lack of particulate filter, however, the actual impact based on current and projected population are to be further studied.

Finally, while early developments in autonomous and vehicle-to-vehicle controls are focused on light-duty passenger vehicles, the early application of this technology to heavy-duty, drayage and container transport technologies is more likely. The impact on efficiency and emissions could be substantial. A project to examine this technology to assess its effect on goods movement and emissions associated with goods movement could be beneficial at this time.

Potential Air Quality Benefits:

The development of an emissions reduction database, for various application specific transportation technologies, would assist in the 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 a significant environmental benefit. The demonstration of a quantifiable reduction in operating cost through the intelligent deployment of vehicles will also accelerate the commercial adoption of the various technologies. The accelerated adoption of lower emitting vehicles will further assist in attaining South Coast AQMD's air quality goals.

Proposed Project: Conduct Emissions Studies on Biofuels, Alternative Fuels and Other Related Environmental Impacts

Expected South Coast AQMD Cost: \$400,000

Expected Total Cost: \$1,500,000

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 goal. 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 biofuel use, it is the objective of this project to further analyze these fuels to better understand their benefits and impacts not only on greenhouse gases but also air pollution and associated health effects.

In various diesel engine studies, replacement of petroleum diesel fuel with biodiesel fuel has demonstrated reduced PM, CO and air toxics emissions. Biodiesel also has the potential to reduce greenhouse gas emissions because it can be made from renewable feedstocks, such as soy and canola. However, certain blends of biodiesel have a tendency to increase NOx emissions for certain engines and duty cycles, which exacerbates the 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 to further increase the ethanol content to 10% as a means to increase the amount of renewable fuels in the state. It is projected that the state's ethanol use will increase from 900 million gallons in 2007 to 1.5 billion gallons by 2012 as a result. As in the case of biodiesel, ethanol has demonstrated in various emission studies to reduce PM, CO and toxic emissions; however, the relationship between particle composition and associated health effects from the combustion of ethanol is not well understood either. In 2019, the U.S. EPA approved 15% ethanol (E15) blends for year-round use and CARB, along with South Coast AQMD and other launched an emissions study of E15 to assess the emissions impact of the current fleet of California light duty vehicles, the data is due to be released soon to support the approval of E15. South Coast AQMD also has been monitoring efforts in using ethanol as a primary fuel for medium- and heavy-duty application in optimized engine systems that allows both criteria and GHG reduction which could be another pathway for reducing emissions due to abundance of ethanol from the light duty sector.

CARB recently proposed a regulation on the commercialization of alternative diesel fuels, including biodiesel and renewable diesel, while noting that biodiesel in older heavy-duty vehicles can increase NOx and the need for emerging alternative diesel fuels to have clear ground rules for commercialization. The impact of natural gas fuel composition on emissions from heavy-duty trucks and transit buses is also being studied. Researchers have proposed to evaluate the emissions impact of renewable natural gas and other natural gas blends such as renewable hydrogen.

In order to address these concerns on potential health effects associated with biofuels, namely biodiesel and ethanol blends, this project will investigate the physical and chemical composition and associated health effects of tailpipe PM emissions from light- to heavy-duty vehicles burning biofuels in order 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 for biofuels. Additionally, a study of emissions from well-to-wheel for the extraction and use of shale gas might be considered.

More recently, the Power-to-Gas concept has renewed interest in hydrogen-fossil fuel blends which its emissions impact on the latest ICE technologies needs to be reassessed. Hydrogen fueled ICE was studied heavily in the early 2000's and results have shown significant criteria emissions reduction possible with optimized engine calibration. Since then, ICE technologies have been fitted with advanced aftertreatment

to allow the engines to be certified to today's low NOx standards. Therefore, emissions impact assessment is needed on the latest ICE technologies.

Lastly, in an effort to evaluate the contribution of meteorological factors to high ozone and PM2.5 episodes occurring in the Basin, mainly as a result of higher summer time temperatures and increased air stagnation following the drought years, a comprehensive study is necessary to evaluate the trends of meteorological factors that may adversely impact air quality in the Basin. The study will assist staff to better understand the potential impact of recent weather trends on criteria pollutant emissions and potentially develop 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 any NOx impact, this technology will become a viable strategy to assist 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 the emission benefits and any tradeoffs (NOx impact) that may result from using this alternative fuel. With reliable information on the emissions from using biodiesel and biodiesel blends, the South Coast AQMD can take actions to ensure the use of biodiesel will obtain air pollutant reductions without creating additional NOx emissions that may exacerbate the Basin's ozone problem. Additionally, understanding meteorological factors on criteria pollutant emissions may help identify ways to mitigate them, possibly through targeted advanced transportation deployment.

