Technology Advancement Office

Clean Fuels Program 2011 Annual Report and 2012 Plan Update

March 2012

South Coast Air Quality Management District
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Henry Hogo, Assistant Deputy Executive Officer, Mobile Sources

Lourdes Cordova Martinez, Community Relations Manager
Fred Minassian, Technology Implementation Manager
Dipankar Sarkar, Technology Demonstration Manager

Al Baez, Program Supervisor
Connie Day, Program Supervisor
Ranji George, Program Supervisor
Joseph Impullitti, Program Supervisor
Lisa Mirisola, Program Supervisor
Larry Watkins, Program Supervisor
Vicki White, Program Supervisor

Brian Choe, Air Quality Specialist
Mark Coleman, Air Quality Specialist
Jeff Cox, Air Quality Specialist
Patricia Kwon, Air Quality Specialist
Von Loveland, Air Quality Specialist
Frank Motavassel, Air Quality Specialist
Ashkaan Nikravan, Air Quality Specialist
Shashi Singeetham, Air Quality Specialist
Mei Wang, Air Quality Specialist
Vasken Yardemian, Sr. Staff Specialist

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Arun Kumar, Air Quality Inspector II

Laurie Diton, Senior Administrative Secretary
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Marjorie Eaton, Secretary
Penny Shaw Cedillo, Secretary
Donna Vernon, Secretary
Lani Montojo, Staff Assistant
Michelle White, Staff Assistant
Christina Kusnandar, Contracts Assistant
Benigna Taylor, Contracts Assistant
Ana Troccoli, Contracts Assistant
Deanna Doerr, Senior Office Assistant
Lizette Acosta, Office Assistant

Other Staff Contributors
Philip Barroca, Air Quality Specialist
Lori Berard, Air Quality Specialist
David Coel, Program Supervisor
Wei Li, Air Quality Specialist
Adewale Oshinuga, Program Supervisor
Jean Ospital, Ph.D., Health Effects Officer, Planning, Rule Development & Area Sources
Randall Pasek, Ph.D., Off-Road Mobile Source Manager
Dean Saito, On-Road Mobile Source Manager
Richard Carlson, Air Quality Specialist
Andrew Yoon, Air Quality Specialist

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EXECUTIVE SUMMARY

The South Coast Air Quality Management District (SCAQMD) 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. Recognizing this challenge, the state established the Clean Fuels Program in 1988 which affords the SCAQMD the ability to fund the development, demonstration and accelerated deployment of clean technologies. For over 20 years, the Clean Fuels Program has supported technologies such as fuel cells, natural gas engines, plug-in hybrid electric vehicles and their associated fueling infrastructure. The SCAQMD continues to support a wide variety of technologies, in different stages of maturity, to provide a continuum of emission reductions and health benefits over time.

In recent years, it has become increasingly clear that the importation of goods through the Ports of Los Angeles and Long Beach and the subsequent movement of goods throughout the region not only have a dramatic impact on air quality but also the quality of life to the communities along the major goods movement corridors. In recognition of these impacts, the SCAQMD has initiated a concerted effort in the last two years on developing zero and near-zero emissions goods movement technologies, such as electric trucks, plug-in hybrid trucks with all-electric range, trucks operating from wayside power and even electric locomotives. The prioritization of these types of projects as well as potential technologies which assist with their further development and deployment are emphasized in the 2012 Plan Update portion of the report. The 2011 Annual Report highlights the projects contracted during the previous calendar year and reflect the current status of the program.

2011 Annual Report

The SCAQMD executed 65 new contracts, projects or studies and modified 10 continuing projects adding additional dollars during Calendar Year (CY) 2011 toward research, development, demonstration and deployment (RDD&D) of alternative fuel and clean fuel technologies. Table 2 (page 22) lists these 75 projects or studies, which are further described in this report. The SCAQMD contributed approximately $8.9 million in partnership with other governmental organizations, private industry, academia and research institutes and interested parties, with total project costs of more than $27 million. Table 3 (page 25) provides information on outside funding received into the Clean Fuels Fund ($2.56 million in 2011) as cost-share for contracts executed in this period. Table 4 (page 26) lists federal and state funds awarded to the SCAQMD for programs that align well with the Clean Fuels Program ($6.7 million in 2011), and Table 5 (page 26) provides an update on the $95 million in federal and state funding awarded to the SCAQMD in the prior two years, again for projects that align well with the Clean Fuels Program.

These projects or studies executed in 2011 addressed a wide range of issues and opportunities with a diverse mix of advanced technologies. The following core areas of technology advancement include:

- Hybrid and Electric Vehicle Technologies and Related Infrastructure
- Infrastructure and Deployment (predominantly compressed and liquid natural gas)
- Hydrogen Technology and Infrastructure
- Mobile Fuel Cell Technologies
- Emission Control Technologies
- Engine Systems (particularly in the heavy-duty vehicle sector)
- Fuels and Emission Studies
- Stationary Clean Fuels Technology (including renewables)
- Health Impacts Studies
- Outreach and Technology Transfer

During CY 2011, the SCAQMD supported a variety of projects and technologies, ranging from near-term to long-term research, development, demonstration and deployment activities. This "technology portfolio" strategy provides the SCAQMD the ability and flexibility to leverage state and federal funding while also addressing the specific needs of the South Coast Air Basin (Basin). Projects in CY 2011 included development, demonstration and deployment of fuel cell and electric vehicles and infrastructure, demonstrations of emission control technologies on heavy-duty trucks as well as fuels and emission studies, further expansion of natural gas alternative refueling infrastructure and vehicle deployment and development and demonstration of hydrogen technology and infrastructure.

As of January 1, 2012, there were 125 open contracts in the Clean Fuels Program; these are summarized in Appendix B.

Thirty-one research, development, demonstration and deployment projects or studies and 17 technology assessment and transfer contracts were completed in 2011, as listed in Table 6 (page 57). Appendix C comprises two-page summaries of the technical projects completed in 2011. In accordance with California Health and Safety Code Section 40448.5.1(d), this report must be submitted to the state legislature by March 31, 2012, after approval by the SCAQMD Governing Board.

2012 Plan Update

The Clean Fuels Program (Program) continually seeks to support the deployment of lower emitting technologies. The design and implementation of the Program Plan must balance the needs in the various technology sectors with technology readiness, emissions reduction potential and co-funding opportunity. The SCAQMD Program is significant, especially during these economically tough times when both public and private funding available for technology research and development are limited. However, since national and international activities affect the direction of technology trends, the real challenge for the SCAQMD is to identify project or technology opportunities in which its available funding can make a significant difference in deploying progressively cleaner technologies in the Basin.

The overall strategy is based in large part on technology needs identified in the Air Quality Management Plan (AQMP) and the SCAQMD Governing Board's directives to protect the health of residents in the Basin. The AQMP is the long-term "blueprint" that defines:

- the basin-wide emission reductions needed to achieve federal ambient air quality standards;
- the regulatory measures to achieve those reductions;
- the timeframes to implement these proposed measures; and
- the technologies required to meet these future proposed regulations.

The oxides of nitrogen (NO_x), volatile organic compounds (VOC) and particulate matter (PM) emission sources of greatest concern are heavy-duty on-road vehicles, light-duty on-road vehicles and off-road equipment. The Plan Update includes projects to develop, demonstrate and commercialize a variety of technologies, from near term to long term, that are intended to provide solutions to the emission control needs identified in the AQMP. Large NO_x and $PM_{2.5}$ reductions will be necessary to meet the federal $PM_{2.5}$ standards by 2014 and the federal 8-hour ozone standard by 2023 and so mid- and longer-term alternative fuels, hybrid, electric, and fuel cell based technologies are emphasized. Several of the technology areas of focus include:

- reducing emissions from port-related activities, such as cargo handling equipment and container movement technologies, including demonstration and deployment of zero-emission cargo container movement systems;

- mitigating criteria pollutant increases from renewable fuels, such as low-blend ethanol and high-blend biodiesel;
- increased activities in electric, hybrid, battery and plug-in hybrid technologies across light-, medium- and heavy-duty platforms; and
- production of transportation fuels and energy from renewable biowaste sources.

Table 7 (page 70) lists the potential projects across the core technologies identified in this report. Potential projects for 2012 total more than $16.2 million, with anticipated leveraging of more than $77.6 million. The proposed projects may also be funded by revenue sources other than the Clean Fuels Program, especially VOC and incentive projects.

CLEAN FUELS PROGRAM
2011 ANNUAL REPORT

Program Background

The Basin, which comprises the Los Angeles, Orange, San Bernardino and Riverside Counties, has the worst air quality in the nation due to a combination of factors, including high vehicle population, high vehicle miles traveled within the Basin and geographic and atmospheric conditions favorable for photochemical oxidant (smog) formation. Due to these challenges, the state legislature enabled the SCAQMD to implement the Clean Fuels Program to accelerate the implementation and commercialization of clean fuels and advanced technologies in the Basin. In 1999, state legislation was passed which amended and extended the Clean Fuels Program. Specifically, as stated in the California Health and Safety Code (H&SC) section 40448.5.1(d), the SCAQMD must submit, on or before March 31 of each year to the Legislature, an annual report that includes:

1. A description of the core technologies that the SCAQMD considers critical to ensure attainment and maintenance of ambient air quality standards and a description of the efforts made to overcome barriers to commercialization of those technologies;
2. An analysis of the impact of the SCAQMD's Clean Fuels Program on the private sector and on research, development and commercialization efforts by major automotive and energy firms, as determined by the SCAQMD;
3. A description of projects funded by the SCAQMD, including a list of recipients, subcontractors, co-funding sources, matching state or federal funds and expected and actual results of each project advancing and implementing clean fuels technology and improving public health;
4. The title and purpose of all projects undertaken pursuant to the Clean Fuels Program, the names of the contractors and subcontractors involved in each project and the amount of money expended for each project;
5. A summary of the progress made toward the goals of the Clean Fuels Program; and
6. Funding priorities identified for the next year and relevant audit information for previous, current and future years covered by the project.

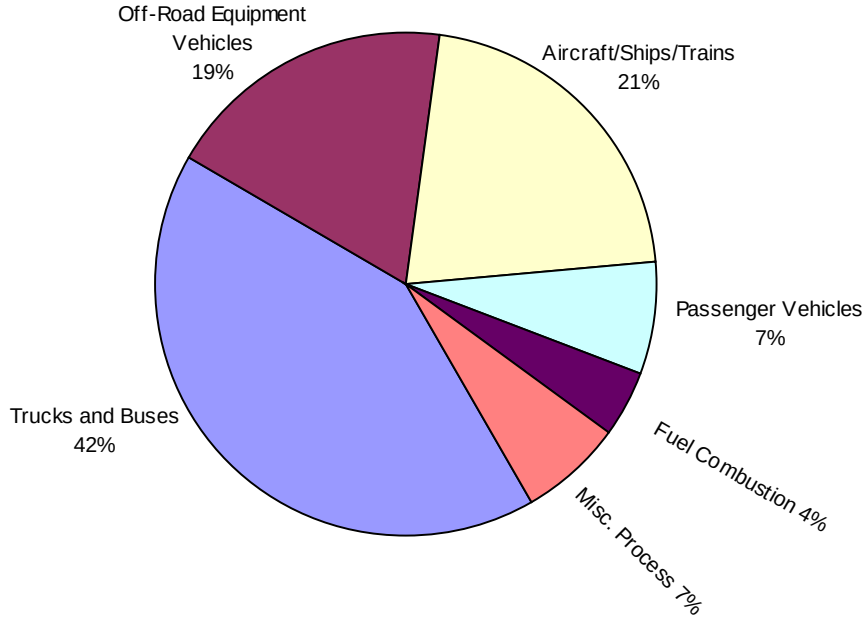
2011 Overview

This report summarizes the progress of the SCAQMD Clean Fuels Program for CY 2011. This SCAQMD program co-sponsors projects to develop and demonstrate zero-, near-zero and low-emission clean fuels and advanced technologies and to promote commercialization and deployment of promising or proven technologies in Southern California. These projects are conducted through public-private partnerships with industry, technology developers, academic and research institutes and local, state and federal agencies.

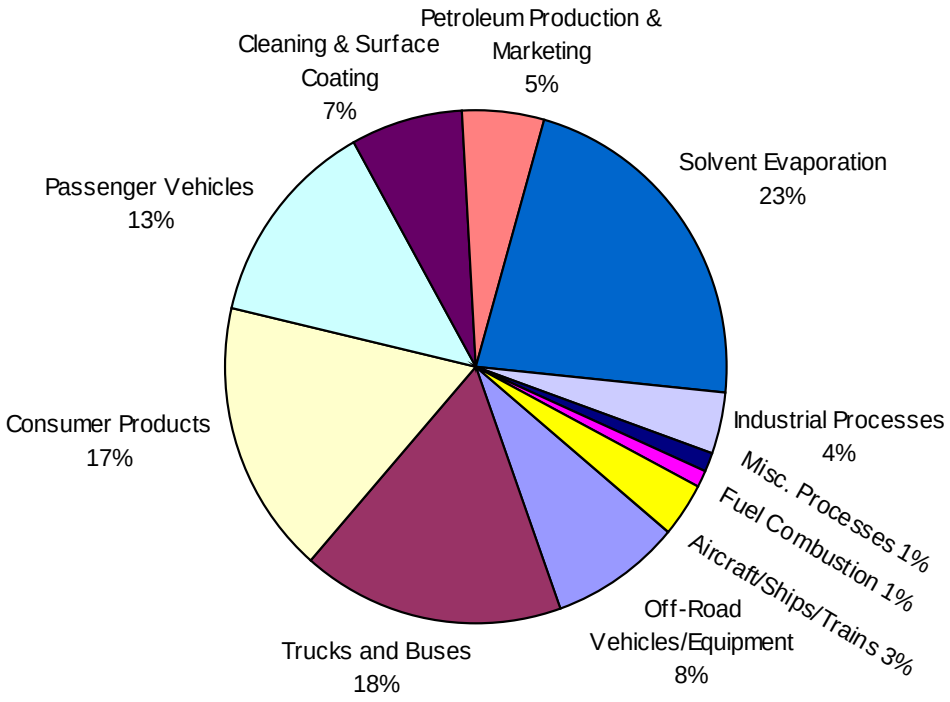
During the period between January 1 and December 31, 2011, the SCAQMD executed 65 new contracts, projects or studies and modified 10 continuing projects adding additional dollars during CY 2011 that support clean fuels and advanced zero-, near-zero and low-emission technologies. The SCAQMD contribution for these projects was nearly $8.9 million, with total project costs of more than $27 million. These projects address a wide range of issues with a diverse technology mix. This report highlights achievements and summarizes project costs of the SCAQMD Clean Fuels Program in this period. The report also provides information on outside funding received into the Clean Fuels Fund ($2.1 million) as cost-share for contracts executed in this period as well as funds awarded to the SCAQMD for programs that align well with the Clean Fuels Program ($6.7 million in 2011). A status update on the $95 million in federal and state funding awarded to the SCAQMD in the prior two years, again for projects that align well with the Clean Fuels Program, is also provided.

The Need for Advanced Technologies & Clean Fuels

Achieving federal and state clean air standards in Southern California will require emission reductions from both mobile and stationary sources beyond those expected using current technologies. The need for advanced technologies and clean fuels is best demonstrated by considering the emissions inventory for the Basin and the future emissions levels projected in the 2007 AQMP. The estimated baseline 2014 NO_x, VOC and $PM_{2.5}$ emissions inventory is shown in Figure 1. Based on the 2007 AQMP, significant reductions are necessary to demonstrate attainment with the federal standards.



2014 NOx = 663 tons/day



2014 VOC = 644 tons/day

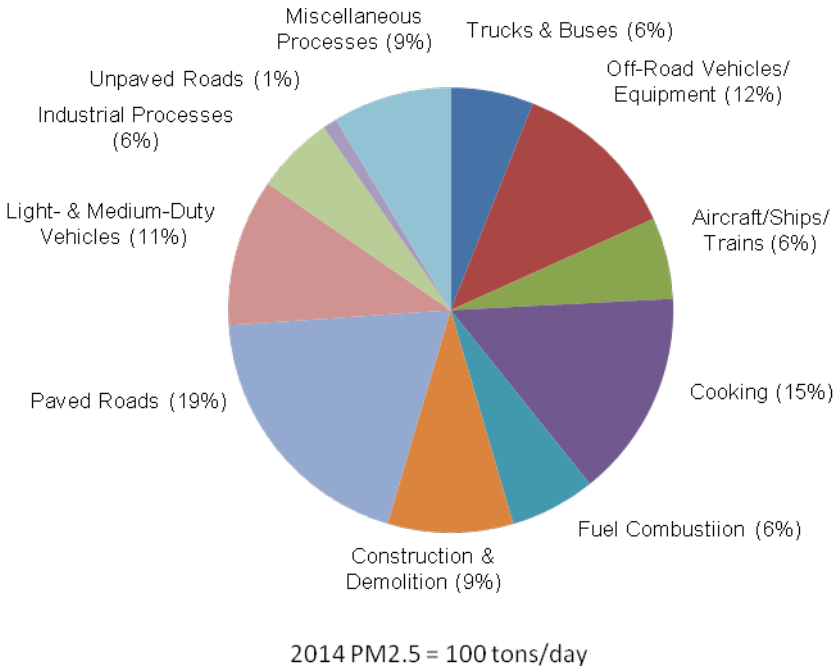


Figure 1: Major Source Contributions (2014)

To fulfill long-term emission reduction targets, the 2007 AQMP relies on advanced technologies that are not yet fully developed for commercial use. Significant reductions are anticipated from implementation of advanced control technologies for both on-road and non-road mobile sources. In addition, the air quality standards for ozone (0.08 ppm, 8-hour average) and fine particulate matter, promulgated by the U.S. Environmental Protection Agency (U.S. EPA) in 1997 and 2006, are projected to require additional long-term control measures for both NO_x and VOC. The 2012 AQMP, which is in the beginning stages of development, will in large part focus control measures on transportation and cleaner fuels with zero-emissions as a key target. To achieve zero-emissions, especially in the goods movement sector, will require an accelerated effort to advance technologies and cleaner fuels.

Recent health studies also indicate a greater need to reduce NO_x emissions and toxic air contaminant emissions. More importantly, the California Air Resources Board (CARB) listed diesel exhaust emissions as a toxic air contaminant in 1998. Subsequently, in 1999, the SCAQMD completed the Multiple Air Toxics Exposure Study (MATES-II) and found that diesel combustion sources (primarily from heavy-duty vehicles) contribute approximately 70 percent to the estimated potential cancer risk from air toxics in the Basin. A follow-on study, MATES-III, in which air quality sampling was initiated in spring 2004 and ended in 2006, was undertaken to evaluate air toxic exposure trends, expand the list of known air toxics and assess local impacts from industrial, commercial and mobile sources. The results have shown a decrease in stationary emitted air toxics and gasoline related air toxics, but continued high levels of emissions from diesel engine sources. The MATES-III report was finalized in spring 2008. Although results showed an overall decrease in toxics exposures throughout the basin, there were localized areas that had increased risk, most notably around the Ports of Los Angeles and Long Beach. This increased risk is likely a result of uncontrolled diesel emissions from goods movement activities, specifically emissions from trucks and cargo handling equipment, locomotives and marine vessels. Currently, SCAQMD is working on the MATES IV study that was approved by the Board in December 2011. While the goal of MATES IV like the prior studies will be to assess air toxic levels, update risk characterization, and determine gradients from selected sources, MATES IV has an added ultrafine PM and black carbon monitoring component too. It is anticipated that a draft report on the findings will be available by late 2013.

Greenhouse gas (GHG) emissions and petroleum dependency arising from the heavy use of conventional technologies continue to be a concern and focal point for state and federal government as well as the general public. In response to these concerns, the federal government has launched several programs (the Hydrogen, Fuel Cells and Infrastructure Technologies Program and the FreedomCAR and Vehicle Technologies Program) to investigate and develop increased efficiency and alternative fuel (including hydrogen) technologies. Independently, the State has adopted goals to reduce long-term dependence on petroleum-based fuels (AB 2076) and the transition to alternative fuels based on life-cycle analyses (AB 1007).

California's Governor took this concern one step further when in January 2007 he established a Low-Carbon Fuel Standard (LCFS) by Executive Order. The LCFS came out of AB 32, the "Global Warming Solutions Act," which was signed by the Governor in fall 2006 and requires California's greenhouse gas emissions to be capped at 1990 levels by 2020. The LCFS standard for transportation fuels will necessitate increased research into alternatives to oil and traditional fuels. In September 2008, the Governor signed SB 375 requiring CARB to set regional targets reducing GHG's from cars and light trucks for 2020 and 2035 and directs regional planning agencies to develop land-use strategies to meet the targets. AB 32 faced a challenge in 2010 when an initiative to suspend it was placed on the November 2010 ballot as Proposition 23, but California voters defeated this proposition, demonstrating California's commitment to air quality and the environment.

To achieve the goals established by these landmark efforts, CARB recently adopted a LEV III program for Model Year (MY) 2015 to 2025 light- and medium-duty vehicles, amended the Zero-Emission Vehicle Regulation, and amended the Clean Fuels Outlet requirements. These tighter standards for passenger cars and light- and medium-duty trucks will require reduced tailpipe emissions and nearly no evaporative emissions. CARB also proposed new requirements for zero-emission vehicles lowering the threshold requirement, which means automakers must begin producing zero-emission vehicles by 2016. To achieve the Governor's Executive Order, CARB envisions that 80 percent of vehicles must be all electric, battery electric, hydrogen and/or fuel cell by 2050. In late 2011 CARB also adopted amendments to low-sulfur marine fuel requirements to extend the nautical zone and loosened cargo handling equipment and transportation refrigeration regulations because sufficient retrofit technologies aren't available in the marketplace. In 2011 the Federal government adopted fuel economy and GHG emissions standards for medium- and heavy-duty vehicles for MYs 2014-2018 and propose to move forward with Tier 3 levels for light- and medium-duty trucks and tighter criteria pollutant standards for passenger vehicles.

In summary, advanced, energy efficient and renewable technologies are needed not only for attainment, but also to protect the health of those who reside within the SCAQMD's jurisdiction; to reduce long-term dependence on petroleum-based fuels; and to support a more sustainable energy future. Conventional strategies and traditional supply and consumption need to be retooled in order to achieve the federal air quality goals. To help meet this need for advanced, clean technologies, the SCAQMD Governing Board continues to aggressively carry out the Clean Fuels Program and promote alternative fuels through the Technology Advancement Office. This Program is intended to assist in the rapid development and deployment of progressively lower-emitting technologies and fuels through innovative public-private partnership. Since its inception, the SCAQMD's Technology Advancement Office has co-funded projects in cooperative partnerships with private industry, technology developers, academic and research institutions and local, state and federal agencies. The following sections describe funding, core technologies and advisory oversight of the Clean Fuels Program.

Program Funding

The Clean Fuels Program is established under California H&SC Sections 40448.5 and 40512 and Vehicle Code Section 9250.11. This legislation establishes mechanisms to collect revenues from

mobile and stationary sources to support the program objectives and identifies the constraints on the use of funds. In 2008, these funding mechanisms were reauthorized under SB 1646 (Padilla), which removed the funding sunset of January 1, 2010, and established the five percent administrative cap instead of the previous cap of two-and-half percent.

The Program is funded through a $1 fee on motor vehicles registered in the SCAQMD. Revenues collected from these motor vehicles must be used to support mobile source projects. Stationary source projects are funded by an emission fee surcharge on stationary sources emitting more than 250 tons of pollutants per year within the SCAQMD. For CY 2011 the funds available through each of these mechanisms were as follows:

- Mobile sources (DMV revenues) $12,092,289
- Stationary sources (emission fee surcharge) $302,775

The SCAQMD Clean Fuels Program also receives grants and cost-sharing revenue contracts from various agencies, on a project-specific basis, that supplement the SCAQMD program. Historically, such cooperative project funding revenues have been received from CARB, the California Energy Commission (CEC), the U.S. EPA, the U.S. Department of Energy (DOE) and the U.S. Department of Transportation (DOT). These supplemental revenues depend in large part on the originating agency, its budgetary and planning cycle and the specific project or intended use of the revenues. Table 3 (page 25) lists the supplemental grants and revenues received in 2011, totaling nearly $2.56 million, and for which contract the funding passes through to.

The final and perhaps most significant funding source can best be described as an indirect source, i.e., funding not directly received by the SCAQMD. This indirect source is the cost-sharing provided by private industry and other public and private organizations. Historically, the Technology Advancement Office has been successful in leveraging its available public funds with nearly $4 of outside funding for each $1 of SCAQMD funding. For 2011, excluding ARRA and other one-time federal opportunities, one-time settlement funds and incentive funding, the Clean Fuels Program leveraged each $1 to slightly more than $3 outside funding. Through these public-private partnership, the SCAQMD has shared the investment risk of developing new technologies along with the benefits of expedited development and commercial availability, increased end-user acceptance, reduced emissions from the demonstration projects and ultimately increased use of clean technologies in the Basin. The SCAQMD's Clean Fuels Program has also avoided duplicative efforts by coordinating and jointly funding projects with major funding agencies and organizations. The major funding partners for 2011 are listed in Table 1 (page 14).

Core Technologies

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

- Hybrid and Electric Vehicle Technologies and Related Infrastructure
- Infrastructure and Deployment (predominantly compressed and liquid natural gas)
- Hydrogen Infrastructure and Mobile Fuel Cell Technologies
- Emission Control Technologies
- Engine Systems
- Stationary Clean Fuels Technologies

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

1. Low- and zero-emission technologies needed to achieve clean air standards in the Basin; and
2. Available funding to support technology development within the constraints imposed by that funding.

The SCAQMD strives to maintain a flexible program to address dynamically evolving technologies and the latest progress in the state of the technology. Although the SCAQMD program is significant, especially at a time when both public and private funding available for technology research and development are limited, national and international activities affect the direction of technology trends. As a result, the SCAQMD program must be flexible in order to leverage and accommodate these changes in state, national and international priorities. This is especially true given the current economic climate which could continue through 2012. The ultimate challenge for the SCAQMD is to identify project or technology opportunities in which its available funding can make a difference in achieving progressively cleaner air in the Basin.

Historically, mobile source projects have targeted low-emission developments in automobiles, transit buses, medium- and heavy-duty trucks and non-road applications. These vehicle-related efforts have focused on advancements in engine design, electric power-trains and energy storage/conversion devices (e.g., fuel cells and batteries); and implementation of clean fuels (e.g., natural gas, propane and hydrogen) including their infrastructure development. Stationary source projects have included a wide array of advanced low NO_x technologies and clean energy alternatives such as fuel cells, solar power and other renewable energy systems.

Specific projects are selected for co-funding from competitive solicitations, cooperative agency agreements and unsolicited proposals. Criteria considered in project selection include emissions reduction potential, technological innovation, potential to reduce costs and improve cost effectiveness, contractor experience and capabilities, overall environmental impact or benefit, commercialization and business development potential, cost sharing and consistency with program goals and funding constraints. The core technologies for the SCAQMD programs that meet both the funding constraints as well as 2007 AQMP needs for achieving clean air are briefly described below.

Hybrid and Electric Vehicle Technologies

There has been an increased level of activity and attention on hybrid vehicles due to a confluence of factors, including the highly successful commercial introductions of hybrid passenger vehicles by almost all of the automakers, volatility in oil prices and increased public attention on global warming. In January 2012, CARB adopted the California Zero Emission Vehicle (ZEV) III requirements and amended the ZEV and Clean Fuels Outlet (CFO) regulations. There are alternative strategies allowed to comply with the ZEV regulation, including producing battery electric vehicles, plug-in hybrid electric vehicles (PHEVs), and hydrogen-fueled internal combustion engine (ICE) vehicles.

As a result, there is now a window of opportunity to leverage state and federal activities in the development and deployment of technologies that can accelerate advanced hybrid technologies, including PHEV, medium- and heavy-duty hybrid vehicle deployment, energy storage technologies, development of medium- and heavy-duty hybrid emission certification cycles, battery durability testing and establishment of driver use patterns. Such technology developments, if successful, are considered *enabling* because they can be applied to a variety of fuels (e.g., gasoline, natural gas, ethanol and hydrogen) and propulsion systems (e.g., ICEs and fuel cells). Electric and hybrid technologies are also being explored to address one of the SCAQMD's 2011 and 2012 priorities, which is to continue demonstration and deployment of zero-emission cargo container movement technologies.

Infrastructure and Deployment

A key element for the widespread acceptance and resulting increased use of alternative fueled vehicles is the availability of the supporting refueling infrastructure. The refueling infrastructure for gasoline and diesel fuel is well established and accepted by the driving public. Alternative, clean fuels such as natural gas, alcohol-based fuels, propane, hydrogen, hydrogen-natural gas mixtures and even electricity are much less available or accessible. To realize the emissions reduction benefits, the alternative fuel infrastructure must be developed in tandem with the growth in alternative fueled vehicles. The objectives of the SCAQMD are to expand the infrastructure to support zero and near-zero emission vehicles through the development, demonstration and installation of alternative fuel vehicle refueling technologies.

Hydrogen Infrastructure and Mobile Fuel Cell Technologies

Most of the automobile manufacturers have conceded that mass commercial introduction of fuel cell vehicles (FCVs) are likely to be delayed due to the cost, durability and infrastructure issues associated with hydrogen fueling. A blind survey of the major automakers conducted by CARB and the California Fuel Cell Partnership (CaFCP), with assistance from the National Renewable Energy Lab (NREL), estimates that there will be 1,400 fuel cell vehicles planned for production in 2014 and 53,000 between 2015-2017, if sufficient hydrogen infrastructure is available. The SCAQMD continues to support the infrastructure required to refuel these demonstration fuel cell vehicles, but is also actively engaged in finding alternatives to the costly and potential longer term fuel cell power plant technology. As mentioned previously, plug-in hybrid technology could help enable fuel cells by reducing the capacity, complexity and cost of the fuel cell vehicle system. Further bridging technologies being investigated are hybrid or plug-in hybrid hydrogen ICE vehicles and hydrogen-CNG blended ICE vehicles.

Emission Control Technologies

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

Low-emission and clean-fuel technologies that appear promising for on-road mobile sources should be effective at reducing emissions from a number of non-road sources. For example, immediate benefits are possible from particulate traps, selective catalytic reduction (SCR) and emulsified fuels that have been developed from diesel applications. Clean fuels such as natural gas, propane, hydrogen and hydrogen-natural gas mixtures may also provide an effective option to reduce emissions from some non-road applications. Reformulated gasoline, ethanol and alternative diesel fuels, such as biodiesel and gas-to-liquid (GTL), also show promise when used in conjunction with advanced emissions controls and new engine technologies. The CARB, U.S. EPA and the SCAQMD have also promulgated regulations that lower the sulfur content of diesel fuels, which provides a direct fuel related PM reduction and improves the efficiency of particulate reduction aftertreatment devices.

Engine Systems

Medium- and heavy-duty on-road vehicles contributed approximately 36 percent of the Basin's NO_x based on 2007 AQMP data. More importantly, on-road heavy-duty diesel engines contributed almost 60 percent of the on-road mobile source $PM_{2.5}$, which has known toxic effects. These figures notably

do not include the significant contribution from off-road mobile sources. In fact, CARB's off-road 2006 emission model estimates that diesel-powered off-road construction equipment alone emits 120 tons per day of NO_x and 7.5 tons per day of PM emissions in the Basin. Clearly, significant emission reductions will be required from mobile sources, especially from the heavy-duty sector, to attain the federal clean air standards.

The use of alternative fuels in heavy-duty vehicles can provide significant reductions in NO_x and particulate emissions. The current NO_x emissions standard for heavy-duty engines is 0.2 g/bhp-hr. The SCAQMD, along with various local, state and federal agencies, continues to support the development and demonstration of alternative fueled heavy-duty engine technologies, using compressed natural gas (CNG) and liquefied natural gas (LNG) for applications in transit buses, school buses and refuse collection and delivery vehicles to meet future federal emission standards.

Stationary Clean Fuel Technologies

Given the limited funding available to support low-emission stationary source technology development, this area has historically been limited in scope. To gain the maximum air quality benefits in this category, higher polluting fossil fuel-fired electric power generation needs to be replaced with clean renewable energy resources or other advanced near zero-emission technologies, such as solar, wind, geo-thermal energy, bio-mass conversion and stationary fuel cells. Although combustion sources are lumped together as stationary, the design and operating principles vary significantly and thus also the methods and technologies for control of their emissions. Included in the stationary category are boilers, heaters, gas turbines and reciprocating engines. Boilers and heaters vary in size, heat input, process conditions and operating ranges. Gas turbines vary greatly in size and application and are typically natural gas-fired with add-on controls to clean up the flue gas. Stationary ICEs can be either rich-burn or lean-burn. The core technologies for this category focus on using advanced combustion processes, development of catalytic add-on controls, alternative fuels and technologies and stationary fuel cells in novel applications.

Program Review

In 1990, the SCAQMD initiated an annual review of its technology advancement program by an external panel of experts. That external review process has evolved, in response to SCAQMD policies and legislative mandates, into two external advisory groups. The Technology Advancement Advisory Group (one of six standing Advisory Groups that make up the SCAQMD Advisory Council) is made up of stakeholders representing industry, academia, regulatory agencies, the scientific community and environmental impacts. The Technology Advancement Advisory Group, whose members are listed within Appendix A, serves to:

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

The second advisory group was formed as required by SB 98 (Alarcon). Under H&SC Section 40448.5.1(c), this advisory group must comprise 13 members with expertise in clean fuels technology and policy or public health and appointed from the scientific, academic, entrepreneurial, environmental and public health communities. This legislation further specified conflict-of-interest guidelines prohibiting members from advocating expenditures towards projects in which they have professional or economic interests. The objectives of the SB 98 Clean Fuels Advisory Group are to make recommendations regarding projects, plans and reports, including approval of the required annual report prior to submittal to the SCAQMD Governing Board. The members of the SB 98 Clean Fuels Advisory Group are also listed in Appendix A.

The review process of the Clean Fuels Program now includes several meetings of the two Advisory Groups, review by the Technology Committee of the SCAQMD Governing Board, public hearing of the Annual Report and Plan Update before the full SCAQMD Governing Board and submittal of the Annual Report to the Legislature by March 31 of every year.

PROGRAM STRATEGY AND IMPACT

Scope and Benefits of the Clean Fuels Program

To reap the maximum emissions benefits from any technology, widespread deployment and thus end-user acceptance must occur. The product manufacturers must overcome technical and market barriers to ensure a competitive and sustainable business. Unfortunately, the time needed to overcome these barriers can be long and the costs high, which tends to discourage both manufacturers and end-users from considering advanced technologies. A combination of real-world demonstrations, education, outreach and regulatory impetus and incentives is necessary to catalyze new, clean technologies. The Clean Fuels Program addresses these needs by co-funding research, development, demonstration and deployment projects to share the risk of emerging technologies with their developers and eventual users.

Figure 2 provides a conceptual design of the wide scope of the Clean Fuels Program. As mentioned in the Core Technologies section, various stages of technology projects are funded not only to provide a portfolio of emissions technology choices but to achieve emission reduction benefits in the nearer as well as over the longer term.

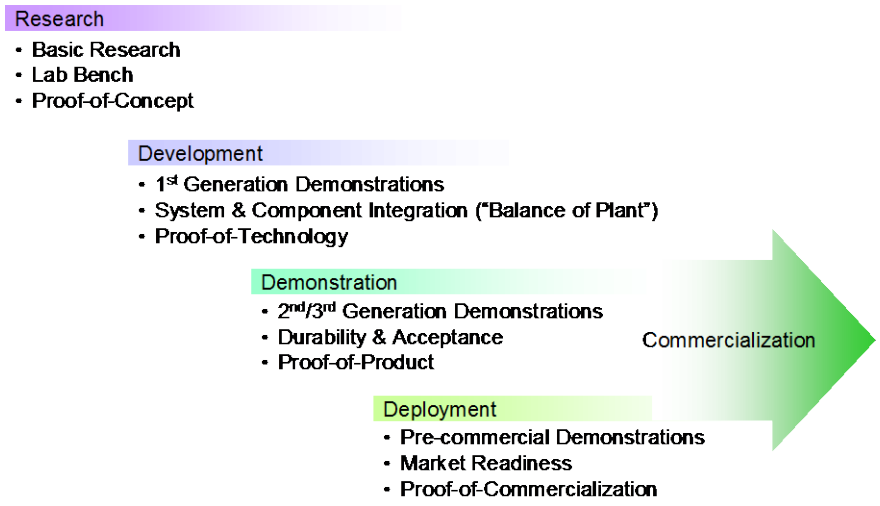


Figure 2: Stages of Clean Fuels Program Projects

Due to the nature of these advanced technology research, development, demonstration and deployment projects, the benefits are difficult to quantify since their full emission reduction potential may not be realized until sometime in the future, or perhaps not at all if displaced by superior technologies. Nevertheless, a good indication of the impact and benefits of the Clean Fuels Program overall is provided by this selective list of sponsored projects that have resulted in commercialized products or helped to advance the state-of-the-technology.

➢CNG Engine Development for Heavy-Duty Vehicles

- Emission Solutions: 7.6L (NG)
- Cummins Westport: C8.3L (CNG, LNG), B5.9L (CNG) L10 (CNG), ISL G 8.9L (CNG, LNG)
- Westport Power: ISX 15L (LNG), Westport GX 15 L (dual fuel)
- Detroit Diesel: Series 60G (CNG/LNG), Series 50G (CNG/LNG);
- John Deere: 6068 (CNG), 6081 (CNG);
- Mack: E7-400G (LNG); and

- Clean Air Partners/Power Systems (Caterpillar): 3126B (Dual Fuel), C-10 (Dual Fuel), C-12 (Dual Fuel).

➢ Fuel Cell Development and Demonstrations
- Ballard Fuel Cell Bus (first of its kind);
- ISE/ThunderPower Fuel Cell Bus;
- Sunline Transit Agency Advanced Fuel Cell Bus;
- Commercial Stationary Fuel Cell Demonstration with UTC and SoCalGas (first of its kind); and Orange County Sanitation District hydrogen and combined heat and power generation from biogas using molten carbonate fuel cell technology.

➢ Electric and Hybrid Electric Vehicle Development and Demonstrations
- EPRI hybrid vehicle evaluation study;
- Hybrid electric vehicle demonstrations with SCE, UC Davis and AC Propulsion;
- Electric vehicle demonstrations with Santa Barbara Bus Works, Toyota and GM;
- Plug-in Hybrid Electric Van with EPRI, DaimlerChrysler and SCE;
- Hybrid electric delivery trucks with Azure Dynamics, NREL and FedEx;
- Plug-in hybrid work truck with Odyne Systems, Los Angeles Department of Water and Power and Los Angeles County;
- Proterra battery electric transit bus and fast charging system; and
- Municipal battery electric utility truck.

➢ Aftertreatment Technologies for Heavy-Duty Vehicles
- Johnson Matthey and Engelhard trap demonstrations on buses and construction equipment;
- Johnson Matthey SCRT and SCCRT NOx and PM reduction control devices on heavy-duty on-road trucks; and
- Lubrizol optimization and demonstration of oxidation catalysts on CNG, heavy-duty vehicles.

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

Overcoming Barriers

Commercialization and implementation of advanced technologies come with a variety of real-world challenges and barriers. These include project-specific issues as well as general technology concerns.

Technology Implementation Barriers

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

Project-Specific Issues

- Identifying a committed demonstration site
- Overall project cost and cost-share using public monies
- Securing the fuel
- Identifying and resolving real & perceived safety issues
- Quantifying the actual emissions benefits
- Viability of the technology provider

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

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

The SCAQMD actively seeks additional partners for its program through participation in various working groups, committees and task forces. This participation has resulted in coordination of the SCAQMD program with a number of state and federal government organizations, including CARB, CEC, U.S. EPA and U.S. DOE and several of its national laboratories. Coordination also includes the AB 2766 Discretionary Fund Program administered by the Mobile Source Air Pollution Reduction Review Committee (MSRC), various local air districts, National Association of Fleet Administrators (NAFA), major local transit districts and local gas and electric utilities. The list of organizations with which the SCAQMD coordinates research and development activities also includes organizations specified in H&SC Section 40448.5.1(a)(2).

In addition, the SCAQMD holds periodic meetings with several organizations specifically to review and coordinate program and project plans. For example, the SCAQMD staff meets with CARB staff to review research and development plans, discuss project areas of mutual interest, avoid duplicative efforts and identify potential opportunities for cost-sharing. Periodic meetings are also held with industry-oriented research and development organizations, such as the Manufacturers of Emission Controls Association (MECA), the California Fuel Cell Partnership (CaFCP), the California Stationary Fuel Cell Collaborative and the California Natural Gas Vehicle Partnership (CNGVP). The coordination efforts with these various stakeholders have resulted in a number of co-sponsored projects.

Descriptions of some of the key contracts executed in CY 2011 are provided in the next section of this report. It is noteworthy that most of the projects are co-sponsored by various funding organizations and include the active involvement of manufacturers. Such partnerships are essential to address commercialization barriers and to help expedite the implementation of advanced low-emission technologies. Table 1 below lists the major funding agency partners and manufacturers actively involved in SCAQMD projects for this reporting period. It is important to note that, although not listed, there are many other technology developers, small manufacturers and project participants who make important contributions critical to the success of the SCAQMD program. These partners are identified in the more detailed 2011 Project Summaries contained within this report.

Table 1: SCAQMD Major Funding Partners in CY 2011

Research Funding Organizations	Major Manufacturers/Providers
California Air Resources Board	Ports of Los Angeles & Long Beach
California Energy Commission	Southern California Gas Company
U.S. & California Departments of Transportation	TransPower United Parcel Service
U.S. Department of Energy	University of California Riverside/ CE-CERT
U.S. Environmental Protection Agency	West Virginia University

The following two subsections broadly address the SCAQMD's impact and benefits by describing specific examples of accomplishments and commercial—or near-commercial—products supported by the Clean Fuels Program in CY 2011. Such examples are provided in the following sections on Technology Advancement's Research, Development and Demonstration projects and Technology Deployment and Commercialization efforts.

Research, Development and Demonstration

Important examples of the impact of the SCAQMD research and development coordination efforts are: (a) the further development and demonstration of fuel cell, plug-in hybrid and electric vehicle technologies and infrastructure; (b) in-use emissions testing and further demonstration of emission control technologies to reduce NO_x and PM emissions reductions on heavy-duty diesel trucks; and (c) a major health study evaluating ultrafine particles from sources and composition to variability and toxicology characteristics.

Develop & Demonstrate Plug-In Hybrid Electric Drive System on Medium- and Heavy-Duty Trucks

Medium- and heavy-duty fleet vehicles represent a large emissions category within the South Coast Air Basin. The SCAQMD has partnered with Odyne Systems, LLC, Los Angeles Department of Water and Power and Los Angeles County to develop and demonstrate two medium- and heavy-duty Plug-in Hybrid Electric Vehicles (PHEVs). These vehicles will be deployed in normal fleet service to evaluate their utility, emissions reduction and fossil fuel consumption reduction potential.

Odyne is a clean technology company that develops and manufactures propulsion systems for medium- and heavy-duty PHEVs. Odyne has developed proprietary and patented hybrid technology combining electric power conversion, power control and energy storage technology with standard electric motors, storage batteries, and other components.

Figure 3: Odyne PHEV

Odyne's plug-in hybrid technology has been applied to commercial truck applications including bucket trucks, digger derricks and compressor trucks. The incorporation of plug-in hybrid technology will add functionality that includes idle reduction, launch assist, regenerative braking, in-cab climate controls, and exportable power. These features will improve vehicle efficiency while driving and completely electrify their operation while working at a jobsite. Electrification of the vehicle's jobsite operation will eliminate emissions at the point of use, reduce emissions on a full-cycle basis, and provide the co-benefit of reducing fossil fuel consumption.

Develop & Demonstrate Zero-Emission Medium-Duty Trucks in UPS Delivery Fleet

In June 2011, the Board approved a project with Electric Vehicle International, Inc. (EVI) to cosponsor the demonstration and replacement of up to 28 older United Parcel Service (UPS) diesel delivery trucks with zero-emission medium-duty trucks for a total amount not to exceed $1.4 million from the Clean Fuels Fund. The total cost of the project is $4.9 million and the cost sharing project partners are CARB, EVI and UPS.

UPS is a world leader in goods movement and delivery and operates over 100,000 vehicles worldwide. It has one of the world's largest natural gas vehicle fleets and a growing fleet of hybrid electric vehicles. UPS has an immediate interest in expanding the electrification of this fleet, with a five-year 40-vehicle demonstration in South Coast Air Basin as the kickoff. EVI has developed a zero-emission, medium heavy-duty return-to-base delivery truck ideal for package delivery service providers such as UPS. The new, clean vehicle uses an Original Equipment Manufacturer (OEM) chassis with EVI signature power train to create a zero-emission, aerodynamic model of the walk-in vehicles UPS drivers are accustomed to.