Proposed Project: Identify and Demonstrate In-Use Fleet Emissions 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 heavy-duty 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 the 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, the in-use fleet lacks telematic systems--particularly heavy-duty engines in trucks, buses, construction equipment, locomotives, commercial harbor craft and cargo handling equipment--have fairly long working lifetimes (up to 20 years due to remanufacturing in some cases). Even light-duty vehicles routinely have lifetimes exceeding 200,000 miles and 10 years. And it is the in-use fleet, especially the oldest vehicles, which are responsible for the majority of emissions. In the last a few years, real-time emissions and fuel economy data reporting along with telematics has been demonstrated with large fleets to as fleet management tools to identify high emitters and increase operational efficiency. Similar efforts have already been proposed by CARB as part of HD I/M regulation. Moreover, the same telematic systems are being installed on zero-emission trucks where fleet and charging management are more important than ever, cloud based fleet management concept are being proposed by researchers to maximize the range and air quality benefits of zero-emission trucks.

This project category is to investigate near-term emissions 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 heavy-duty vehicles;
- annual testing for high mileage vehicles (>100,000 miles);
- replace or upgrade emissions 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; and fleet and charger management concepts
- low NOx sensor development.

Potential Air Quality Benefits:

Many of the technologies identified can be applied to light- and heavy-duty 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. The identification and replacement of high-emitting vehicles has been identified in the Community Emission Reduction Plans (CERPs) from the Year 1 AB 617 communities as a high priority for residents living in these communities, particularly as heavy-duty trucks frequently travel on residential streets to bypass traffic on freeways surrounding these disadvantaged communities.

Emissions Control Technologies

Proposed Project: Develop and Demonstrate Advanced Aftertreatment Technologies for On-High Way

Expected South Coast AQMD Cost: \$500,000

Expected Total Cost: \$2,000,000

Description of Technology and Application:

There are a number of aftertreatment technologies which have shown substantial emissions reductions in diesel engines. These technologies include zoned catalyst soot filters, early light -off catalysts, dual SCR systems, pre-NOx absorbers, and ammonia slip catalysts. Additional heating technologies enabled by the availability of 48 volt battery system can be used to keep desired catalyst temperatures such as heated dosing and heated catalysts are also part of the complete aftertreatment system design towards near-zero emission NOx. This project category is to develop and demonstrate these aftertreatment technologies alone or in tandem with an alternative fuel to produce the lowest possible PM, ultrafine particles, nanoparticles, NOx, CO, carbonyl and hydrocarbon emissions in retrofit and new applications. With the increasing focus on zero and near-zero emissions goods movement technologies, this category should examine idle reduction concepts and technologies that can be employed at ports and airports. The proposed Clean Truck Initiative by the EPA as well as the adopted CARB Omnibus Regulation will require aftertreatment systems to maintain certification to a much longer useful life via new in-use testing metrics. Technology durability and in-use performance will need to be studied.

Possible projects include advancing the technologies for on-road truck demonstrations beyond the lab based testing, retrofit applications, such as heavy-duty line-haul and other large displacement diesel engines, street sweepers, and waste haulers. Applications for non-road may include construction equipment, yard hostlers, gantry cranes, locomotives, commercial harbor craft, ground support equipment and other similar industrial applications. Potential fuels to be considered in tandem are low-sulfur diesel, emulsified diesel, biodiesel, gas-to-liquids, hydrogen and natural gas. This project category will also explore the performance, economic feasibility, viability (reliability, maintainability and durability) and ease-of-use to ensure a pathway to commercialization.

Potential Air Quality Benefits:

The transfer of mature emission control technologies, such as DPFs and oxidation catalysts, to the off-road sector is a potentially low-risk endeavor that can have immediate emissions reductions. Further development and demonstration of other technologies, such early light -off SCR and heated dosing, could also have NOx reductions of up to 90%.

Proposed Project: Develop Methodology and Evaluate and Demonstrate Onboard Sensors for On-Road Heavy-Duty Vehicles

Expected South Coast AQMD Cost: \$250,000

Expected Total Cost: \$1,000,000

Description of Technology and Application:

New heavy-duty on-road vehicles represent one of the largest categories in the NO_x emissions inventory in the Basin. To meet the 2023 and 2031 ozone standards, NO_x emissions need to be reduced by 45% and an additional 55% from 2012 levels, respectively, mainly from mobile sources. Previous in-use emission studies, including studies funded by the South Coast AQMD, have shown significantly higher NO_x emissions from on-road heavy-duty vehicles than the certification limit under certain in-use operations, such as low power duty cycles. In CARB's adopted Heavy-Duty On-Road "Omnibus" Low NO_x regulation, in addition to the lower certification values, a low load test cycle and revisions to the not-to-exceed compliance tests. A NO_x sensor data reporting are also introduced where the vehicle computer are 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 the sensors to better monitor emissions compliance and leverage the real-time data from sensors to enable advances concepts such as geofencing. CARB's newly proposed HD I/M rule will be looking at address in-use emissions from the older legacy fleets, one of the pathways is also using onboard sensors.