The zero-emission vehicles will be Class 6 trucks with a maximum gross vehicle weight rating (GVWR) of 20,000 pounds. The vehicles include up to 1,000 square feet of package space and will be 18 feet long and 88 inches wide. The power system includes a 99 kWh lithium iron magnesium phosphate battery pack, which has a guaranteed battery life of 1,500 cycles, equivalent to five years of service in the UPS fleet. EVI is currently manufacturing the vehicles and plans to deliver them to UPS at its San Bernardino facility in August 2012.

Figure 4: EVI/UPS ZEV Delivery Truck

The older diesel-powered UPS delivery trucks that are being replaced with the electric trucks will be decommissioned, dismantled and scrapped according to EPA guidelines. All of the vehicles will be based out of UPS's facility in the City of San Bernardino. UPS will demonstrate the vehicles for a five-year period in their regular operations, during which UPS and EVI will collect data daily on vehicle usage and mileage, electricity provider information, and emissions benefits.

In-Use Emissions Testing & Demonstration of Heavy-Duty Vehicle Retrofit Technologies

On-road heavy-duty engines are now subject to the 2010 U.S. EPA emissions standards of 0.01 gram per brake-horsepower-hr (g/bhp-hr) PM and 0.20 g/bhp-hr NO_x. Some engine manufacturers are using emissions credits which allow them to produce a mixture of engines certified at, below, or above 0.20 g/bhp-hr NO_x. This mixture of engines allows engine manufacturers to comply with the emissions standards on an average basis. These engines are either stoichiometric engines with three-way catalysts or lean-burn engines equipped with exhaust gas recirculation (EGR), selective catalytic reduction (SCR) and/or diesel particulate filter (DPF) technology.

While limited-scale studies have shown reduced NO_x and PM emissions from trucks powered by compliant engines, other studies indicate a potential increase in some exhaust emissions. In particular, in a heavy-duty in-use emissions measurement study conducted by the University of Colorado, ammonia emissions from liquefied natural gas trucks were found to be significantly higher due to the nature of spark-ignited engines. Studies conducted by The Netherland Organization (TNO) indicated that heavy-duty diesel engines equipped with SCR technologies have higher NO_x exhaust emissions than their certified levels. As such, additional studies are required to assess the impact of the technologies on emissions from engines used in a variety of applications, particularly since the number of these engines will continue to increase in the future.

In December 2010, the SCAQMD Board awarded contracts to the University of California Riverside (UCR) and West Virginia University (WVU) to conduct in-use emissions testing, and if needed, to evaluate emission-reduction potential of retrofit technology on existing and new on-road heavy-duty engines. Both WVU and UCR will perform chassis dynamometer tests of in-use emissions of total hydrocarbons, nitrogen dioxide, nitric oxide, NO_x, CO, PM, ammonia, formaldehyde, and toxic air

Figure 5: WVU Transportable Chassis Dynamometer

Figure 6: UCR/CE-CERT Chassis Dynamometer

contaminants from the test vehicles. In addition, if the dynamometer tests results show emissions higher than state or federal allowable limits, WVU will design an oxidation catalyst or identify an alternative retrofit technology capable of reducing ammonia and formaldehyde emissions from natural gas vehicles. The designed or identified retrofit technology will be installed on up to three of the natural gas vehicles, which have three-way catalysts and tested on the chassis dynamometer to assess the performance and emission-reduction potential of the technology.

Ultrafine Particle Health Study

The objective of this project is to provide information on ultrafine particle sources, spatial and seasonal characteristics, and toxicity in Southern California. Current regulatory efforts are focused on reduction of ambient levels of particulate mass for PM_{10} and $PM_{2.5}$. However, recent studies have demonstrated that ultrafine particles (UFP), generally defined as smaller than approximately 0.1-0.2 nanometers in diameter, may be more toxic on a per mass basis. Also, recent studies have indicated that while vehicle emissions controls have substantially reduced the mass of particle emissions from motor vehicles, the ambient levels expressed as the number of ultrafine particles per unit of air volume has increased near roadway sources.

This project will make use of samples that have already been collected by the University of Southern California over an approximate 15-month cycle at 10 locations in the Los Angeles Basin reflecting different source and receptor locations, including near freeways. The samples were collected in conjunction with a U.S. EPA funded project characterizing the chemical composition and toxicity of course particulate matter ($PM_{2.5} - PM_{10}$).

The results of this project will provide information to help understand the linkage between sources, chemical composition, and the toxicity of ultrafine particulates, which will provide a strong scientific basis on which to develop cost-effective strategies to protect the public from sources of toxic ultrafine particulate matter. The data will help determine if there is scientific foundation for reducing emissions of ultrafine particulate matter from a subset of sources, including motor vehicles.

Technology Deployment and Commercialization

One function of the Clean Fuels Program is to help expedite the deployment and commercialization of low- and zero-emission technologies and fuels needed to meet the requirements of the AQMP control measures. In many cases, new technologies, although considered "commercially available," require assistance to fully demonstrate the technical viability to end-users and decision-makers.

The following projects contracted during the CY 2011 reporting period illustrate the impact of the SCAQMD's technology deployment and commercialization efforts.

Deploy Natural Gas-Powered Vehicles for Taxicab Services

The SCAQMD is accelerating the demonstration and deployment of natural gas vehicle technology by providing funding assistance to taxicab operators for the purchase of up to 119 natural gas-powered Ford Transit Connect taxicabs. A total of $357,000 was approved by the Board to provide a $3,000 per vehicle subsidy, which in combination with an existing $3,000 subsidy from the California Energy Commission (CEC), results in an overall purchase incentive of $6,000 per vehicle. The CEC funds are provided under the Alternative and Renewable Fuel and Vehicle Technology Program, which was established by AB 118.

Deployment of natural gas vehicle technology is of particular interest since taxicab fleets generate high annual mileage, estimated to be approximately 75,000 miles per year on a per vehicle basis. As such, these fleets provide a favorable platform for maximizing both criteria and greenhouse gas emission benefits from natural gas vehicle technology.

Figure 7: CNG Taxicab

The SCAQMD has historically provided funding to assist in the buy-down of clean fuel taxicabs. In 2005 and 2006, the Board allocated $1.55 million and $1.19 million, respectively, to incentivize the purchase of 115 natural gas powered taxicabs. Such funding was made available through the Rule 2202 Air Quality Investment Program (AQIP) which allows subject employers to participate by electing to invest in an SCAQMD-administered restricted fund.

In 2010, the Board allocated $750,000 to cosponsor a buy-down program under the U.S. DOE's Petroleum Reduction program resulting in the purchase of natural gas-powered airport ground transportation vehicles including taxicabs and airport shuttle vans. Funding applications are expected to be received shortly for the current incentive program.

Figure 8: Kiosk Design

Establish Customer Service Centers for Truck Owners & Operators

The SCAQMD Chairman's Helping Hand Initiative required the establishment of two truck outreach centers for heavy-duty truck owners and operators. The centers will be strategically located in areas of heavy truck traffic. The SCAQMD has contracted with Gladstein, Neandross & Associates, LLC (GNA) to perform the work under this project.

Each center will be equipped with an interactive touch-screen kiosk, which will provide information in four categories: technology, educational opportunities, funding, and regulatory information. The kiosks will act as information conduits

to initiate truck drivers on the path towards obtaining helpful information. They will introduce drivers to the resources at their disposal and will provide contacts, phone numbers, websites, and brochures, all designed to take the driver's knowledge of a particular subject to the next level. Truck drivers can then call a toll-free hotline that will be staffed by GNA. Questions will be answered by a knowledgeable bilingual staff member in a one-on-one format. The project also includes development and maintenance of a website for access any day or time.

Through a separate contract funded by the Department of Energy, Advanced Transportation Technology & Energy Network of the California Community Colleges is developing materials to be displayed on the kiosks and uploaded onto the website by GNA. This may include video clips that can be viewed on the kiosks. All of these elements will combine to form a comprehensive package of information to educate drayage truck owners and operators on applicable regulations, approved emission control technologies, and available incentive funding opportunities.

Develop & Implement Clean Vehicle Outreach Project

The SCAQMD has long supported the development and demonstration of clean, advanced technology vehicles due to the clean air benefit. Multiple automakers are increasing production of cleaner cars for California, and the SCAQMD has several initiatives to support deployment of these vehicles in our region.

The intent of this outreach campaign is to implement outreach goals of the SCAQMD Board to provide the general public, local governments and employers with accurate and timely information that communicates the true value, both in costs and benefits, associated with the purchase and fueling of clean and efficient vehicles. This is a proactive information campaign that highlights programs and services provided by SCAQMD and other stakeholders that will assist in increasing consumer confidence in new vehicle technology.

The SCAQMD has contracted with Three Squares Inc. (TSI) to retool existing SCAQMD programs to include and expand the current efforts to focus some or all of the messaging aspects, where appropriate, in the near-term on clean and high-efficiency vehicles. These efforts will be included under a newly badged Clean Air Choices (CAC) program, which will provide an umbrella platform to promote all of the SCAQMD clean air technology activities in the future, such as low-VOC paints and solvents, electric lawn and garden equipment, as well as clean vehicles.

Figure 9: New Clean Air Choices Logo

The SCAQMD is preparing to relaunch the Clean Air Choices program, which will begin with an initial focus on the benefits of clean fueled vehicles, including PEVs. This initial vehicle outreach program is envisioned to include multiple elements to direct online traffic to CleanAir Choices.org, and link to other synergistic programs. There will be a mobile web site that will serve as the information portal for the program and will include clean vehicle models, local dealerships, and a fuel and cost savings calculator. Also a Local Events Calendar that lists when and where PEVs will be available for test-drives at public venues in the South Coast region (tradeshows, malls, and environmental events). Dealerships and vehicle manufacturers will have the option to submit events to the calendar listing. Widgets to find charging stations will also be on the webpage. The website will be designed to be smart-phone accessible to take advantage of mobile and tablet connectivity. The project tasks will be completed within 12 months, with benefits ongoing.

2011 FINANCIAL SUMMARY

The SCAQMD Clean Fuels Program supports clean fuels and technologies that appear to offer the most promise in reducing emissions, promoting energy diversity and in the long term, providing cost-effective alternatives to current technologies. In order to address the wide variety of pollution sources in the Basin and the need for reductions now and in the future, the SCAQMD seeks to fund a wide variety of projects to establish a diversified technology portfolio to proliferate choices with the potential for different commercial maturity timing. Given the evolving nature of technology and changing market conditions, such a representation is only a "snapshot-in-time," as reflected by the projects approved by the Governing Board.

As projects are approved by the Governing Board and executed into contracts throughout the year, the finances may change to reflect updated information provided during the contract negotiation process. As such, the following represents the status of the Clean Fuels Fund as of December 31, 2011.

Funding Commitments by Core Technologies

The SCAQMD continued its successful leveraging of public funds with outside investment to support the development of advanced clean air technologies. During the period January 1 through December 31, 2011, a total of 75 contracts, projects or studies that support clean fuels were executed or amended, as shown in Table 2 (page 22).

The major technology areas summarized are: hybrid/electric technologies, infrastructure and deployment, fuels/emission studies, emission control technologies, hydrogen technology and infrastructure, mobile fuel cell technologies, engine systems, stationary clean fuel technologies, health impacts studies, outreach and technology transfer. The distribution of funds based on technology area is shown graphically in Figure 10 (page 20). This wide array of technology support represents the SCAQMD's commitment to researching, developing, demonstrating and deploying potential near-term and longer-term technology solutions.

The project commitments that were contracted or purchased for the 2011 reporting period are shown below with the total projected project costs:

- SCAQMD Clean Fuels Fund Contribution $8,859,841
- Total Cost of Clean Fuels Projects $27,434,969

Each year, the SCAQMD Governing Board approves funds to be transferred to the General Fund Budget for Clean Fuels administration. For 2011, the Board transferred $600,000 for workshops, conferences, co-sponsorships and outreach activities as well as postage, supplies and costs for special conferences. Only the funds committed by December 31, 2011, are included within this report. Any portion of the Clean Fuels Funds not spent by the end of Fiscal Year 2011-12 ending June 30, 2012, will be returned to the Clean Fuels Fund.

Partially included within the SCAQMD contribution are supplemental sponsorship revenues from various organizations that support these technology advancement projects. This supplemental revenue totaling $2,563,350 is listed within Table 3 (page 25). Appendix B lists all Clean Fuels Fund contracts, totaling 125, that were open and active as of January 1, 2012.

For Clean Fuels executed and amended contracts, projects and studies in 2011, the average SCAQMD contribution is approximately 32 percent of the total cost of the projects, identifying that each dollar from the SCAQMD was leveraged with more than three dollars of outside investment.

During 2011, the SCAQMD executed contracts, projects, studies or contract amendments with additional funding of approximately $8.9 million for Clean Fuels projects. The distribution of funds is shown in Figure 10 below.

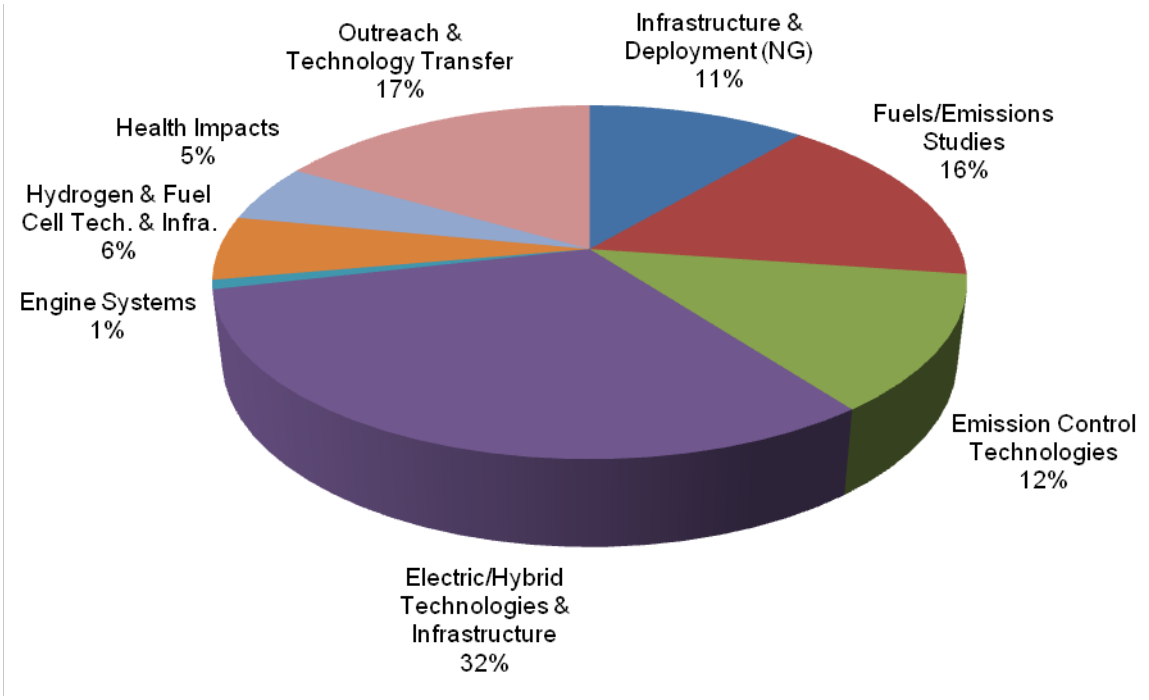


Figure 10: Distribution of Funds for Executed Clean Fuels Projects CY 2011 ($8.9 million)

As noted in the last annual report, the SCAQMD applied and was awarded more than $95 million in 2009 and 2010 through the American Recovery and Reinvestment Act as well as other federally and state-funded programs to implement projects that align well with the Clean Fuels Program. The SCAQMD continued to seek funding opportunities and in 2011 was awarded an additional $6,743,676 for similar complementary projects. Table 4 (page 26) provides a breakdown of these $6.7 million awards. Table 5 (page 26) provides an update and project status of the $95 million in awards from 2009 and 2010.

Review of Audit Findings

State law requires an annual financial audit after the closing of each SCAQMD's fiscal year. The financial audit is performed by an independent Certified Public Accountant selected through a competitive bid process. For the fiscal year ended June 30, 2011, the firm of Thompson, Cobb, Bazilio & Associates, P.C. conducted the financial audit. As a result of this financial audit, a Comprehensive Annual Financial Report (CAFR) was issued. There were no adverse internal control weaknesses with regard to SCAQMD financial statements, which include the Clean Fuels Program revenue and expenditures. Thompson, Cobb, Bazilio & Associates, P.C. gave the SCAQMD an "unqualified opinion," the highest obtainable. Notably, the SCAQMD has achieved this rating on all prior annual financial audits.

Project Funding Detail

The 75 new and continuing contracts, projects and studies that received SCAQMD funding in 2011 are summarized in Table 2 together with the funding authorized by the SCAQMD and by the collaborating project partners.

Table 2: Contracts Executed or Amended (w/$) between January 1 & December 31, 2011

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Infrastructure and Deployment						
09218	Rim of the World Unified School District	Install Mountain Safety Equipment on Seven New CNG School Buses	01/05/10	12/31/16	65,850	65,850
10067	Rim of the World Unified School District	Install Mountain Safety Equipment on Five New CNG School Buses	12/21/09	12/31/16	92,190	92,190
11559	Ace Parking Management	Purchase Six Natural Gas-Powered Cutaway-Type Shuttle Vans	05/06/11	07/31/13	96,200	600,950
11561	Supershuttle International	Purchase and Convert 20 Gasoline-Powered Passenger Vans to CNG-Powered Passenger Shuttle Vans	06/01/11	07/31/13	320,600	954,600
12135	Placentia-Yorba Linda Unified School District	Upgrade CNG Fueling Station	11/18/11	11/30/17	60,000	60,000
Direct Pay	South Bay Ford	Purchase Up to 119 Natural Gas-Powered Vehicles for Taxicab Services	07/08/11	07/08/11	357,000	714,000
Fuels/Emissions Studies						
11611	West Virginia University Research Corporation	In-Use Emissions Testing and Demonstrate Retrofit Technology of On-Road Heavy-Duty Engines	07/08/11	10/07/12	734,742	894,647
11612	University of California Riverside	In-Use Emissions Testing and Demonstrate Retrofit Technology of On-Road Heavy-Duty Engines	07/08/11	10/07/12	689,742	708,524
Emission Control Technologies						
08246	Griffith Company	Showcase: Demonstrate NO_x and PM Emissions Control Technology on Diesel Powered Construction Equipment	08/25/11	12/31/12	450	450
08261	Community Recycling & Resource Recovery, Inc.	Showcase: Demonstrate NO_x and PM Emissions Control Technology on Diesel Powered Construction Equipment	12/12/08	03/24/11	(450)	(450)
11655	California State University Long Beach Foundation	CSULB CEERS Student Education Study to Assess the Effects of an Exhaust Scrubber on Diesel Emissions	06/14/11	12/31/11	28,000	28,000
12113	Southern Counties Terminals dba Griley Air Freight	Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/13/11	03/31/14	15,000	45,000
12114	South Bound Express, Inc.	Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/13/11	03/31/14	15,000	54,623
12118	National Ready Mixed Concrete	Retrofit 13 Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/13/11	03/31/14	65,000	239,806
12120	Standard Concrete Products	Retrofit 40 Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/13/11	03/31/14	200,000	596,665
12121	Challenge Diary Products, Inc.	Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters	11/18/11	03/31/14	15,000	46,845

Table 2: Contracts Executed or Amended (w/$) between January 1 & December 31, 2011

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Emission Control Technologies (cont'd)						
12122	Bear Trucking, Inc.	Retrofit One Heavy-Duty Diesel Truck with Diesel Particulate Filter	10/14/11	03/31/14	5,000	13,555
12123	RRM Properties	Retrofit 107 Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/06/11	03/31/14	535,000	1,481,067
12124	Gaio Trucking, Inc.	Retrofit Nine Heavy-Duty Diesel Trucks with Diesel Particulate Filters	09/28/11	03/31/14	45,000	165,669
12125	Spragues Ready Mix	Retrofit Four Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/14/11	03/31/14	20,000	62,953
12175	RRM Properties	Retrofit Seven Heavy-Duty Diesel Trucks with Diesel Particulate Filters	12/08/11	03/31/14	35,000	84,812
12186	Pipeline Carriers Inc.	Retrofit 25 Heavy-Duty Diesel Trucks with Diesel Particulate Filters	12/16/11	03/31/14	125,000	455,750
Electric/Hybrid Technologies						
99109	Toyota	Lease Two Toyota RAV4 Electric Vehicles for CY 2011	04/04/99	02/01/11	7,902	7,902
05260	Energy Control Systems Engineering, Inc.	Conversion of Light-Duty Vehicle to Plug-In Hybrid Vehicles	09/09/05	03/31/12	(45,000)	(45,000)
09360	BMW of North America LLC	Lease of Five Mini Cooper Electric Vehicles for CY 2011	05/14/08	12/31/12	10,953	10,953
11606	Odyne Systems, LLC	Develop and Demonstrate Plug-In Hybrid Electric Drive System for Medium- and Heavy-Duty Vehicles	07/08/11	07/07/13	494,000	2,599,000
11725	Puente Hills Nissan	Lease of Three Nissan Leaf Vehicles for 39 Months	05/27/11	08/26/14	60,222	82,722
12024	ECOtality North America	Install Electric Charging Infrastructure	11/04/11	05/03/13	70,000	70,000
12028	Electric Vehicle International, Inc.	Demonstrate and Replace UPS Diesel Delivery Trucks with Zero-Emission Medium-Duty Trucks	09/09/11	09/08/17	1,400,000	4,872,000
Direct Pay	Clean Fuel Connection	Install Three Electric Vehicle Chargers by Coulomb Technologies at SCAQMD Headquarters	08/23/11	08/23/11	9,007	9,007
Transfer	Transfer from Clean Fuels (for Volvo Project)	Develop Class 8 Plug-In Hybrid Heavy-Duty Vehicle	12/02/11	12/02/11	600,000	2,400,000
Transfer	Transfer from Clean Fuels (for TransPower Contract #11614)	Demonstrate Battery Electric Heavy-Duty Trucks	03/04/11	03/04/11	196,505	2,616,275
Engine Systems						
11485	Waste Management Collection & Recycling, Inc.	Demonstrate Refuse Truck Retrofitted with Cummins ISL-G Natural Gas Engine	03/18/11	01/31/12	75,000	300,876