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 of existing 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 light-duty, 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. Reduction of NO_x 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: \$176,300

Expected Total Cost: \$800,000

Description of Technology and Application:

On-road heavy-duty engines have demonstrated progress in meeting increasingly stringent federal and state requirements. New heavy-duty engines have progressed from 2 g/bhp-hr NO_x in 2004 to 0.2 g/bhp-hr NO_x in 2010, which is an order of magnitude decrease in just six years. Off-road engines, however, have considerably higher emissions limits depending on the engine size. For example, Tier 3 standards for heavy-duty engines require only 3 g/bhp-hr NO_x. 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 the cleaner emission standards as the engine being 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 the 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 heavy-duty line-haul trucks at weigh stations.

Potential Air Quality Benefits:

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

Health Impacts Studies

Proposed Project: Evaluate Ultrafine Particle Health Effects

Expected South Coast AQMD Cost: \$88,150

Expected Total Cost: \$1,000,000

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 of the toxic air contaminants emitted from diesel exhaust. Additionally, health studies indicate that the ultrafine particulate matter (UPM) may be more toxic on a per-mass basis than other fractions. Several technologies have been introduced and others are under development to reduce diesel emissions. These include among others low-sulfur diesel fuel, particulate matter traps and heavy-duty engines operating on alternative fuel such as CNG and LNG. 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 the number of 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 the 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 to characterize their toxicity. The composition of PM can further be used to determine the contribution from specific combustion sources. Additionally, engine or chassis dynamometer testing may be conducted on heavy-duty vehicles to measure, evaluate and compare UPM, PAH and other relevant toxic emissions from different types of fuels such as CNG, low-sulfur diesel, biofuels and others. This project needs to be closely coordinated with the development of technologies for alternative fuels, aftertreatment technologies, and new engine development in order to determine the 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 the SOA potential from these vehicles as it could lead to further impact on the ambient PM concentration in our region. Consequently, in 2015 a project was initiated with UCR/CE-CERT to investigate the physical and chemical composition of aerosols from GDI vehicles using a mobile environmental chamber that has been 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 medium- and heavy-duty vehicles to understand potential emissions impact.

Potential Air Quality Benefits:

The AQMP for the Basin relies on significant penetration of low emission vehicles to attain federal clean air standards. Reduction of PM emissions from the 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

Expected South Coast AQMD Cost: \$132,225

Expected Total Cost: \$500,000

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 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 in order 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

Expected South Coast AQMD Cost: \$132,225

Expected Total Cost: \$300,000

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.

MATES V was launched in 2017 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 finalized in June 2021 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. Highest risk locations are at LAX and the Ports along goods movement and transportation corridors. Diesel PM continues to be the major contributor to 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.

This project category would include other related factors, such as toxicity assessment based on age, source (heavy-duty, light-duty 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.

Technology Assessment/Transfer and Outreach

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 the assessment of clean fuels and advanced technologies, their progress towards commercialization and the dissemination of information on demonstrated technologies. The objective of this project is to expedite the transfer of technology developed as a result of Technology Advancement Office projects to the public domain, industry, regulatory agencies and the scientific community. This project is a fundamental element in the South Coast AQMD's outreach efforts by coordinating activities with other organizations to expedite the 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 fuel refueling and 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, improving public relations and public communications of successful clean technology demonstrations;
- participation in and coordination of workshops and various meetings;
- support for training programs related to fleet operation, maintenance and refueling 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:

South Coast AQMD adopted fleet regulations requiring public and private fleets within the Basin to acquire alternatively fueled vehicles when making new purchases. The benefits of highlighting success stories in the use of advanced alternatively fueled vehicles could expedite the acceptance and commercialization of advanced technologies. Especially, by the operators seeking to comply with the provisions of the South Coast AQMD fleet rules. The emission reduction benefits will contribute to the goals of the AQMP.

Proposed Project: Support Implementation of Various Clean Fuels Vehicle Incentive Programs

Expected South Coast AQMD Cost: \$350,000

Expected Total Cost: \$400,000

Description of Project:

This project supports the implementation of incentive programs, including the state and federal grant programs, the Carl Moyer, lower emission school bus, Replace Your Ride Programs and the South Coast AQMD residential EV charger rebate program. Implementation support includes application review, funds allocation, equipment owner reports collection, documentation to the 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 dealers, individuals and fleets. To date, the South Coast AQMD residential EV charger rebate program has provided over 1,900 rebates, totaling \$553,596. The total available funds of \$1 million is consisted with \$500,000 from South Coast AQMD Clean Fuels Fund and \$500,000 from the Mobile Source Air Pollution Reduction Review Committee (MSRC).

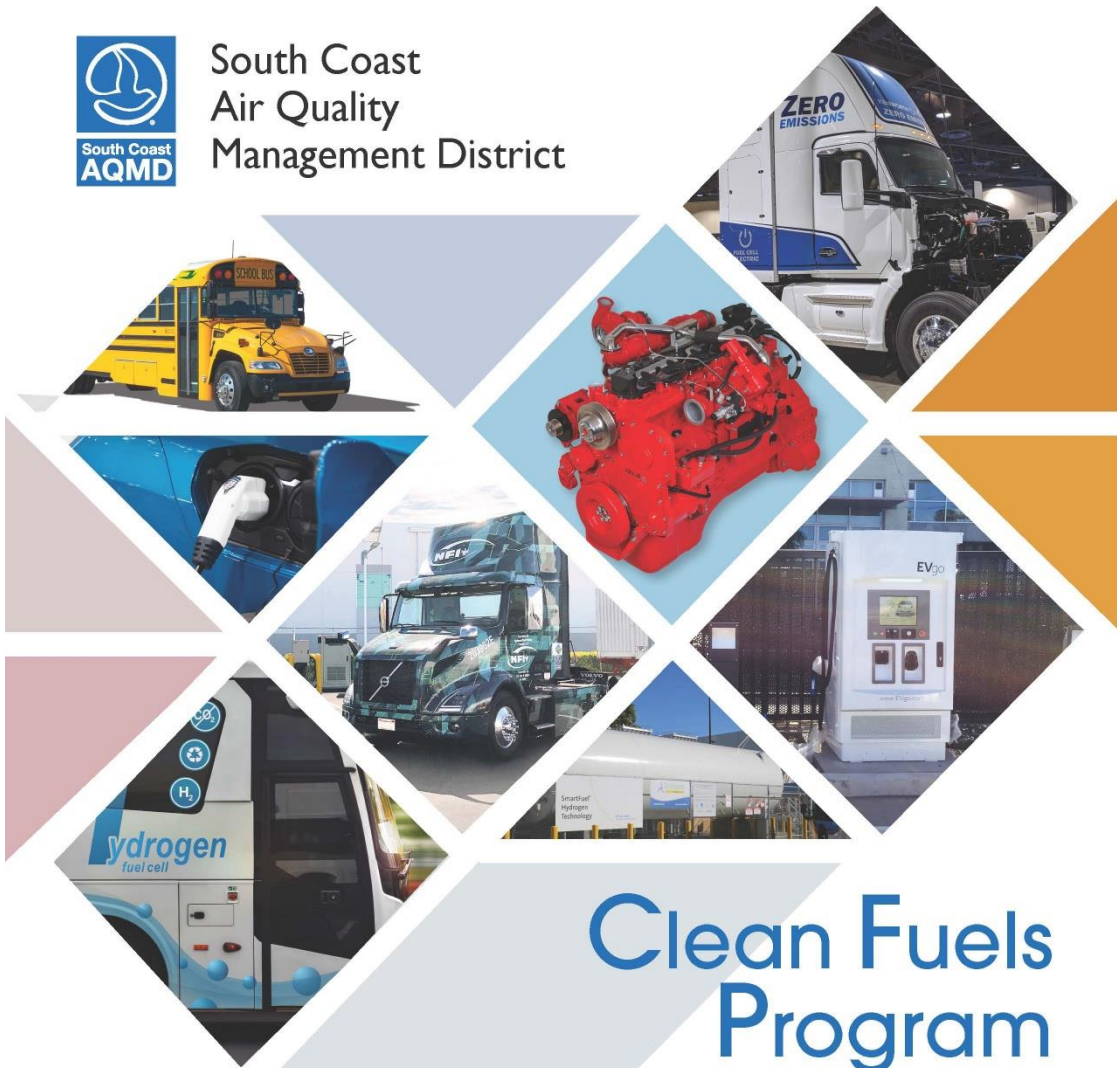
Potential Air Quality Benefits:

As described earlier, the South Coast AQMD will provide matching funds to implement several key incentives programs to reduce emissions in the Basin. Furthermore, the South Coast AQMD adopted fleet regulations requiring public and private fleets within the Basin to acquire alternatively fueled vehicles when making new purchases. The benefits of highlighting zero emission vehicle incentives could potentially expedite the acceptance and commercialization of advanced technologies by operators seeking to comply with the South Coast AQMD fleet rules provisions. The result of future emission reduction benefits will contribute to the goals of the AQMP. The lower emission school bus, AB 617 Community Air Protection, Volkswagen Environmental Mitigation Trust and Carl Moyer incentives programs could reduce large amounts of NOx and PM emissions, and toxic air contaminants in the Basin.