Table 2: Contracts Executed or Amended (w/$) between January 1 & December 31, 2011

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Mobile Fuel Cell Technologies						
10714	University of California Irvine	Develop Fuel Cell Gas Turbine Hybrid System for On-Board Locomotive Applications	12/02/11	12/01/13	78,000	156,000
11656	Bevilacqua-Knight, Inc.	Participate in California Fuel Cell Partnership for Calendar Year 2011 and Provide Support for Regional Coordinator	01/01/11	12/31/11	137,800	1,632,600
Hydrogen Infrastructure						
10061	Hydrogenics Corporation	Maintenance & Data Management for the SCAQMD's Hydrogen Fueling Station	10/30/09	06/30/12	50,000	50,000
10482	California State University Los Angeles	Install and Demonstrate PEM Electrolyzer, Providing Hydrogen Fueling for Vehicles and Utilizing the Technology in the Engineering Technology Curriculum at the University	03/04/11	10/03/17	250,000	1,662,000
Health Impact Studies						
11527	University of Southern California	Conduct Study on Sources, Composition, Variability and Toxicological Characteristics of Ultrafine Particles in Southern California	07/24/11	07/24/14	470,969	470,969
Outreach and Technology Transfer						
10062	TIAX LLC	Technical Assistance for Implementation of Proposition 1B Goods Movement Program and Truck Replacement Program	11/13/09	12/31/12	200,000	575,000
10662	Gladstein, Neandross & Associates	Technical Assistance for Implementation of Proposition 1B Goods Movement and Truck Replacement Program	05/12/10	12/31/13	175,000	175,000
10663	Clean Fuel Connection	Technical Assistance for Implementation of Proposition 1B Goods Movement Program	05/12/10	12/31/12	250,000	350,000
11028	Marty Kay	Technical Assistance on Stationary Source Control Measures and Future Consultation on TAO Activities	08/04/10	12/31/12	15,000	15,000
11144	San Diego Community College District on behalf of Advanced Transportation Technology and Energy	Natural Gas-Powered Vehicle Training and Safety and Fuel Cylinder Inspection Program	12/10/10	05/31/13	130,000	130,000
11484	Gladstein, Neandross & Associates, LLC	Develop and Implement Two Customer Centers to Provide Education and Outreach to Truck Owners and Operators	01/27/11	05/31/12	150,000	150,000

Table 2: Contracts Executed or Amended (w/$) between January 1 & December 31, 2011

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Outreach and Technology Transfer (con'd)						
12104	Three Squares, Inc.	Development, Initiation & Implementation of a Clean Vehicle Outreach Project	09/23/11	09/22/12	100,000	100,000
Transfer	Transfer from Clean Fuels	Conduct Clean Vehicle Outreach and Expand Clean Air Choices Program	07/08/11	07/08/11	50,000	50,000
Transfer	Transfer from Clean Fuels	Participation in California Natural Gas Vehicle Partnership for Fiscal Years 2010-11 and 2011-12	3/4/11	3/4/11	25,000	210,000
Direct Pay	Various	Cosponsor 21 Conferences, Workshops & Events plus 9 Memberships & Subscriptions	Various	Various	380,159	1,419,159

Table 3: Supplemental Revenue Grants Received into Clean Fuels Fund between Jan. 1 & Dec. 31, 2011

Revenue Agreement	Revenue Source	Project Title	Contractor	SCAQMD Project	Total
10739	U.S. Dept. of Energy/National Energy Tech Lab	Purchase of CNG Taxicabs and Shuttle Vans	Supershuttle International and Ace Parking Management	#11561 & #11559	$ 110,350
11617	Southern California Gas Company	Natural Gas-Powered Vehicle Training and Safety and Fuel Cylinder Inspection Program	San Diego Community College District on behalf of Advanced Transportation Technology and Energy	#11144	53,000
10707	U.S. Environmental Protection Agency	Demonstrate and Replace UPS Diesel Delivery Trucks with Zero-Emission Medium-Duty Trucks	Electric Vehicle International Inc.	#12028	1,400,000
09320	U.S. Environmental Protection Agency	Retrofit Heavy-Duty Diesel Trucks with Diesel Particulate Filters	Ten Different Contractors	Ten Contractors	1,000,000
					$2,563,350

Table 4: Summary of Federal & State Funding Awarded between Jan. 1 & Dec. 31, 2011

Awarding Entity or Program	Award Date	Purpose	Contractors	Total
California Department of Transportation 07-6373R	06/15/11	Replace Existing Heavy-Duty Diesel Trucks with New Heavy-Duty Natural Gas Trucks **(Revenue Agreement #11458 – Executed 07/12/11)**	TBD	$ 1,799,612
California Air Resources Board(AB 118 AQIP Program) G10-AQIP-09	04/05/11	Purchase Cordless Electric Lawnmowers **(Revenue Agreement #11595 – Executed 04/05/11)**	Various	494,314
U.S. EPA (Clean Air Technology Initiative Program) A 00909411	12/15/10	Demonstrate Battery Electric Heavy-Duty Trucks & Install Air Filtration Systems at Schools or Community Centers **(Revenue Agreement #11530 – Executed 01/11/11)**	TransPower Contract #11614 and IQAir North America	400,000
U.S. EPA EM-83493501	07/14/11	Implement Garden Equipment and Boiler Efficiency Incentive Programs to Demonstrate Reductions in Ozone and PM2.5 Air Pollution in LA-San Bernardino Nonattainment Areas **(Revenue Agreement #11598 – Executed 3/25/11)**	Various	1,270,000
California Energy Commission ARV-10-045	05/20/11	Administer the SoCalEV Infrastructure Project (Install or Upgrade Up to 315 Electric Vehicle Charging Stations throughout Southern California) **(Revenue Agreement #12295 - Pending Execution)**	Various	840,750
California Air Resources Board (AB 118 AQIP) G10-AQIP-10	08/10/11	Demonstrate Combined DPF and SCR Technologies on Marine Vessels **(Revenue Agreement #12022 – Executed 08/10/11)**	HUG	439,000
U.S. Department of Energy (Clean Cities Program) DE-EE0005588	09/26/11	Plug-In Electric Vehicle Infrastructure Planning **(Revenue Agreement #12167 – Executed 11/12/11)**	6 Contractors Pending	1,000,000
Southern California Gas Company 5660020940 (augmenting U.S.DOE funding to NREL)	06/24/11	Develop, Integrate & Demonstrate Heavy-Duty Natural Gas Engines and Vehicles **(Revenue Agreement #11722 – Executed 06/24/11)**	National Renewable Energy Laboratory	500,000
				$6,743,676

Table 5: Update of Federal & State Funding Awarded between Jan. 1, 2009 & Dec. 31, 2010

Awarding Entity or Program	Award Date	Purpose	Contractors	Total
U.S. EPA/DERA DE 96085601	02/03/09	Retrofit 200 Heavy-Duty Trucks with Diesel Particulate Filters **(Revenue Agreement #09320 – Executed 02/18/09)**	Various	$ 1,000,000
CARB (from U.S. EPA/DERA Program) G08-DERA-02	05/22/09	Placement of up to 43 aftertreatment devices (retrofit traps) on public school buses operating on diesel fuel **(Revenue Agreement #G-08-DERA-02 – Executed 05/22/09) – Project Completed**	3 School Districts	898,000

Table 5: Update of Federal & State Funding Awarded between Jan. 1, 2009 & Dec. 31, 2010

Awarding Entity or Program	Award Date	Purpose	Contractors	Total
U.S. EPA/DERA Program EM-00T16601	07/10/09	Implement Heavy-Duty Diesel Drayage Truck Replacement Program **(Revenue Agreement #10119 – Executed 10/28/09)**	Various	7,500,000
U.S. EPA/DERA Program (Emerging Technologies) 2A 83442501 2A 83442101	10/02/09	Implement program to optimize and demonstrate selective catalytic regenerating and selective catalytic continuously regenerating technologies on on-road heavy-duty diesel trucks **(Revenue Agreements #10064 & #10063 - Executed 10/20/09)**	Johnson Matthey Contracts #10696 and #10697	4,000,000
Dept. of Energy/ Transportation Electrification Program DE-EE0002549	12/14/09	Develop U.S. manufactured next-generation batteries and electric vehicles and to fully integrate plug-in hybrid electric vehicle systems for 378 medium-duty utility and delivery trucks and shuttle buses **(Revenue Agreement #10193 - Executed 03/25/10) – project in progress**	Electric Power Research Institute Contract #10659	45,443,332
Dept. of Energy/ Clean Cities Program DE-EE0002562	12/18/09	Expansion of an LNG corridor from Ontario to Las Vegas, which would include both vehicles and infrastructure and be implemented in conjunction with the United Parcel Service (UPS) **(Revenue Agreement #10467 - Executed 03/04/10) – project in progress**	4 Contractors	5,591,611
Dept. of Energy/ Clean Cities Program DE-EE0002547	12/18/09	Implement a natural gas drayage truck replacement program **(Revenue Agreement #10480 - Executed 1/26/10) – projects in progress**	Various	9,408,389
Dept. of Energy/ Clean Cities Program DE-EE0002545	03/12/10	Ontario LNG Station Upgrade **(Revenue Agreement #10685 - Executed 05/07/10) – project in progress**	TBD	150,000
U.S. EPA EM 00T34701	04/21/10	Truck Replacement (diesel to diesel and diesel to zero emission), install shorepower to two ships, demonstrate a combined diesel particulate filter and selective catalytic reduction system on two tugboat engines. **(Revenue Agreement #10707 – Executed 05/06/10) – pass-through contracts in process**	4-5 Contractors	5,000,000
U.S. EPA DE 83420301	04/28/09	Develop & Demonstrate SCRT® for NO_x and PM Emissions Control **(Revenue Agreement #09405 - Executed 06/02/09)**	Johnson Matthey, Inc. Contract #10069	900,000
U.S. EPA DE-83468501	06/23/10	Demonstrate Emerging Technologies Advanced Maritime Emissions Controls **(Revenue Agreement #11030 – Executed 07/23/10) – Pass-through contracts in process**	Advanced Cleanup Technologies Inc.	1,500,000
Dept. of Energy/ Clean Cities Petroleum Reduction Technologies Program DE-EE0000150	06/24/10	Implement buydown program for natural gas-powered taxicabs and shuttles **(Revenue Agreement #10739 - Executed 11/12/10) – projects in progress**	3-4 Contractors	500,000
U.S. EPA DE 00T37701	06/30/10	National Clean Diesel Program – School Bus Replacement **(Revenue Agreement #11029 - Executed 07/16/10) – Deliverables Completed**	Various	1,065,465

Table 5: Update of Federal & State Funding Awarded between Jan. 1, 2009 & Dec. 31, 2010

Awarding Entity or Program	Award Date	Purpose	Contractors	Total
California Energy Commission ARV-09-003	09/02/10	Develop U.S. manufactured next-generation batteries and electric vehicles and to fully integrate plug-in hybrid electric vehicle systems for 378 medium-duty utility and delivery trucks and shuttle buses **(Revenue Agreement #11043 - Executed 09/02/10) – project in progress**	Electric Power Research Institute Contract #106591	5,000,000
California Energy Commission/AB118	09/10/10	Alternative and Renewable Fuel and Vehicle Technology Program – Construct & Install 10 NG Fueling Stations **(Revenue Agreement #12152 – Executed 11/08/11) – Pass-through contracts in process**	Various	2,600,000
California Energy Commission/AB118	09/10/10	Alternative and Renewable Fuel and Vehicle Technology Program – Construct & Install One NG Fueling Station **(Revenue Agreement #12286 – Pending Execution)**	Earth Energy Fuels	300,000
California Energy Commission ARV-09-002	10/07/10	Implement LNG Drayage Truck Replacement Program **(Revenue Agreement #11040 - Executed 10/07/10) – project in progress**	Various	5,142,000
				$95,998,797

Project Summaries by Core Technologies

The following represents summaries of the contracts, projects and studies executed or amended with additional dollars in 2011. They are listed in the order found in Table 2 by category and contract number. The summaries provide the project title, contractors and subcontractors, SCAQMD cost-share, co-sponsors and their respective contributions, contract term and a description of the projects as required by H&SC Section 40448.5.1(d).

Infrastructure and Deployment

09218: Install Mountain Safety Equipment on Seven New CNG School Buses

Contractor: Rim of the World Unified School District	SCAQMD Cost-Share	$ 65,850
Term: 01/05/10 – 12/31/16	Total Cost:	$ 65,850

In 2011, this Lower-Emission School Bus Retrofit Program grant with Rim of the World Unified School District was amended to add additional funding of $13,170 per bus for mountain safety equipment. Rim school buses travel on many routes that have steep grades and are covered in snow during the winter season. To protect the safety of the kids who travel in these buses, the SCAQMD awarded this safety package along with the new CNG buses to help improve traction, braking and visibility during driving. This modification awarded mountain safety equipment for seven new CNG buses, which replaced seven pre-1987 diesel school buses.

10067: Install Mountain Safety Equipment on Five New CNG School Buses

Contractor: Rim of the World Unified School District	SCAQMD Cost-Share	$ 92,190
Term: 12/21//09 – 12/31/16	Total Cost:	$ 92,190

In 2011, this Lower-Emission School Bus Retrofit Program grant with Rim of the World Unified School District was amended to add additional funding of $13,170 per bus for mountain safety equipment. Rim school buses travel on many routes that have steep grades and are covered in snow during the winter season. To protect the safety of the kids who travel in these buses, the SCAQMD awarded this safety package along with the new CNG buses to help improve traction, braking and visibility during driving. This modification awarded mountain safety equipment for five new CNG buses, which replaced five pre-1977 diesel school buses.

11559: Purchase Six Natural Gas-Powered Cutaway-Type Shuttle Vans

Contractor: Ace Parking Management	SCAQMD Cost-Share	$ 96,200
	Cosponsor:	
	Ace Parking Management	504,750
Term: 05/06/11 – 07/31/13	Total Cost:	$ 600,950

In February 2011 the Board approved funding of $96,200, which comprised $70,700 from Clean Fuels plus pass-through revenue of $25,500 awarded by the U.S. Department of Energy Clean Cities under the Petroleum Reduction Technologies This project involves the purchase and conversion of six new gasoline-powered Ford E450 medium-duty cutaway buses to CNG-powered cutaway buses, including fuel system retrofit and fuel tank replacement. The program

has a three-year life and requires quarterly reporting of fuel use and mileage. These vehicles are used to provide airport ground transportation services to commercial airports in the South Coast Air Basin and will accrue high mileage during the project life. The project is expected to provide additional demonstration of CNG-powered high mileage vehicles, and a reduction in emissions from petroleum based fuels.

11561: Purchase and Convert 20 Gasoline-Powered Passenger Vans to CNG-Powered Passenger CNG Shuttle Vans

Contractor: SuperShuttle International	SCAQMD Cost-Share	$ 320,600
	Cosponsor:	
	SuperShuttle International	634,000
Term: 06/01/11 – 07/31/13	Total Cost:	$ 954,600

In February 2011 the Board approved funding of $320,600, which comprised $25,000 from Clean Fuels plus pass-through revenue of $84,580 awarded by the U.S. Department of Energy Clean Cities under the Petroleum Reduction Technologies Projects for the Transportation Sector. This project involves the purchase and conversion of 20 new gasoline-powered Ford E350 passenger class vans to CNG-powered passenger shuttle vans, including fuel system retrofit and fuel tank replacement. The program has a three-year life and requires quarterly reporting of fuel use and mileage. These vehicles are used to provide airport ground transportation services to commercial airports in the South Coast Air Basin and will accrue high mileage during the project life. The project is expected to provide additional demonstration of CNG-powered high mileage vehicles, and a reduction in emissions from petroleum based fuels.

12135: Upgrade CNG Fueling Station

Contractor: Placentia-Yorba Linda Unified School District	SCAQMD Cost-Share	$ 60,000
Term: 11/18/11 – 11/30/17	Total Cost:	$ 60,000

At the May 7, 2010 meeting, the Board authorized awards of $40,000 to Placentia-Yorba Linda Unified School District to upgrade their CNG school bus fueling station from the Clean Fuels Fund. At the time the awards were made, the compressors that were quoted were undersized as they did not take into account the school districts expanding natural gas fleet. As a result, on October 7, 2011, the Board authorized an increase of $20,000 to the award to Placentia-Yorba Linda for a total of $60,000 to upgrade their CNG school bus fueling stations.

Direct Pay: Purchase Up to 119 Natural Gas-Powered Vehicles for Taxicab Services

Contractor: South Bay Ford	SCAQMD Cost-Share	$ 357,000
	Cosponsor	
	California Energy Commission	357,000
Term: 07/08/11 – 07/08/11	Total Cost:	$ 714,000

In July 2011 the Board approved funding of $357,000 from Clean Fuels to match a California Energy Commission award to South Bay Ford of $357,000 under the AB 118 Alternative and Renewable Fuel and Vehicle technology Program. The CEC program includes a $3,000 vehicle rebate for light-and medium-duty natural gas vehicles including vehicles used in taxicab services.

This project involves the purchase and conversion of 119 new gasoline-powered Ford passenger class vehicles (expected to be the new Ford Transit Connect compact multi-purpose vehicle) to CNG-powered taxi cabs, including fuel system retrofit and fuel tank replacement. The program has no reporting requirements of fuel use and mileage. These vehicles will be used to provide ground transportation services throughout the SCAQMD's jurisdictional area and will accrue high mileage, typically averaging 75,000 miles per year. The project is expected to provide additional demonstration of CNG-powered high mileage vehicles, and a reduction in emissions from petroleum based fuels. The total cost for the project, excluding base vehicle costs, is $714,000.

Fuels/Emission Studies

11611: In-Use Emissions Testing and Demonstrate Retrofit Technology of On-Road Heavy-Duty Engines

Contractor: West Virginia University Research Corporation	SCAQMD Cost-Share	$ 734,742
	Cosponsor	
	West Virginia University Research Corporation	159,905
Term: 07/08/11 – 10/07/12	Total Cost:	$ 894,647

On-road heavy-duty engines are now subject to the 2010 U.S. EPA emissions standards of 0.01 gram per brake-horsepower-hr (g/bhp-hr) PM and 0.20 g/bhp-hr NO_x. Some engine manufacturers are using emissions credits which allow them to produce a mixture of engines certified at, below, or above 0.20 g/bhp-hr NO_x. This mixture of engines allows engine manufacturers to comply with the emissions standards on an average basis. These engines are either stoichiometric engines with three-way catalysts or lean burn engines equipped with exhaust gas recirculation (EGR), selective catalytic reduction (SCR) and/or diesel particulate filter (DPF) technology. While recent limited-scale studies have shown reduced NO_x and PM emissions from trucks powered by compliant engines, other studies indicate a potential increase in some exhaust emissions. In particular, in a recent heavy-duty in-use emissions measurement study conducted by the University of Colorado, ammonia emissions from liquefied natural gas trucks were found to be significantly higher due to the nature of spark-ignited engines. Studies conducted by The Netherland Organization (TNO) indicated that heavy-duty diesel engines equipped with SCR technologies have higher NO_x exhaust emissions than their certified levels. As such, additional studies are required to assess the impact of the technologies on emissions from engines used in a variety of applications, particularly since the number of these engines will continue to increase in the future. On December 3, 2010, the Board awarded contracts to West Virginia University for $734,742 to conduct in-use emissions testing, and if needed, to evaluate emission-reduction potential of retrofit technology on existing and new on-road heavy-duty engines.

11612: In-Use Emissions Testing and Demonstrate Retrofit Technology of On-Road Heavy-Duty Engines

Contractor: University of California Riverside	SCAQMD Cost-Share	$ 689,742
	Cosponsor	
	University of California Riverside	18,782
Term: 07/08/11 – 10/07/12	Total Cost:	$ 708,524

On-road heavy-duty engines are now subject to the 2010 U.S. EPA emissions standards of 0.01 gram per brake-horsepower-hr (g/bhp-hr) PM and 0.20 g/bhp-hr NO_x. Some engine manufacturers are using emissions credits which allow them to produce a mixture of engines certified at, below, or above 0.20 g/bhp-hr NO_x. This mixture of engines allows engine manufacturers to comply with the emissions standards on an average basis. These engines are either stoichiometric engines with three-way catalysts or lean burn engines equipped with exhaust gas recirculation (EGR), selective catalytic reduction (SCR) and/or diesel particulate filter (DPF) technology. While recent limited-scale studies have shown reduced NO_x and PM emissions from trucks powered by compliant engines, other studies indicate a potential increase in some exhaust emissions. In particular, in a recent heavy-duty in-use emissions measurement study conducted by the University of Colorado, ammonia emissions from liquefied natural gas trucks were found to be significantly higher due to the nature of spark-ignited engines. Studies conducted by The Netherland Organization (TNO) indicated that heavy-duty diesel engines equipped with SCR technologies have higher NO_x exhaust emissions than their certified levels. As such, additional studies are required to assess the impact of the technologies on emissions from engines used in a variety of applications, particularly since the number of these engines will continue to increase in the future. On December 3, 2010, the Board awarded a contract to the University of California Riverside for $689,742 to conduct in-use emissions testing of existing and new on-road heavy-duty engines.

Emission Control Technologies

08246: Showcase: Demonstrate NO_x and PM Emissions Control Technology on Diesel Powered Construction Equipment

Contractor: Griffith Company	SCAQMD Cost-Share	$ 450
Term: 05/14/08 – 12/31/2012	Total Cost:	$ 450

The objective of this project was to demonstrate after-treatment DPF-SCR emission control systems for off-road construction vehicles. The control system consisted of a diesel particulate filter (DPF) for control of PM emissions and selective catalytic reduction (SCR) system for control of NO_x emissions. On October 5, 2007, the SCAQMD Board awarded a contract to Griffith Company to participate in the "Showcase" demonstration of NO_x and PM control technologies. The original award to Griffith was $77,550 for two off-road vehicles. On October 2, 2009, funding was increased to $191,000 to allow for five vehicles and specific control technologies selected by CARB. Unfortunately, the technology providers for two vehicles withdrew from the program. New providers were selected by CARB but they submitted higher quotations that the original providers. Also, the actual cost for a third vehicle was less than originally included in the contract. The net cost change reflecting the new quotations and the actual costs incurred was an increase of $450 for a final contract value of $191,450.