[This Page Intentionally Left Blank]



South Coast
Air Quality
Management District



Technology Committee Meeting

Clean Fuels Program

2020 Annual Report
& 2021 Plan Update

Technology Advancement Office

Leading the way to cleaner air

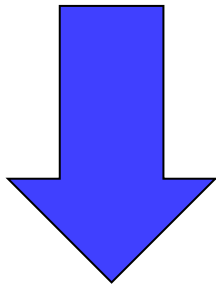
November 19, 2021

Aaron Katzenstein

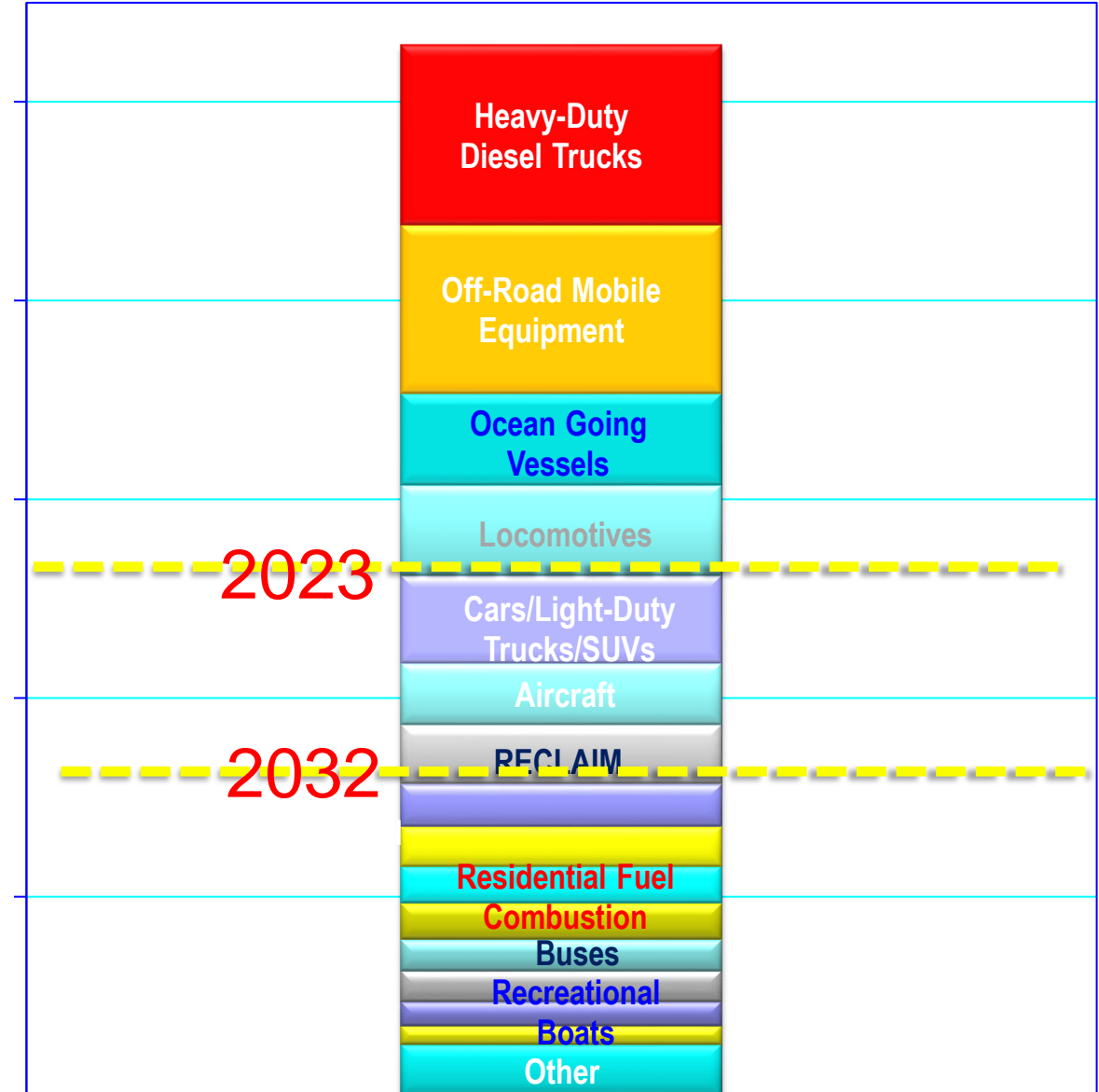
Assistant Deputy Executive Officer

NOx Reductions Needed

45-55%

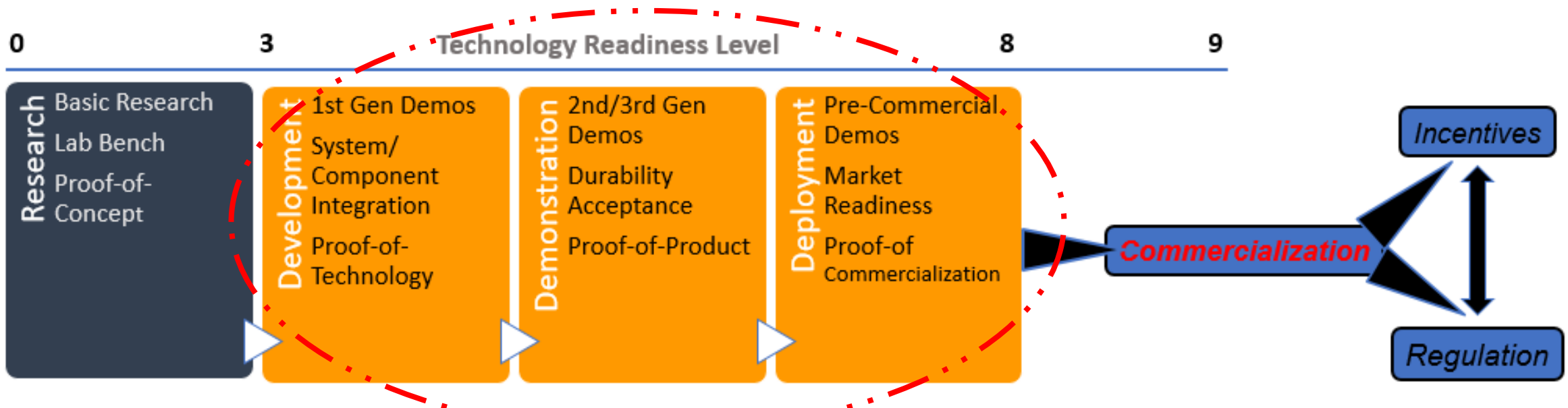


NOx Tons/Day



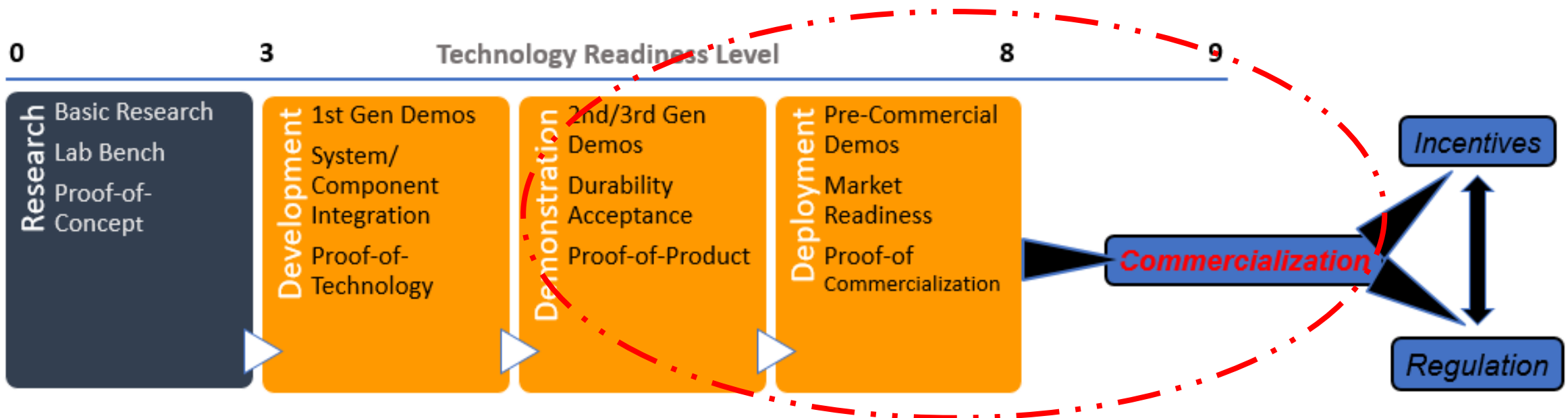
Clean Fuels Fund Program

- Established in 1988
- \$1 fee on DMV registrations (\$~12M/yr)
- Stationary source fee (~\$300k/yr)
- Research, develop, demonstrate, and deploy clean technologies