08261: Showcase: Demonstrate NO_x and PM Emissions Control Technology on Diesel Powered Construction Equipment

Contractor: Community Recycling & Resource Recovery, Inc.	SCAQMD Cost-Share	$ (450)
Term: 12/12/08 – 3/24/11	Total Cost:	$ (450)

The objective of this project was to demonstrate after-treatment DPF-SCR emission control systems for off-road construction vehicles. The control system consisted of a DPF for control of

PM emissions and a SCR system for control of NO_x emissions. On October 5, 2007, the SCAQMD Board awarded a contract to Community Recycling to participate in the "Showcase" demonstration of NO_x and PM control technologies. The original award to Community Recycling was $363,250 for nine off-road vehicles. Unfortunately, only two off-road vehicles could be retrofitted with devices due to their mechanical condition, configuration, or the withdrawal of device manufacturers from the Showcase Program. The total cost for Community Recycling was $77,700. The balance of $285,550 was de-obligated and $450 of that was reallocated to Griffith Company Contract #08246.

11655: CSULB CEERS Student Education Study to Assess the Effects of an Exhaust Scrubber on Diesel Emissions

Contractor: California State University Long Beach Foundation	SCAQMD Cost-Share	$ 28,000
Term: 06/14/11 – 12/31/11	Total Cost:	$ 28,000

Air misting has been used to remove dust particles in the air. In general, fogging and air misting could reduce concentration of large particles of 2-10 microns but not smaller ones. One of the effective methods for removing small particles is electrostatic scrubber. The objective of the investigation by the students at CSULB's Center for Energy and Environmental Research and Services (CEERS) was focused on reducing PM emission of diesel engines with an electrostatic fog. Initial investigation was focused on feasibility study of incorporating an electro static fog as part of an emission reduction system. Further development will include development of a system on board the diesel engine that could use the exhaust heat for generating fog from distilled water and an effective electrostatic device for the generated fog and a collecting device for capturing the PM emission.

12113: Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: Southern Counties Terminals dba Griley Air Freight	SCAQMD Cost-Share	$ 15,000
	Cosponsor	
	Southern Counties Terminals dba Griley Air Freight	30,000
Term: 10/13/11 – 03/31/14	Total Cost:	$ 45,000

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. The three trucks have been retrofitted and are or will be placed into operation.

12114: Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: South Bound Express, Inc.	SCAQMD Cost-Share	$ 15,000
	Cosponsor	
	South Bound Express, Inc	39,623
Term: 10/13/11 – 03/31/14	Total Cost:	$ 54,623

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. The three trucks have been retrofitted and are or will be placed into operation.

12118: Retrofit 13 Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: National Ready Mixed Concrete	SCAQMD Cost-Share	$ 65,000
	Cosponsor	
	National Ready Mixed Concrete	174,806
Term: 10/13/11 – 03/31/14	Total Cost:	$ 239,806

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. The 13 trucks have been retrofitted and are or will be placed into operation.

12120: Retrofit 40 Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: Standard Concrete Products	SCAQMD Cost-Share	$ 200,000
	Cosponsor	
	Standard Concrete Products	396,665
Term: 10/13/11 – 03/31/14	Total Cost:	$ 596,665

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. Fifteen of the 40 trucks have been retrofitted and are or will be placed into operation; the contractor has decided not to retrofit the remaining 35 trucks.

12121: Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: Challenge Diary Products, Inc.	SCAQMD Cost-Share	$ 15,000
	Cosponsor	
	Challenge Diary Products, Inc.	31,845
Term: 11/18/11 – 03/31/14	Total Cost:	$ 46,845

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. The three trucks have been retrofitted and are or will be placed into operation.

12122: Retrofit One Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: Bear Trucking, Inc.	SCAQMD Cost-Share	$ 5,000
	Cosponsor	
	Bear Trucking, Inc.	8,555
Term: 10/14/11 – 03/31/14	Total Cost:	$ 13,555

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. The contractor is in the process of ordering the retrofit device.

12123: Retrofit 107 Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: RRM Properties	SCAQMD Cost-Share	$ 535,000
	Cosponsor	
	RRM Properties	946,067
Term: 10/6/11 – 03/31/14	Total Cost:	$ 1,481,067

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. Of 107 trucks, 105 of them have been retrofitted and are or will be placed into operation.

12124: Retrofit Nine Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: Gaio Trucking, Inc.	SCAQMD Cost-Share	$ 45,000
	Cosponsor	
	Gaio Trucking, Inc.	120,669
Term: 9/28/11 – 03/31/14	Total Cost:	$ 165,669

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. Four of the nine trucks have been retrofitted and are or will be placed into operation.

12125: Retrofit 4 Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: Spragues Ready Mix	SCAQMD Cost-Share	$ 20,000
	Cosponsor	
	Spragues Ready Mix	42,953
Term: 10/14/11 – 03/31/14	Total Cost:	$ 62,953

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. Two of the four trucks have been retrofitted and are or will be placed into operation.

12175: Retrofit Seven Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: RRM Properties	SCAQMD Cost-Share	$ 35,000
	Cosponsor	
	RRM Properties	49,812
Term: 12/8/11 – 03/31/14	Total Cost:	$ 84,812

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be

completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. The seven trucks have been retrofitted and are or will be placed into operation.

12186: Retrofit 25 Heavy-Duty Diesel Trucks with Diesel Particulate Filters

Contractor: Pipeline Carriers Inc.	SCAQMD Cost-Share	$125,000
	Cosponsor	
	Pipeline Carriers Inc.	330,750
Term: 12/16/11 – 03/31/14	Total Cost:	$ 455,750

On March 6, 2009, the Board recognized $1 million from the U.S. EPA under the Diesel Emissions Reduction Act (DERA) program to retrofit heavy-duty diesel trucks with DPFs. The scope of the project includes the design, installation and operation of DPF technologies on 200 1998-2006 model year heavy-duty diesel trucks. A total of 833 applications were received, 14 of which were for retrofit of 216 heavy-duty diesel trucks with DPFs at $5,000 per truck. Staff has evaluated and ranked those 14 applications based on cost-effectiveness of the projects and the U.S. EPA DERA program requirement. Of those, staff has selected 13 proposals and has been in discussion with the applicants to ensure that upon Board approval, the retrofit projects will be completed. The successful implementation of the proposed project will provide direct PM emission reduction in a cost-effective and expeditious manner as required under the U.S. EPA DERA program and meet the goals of the 2007 AQMP. The above-proposed trucks will operate for many years in the South Coast Air Basin. The contractor informed us in January 2012 that only 5 trucks will be retrofitted by 4/30/2012. Due to the sluggish economy, Pipeline Carriers plans to retrofit only 5 of the 25 vehicles originally identified. A modification to the contract will be processed in 2012 to de-obligate funds reducing the contract award to only $25,000.

Electric/Hybrid Technologies

99109: Lease Two Toyota RAV4 Electric Vehicles for CY 2011

Contractor: Toyota	SCAQMD Cost-Share	$ 7,902
Term: 04/04/99 – 02/01/12	Total Cost:	$ 7,902

The SCAQMD operates a number of alternative fuel vehicles (AFVs), including EVs and HEVs. The primary objective of having these vehicles as part of the SCAQMD fleet is to continue to demonstrate the use of zero-emission vehicles in our fleet. Various SCAQMD-owned AFVs are used to demonstrate new clean fuel vehicles to public and private organizations so that potential purchasers may familiarize themselves with available low-emission technologies. This contract amendment provides for a lease extension and corresponding funding for 2011. It is anticipated that the lease will be extended again for 2012 and newer model year RAV4s may be provided under the lease.

05260: Conversion of Light-Duty Vehicle to Plug-In Hybrid Vehicles

Contractor: Energy Control Systems Engineering, Inc.	SCAQMD Cost-Share	$ (45,000)
Term: 09/09/05 – 03/31/12	Total Cost:	$ (45,000)

The SCAQMD de-obligated $45,000 since the option to convert the last two hybrids to plug-in was not exercised, but SCAQMD provided support for service and maintenance during operation of the three plug-in hybrids in its demonstration fleet and extended the contract for additional time to complete reporting.

09360: Lease of Five Mini Cooper Electric Vehicles for CY 2011

Contractor: BMW of North America LLC	SCAQMD Cost-Share	$ 10,953
Term: 05/14/08 -12/31/12	Total Cost:	$ 10,953

The SCAQMD leased five Mini Cooper electric vehicles from BMW North America. The electric vehicles are part of a 450 vehicle demonstration program being conducted by BMW North America. BMW has deployed these vehicles in the Los Angeles and New York areas to collect user feedback, which will be used to assist in developing vehicle requirements for an upcoming electric vehicle that BMW has announced. This contract amendment provides for a lease extension and corresponding funding for 2011.

11606: Develop and Demonstrate Plug-In Hybrid Electric Drive System of Medium- and Heavy-Duty Vehicles

Contractor: Odyne Systems, LLC	SCAQMD Cost-Share	$ 494,000
	Cosponsors	
	Odyne Systems, LLC	1,011,000
	U.S. Department of Energy	809,000
	Los Angeles Department of Water & Power	200,00
	Los Angeles County	85,000
Term: 07/08/11 – 07/07/13	Total Cost:	$ 2,599,000

The SCAQMD has partnered with Odyne Systems to develop, deploy and demonstrate plug-in hybrid technology on medium- to heavy-duty work truck applications. The incorporation of plug-in hybrid technology will add functionality that includes electrification of jobsite operation, electric launch assist, regenerative braking, electrification of in-cab climate controls, and exportable power. These features will improve vehicle efficiency while driving and electrify their operation while working at a jobsite. The jobsite vocations targeted by this technology includes bucket trucks, digger derricks and compressor trucks. Electrification of the vehicle's jobsite operation will eliminate emissions at the point of use, reduce emissions on a full-cycle basis, and provide the co-benefit of reducing fossil fuel consumption.

11725: Lease of Three Nissan Leaf Vehicles for 39 Months

Contractor: Puente Hills Nissan	SCAQMD Cost-Share	$ 60,222
	Cosponsor	
	Federal Tax credit $7500 partially offset by Nissan lease financing	22,500
Term: 05/27/11 – 08/26/14	Total Cost:	$ 82,722

The SCAQMD operates a number of alternative fuel vehicle, including electric vehicles, fuel cell vehicles, and plug-in hybrid-electric vehicles. The primary objective of having these vehicles as part of the SCAQMD demonstration fleet is to continue to support the use of zero emission vehicles. The three Nissan Leaf battery electric vehicles with lithium-ion batteries will be used to demonstrate these new clean-fuel vehicles to public and private organizations so that potential purchasers may familiarize themselves with available low-emission technologies.

12024: Install Electric Charging Infrastructure

Contractor: ECOtality North America	SCAQMD Cost-Share	$ 70,000
Term: 11/04/11 -05/03/13	Total Cost:	$ 70,000

There are approximately 1,800 EV chargers in need of upgrading in the South Coast Air Basin. These sites are ideal locations to upgrade EV infrastructure to Level 2 charging at a lower cost than to install EV infrastructure at new site locations. Leveraging the U.S. DOE and CEC funding received by the three major EVSE manufacturers—ECOtality, Coulomb Technologies, and Clipper Creek, the SCAQMD has executed a contract with ECOtality (and is in the process of executing contracts with the other two manufacturers) to install new or upgraded Level 2 EV infrastructure at high usage site locations identified by SCAQMD and the manufacturers. ECOtality has received a combination of U.S. DOE and CEC funding which will pay for the equipment and up to $2,000 of the installation cost for Level 2 EV infrastructure at 70 site locations. The SCAQMD is providing co-funding of $1,000 per charger to offset installation costs at these locations. Data will be collected by ECOtality from these chargers and provided to SCAQMD to assist in SCAQMD's PEV infrastructure planning process for the U.S. DOE and CEC PEV infrastructure grants for the South Coast region.

12028: Demonstrate and Replace UPS Diesel Delivery Trucks with Zero-Emission Medium-Duty Trucks

Contractor: Electric Vehicle International, Inc.	SCAQMD Cost-Share	$ 1,400,000
	Cosponsors	
	United Parcel Service (UPS)	2,772,000
	California Air Resources Board	560,000
	Electric Vehicle International, Inc.	140,000
Term: 09/09/11 – 09/08/17	Total Cost:	$ 4,872,000

The SCAQMD recognizes the impact of goods movement on air quality in the South Coast Air Basin, as well as the relationship between the goods movement industry and nearly every other sector of California's economy. The emissions generated from goods movement involve the transportation of merchandise, supplies, and other cargo in to, out of, or within California. Emissions from the movement of goods and freight through California's ports and along its transportation corridors pose a threat to statewide air quality and public health. United Parcel Service (UPS) is a world leader in goods movement and delivery and operates over 100,000 vehicles worldwide. It has one of the world's largest natural gas vehicle fleets and a growing fleet of hybrid electric vehicles. UPS has an immediate interest in expanding the electrification of this fleet, with a five-year, 40-vehicle demonstration in South Coast Air Basin as the kickoff. Electric Vehicle International (EVI) has developed a zero-emission, medium heavy-duty return-to-base delivery truck ideal for package delivery service providers such as UPS. The new, clean vehicle

uses an Original Equipment Manufacturer (OEM) chassis with EVI's signature power train to create a zero-emission, aerodynamic model of the walk-in vehicles UPS drivers are accustomed to. The vehicles will be delivered to UPS in August 2012.

Direct Pay: Install Three Electric Vehicle Chargers by Coulomb Technologies at SCAQMD Headquarters

Contractor: Clean Fuel Connection	SCAQMD Cost-Share	$ 9,007
Term: 08/23/11 – 08/23/11	Total Cost:	$ 9,007

As part of the U.S. DOE ChargePoint America program, Coulomb Technologies will be installing three electric vehicle chargers at SCAQMD headquarters. The ChargePoint America program gives the potential station owner the opportunity to own charging stations at no cost except the cost of installation. This is made possible by the American Recovery and Reinvestment Act through the Transportation Electrification Initiative administered by the U.S. Department of Energy and the objective is to accelerate the development and production of electric vehicles to substantially reduce petroleum consumption, reduce greenhouse gas production, and create jobs. The chargers will be installed in the front lobby parking area and replace the older existing chargers. The installation will be performed by Clean Fuel Connection, Inc.

Transfer: Develop Class 8 Plug-In Hybrid Heavy-Duty Vehicle

Contractor: Transfer from Clean Fuels (for Volvo Project)	SCAQMD Cost-Share	$ 600,000
	Cosponsors	
	Volvo	1,200,000
	Ports of Los Angeles/Long Beach	600,000
Term: 12/2/11 – 12/2/11	Total Cost:	$ 2,400,000

The SCAQMD will contract with Volvo to develop, build and demonstrate a prototype level Class 8 plug-in hybrid electric drayage truck. The truck will feature a new MD8 engine in a proprietary 6x2 Mack chassis with a second generation, I-SAM hybrid powertrain, a new energy optimized battery, external charging interface and newly developed energy management and control systems. The supplemental power and torque capabilities provided by the hybrid system will allow for the vehicle to be designed with a downsized internal combustion engine, which will provide additional fuel economy benefits. Studies will also be conducted to evaluate the adaptation of the plug-in hybrid system to interface with a wayside power system. The wayside power connection would enable the vehicle to drive electrically, on a dedicated corridor, without the need for significant on-board energy storage.

Transfer: Demonstrate Battery Electric Heavy-Duty Trucks

Contractor: Transfer from Clean Fuels Fund (for TransPower Contract #11614)	SCAQMD Cost-Share	$ 196,505
	Cosponsor	
	California Energy Commission	1,000,000
	TransPower	1,119,770
	U.S. Environmental Protection Agency	300,000
Term: 07/08/11 – 11/07/13	Total Cost:	$ 2,616,275

The electrification of transportation technologies has the potential to significantly reduce criteria pollutant and greenhouse gas emissions. This can provide substantial benefits to communities, neighborhoods, and school areas where these vehicles operate. The TransPower "ElecTruck" drive system is a zero-emission solution that eliminates 100% of the harmful emissions produced by road vehicles, at the point of operation. TransPower has selected port trucks as its initial target market because of the high potential for environmental benefits if these vehicles can be converted to electric propulsion. TransPower will demonstrate two zero emission battery-electric Class 8 truck at the Ports of Los Angeles and Long Beach and intermodal facilities. TransPower will integrate electric drive components into two Class 8 trucks. One truck will be used as a static test vehicle to test new components, and the other will be placed into revenue service carrying cargo containers at the Ports of Los Angeles and Long Beach to intermodal facilities. The battery-electric drive system will utilize high-power drive motors and inverters and energy will be stored in high-energy lithium battery packs. The revenue service vehicle will be operated by a leading drayage firm, and closely monitored under real-world operating conditions. Currently, TransPower is conducting tests on the early prototype vehicles.

Engine Systems

11485: Demonstrate Refuse Truck Retrofitted with Cummins ISL-G Natural Gas Engine

Contractor: Waste Management Collection & Recycling Inc.	SCAQMD Cost-Share	$ 75,000
	Cosponsor	
	Waste Management Collection & Recycling Inc.	225,876
Term: 03/18/11 – 01/31/12	Total Cost:	$ 300,876

Recent amendments to Rule 1193 require public and private solid waste collection fleets having exclusive contracts with public entities and greater than 15 trucks to purchase or replace existing vehicles with alternative-fuel vehicles to reduce air toxic and criteria pollutant emissions. In October 2010, the SCAQMD Board awarded Waste Management Collection & Recycling a $75,000 grant for a project to repower a diesel-fueled refuse truck with a Cummins ISL-G natural gas engine that is compliant with the 2010 emissions standard. This project will provide a cost-effective CNG vehicle option to comply with Rule 1193 and help accelerate the turnover of older diesel-fueled refuse trucks in the Basin. Waste Management has partnered with Cummins Cal Pacific and AFV Fleet Services to engineer a diesel-to-CNG proof-of-concept (POC) vehicle,

equipped with a new cooling system designed to provide sufficient cooling capacity for a spark-ignited natural gas engine. The successful demonstration of the POC vehicle will have the potential to reduce emissions significantly from approximately 3,800 diesel-fueled refuse collection trucks affected by Rule 1193.

Mobile Fuel Cell Technologies

10714: Develop Fuel Cell Gas Turbine Hybrid System for On-Board Locomotive Applications

Contractor: University of California Irvine	SCAQMD Cost-Share	$ 78,000
	Cosponsor	
	California Air Resources Board	78,000
Term: 12/02/11 – 12/01/13	Total Cost:	$ 156,000

SCAQMD has sponsored the development and deployment of fuel cell systems for mobile and stationary applications for many years and has successfully demonstrated molten carbonate fuel cell (MCFC) technology for stationary source applications. The high operating temperature and nature of materials used in solid oxide fuel cells (SOFCs) allow for the direct internal reforming of hydrocarbon based fuels and direct utilization of fuel impurities such as carbon monoxide. This has the advantage of lower capital and maintenance costs required for pre-reformers, gas cleaning systems, and water management systems required for low temperature PEM fuel cell technology requiring high purity hydrogen. Additionally, SOFCs when combined with gas turbines (GT) can achieve system efficiencies exceeding 70%. In 1999, AQMD executed a contract with Edison Technology Solutions (ETS) in conjunction with UCI's National Fuel Cell Research Center (NFCRC) to develop and demonstrate a 250 kW SOFC-microturbine power plant, and the project was successfully completed in 2003. Recently the NFCRC at UCI has conducted a preliminary research study under a National Science Foundation grant to critically review the potential of fuel cell-gas turbine hybrid technology for powering locomotives. The completion of this project would lead to a real world demonstration project for a first of its kind, fuel flexible SOFC-GT powered locomotive. Union Pacific will share their expertise and experience to identify the needs of the rail industry in order to ensure that the analysis conducted by NFCRC will meet practical requirements. The success of this project will also demonstrate technology transfer of SOFCs utilizing currently available fuels on board existing medium- and heavy-duty diesel trucks, other mobile source, and stationary source applications. For this project, a proof-of-concept SOFC-GT system analysis on-board a locomotive and a conceptual design for real world demonstration will be developed. The proof-of-concept stage of this project will consist of modeling and analysis of the SOFC-GT system to meet the expectations of the railroad industry and technical requirements set forth by the fuel cell and gas turbine manufactures. The conceptual design will include the design of the main power systems, including the SOFC, GT, reformer, and fuel storage; design of peripheral systems such as thermal management and traction control systems; and packaging of the unit into the locomotive.

11656: Participate in California Fuel Cell Partnership for Calendar Year 2011 and Provide Support for Regional Coordinator

Contractor: Bevilacqua-Knight, Inc.	SCAQMD Cost-Share	$ 137,800
	Cosponsors	
	8 automakers; 2 energy providers; 6 government agencies; 1 fuel cell provider, and 14 associate members	1,494,800
Term: 01/01/11 – 12/31/11	Total Cost:	$ 1,632,600

In April 1999, the California Fuel Cell Partnership (CaFCP) was formed with eight members; SCAQMD joined and has participated since 2000. The CaFCP and its members are demonstrating fuel cell passenger cars and transit buses with associated hydrogen fueling infrastructure in California. Since the CaFCP is a voluntary collaboration, each participant contracts with Bevilacqua-Knight, Inc. (BKI) for their portion of CaFCP administration. In 2011, the SCAQMD Board contributed $87,800 for membership and up to $50,000, along with four cubicles at SCAQMD Headquarters, to provide support for the CaFCP Regional Coordinator.

Hydrogen Infrastructure

10061: Maintenance & Data Management for the SCAQMD's Hydrogen Fueling Station

Contractor: Hydrogenics	SCAQMD Cost-Share	$ 50,000
Term: 10/30/09 – 06/30/12	Total Cost:	$ 50,000

Hydrogenics Corporation has had a sole-source contract for the continued maintenance of the SCAQMD hydrogen fueling station for the last few years. In order to continue maintenance and data management of the existing SCAQMD hydrogen station, an amendment of the existing contract with Hydrogenics Corporation was required. This contract modification extends beyond the original scope of the project and will ensure the station is maintained while plans are made for the station's upgrade. Maintenance and management services will include the following: 1) Train staff in the proper use of the fueling dispenser, card-lock system and vehicle fueling procedures; 2) Repair unsafe or inoperable equipment or parts of the fueling system as needed; 3) Detailed vehicle fueling reports (paper and electronic); and 4) Summary reports for station use.