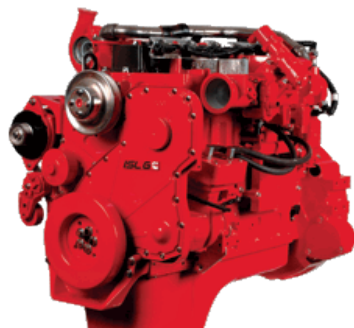
Clean Fuels Fund Program

- Established in 1988
- \$1 fee on DMV registrations (\$~12M/yr)
- Stationary source fee (~\$300k/yr)
- Research, develop, demonstrate, and deploy clean technologies



Draft 2022 Plan Update (Key Technical Areas)

- Focus priorities on large demonstrations of zero emissions drayage trucks to test and validate OEM readiness and infrastructure viability
- Defining technology pathways via special projects - the Ultra-Low Emissions Engine Program
- Near-zero emission (gaseous and liquid fuel) engine systems, with a focus on high HP HD engine technology
- Long range fuel cell electric truck development and demonstration
- Hydrogen production, dispensing and mobile refueling
- Maintain other areas of emphasis



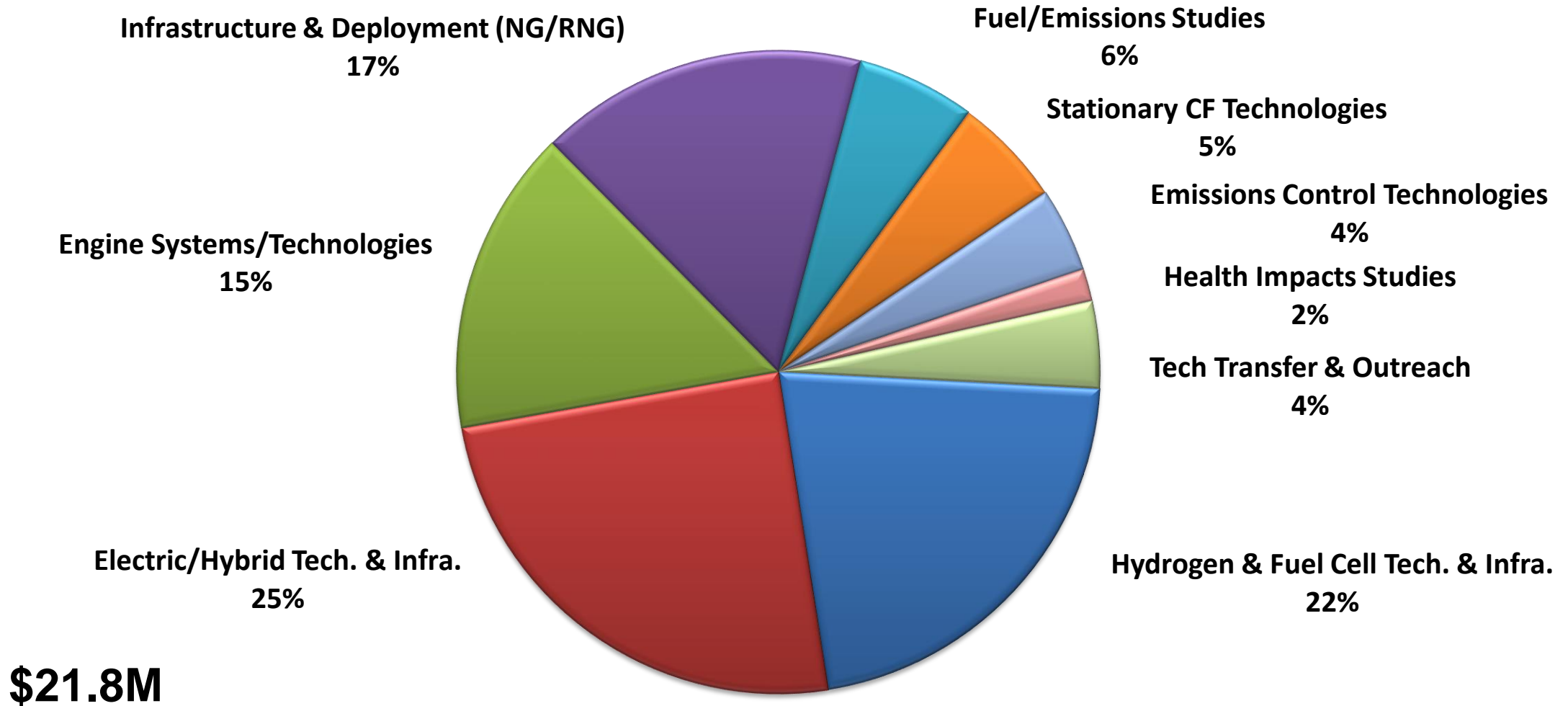
Draft 2022 Plan Update

Proposed Projects

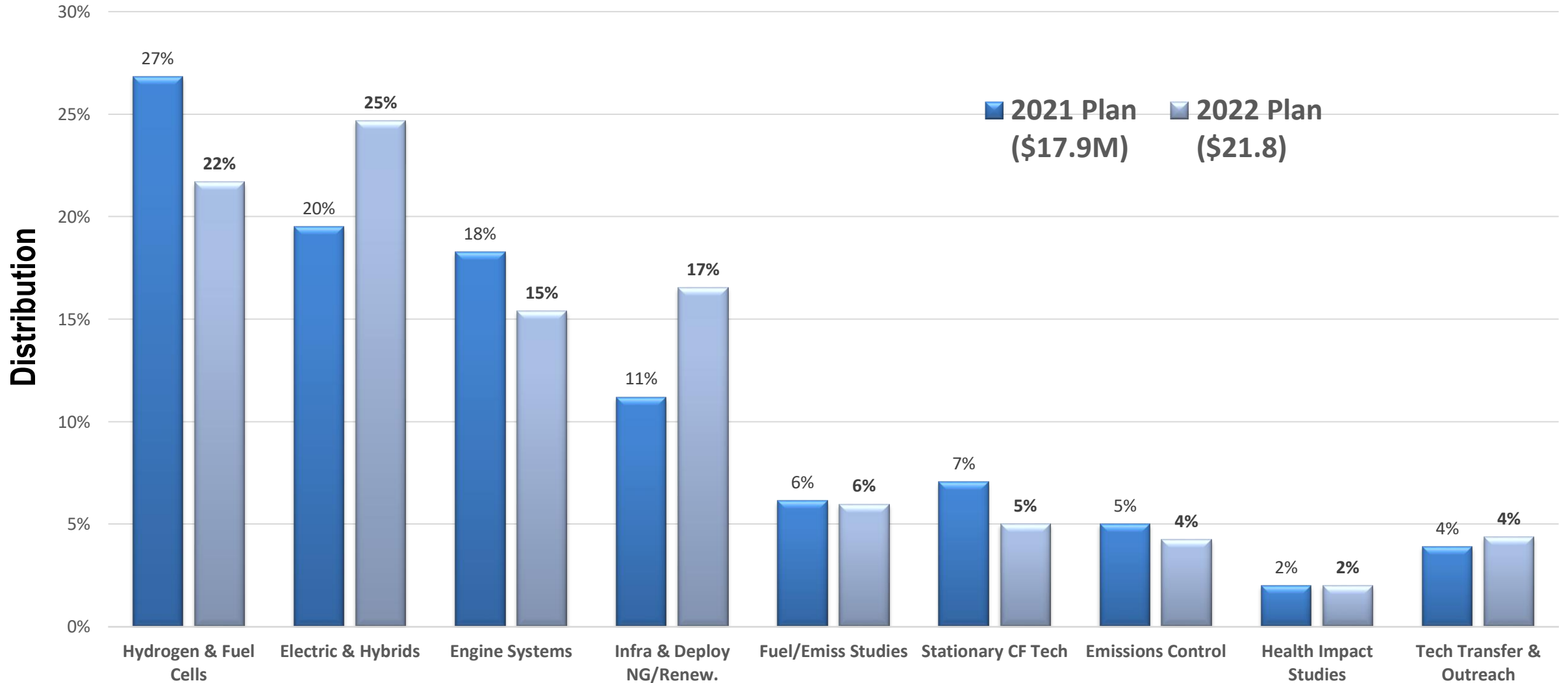
- Large deployment projects of HD zero emission battery electric trucks and infrastructure
- Continue microgrid demonstrations to support large HD truck deployment projects
- Support advanced high power quick charge infrastructure to support HD BET's
- Develop and demonstrate long range fuel cell electric trucks
- Develop pathways and demonstrate green hydrogen production
- Replace Heavy-duty diesel truck with near-zero emissions trucks
- Engine System Technologies:
 - Development and demonstration of 15L HD Low-NOx engine
 - On-road demonstration of Low NOx diesel engine
 - Ethanol/H2 combustion studies



Proposed 2022 Plan Distribution



Plan Update Comparison



Proposed Distribution

	2021 Plan	Draft 2022 Plan
Hydrogen & Fuel Cell Tech. & Infra.	27%	↓ 22%
Engine Systems/Technologies	18%	↓ 15%
Electric/Hybrid Tech. & Infra.	20%	↑ 25%
Infrastructure & Deployment (NG/RNG)	11%	↑ 17%
Stationary CF Technologies	7%	↓ 5%
Fuel/Emissions Studies	6%	6%
Emissions Control Technologies	5%	↓ 4%
Tech Transfer & Outreach	4%	4%
Health Impacts Studies	2%	2%
	100%	100%

Feedback

Email

Aaron Katzenstein

akatzenstein@aqmd.gov

or

Joseph Impullitti

jimpullitti@aqmd.gov