10482: Install/Demonstrate PEM Electrolyzer, Providing Hydrogen Fueling for Vehicles and Utilizing the Technology in the Engineering Technology Curriculum at the University

Contractor: California State University Los Angeles	SCAQMD Cost-Share	$ 250,000
	Cosponsors	
	California State University Los Angeles	1,112,000
	MSRC/AB2766 Discretionary Fund	250,000
	So. California Automobile Club	50,000
Term: 03/04/11 – 10/03/17	Total Cost:	$ 1,662,000

The implementation of zero-emission vehicles (ZEVs) is a key component in the effort to achieve air quality attainment in the South Coast Air Basin. Fuel Cell Vehicle (FCV) technology is emerging at an accelerated pace and may play a crucial role in this effort. To accelerate this technology as a viable commercial alternative, the SCAQMD includes funding in its program allocations to support the installation of a network of hydrogen fueling stations throughout the Basin to support the operation and demonstration of FCVs in the South Coast Air Basin. California State University, Los Angeles submitted a proposed project for SCAQMD to co-fund the construction, installation and operation of a hydrogen fueling station which consists of a Polymer Electrolyte Membrane (PEM) Electrolyzer system that generates, compresses, stores and dispenses hydrogen located near CSULA's Engineering Technology Laboratory on the university's campus. The station is currently going through the commissioning process.

Health Impacts Studies

11527: Conduct Study on Sources, Composition, Variability and Toxicological Characteristics of Ultrafine Particles in Southern California

Contractor: University of Southern California	SCAQMD Cost-Share	$ 470,969
Term: 07/24/11 – 07/24/14	Total Cost:	$ 470,969

The objective of the proposal is to provide information on ultrafine particle sources, spatial and seasonal characteristics, and toxicity in Southern California. The proposed project will make use samples that have already been collected by USC over an approximate 15-month cycle at 10 locations in the Los Angeles Basin reflecting different source and receptor locations, including near freeways. The samples were collected in conjunction with a U.S. EPA funded project characterizing the chemical composition and toxicity of course particulate matter (PM2.5 – 10). Seven of these locations are also sampling sites for the EPA's Multiple Ethnic Study of Atherosclerosis Air Pollution Study (MESA Air). MESA Air is a multi-year study funded by U.S. EPA that is looking into the health effects of PM2.5. Thus, the results of the proposed study can be used to compare the composition, sources, and toxicity of UFP with those of PM2.5 and PM2.5 – 10. These results will be important in forming the scientific basis for air quality policies to reduce emissions and improve public health.

Outreach and Technology Transfer

10062: Technical Assistance for Implementation of Proposition 1B Goods Movement Program and Truck Replacement Program

Contractor: TIAX LLC	SCAQMD Cost-Share	$ 200,000
	Cosponsor	
	Proposition 1B-Goods Movement/Fund 81	375,000
Term: 11/13/09 – 12/31/12	Total Cost:	$ 575,000

Under this Contract, TIAX is providing expert technical assistance to SCAQMD to implement the Proposition 1B-Goods Movement Clean Truck incentive program as it complements the goals and objectives of the Clean Fuels Program. Their services will include helping SCAQMD staff in outreach, application quality control and evaluations, and other project implementation activities.

TIAX has previously assisted SCAQMD with implementing a wide-array of incentive programs to deploy lower-emitting heavy-duty vehicles and advanced transportation technologies. TIAX has extensive experience and professional knowledge about the feasibility and inner workings of such incentive programs.

10662: Technical Assistance for Implementation of Proposition 1B Goods Movement Program and Truck Replacement Program

Contractor: Gladstein, Neandross & Associates	SCAQMD Cost-Share	$ 175,000
Term: 05/12/10 – 12/31/13	Total Cost:	$ 175,000

Under this Contract, Gladstein, Neandross & Associates (GNA) is providing expert technical assistance to SCAQMD to implement the Proposition 1B-Goods Movement Clean Truck incentive program as it complements the goals and objectives of the Clean Fuels Program. GNA has previously assisted SCAQMD with implementing a wide-array of incentive programs to deploy lower-emitting heavy-duty vehicles and advanced transportation technologies. GNA has extensive experience and professional knowledge about the feasibility and inner workings of such incentive programs.

10663: Technical Assistance for Implementation of Proposition 1B Goods Movement Program

Contractor: Clean Fuel Connection	SCAQMD Cost-Share	$ 250,000
	Cosponsor	
	Proposition 1B-Goods Movement/Fund 81	100,000
Term: 05/12/10 – 12/31/12	Total Cost:	$ 350,000

Under this Contract, Clean Fuel Connection is providing expert technical assistance to SCAQMD to implement the Proposition 1B-Goods Movement Clean Truck incentive program as it complements the goals and objectives of the Clean Fuels Program. Their services will include helping SCAQMD staff in outreach, application quality control and evaluations, and other project implementation activities. Clean Fuel Connection has previously assisted SCAQMD with implementing a wide-array of incentive programs to deploy lower-emitting heavy-duty vehicles and advanced transportation technologies. Clean Fuel Connection has extensive experience and professional knowledge about the feasibility and inner workings of such incentive programs.

11028: Technical Assistance on Stationary Source Control Measures & Future Consultation on TAO Activities

Contractor: Marty Kay	SCAQMD Cost-Share	$ 15,000
Term: 08/04/10 – 12/31/12	Total Cost:	$ 15,000

In mid-2010, a contract with Marty Kay was approved for technical assistance on research, to define and develop stationary source control measures and clean energy projects in the amount of $25,000. In 2011 Marty Kay's contract was modified to extend the term through the end of 2012 and add an additional $15,000 to accomplish two new tasks: 1) Develop the scope of work and provide guidance in review, evaluation and implementation of proposals for estimating the impacts on overall pollutant emission inventories and air quality from natural gas combustion

equipment from a residential, commercial, and industrial perspective from the introduction of LNG in the pipeline in the South Coast Air Basin and also assist SCAQMD staff in the implementation of future research on this subject; and 2) Provide technical support in the evaluation of proposals associated with RFP #P2011-21 - Deployment of Five Megawatts or More of In-Basin Renewable Distributed Electricity Generation and Storage to Support Electric Transportation Technologies and to provide technical guidance on the implementation of the contractor's work.

11144: Natural Gas-Powered Vehicle Training and Safety and Fuel Cylinder Inspection Program

Contractor: San Diego Community College District on behalf of Advanced Transportation Technology and Energy	SCAQMD Cost-Share	$ 130,000
Term: 12/10/10 – 05/31/13	Total Cost:	$ 130,000

In February 2011 the Board approved an augmentation of funding for an existing contract with Advanced Transportation Technology and Energy Network of the California Community Colleges (ATTE) to provide outreach in education and safety training for natural gas vehicle operators, technicians, and fleet managers operating within the SCAQMD's jurisdictional area. The trainings include: four natural gas vehicle safety overview courses, three CNG fueling cylinder inspection courses, and six natural gas vehicle diagnostics courses. The training courses are developed for heavy-duty vehicles, particularly CNG-powered school buses, and outreach efforts are being primarily directed to school districts which operate and maintain their own CNG-powered school buses. The project is expected to provide additional training and expertise to individuals whose occupations range from fleet manager to vehicle technician, and will improve the reliability and safety of CNG-powered heavy-duty vehicles operating in the South Coast Air Basin and particularly school districts in this air basin. The total cost for the project is $130,000, which is comprised of $77,000 from Clean Fuels plus pass-through revenue of $53,000 from the Southern California Gas Company.

11484: Develop and Implement Two Customer Centers to Provide Education and Outreach to Truck Owners and Operators

Contractor: Gladstein, Neandross & Associates, LLC	SCAQMD Cost-Share	$ 150,000
Term: 01/27/11 – 05/31/12	Total Cost:	$ 150,000

This project addresses the component of the Chairman's Helping Hand Initiative that provides customer service centers for heavy-duty truck owners and operators. Two customer service centers are being established for truck owners and operators; a toll-free hotline will be staffed by experts who can respond to inquiries generated at the service centers; and a supporting website is being developed. The service centers are being strategically located in areas with heavy truck traffic. Through a separate contract funded by the Department of Energy, Advanced Transportation Technology & Energy Network of the California Community Colleges is providing materials to be displayed and distributed by Gladstein, Neandross & Associates, LLC.

12104: Develop, Initiate and Implement a Clean Vehicle Outreach Project

Contractor: Three Squares	SCAQMD Cost-Share	$ 100,000
Term: 09/23/11 – 09/22/12	Total Cost:	$ 100,000

The intent of this outreach campaign is to implement outreach goals of the SCAQMD Board. Three Squares Inc. (TSI) will retool existing SCAQMD programs to include and expand the current efforts to focus some or all of the messaging aspects, where appropriate, in the near-term on clean and high-efficiency vehicles. These efforts will be included under a newly badged Clean Air Choices (CAC) program, which will provide an umbrella platform to promote all of the SCAQMD clean air technology activities in the future, such as low-VOC paints and solvents, electric lawn and garden equipment, air filters, low NO_x boiler and aftertreatment technologies, as well as clean vehicles. A CAC Showcase is envisioned in the SCAQMD headquarters lobby to highlight all of these technologies and "choices" residents can make for clean air. This initial vehicle outreach program is envisioned to include multiple elements to direct online traffic to CleanAirChoices.org, and link to other synergistic programs.

Transfer: Conduct Clean Vehicle Outreach and Expand Clean Air Choices Program

Contractor: Transfer from Clean Fuels Fund	SCAQMD Cost-Share	$ 50,000
Term: 07/08/11 – 07/08/11	Total Cost:	$ 50,000

A re-launch of the SCAQMD's Clean Air Choices Program was initiated with the intent of expanding the program to showcase clean vehicle technologies supported and promoted by the SCAQMD. The Board approved a $50,000 transfer of funds from the Clean Fuels Fund to support activities in other departments related to the implementation of this program, such as software upgrades to support the mobile phone application, design and printing of program materials, and outreach events with local vehicle dealerships.

Transfer: Participate in California Natural Gas Vehicle Partnership

Contractor: Transfer from Clean Fuels	SCAQMD Cost-Share	$ 25,000
	Cosponsors	
	CNGVP Participating Members	185,000
Term: 03/04/11 – 03/04/11	Total Cost:	$ 210,000

The California Natural Gas Vehicle Partnership (CNGVP) was formed to accelerate the development of advanced The CNGVP was formed to accelerate the development of advanced natural gas vehicle technologies, to provide a benchmark for lowering emissions from petroleum-based engines, and to provide a pathway to future fuel cell use in the next two decades. The SCAQMD spearheaded the formation of this strategic alliance, which comprises state and federal air quality, transportation and energy agencies, vehicle and engine manufacturers, fuel providers, and transit and refuse hauler organizations. Partnership Steering Committee members contribute monies to fund specific projects intended to achieve the goal of the Partnership. In March 2011, the SCAQMD approved $25,000 for the SCAQMD's participation on the Steering Committee for the next two years.

Direct Pay: Cosponsor 21 Conferences, Workshops & Events, plus 9 Memberships & Subscriptions

Contractor: Various	SCAQMD Cost-Share	$ 380,159
	Cosponsors:	
	Various	1,039,000
Term: Various	Total Cost:	$ 1,419,159

The SCAQMD regularly participates in and hosts or cosponsors conferences, workshops and events. These funds provide support for the 21 events during 2011, plus 9 business council/association memberships and subscriptions. The 21 conferences, workshops and events are as follows: 12th Annual Western Riverside Council of Governments Advancing the Choice Event, the Move LA "We Love LA" Events Series, outreach & planning assistance for MSRC's 20th anniversary workshop & retreat; the Coordinating Research Council's Life Cycle Analysis Workshop of Biofuels, The Women in Green Forum, the Asilomar 2011 Conference on Transportation and Energy; Calstart's CalHeat Forum, UCR's PEMS Workshop, CRC's Real World Emissions Workshop, U.S. EPA's Forum Clean Tech Conference, the Coachella Valley Energy Summit, UCR's UC Eco-Driving Workshop, Aztlan Athletics' Greenest Fastest Mile, KABC's 7th Annual Clean Air Car Showase, the Sixth Annual Alt Car Expo, the 3rd Annual Electric & Alternative Fuel Vehicle Fair, JLP's Climate Day 2011, the 4th METRANS National Urban Freight Conference, Calstart's "Advanced Clean Vehicles: Working to Ensure Sustainability Workshop," West Virginia University's "Workshop on Advances in Tailpipe Sensors: Research and Development," and the Fourth Symposium on Global Emerging Environmental Challenges and Government Responses. Platinum membership for the California Hydrogen Business Council, Core Program Sponsor Member Renewal with the Transportation Review Board and general memberships for the CalETC and Fuel Cell & Hydrogen Energy Association for both 2011 & 2012, plus subscriptions to Automotive News, Autoweek, Green Car Journal and the California Natural Gas Vehicle Coalition's NGV Fuel Station Directory are also included.

PROGRESS IN 2011

Key Projects Completed

A large number of emission sources contribute to the air quality problems in the South Coast Air Basin. Given the diversity of these sources, there is no single technology or "silver bullet" that can solve all of the region's problems. Accordingly, the SCAQMD continues to support a wide range of advanced technologies, addressing not only the diversity of emissions sources, but also the time frame to commercialization of these technologies. Projects co-funded by the SCAQMD's Clean Fuels Program include emission reduction demonstrations for both mobile and stationary sources, although legislative requirements limit the use of available funds primarily to on-road mobile sources.

Historically, mobile source projects have targeted low-emission technology developments in automobiles, transit buses, medium- and heavy-duty trucks and off-road applications. These vehicle-related efforts have focused on: 1) advancements in engine design, electric power trains, energy storage/conversion devices (e.g., fuel cells and batteries); and 2) implementation of clean fuels (e.g. natural gas, propane and hydrogen) including their infrastructures. Stationary source projects have included a wide array of advanced low NO_x technologies and clean energy alternatives, such as fuel cells, solar power and other renewable energy systems.

Table 6 (page 57) provides a list of 48 projects and contracts completed in 2011. Summaries of the completed technical projects are included in Appendix C. Selected projects which represent a range of key technologies from near-term to long-term are highlighted below.

Develop & Demonstrate Hydraulic-Hybrid Shuttle Bus

The project has designed, developed and tested a series hydraulic hybrid vehicle (HHV) with gasoline Homogeneous Charge Compression Ignition (HCCI) engine in an urban based shuttle bus; exploring its potential to cost-effectively achieve ultra-low levels of both criteria and greenhouse gas emissions. The integration of these two new technologies in a medium-duty shuttle bus platform demonstrates its potential as an additional solution to dramatically reduce greenhouse gases, NO_x to the 2010 standards without NO_x aftertreatment, PM to gasoline engine levels or lower, and other regulated emissions.

The series HHV shuttle bus is powered by a 6.4 liter gasoline HCCI engine and was compared to the conventional Navistar IC 3200 Shuttle Bus with a "stock" 2008 6.4 liter diesel engine on a myriad of drive cycles. The drive cycles shown below are represented in an increasing level of inertial intensity, which would be indicative of driving behavior that has more stop and go driving behavior. The series hydraulic hybrid drive system is a power dense system that has the ability to recover a significant amount of energy during braking events, and later expend this recovered energy during the next acceleration event. These attributes are well suited for inertially intensive drive cycles. However, the series architecture of the system is not as efficient for high speed operation or driving behavior that does not provide the opportunity to recover braking energy.

The fuel economy improvements shown below are indicative of these attributes, with the HWFET cycle showing a small reduction in fuel economy and the Denver Bus showing a 182% improvement in fuel economy. The HWFET is the drive cycle used by the EPA to estimate highway fuel economy for passenger cars, and is characterized by higher speeds with minimal stop and go driving behavior; whereas, the Denver Bus cycle has driving behavior typical of an urban transit bus which would be characterized by intensive stop and go driving behavior.

Figure 11: Fuel Economy Results

Drive Cycle	Fuel Economy (mpg)		
	Diesel (baseline)	HCCI - Series Hybrid	Improvement
HWFET	10.2	9.25	-9%
LA4	7.51	10.26	37%
Manhattan Bus	4.35	10.3	137%
Denver Bus	3.16	8.92	182%

The NO_x measurements shown below are 70-90% lower than those from the conventional pre-2010 standards diesel engine. The measurements are in line with 2010 emission standards for NO_x, but without the need for costly diesel aftertreatment. These results are summarized below.

Figure 12: NO_x Emission Results

Drive Cycle	NO_x (g/mile)		
	Diesel (baseline)	HCCI - Series Hybrid	Improvement
HWFET	2.67	0.392	-85%
LA4	3.758	0.769	-80%
Manhattan Bus	8.176	0.83	-90%
Denver Bus	8.124	1.004	-88%

Demonstrate Battery Electric Class 4 Utility Truck

In June 2009, the Board approved a project with the City of Santa Monica to develop and demonstrate a zero-emission battery electric medium-duty truck with an advanced lithium ion battery pack. The SCAQMD provided $87,205 for this project from the Clean Fuels Fund, and the total project cost of $174,410 was cost-shared by the City of Santa Monica, Electrorides, EV Innovation and Velocity Vehicle Group.

Figure 13: Santa Monica's ZeroTruck

This ZeroTruck utility vehicle was developed and is being used by Santa Monica's Water Resources Division of the Public Works Department for maintenance, repairs, and customer service visits throughout the city. The ZeroTruck has a low cab forward design and brings the latest in electric drive technology. It is powered by 350-400-volt Dow Kokam lithium battery pack and a high efficiency 100-kilowatt electric motor from UQM Technologies. The battery has a 2,500 cycle life battery life that translates to approximately eight years of service life for this application. The truck has a fully automated transmission with a 65-mile range for city driving at speeds up to 50 mph. The overall performance, range, functionality is very positive, and the fit, finish and layout of the systems on board the truck all were professionally assembled. The truck's range of approximately 60-65 miles is sufficient to operate on all routes and locations in Santa Monica. The performance of the truck when fully loaded is also sufficient to climb grades and accelerate to maintain flow with the traffic. The truck can be plugged in overnight and be ready for use during the day using a standard 220 volt 30 amp outlet.

This project will allow the City of Santa Monica to evaluate the potential of replacing an additional ten medium-duty trucks with electric vehicles in the Public Works Department, as well as other divisions of the City fleet services. With modifications, the ZeroTruck could eventually replace as many as 30 medium-duty vehicles in the city fleet. The City of Santa Monica is pursuing this project in an effort to make further progress towards meeting the goals of switching municipal fleets to zero-emission technologies.

Develop & Demonstrate 2010 Compliant LNG Heavy-Duty Truck

In November 2006, the Ports of Los Angeles and Long Beach adopted a five-year Clean Air Action Plan (CAAP) establishing several control measures and programs to reduce emissions from port-related operations. One such measure, HDV1 (performance standards for on-road heavy-duty vehicles) includes the replacement of approximately 16,000 drayage trucks serving the ports to meet the clean truck standard, which is defined as the EPA 2007 on-road emissions standard, and includes both diesel and LNG-fueled engines. Year by year, the oldest trucks will be barred from the ports until only trucks meeting the clean truck standard will be permitted to work in the ports. In addition, the CAAP also established a Technology Advancement Program, which seeks to accelerate the verification or commercial availability of new, clean technologies, through evaluation and demonstration activities, to identify cleaner technologies for port-related emissions sources. A portion of the drayage trucks can now be replaced with LNG trucks powered by Westport Power 1.2 g/bhp-hr NO_x High Pressure Diesel Injection (HPDI) engines. A portion of the remaining trucks can be replaced with LNG trucks powered by 0.8 g/bhp-hr NO_x HPDI engine or 0.6 g/bhp-hr NO_x HPDI engines, which are being proposed for development by Westport Power, Inc.

Figure 14: Westport Engine and LNG System

The primary objective of this project completed by Westport Power was to develop, demonstrate, and certify an LNG HPDI engine used in Class 8 heavy-duty truck applications at or below 0.6 g/bhp-hr NO_x and 0.01 g/bhp-hr PM in early 2008, and 0.2 g/bhp-hr NO_x and 0.01 g/bhp-hr PM emissions in mid-2009. Phase 1 focused on calibration improvements using the existing engine hardware, as well as development of processes in conjunction with Kenworth Truck Company to make the LNG truck available as a Kenworth product. This included development of a new higher-volume production facility for Westport systems which opened in February 2007. Phase 1 was completed with the Kenworth truck offering in February 2009. Phase 2 included the development of new 2010 system architecture leading to certification and on-road demonstration of the 0.2g NOx solution. A draft version of the final report task was submitted to SCAQMD in December 2011 and the final version will be completed by the end of February 2012.

Due to limitations of the engine hardware the sub-0.6 g/bhp-hr NO_x calibration developed during Phase 1 was considered not robust enough for certification and with the agreement of SCAQMD, a different (0.68g NO_x) calibration was introduced as a running change. This solution still offered

benefits over the current product at that time, including a 0.1g/bhph reduction in NO_x over the transient cycle representative of urban driving and a 3.3% fuel economy improvement over the steady-state cycle representative of highway driving. For the 0.2g NO_x solution, the new system architecture and in particular the addition of the SCR to the aftertreatment system required wide-ranging calibration development. This included improving fuel system control algorithms and diagnostics and further fine-tuning of the Auxiliary Emissions Control Devices (AECDs). Following extensive engine dynamometer and vehicle testing the system was certified at a third-party facility to the following emissions levels, comfortably exceeding the EPA regulations.

Regulated Emissions (g/bhp-hr)			
CO	NOx	nmHC	PM
0.13	**0.14**	**0.02**	**0.004**

A six-month field trial of three trucks equipped with the 0.2g NO_x engine was completed in March 2011 and accumulated 167,000 miles. The vehicles selected as the demonstration fleet operated as port drayage trucks between the Port of Long Beach and locations within the Southern California Basin. With its launch in 2010 the Westport GX 15L engine in the Kenworth T800 became the first commercially available LNG-fuelled truck meeting the EPA 2010 on-road heavy-duty emissions standards. As of January 2012 over three hundred of these trucks have been put into service in the U.S., surpassing the sales of the pre-2010 version developed in Phase 1. Sales are projected to increase in 2012 and the next few years as LNG fuelling infrastructure is expanded across the country. Westport continues to work on refinements and cost-reduction initiatives to further improve the product.

Develop & Demonstrate Selective Catalytic Reduction Technology (SCRT™) for NO_x and PM Emissions Control of Diesel-Powered Heavy Heavy-Duty Trucks

Diesel-powered on-road heavy heavy-duty vehicles contribute over 70 percent and 85 percent of the total Basin NO_x and PM emissions, respectively from 1998 to 2002 model year heavy-duty diesel vehicles, based on CARB's EMFAC 2007 emissions model. Selective catalytic reduction and particulate filter technologies are capable of significantly reducing NO_x and PM emissions from diesel engines. Additional field demonstration would provide further information on the use of such technologies and could lead to early commercialization.

The goal of the project completed by Johnson Matthey, Inc. was to develop, optimize, and demonstrate a combined diesel particulate filter and selective catalytic reduction technology, otherwise called selective catalytic regeneration technology (SCRT™) on fourteen 1998 through 2002 model year on-road vehicles powered by diesel engines rated at 350 hp or more.

Figure 15: Truck Equipped with SCRT™

In this project, Johnson Matthey's SCRT™ systems were installed on fourteen 1998 through 2002 model year trucks operating out of the Ralph's Grocery distribution center in Riverside California. The trucks were powered with Caterpillar C12 or DDC Series 60 diesel engines. The trucks were operated with the SCRT™ systems for periods ranging from one year to three years. Two trucks were tested over UDDS cycle on a fresh (< 30 hours of operation) and aged (>2,500 hours) SCRT™ systems.

The test result showed that the SCRT™ system reduced engine out NO_x emission by between 67 and 70 percent and PM emission by more than 85 percent over the test cycle as shown in Figure 2. This project identified areas in the system that needed improvement like the wiring harness to increase the system reliability. The project also highlighted a need for larger diameter catalysts to minimize the back pressure caused by the system. The improvements to the system that resulted from this project are being used by SCAQMD in three new programs funded under the EPA emerging technologies program.

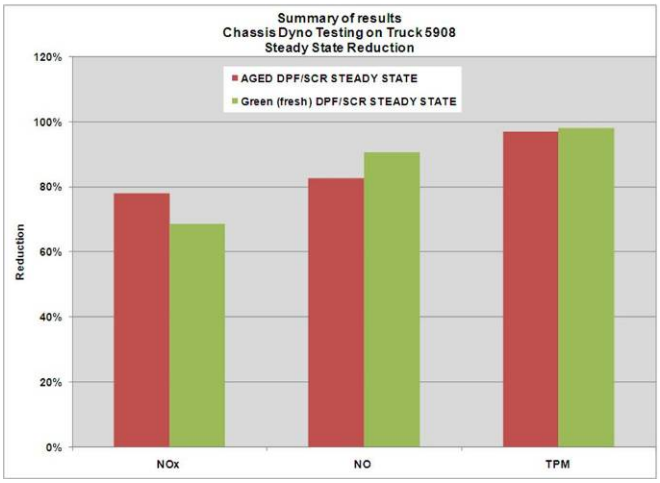


Figure 16: Chassis Dyno Testing Results on Truck 5908 Steady State Reduction

Demonstrate Projects for Renewable Feedstock to Energy and Fuel Technologies

Renewable energy is an integral part of California's strategy to reduce greenhouse gas emissions and to diversify domestic energy supplies. In order to meet the targets and goals established by state initiatives such as the Renewable Portfolio Standard which has a 33% target for electricity generation from renewable sources by 2020, it is essential to develop and implement more advanced technologies to convert various renewable feedstocks, including biowaste, to renewable energy. UCR/CE-CERT has developed the Steam Hydrogasification Reaction (SHR) process to produce Synthetic Natural Gas (SNG) with high methane content from biomass and biowaste. SHR is a thermo-chemical process to convert carbonaceous matters to methane in a hydrogen rich environment. One of the benefits of this process is that it can handle wet feedstocks like wastewater sludge. Given that the fraction of solid wastes with high moisture content, such as food waste, wastewater sludge and green waste that can pose more environmental issues in proper disposal, has increased over the years, SHR can provide a viable option to process such wastes more efficiently. Another key benefit of this process is that the use of steam increases the rate of methane formation significantly with high carbon conversion efficiency compared to other gasification technologies. In addition, the SHR process does not require an expensive oxygen plant, therefore reducing considerable capital costs, which can be a critical factor for smaller production facilities.

Figure 17: Bench Scale SHR-WGS System

The purpose of this project was to conduct a bench scale demonstration for the SHR process to produce natural gas from green waste and biosolids. Pine sawdust and wastewater sludge from Riverside Waste Water Treatment Plant were used as feedstocks and pretreated in a hydrothermal reactor to make pumpable slurry with 40% solid loading. In this demonstration project, pretreated feedstock is fed to a pressurized rotating kiln type SHR reactor, in which carbons in the feedstock reacts with hydrogen to produce methane. Some CO and CO_2 are also created in the process but the amounts are much smaller in

comparison to typical oxidation gasification processes. A new Water Gas Shift (WGS) unit was developed to convert CO in the product gas to hydrogen with steam over iron based catalyst in order to meet the hydrogen demand in the SHR reactor. Once hydrogen is separated and recycled, the process is left with methane rich SNG as a final product.

The total project cost was approximately $210,000 including $100,000 SCAQMD funding. Viresco Energy provided the rest in both monetary and in-kind contributions. This project, which was completed in March 2011, has demonstrated that the SHR process is capable of achieving as high as 69% carbon conversion rate and producing Synthetic Natural Gas with 90% mass methane content. Based on these results, production of SNG with HHV of 13.9 GJ/day (13.2 MMBTU/day) is estimated at a feedstock flow rate of 1 BDT/day. Furthermore, a feedstock availability assessment conducted by UCR/CE-CERT projected that 15.4 billion CF of SNG, approximately 5% of the total annual natural gas production in CA, can be annually produced using this process from available green waste and biosolids in the South Coast Air Basin.

Table 6: Projects Completed between January 1 & December 31, 2011

Contract	Contractor	Project Title	Date
Infrastructure and Deployment			
06029	Clean Energy	Upgrade CNG Fueling Station at SoCalGas Santa Monica Facility	Dec-11
06030	Clean Energy	Purchase & Install CNG Fueling Station at Foothill Transit's Pomona Facility	Dec-11
06042	UCLA Fleet & Transit Services	Upgrade Existing CNG Public Access Station with Dispenser & Card Reader	Dec-11
06043	County Sanitation Districts of Los Angeles	Purchase & Install CNG Fueling Station at Joint Water Pollution Control Plant in Carson City	Dec-11
06074	City of Sierra Madre	Purchase & Install New Public Access CNG Fueling Station at City Yard	Dec-11
06082	Clean Energy	Purchase & Install New 24-Hour Public Access CNG Fueling Station at SoCalGas's Canoga Park Facility	Dec-11
06139	Lake Elsinore Unified School District	Purchase and Install New Public Access CNG Fueling Station at Maintenance Yard	Dec-11
08033-1	California Air Resources Board	Demonstrate LPG Stop-Fill Unit	Jun-11
10181	BAF Technologies	Demonstrate Natural Gas-Powered Police Vehicle	Mar-11
Fuels/Emission Studies			
07181	California Air Resources Board	Physical, Chemical & Toxilogical Assessment of the Semi-Volatile & Non-Volatile Fraction of PM	Apr-11
08033-2†	California Air Resources Board	Test Particulate Measurement Device for In-Use Vehicles	Jun-11
08263	University of California Riverside/CE-CERT	Evaluate Emissions Impacts from Diesel Biofuel & Biofuel Blends	Dec-11
10693	West Virginia University Research Corporation	Provide Transportable Laboratory Testing to Quantify Emissions from SCR Technology	Aug-11
11519	University of California Riverside	Evaluate Protocols for Measuring Emissions from Cleaning of Application Equipment & Surfaces	Jun-11
Emission Control Technologies			
08033-3†	California Air Resources Board	Demonstrate Retrofit SCR System for NO_x Emission Reduction Using Crystalline Matrix Storage for Ammonia	Jun-11
08068	Johnson Matthey Inc.	Develop & Demonstrate SCR Technology for NO_x and PM Emissions	Jan-11
08261	Community Recycling & Resource Recovery, Inc.	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	Mar-11
10125	University of California Riverside	Demonstrate Projects for Renewable Feedstock to Energy and Fuel Technologies	Mar-11

Table 6: Projects Completed between January 1 & December 31, 2011

Contract	Contractor	Project Title	Date
Emission Control Technologies (cont'd)			
11655	California State University Long Beach Foundation	CSULB CEERS Student Education Study to Assess the Effects of an Exhaust Scrubber on Diesel Emissions	Dec-11
Electric/Hybrid Technologies			
09017	U.S. Environmental Protection Agency	Develop & Demonstrate Hydraulic-Hybrid Shuttle Bus	Oct-11
09023†	ISE Corporation	Develop & Demonstrate a Battery Electric Transit Bus	May-11
09360†	BMW of North America LLC	Lease of Five Mini-E Electric Vehicles	Dec-11
09427	City of Santa Monica	Demonstrate Battery Electric Class 4 Utility Truck	Dec-11
Engine Systems			
08192	Westport Power, Inc.	Develop & Demonstrate 2010 Compliant LNG Heavy-Duty Truck	Jun-11
10041	McNeilus Truck and Manufacturing	Develop Prototype Natural Gas-Powered Concrete Mixer Truck and Demonstrate Performance and Emissions	Jun-11
Mobile Fuel Cell Technologies			
11656	Bevilacqua-Knight, Inc.	Participate in California Fuel Cell Partnership for Calendar Year 2011 & Provide Support for Regional Coordinator	Dec-11
Hydrogen Infrastructure			
05165	Air Products and Chemicals Inc.	Install & Demonstrate Three Electrolyzers (in Burbank, Riverside & Santa Monica) and Two Mobile Fuelers (in Santa Ana & Ontario)	Jun-11
10149	NextEnergy Center	Cosponsor Feasibility, Design & Development of 70 MPa Hydrogen Home Fueling Appliance	Nov-11
Health Impacts Studies			
08033-4	California Air Resources Board	Spatiotemporal Analysis of Air Pollution and Mortality in California Based on the American Cancer Society Cohort	Jun-11
08033-5	California Air Resources Board	Extended Analysis of Air Pollution & Cardiopulmonary Disease in the California Teachers Study Cohort	Jun-11
Stationary Clean Fuels Technology			
05027	SolSource Energy	Install an 80 kW Solar Panel System at SCAQMD Headquarters	Jun-11
10114	Orange County Sanitation Districts	Retrofit Digester Gas Engine with Fuel Gas Clean-Up and Exhaust Emission Control Technology	Sep-11

Table 6: Projects Completed between January 1 & December 31, 2011

Contract	Contractor	Project Title	Date
Outreach and Technology Transfer			
02311†	Cole, Jerald A.	Technical Assistance for Development, Outreach & Commercialization of H2 Infrastructure & Reforming Technology	Jun-11
02333†	University of California Riverside	Technical Assistance on Clean Fuels, Hydrogen, Fuel Cell & Natural Gas Technologies	Jun-11
04146†	Gross, Tom	Technical Assistance for Hydrogen & Fuel Cell Technologies	May-11
05121†	Sullivan, Cindy	Technical Assistance for Development, Analysis & Technology Implementation of Incentive Programs	Mar-11
05171†	Hazelton, James	Technical Assistance on AB 1222 Advisory Group	Mar-11
07130†	Burnett & Burnette	Technical Assistance with CNG Technology	Dec-11
09184†	University of California Riverside	Technical Assistance on Advanced, Low- and Zero-Emission Technologies and Implementation Activities	Aug-11
10716†	California Hydrogen Business Council	Platinum Membership Renewal	May-11
11156†	Gladstein, Neandross & Associates LLC	Cosponsor the ACT "Alternative Clean Transportation" Expo 2011	Jul-11
11207†	Coordinating Research Council, Inc.	Cosponsor the CRC Mobile Source Air Toxics Workshop	May-11
11563†	Western Riverside Council of Governments	Cosponsor 12th Annual WRCOG's Advancing the Choice Event	May-11
11565†	Community Partners FBO Move LA	Cosponsor the Move LA "We Love LA" Events Series	Aug-11
11591†	Better World Group, The	Outreach & Planning Assistance for MSRC's 20th Anniversary Workshop & Retreat	Sep-11
11618†	Coordinating Research Council, Inc.	Cosponsor the CRC Life Cycle Analysis Workshop of Biofuels	Dec-11
11622†	Three Squares, Inc.	Cosponsor the Women in Green Forum	Nov-11
11678†	University of California Davis-Institute of Transportation Studies	Cosponsor the Asilomar 2011 Conference on Transportation and Energy	Dec-11

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

CLEAN FUELS PROGRAM
2012 PLAN UPDATE

Technology Funding Priorities for 2012

The Clean Fuels Program continually seeks to support the development and deployment of zero and near-zero emission technologies over a broad array of applications and spanning near- and long-term implementation. Planning has been and remains an ongoing activity for the program, which must remain flexible to address evolving technologies and the latest progress in the state-of-the-technology. The past few years have been especially difficult for technology partnering due to the dramatic global economic downturn, which has shifted national research and development priorities and opportunities. The challenge for the SCAQMD continues to be how to identify project or technology opportunities in which its available funding can accelerate the commercialization and deployment of progressively cleaner technologies in the Basin.

The overall strategy is based in large part on technology needs identified in the 2007 AQMP for the Basin and the SCAQMD Board's directives to protect the health of residents of Southern California. The 2007 AQMP is the long-term "blueprint" that defines the basin-wide emission reductions needed to achieve ambient air quality standards by 2014 and 2023, the regulatory measures to achieve those reductions, the timeframes to implement these proposed measures and the technologies or types of technologies required to meet these future federal standards. As previously identified, the NO_x and VOC emission sources of greatest concern are heavy-duty on-road and off-road and light-duty on-road vehicles.

In addition to providing for specific control measures based on known technologies and control methods, the Clean Air Act has provisions for more general measures based on future, yet-to-be-developed technologies. These "black box" measures are provided under Section 182(e)(5) of the Clean Air Act for regions that are extreme non-attainment areas, such as the South Coast Basin.

In recent years, it has become increasingly clear that the importation of goods through the Ports of Los Angeles and Long Beach and the subsequent movement of goods throughout the region not only have a dramatic impact on air quality but also the quality of life to the communities along the major goods movement corridors. In recognition of these impacts, the SCAQMD has initiated a concerted effort in the last two years on developing zero and near-zero emissions goods movement technologies, such as electric trucks, plug-in hybrid trucks with all-electric range, trucks operating from wayside power and even electric locomotives. The prioritization of these types of projects as well as potential technologies which assist with their further development and deployment are emphasized in the 2012 Plan Update.

This 2012 Plan Update includes projects to develop, demonstrate and commercialize a variety of technologies, from near-term to long-term, that are intended to provide solutions to the emission control measures identified in the 2007 AQMP and to address the increasing challenges this region is facing to meet air quality standards, including new and changing federal requirements, implementation of new technology measures, and the continued development of economically sound, flexible compliance approaches. The scope of projects in the 2012 Plan Update also needs to remain sufficiently flexible to address requirements in the 2012 AQMP as they are identified during development of this AQMP update.

Within each technical area, there exists a range of projects that represent near-term to long-term efforts. The SCAQMD Clean Fuels Program tends to support development, demonstration and technology commercialization efforts, or deployment, rather than fundamental research. The general time-to-product for these efforts, from long-term to near-term, is described below.

- Technology *development* projects are expected to begin during 2012 with durations of about two years. Additional field demonstrations to gain long-term verification of performance, spanning up to two years, may also be needed prior to commercialization. Certification and ultimate commercialization would be expected to follow. Thus, development projects identified in this plan are expected to result in technologies ready for commercial introduction as soon as 2014. Projects are also proposed that may involve the development of emerging technologies that are considered longer term and, perhaps higher risk, but with significant emission reduction potential. Commercial introduction of such long-term technologies would not be expected until 2015 or later.
- More mature technologies, those ready to begin field *demonstration* in 2012, are expected to result in a commercial product in the 2013-14 timeframe. Technologies being field demonstrated generally are in the process of being certified. The field demonstrations provide a controlled environment for manufacturers to gain real-world experience and address any end-user issues that may arise prior to the commercial introduction of the technology. Field demonstrations provide real-world evidence of a technology's performance to help allay any concerns by potential early adopters.
- *Deployment* or technology commercialization efforts focus on increasing the utilization of clean technologies in conventional applications. It is often difficult to transition users to a non-traditional technology or fuel, even if such a technology or fuel offers significant societal benefits. As a result, one of government's roles is to support and offset any incremental cost to help accelerate the transition and use of the cleaner technology. The increased use and proliferation of these cleaner technologies often depends on this initial support and funding as well as efforts intended to increase confidence of stakeholders that these technologies are real, cost-effective in the long term and will remain applicable.

Technical Priorities

The SCAQMD program maintains flexibility to address dynamically evolving technologies incorporating the latest progress. Over the years, the SCAQMD has provided funding for projects for a wide variety of low- and zero-emission projects. In order to meet the upcoming 2014 PM2.5 and 2023 8-hour ozone standards, the areas of zero- and near-zero emission technologies need to be emphasized and this effort can be seen in the following sections and in the proposed funding distribution in Figure 1. The major technical program areas are identified below with specific project categories discussed in more detail in the following sections. The technology areas identified reflect the staff's forecast for upcoming projects and needs within the basin but is not intended to be considered a budget.

Not all project areas will be funded, due to cost-share constraints, focus on the control measures identified in the AQMP and the availability of suitable projects. The technical areas identified below are clearly appropriate within the context of the current air quality challenges and opportunities for technology advancement. Within these areas there is significant opportunity for SCAQMD to leverage its funds with other funding agencies to expedite the implementation of cleaner alternative technologies in the Basin. In fact, the AQMD historically has leveraged its funds $1 for every $4 of total project costs.

It should be noted, however, that these priorities may shift during the year in keeping with the diverse and flexible "technology portfolio" approach. Changes in priority may occur 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 SCAQMD's jurisdiction. As such, these technical areas are not listed by priority but rather based on proximity to commercialization and large-scale deployment.

Infrastructure and Deployment

The importance of refueling infrastructure cannot be overemphasized for the realization of large deployment of alternative fuel technologies. 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 of public and private infrastructure investments, 2) expand the network of public-access and fleet fueling stations and charging sites based on the population of existing and anticipated vehicles, and 3) put in place infrastructure that will ultimately be needed to accommodate transportation fuels with very low gaseous emissions.

CNG and LNG refueling stations are being positioned to support public and private fleet applications. Upgrades and expansions are also needed to refurbish or increase capacity for some of the stations installed five years ago as well as standardize fueling station design, especially to ensure growth of alternative fuels throughout the South Coast Air Basin and beyond. Funding has been provided at key refueling points for light-, medium- and heavy-duty natural gas vehicle users traveling from the local ports, along I-15 and the greater ICTC network.

Active participation in the development of NFPA fire and safety codes and standards, cost and economics of the new fuels, public education and training and emergency response capability are just a few areas of the funded efforts that have overcome public resistance to these new technologies. Some of the projects expected to be developed and co-funded for infrastructure development are:

- Development and demonstration of renewable natural gas as a vehicle fuel from renewable feedstocks and biowaste;
- Development and demonstration of advanced, cost effective methods for manufacturing synthetic gas to be converted into renewable natural gas;
- Deployment of natural gas home refueling appliances for light-duty vehicles;
- Investigation and enhancing safety of and emission reduction for LNG refueling equipment;
- Expansion of fuel infrastructure, fueling stations, and equipment; and
- Expansion of infrastructure connected with existing fleets, public transit, and transportation corridors.

Emissions, Fuels and Health Impacts Studies

The monitoring of pollutants in the Basin is extremely important, especially when focused on (1) a particular sector of the emissions inventory (to identify the responsible technology) or (2) exposure to pollution (to assess the potential health risks). Recent studies indicate that smoggy areas can produce irreversible damage to children's lungs. This information highlights the need for further emissions and health studies to identify the emissions from high polluting sectors as well as the health effects from these technologies.

Over the past few years, the SCAQMD has funded emission studies to evaluate the impact of tailpipe emissions of biodiesel and ethanol fueled vehicles mainly focusing on criteria pollutants and greenhouse gas emissions. These studies showed that biofuels, especially biodiesel, contribute to higher NO_x emissions while reducing other criteria pollutant emissions. 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. Therefore, the SCAQMD has recently funded studies to investigate the physical and chemical composition and toxicological potential of tailpipe PM

emissions from biodiesel and ethanol fueled vehicles to better understand their impact on public health.

In recent years, there has also been an increased interest both at the state and national level on the use of alternative fuels including biofuels 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 and cellulosic biomass plays an important role in this regard. In this regard, the SCAQMD funded a research project in 2011 to identify regional cellulosic biofuel feedstocks best suited for a large scale production in California. This project utilizes a newly developed robotic system capable of handling a large number of samples to determine their sugar yields and potentials as biofuel feedstocks.

Some areas of focus include:

- demonstration of remote sensing technologies to target different high emission applications and sources;
- studies to identify the health risks associated with ultrafines and ambient particulate matter including their composition to characterize their toxicity and determine specific combustion sources;
- in-use emissions studies to determine the impact of new technologies, in particular PEVs on local air quality as well as the benefit of telematics on emissions reduction strategies; and
- lifecycle energy and emissions analyses to evaluate conventional and alternative fuels.

Emission Control Technologies

Although engine technology and engine systems research is required to reduce the emissions at the combustion source, post-combustion cleanup methods are also needed to address the current installed base of on-road and off-road technologies. Existing diesel emissions can be greatly reduced with aftertreatment controls such as particulate matter traps and catalysts, as well as lowering the sulfur content or using additives with diesel fuel. Gas-to-Liquid (GTL) fuels, formed from natural gas or other gas 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. 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 advanced aftertreatment technologies for mobile applications (including particulate traps and selective catalytic reduction catalysts);
- development and demonstration of low-VOC and PM lubricants for diesel and natural gas engines; and
- development and demonstration of advanced air pollution control equipment.

Electric and Hybrid Technologies

If the region hopes to meet the federal standards for $PM_{2.5}$ and ozone, a primary focus must be on zero- and near-zero emission technologies. A leading strategy to achieve these goals is the widescale implementation of electric drive systems for all applicable technologies. With that in mind, the SCAQMD seeks to support projects to address the main concerns regarding cost,

battery lifetime, travel range, charging station infrastructure and manufacturer commitment. Integrated transportation systems can encourage further reduction of emissions by matching the features of electric vehicles (zero emissions, zero start-up emissions, limited range) to typical consumer demands for mobility by linking them to transit.

The development and deployment of zero emission goods movement systems remains one of top priorities for the SCAQMD to support a balanced and sustainable growth in the port complex. In addition to collaborating with the Ports of Los Angeles and Long Beach to identify promising technologies for such systems, the SCAQMD released a Request for Information in November 2011 to seek information on viable zero- and near-zero emission locomotive technologies such as dual-mode locomotives using wayside power like catenary or third rail, battery tender cars, maglev, linear motor systems, fuel cell and other applicable technologies. The information provided will be used to better understand technology options and associated requirements in preparation for potential future development and deployment initiatives. Another notable action the SCAQMD has taken in support of zero-emission goods movement systems is the release of a Request for Proposal in December 2011 for a prototype zero-emission linear motor goods movement system. The project selected in this program shall be funded from the Advanced Technology Goods Movement Fund which has been established to facilitate the development and deployment of low- and zero-emission goods movement technologies.

There also remains high interest by the major automobile manufacturers for hybrid-electric technologies in light-, medium- and heavy-duty applications as well as off-road equipment. In particular, diesel- and gasoline-fueled hybrid-electric vehicles and specialty light-duty pure electric vehicles have entered the commercial market. Such vehicles offer the benefits of higher fuel economy and range as well as lower emissions. Hybrid electric technology is not limited to gasoline and diesel engines and can be coupled with natural gas engines, microturbines and fuel cells for further emission benefits. Opportunities to develop and demonstrate technologies that could enable expedited widespread use of electric and hybrid-electric vehicles in the Basin include the following:

- evaluation and demonstration of light-, medium- and heavy-duty plug-in hybrid electric vehicles;
- demonstration of full performance and niche application battery electric vehicles;
- demonstration of advanced energy storage technologies;
- demonstration of integrated programs that make best use of electric drive vehicles through interconnectivity between fleets of electric vehicles and mass transit, and web-based reservation systems that allow multiple users;
- demonstration of heavy-duty battery electric vehicles;
- demonstration of heavy-duty hybrid vehicles including hydraulic and series hybrid concepts;
- development and demonstration of hybrid and electric technologies for goods movement, e.g., linear inductive motors and series hybrids with all electric range trolley trucks on catenary wayside power;
- development of streamlined implementation procedures to prepare and accelerate EV market penetration and commercialization; and
- demonstration and installation of EV infrastructure to support the electric/hybrid-electric vehicle fleets currently on the roads or soon entering the market.

Engine Systems

The use of alternative fuels can provide significant reductions in NO_x and PM emissions, especially in heavy-duty diesel engines for on-road, off-road and marine applications. Natural gas engines have shown significant promise, with the greatest benefit coming from heavy-duty diesel truck and bus replacement with new natural gas vehicles in urban areas.

In order for alternative fuel heavy-duty engines to achieve commercial acceptance and market penetration, their performance, durability and cost-effectiveness, in addition to emissions reduction, must be demonstrated to the end user. Future projects will support the development, demonstration and certification of alternative fuel engines using an optimized systems approach to broaden their application and availability. Specifically, these projects are expected to target the following:

- continued development and demonstration of alternative fuel medium-duty and heavy-duty engines and vehicles;
- development and demonstration of clean alternative fuel engines for off-road applications;
- development and demonstration of hybrid electric technologies for off-road applications;
- evaluation of alternative engine systems such as compressed air propulsion and hydraulic plug-in hybrid vehicles; and
- development and demonstration of engine systems that employ advance fuel or alternative fuels, engine design features, improved exhaust or recirculation systems, and aftertreatment devices.

Hydrogen Infrastructure & Fuel Cell Technologies

The SCAQMD supports hydrogen infrastructure and fuel cell technologies as one option in our technology portfolio and is dedicated to assisting the federal and state governments in commercializing fuel cell vehicles by supporting the required refueling infrastructure.

SCAQMD has supported many efforts for fuel cell demonstration and deployment in the South Coast district. Stationary fuel cells offer base-load power solutions that can operate 24/7. To combine power generation, hydrogen infrastructure and renewable energy within a single technology advancement would present a unique opportunity to produce clean renewable energy. The SCAQMD has partnered with federal and state agencies, industry and universities to develop a stationary fuel cell that operates on biogas to produce heat, power and hydrogen. An SCAQMD project demonstrating this technology is in progress at a wastewater sanitation district in the Basin. This project could advance SCAQMD's goals for clean distributed generation, hydrogen infrastructure and renewable energy. Going forward the technology is being refined and tested with the goal to apply it to other sites where biogas is a byproduct that can be utilized.

Hydrogen use as a vehicle fuel offers an attractive combination of benefits including zero-tailpipe emissions, petroleum displacement and greenhouse gas emissions reduction, with long driving range and short refueling times compared to other zero-emissions vehicle technologies. While technical hurdles have kept fuel cell vehicles from quickly advancing to commercial deployment, they are now emerging in fleets that will be significantly deployed in the south coast region of California. In particular, the production of hydrogen from renewable sources is of interest, either using photovoltaics and electrolyzer technologies or biomass feedstocks and reformation technologies, due to the potential for lower greenhouse gas emissions compared to conventional fuels. Such renewable energy projects would provide data to help understand and benchmark critical parameters for enabling these technologies.

Considerable research, development and demonstration efforts are already underway to address these issues by some of the largest automobile manufacturers and fuel suppliers. Yet more work is needed to improve the performance and range of these vehicles, reduce costs, develop a viable fueling infrastructure and obtain public acceptance for a new technology in everyday applications.

The SCAQMD has sponsored the development and deployment of fuel cell bus technologies because these heavy-duty vehicles have zero tailpipe emissions, help establish hydrogen infrastructure and provide outreach potential through ridership. The SCAQMD is currently supporting the development of advanced fuel cell transit bus applications to commercialize the technology and make it available for federal funding. The American Fuel Cell Bus Project is a program to create a purpose built fuel cell bus platform with components that are sourced in the U.S. This successful project will open up FTA funding for future transit purchases of the clean zero emission bus technology. Work continues on supplier development and manufacturing integration.

The SCAQMD is actively working with the California Fuel Cell Partnership and the California Hydrogen Highway Network to further the commercialization of fuel cells and install the required hydrogen refueling infrastructure. Calendar Years 2015-2017 is a critical timeframe for the introduction of fuel cell vehicles. Since stations need one to two years lead time for permitting and construction, plans for stations need to be initiated now. In addition, new business models and funding besides grants for construction need to be explored to enable the station operations to remain solvent during the early years until vehicle numbers ramp up.

The 2012 Plan Update identifies key opportunities consistent with both organizations while clearly leading the way for pre-commercial demonstrations of OEM vehicles. Future projects may include the following:

- development and demonstration of hydrogen-natural gas vehicles for medium- and heavy-duty vehicle applications as well as stationary power applications;
- continued development and demonstration of distributed hydrogen production and refueling stations, including energy stations with electricity and hydrogen co-production and higher pressure (10,000 psi) hydrogen dispensing;
- development and demonstration of cross-cutting fuel cell applications (e.g. plug-in hybrid fuel cell vehicles);
- development and demonstration of fuel cells in off-road, locomotive and marine applications; and
- demonstration of fuel cell vehicles in controlled fleet applications in the Basin.

Stationary Clean Fuel Technologies

Although stationary source emissions are small compared to mobile sources in the South Coast Air Basin, there are areas where cleaner fuel technology can be applied to reduce NO_x, VOC and PM emissions. For example, inspections suggest there is a large population of small combustion generators within the Basin that are operating outside their permit limits due to poor maintenance, deliberate tuning for different performance, operation outside equipment design or changes in fuel quality. Cleaner, more robust distributed generation technologies exist that could be applied to not only improve air quality, but enhance power quality and reduce electricity distribution congestion.

The use of renewable feedstocks for energy production is a viable and necessary strategy to provide sustainable power for future needs while reducing greenhouse gas emissions and achieving domestic energy diversity. One of the projects that the SCAQMD recently supported in

this effort was a bench scale demonstration project using steam hydrogasification process to produce natural gas from biomass and biosolids (sewage sludge) feedstocks. Steam Hydrogasification Reaction (SHR) has been developed to produce various forms of energy products from carbonaceous resources. SHR is capable of handling wet feedstocks like sludge, does not require expensive oxygen plants and has been demonstrated to be most efficient and cost-effective compared to other conventional gasification technologies. This project successfully demonstrated that the SHR process coupled with a WGS reactor can produce substituted natural gas containing up to 90% methane.

Projects conducted under this category may include:

- development and demonstration of reliable, low-emission stationary technologies (e.g., low NO_x burners, fuel cells or microturbines);
- exploration of renewables as a source for cleaner stationary technologies; and
- evaluation, development and demonstration of advanced control technologies for miscellaneous stationary sources.

Target Allocations to Core Technology Areas

below presents the potential allocation of available funding, based on SCAQMD projected program costs of $16.2 million for all potential projects. The expected actual project expenditures for 2012 will be less than the total SCAQMD projected program cost since not all projects will materialize. The 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 SCAQMD funding. Specific contract awards throughout 2012 will be based on this proposed allocation, the quality of proposals received and evaluation of projects against standardized criteria and ultimately SCAQMD Governing Board approval.

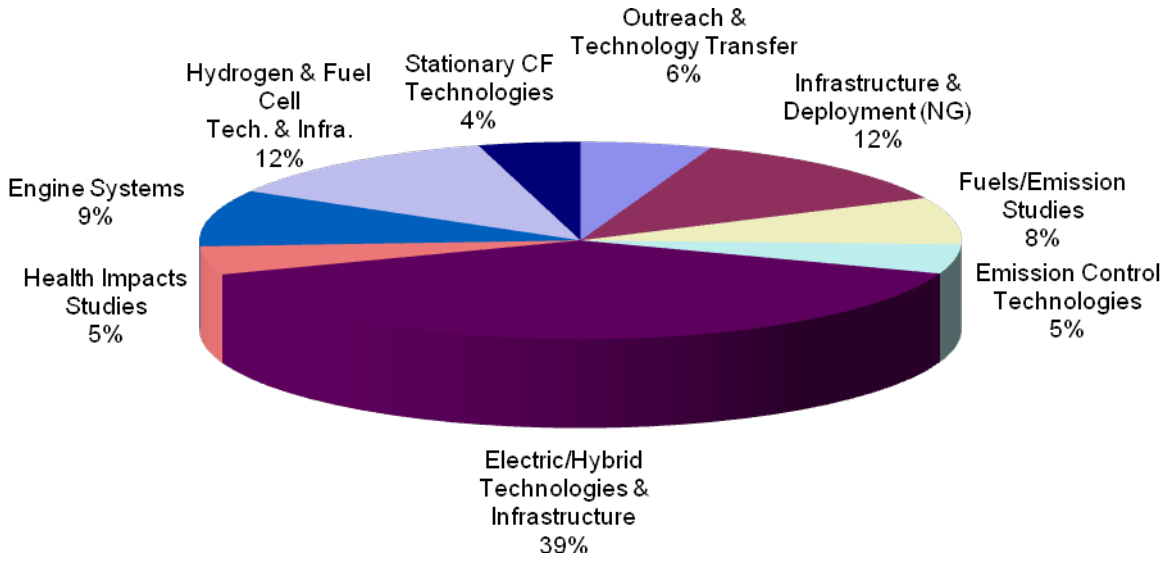


Figure 18: Projected Cost Distribution for Potential SCAQMD Projects 2012 & Beyond ($16.2M)

PROGRAM PLAN UPDATE FOR 2012

This section presents the Clean Fuels Program Plan Update for 2012. The proposed projects are organized by program areas and described in further detail, consistent with the SCAQMD budget, priorities and the best available information. Although not required, this Plan also includes proposed projects that may be funded by revenue sources other than the Clean Fuels Program, specifically related to VOC and incentive projects.

Table 7 summarizes potential projects for 2012 as well as the redistribution of AQMD costs in some areas. The relative shift in funding allocation are a result of the continued but increasing focus on zero and near-zero emission technologies as well as awards over the last year to other technology areas. For the past two years the SCAQMD has emphasized electric and hybrid-electric technologies and the urgency now is to develop and demonstrate heavy-duty all electric fuel cell, plug-in hybrid and hybrid technologies with all electric range for zero and near-zero emission goods movement applications, including the infrastructure for such technologies.

Each of the proposed projects described in this Plan, once fully developed, will be presented to the SCAQMD Governing Board for approval prior to contract initiation. This development reflects the maturity of the proposed technology, identification of contractors to perform the projects, host site participation, securing sufficient cost-sharing to complete the project and other necessary factors. Recommendations to the SCAQMD Governing Board will include descriptions of the technology to be demonstrated and in what application, the proposed scope of work of the project and the capabilities of the selected contractor and project team, in addition to the expected costs and expected 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 7.

Proposed Project: A descriptive title and a designation for future reference.

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

Expected Total Cost: The estimated total project cost including the SCAQMD 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 SCAQMD 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 7: Summary of Potential Projects

Proposed Project	Expected SCAQMD Cost $	Expected Total Cost $
Infrastructure and Deployment		
Deploy Natural Gas Vehicles in Various Applications	500,000	2,000,000
Develop, Maintain & Expand Natural Gas Infrastructure	1,000,000	2,000,000
Demonstrate LNG Manufacturing and Distribution Technologies Including Renewables	500,000	7,000,000
Subtotal	$2,000,000	$11,000,000
Fuels/Emission Studies		
In-Use Emissions Studies for Advanced Technology Vehicle Demonstrations	750,000	1,000,000
Conduct Emissions Studies on Biofuels and Alternative Fuels	100,000	1,300,000
Identify and Demonstrate In-Use Fleet Emissions Reduction Technologies & Opportunities	400,000	2,000,000
Subtotal	$1,250,000	$4,300,000
Emission Control Technologies		
Develop and Demonstrate Advanced Aftertreatment Technologies	525,000	5,000,000
Demonstrate On-Road Technologies in Off-Road and Retrofit Applications	250,000	1,000,000
Subtotal	$775,000	$6,000,000
Electric/Hybrid Technologies		
Demonstrate Light-Duty Plug-In Hybrid & Battery Electric Vehicles and Infrastructure	1,000,000	2,000,000
Develop and Demonstrate Medium- and Heavy-Duty Hybrid Vehicles and Infrastructure	4,000,000	8,000,000
Demonstrate Alternative Energy Storage	300,000	2,000,000
Develop and Demonstrate Electric Container Transport Technologies	1,000,000	5,000,000
Subtotal	$6,300,000	$17,000,000
Engine Systems		
Develop and Demonstrate Advanced Alternative Fuel Medium- and Heavy-Duty Engines and Vehicles	1,000,000	20,000,000
Develop and Demonstrate Alternative Fuel and Clean Conventional Fueled Light-Duty Vehicles	500,000	1,500,000
Subtotal	$1,500,000	$21,500,000

Table 7: Summary of Potential Projects

Proposed Project	Expected SCAQMD Cost $	Expected Total Cost $
Hydrogen Infrastructure & Fuel Cell Technologies		
Develop and Demonstrate Distributed Hydrogen Production and Fueling Stations	1,750,000	6,000,000
Develop and Demonstrate Fuel Cell Vehicles	250,000	4,000,000
Subtotal	$2,000,000	$10,000,000
Health Impacts Studies		
Evaluate Ultrafine Particle Health Effects	250,000	3,000,000
Conduct Monitoring to Assess Environmental Impacts	250,000	1,000,000
Assess Sources and Health Impacts of Particulate Matter	250,000	300,000
Subtotal	$750,000	$4,300,000
Stationary Clean Fuel Technologies		
Develop and Demonstrate Reliable, Low Emission Monitoring Systems and Test Methods	250,000	500,000
Develop and Demonstrate Clean Stationary Technologies	250,000	750,000
Develop and Demonstrate Renewables-Based Energy Generation Alternatives	200,000	1,000,000
Subtotal	$700,000	$2,250,000
Outreach and Technology Transfer		
Assessment and Technical Support of Advanced Technologies and Information Dissemination	500,000	800,000
Support for Implementation of Various Clean Fuels Vehicle Incentive Programs	400,000	400,000
Subtotal	$800,000	$1,200,000
TOTALS FOR POTENTIAL PROJECTS	**$16,175,000**	**$77,550,000**

Technical Summaries of Potential Projects

Infrastructure and Deployment

Proposed Project: Deploy Natural Gas Vehicles in Various Applications

Expected SCAQMD Cost: $500,000

Expected Total Cost: $2,000,000

Description of Technology and Application:

Natural gas vehicles (NGVs) have been very successful in reducing emissions in the South Coast Air Basin due to the deployment of fleets and heavy-duty vehicles utilizing this clean fuel. In order to maintain the throughput, utility and commercial potential of the natural gas infrastructure and the corresponding clean air benefits, deploying additional models of NGVs in existing applications are needed. This technology category seeks to support the implementation of early-commercial vehicles in a wide variety of applications, such as taxis, law enforcement vehicles, shuttle buses, delivery vans, transit buses, waste haulers, class 8 tractors and off-road equipment such as construction vehicles and yard hostlers.

Potential Air Quality Benefits:

Natural gas vehicles have inherently lower engine criteria pollutant emissions than conventional vehicles, especially in the heavy-duty applications where older diesel engines are being replaced. Incentivizing these vehicles in city fleets, goods movement applications and transit bus routes help to reduce the local emissions and exposure to nearby residents. Natural gas vehicles also can have lower greenhouse gas emissions and increase energy diversity depending on the feedstock and vehicle class. Deployment of additional NGVs is in agreement with the SCAQMD AQMP as well as the state's Alternative Fuels Plan as part of AB1007 (Pavley).

Proposed Project: Develop, Maintain & Expand Natural Gas Infrastructure

Expected SCAQMD Cost: $1,000,000

Expected Total Cost: $2,000,000

Description of Technology and Application:

This program would support the development, maintenance and expansion of natural gas fueling station technologies and incorporate advancing concepts to increase the overall number of such fueling stations in strategic locations throughout the Basin including the Ports, reduce the cost of natural gas equipment, standardize fueling station design and construction and help with the implementation of SCAQMD's fleet rules. As natural gas fueling equipment begins to age or has been placed in demanding usage, components begin to age and deteriorate. This program offers an incentive to 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. NGVs have significantly lower emissions than gasoline vehicles 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, besides improving the refueling time. While new or improved NGV stations have an indirect emissions reduction benefit, they help facilitate the introduction of low-emission, NGVs in private and public fleets in the area, which have a direct emissions reduction benefit. The increased exposure and fleet and consumer acceptance of NGVs would lead to significant and direct reductions in NOx, 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 LNG Manufacturing and Distribution Technologies Including Renewables

Expected SCAQMD Cost: $500,000

Expected Total Cost: $7,000,000

Description of Technology and Application:

Lack of statewide LNG production results in increased fuel costs and supply constraints. The cost of transporting LNG from production facilities out-of-state increases the fuel cost anywhere from 15 to 20 cents per gallon of LNG and subjects users to the reliability of a single supply source. High capital costs prevent construction of closer, large scale liquefaction facilities. Small-scale, distributed LNG liquefaction systems may provide 25 percent lower capital costs than conventional technology per gallon of LNG produced. Because these smaller plants can be sited near fleet customers, costs for transporting the LNG to end users are much lower than those for remote larger plants. Beyond these cost reductions, the smaller plants offer key benefits of much smaller initial capital investment and wider network of supply than the larger plant model. Renewable feed stocks including landfill gas, green waste and waste gases can be processed to yield LNG or CNG.

Industry and government agree that LNG promises to capture a significant share of the heavy-duty vehicle and engine market. LNG is preferred for long distance trucking as it provides twice the energy per unit volume as CNG. This translates to longer driving ranges and lower-weight vehicle fuel storage.

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

- commercially viable methods for converting renewable feed stocks into CNG or LNG (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 LNG and L/CNG refueling facilities; and
- strategic placement of LNG storage capacity sufficient to provide supply to users in the event of a production outage.

Potential Air Quality Benefits:

The SCAQMD relies on the significant penetration of zero- and low-emission vehicles in the South Coast Basin to attain federal clean air standards by 2014. This project would help develop a number of small-scale liquefaction technologies that can reduce LNG costs to be competitive with diesel fuel. Such advances are expected to lead to greater infrastructure development. This would make LNG fueled heavy-duty vehicles more available to the commercial market leading to direct reductions in NO_x, PM and toxic compound emissions.

Fuels/Emission Studies

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

Expected SCAQMD Cost: $750,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

Hybrid electric, hybrid hydraulic, plug-in electric hybrid and pure EVs will all play a unique 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.

The environmental benefit for each technology class will be highly 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. These positive results 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 conduct a characterization of application specific drive cycles to best match different transportation technologies to 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.

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 the AQMD's air quality goals.

Proposed Project: Conduct Emissions Studies on Biofuels and Alternative Fuels

Expected SCAQMD Cost: $100,000

Expected Total Cost: $1,300,000

Description of Technology and Application:

The use of biofuels can be an important strategy to reduce petroleum dependency, air pollution and greenhouse gas emissions. Biofuels are in fact receiving increased attention due to national support and state activities resulting from AB 32, AB 1007 and the Low-Carbon Fuel Standard. With an anticipated increase in biofuel use, it is the objective of this program to further analyze these fuels to better understand their benefits and impacts not only on greenhouse gases but also on 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 NO_x emissions, which exacerbates the ozone and $PM_{2.5}$ 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 has recently amended the 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 order to address these concerns on potential health effects associated with biofuels, namely biodiesel and ethanol blends, this program 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 program also supports future studies to identify mitigation measures to reduce NO_x emissions for biofuels. Additionally, a study of emissions from well-to-wheel for the extraction and use of shale gas might be considered.

Potential Air Quality Benefits:

If biodiesel and biodiesel blends can be demonstrated to reduce air pollutant emissions with the ability to mitigate any NO_x impact, this technology will become a viable strategy to assist in meeting air pollutant standards as well as the goals of AB 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 (NO_x impact) that may result from using this alternative fuel. With reliable information on the emissions from using biodiesel and biodiesel blends, the AQMD can take actions to ensure the use of biodiesel will obtain air pollutant reductions without creating additional NO_x emissions that may exacerbate the Basin's ozone problem.

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

Expected SCAQMD Cost: $400,000

Expected Total Cost: $2,000,000

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. Unfortunately, the in-use fleet lacks telematic systems--particularly heavy-duty engines in trucks, buses, construction equipment, locomotives, marine vessels 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.

This project category is to investigate near-term emissions control technologies which can be economically 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; and
- development, deployment and demonstration of smart vehicle telematic systems

The second phase of the project is to validate the technology or strategy on a larger demonstration project over a longer period of time.

Potential Air Quality Benefits:

Many of the technologies identified can be applied to light-duty 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, which is included in Chapter 4 of the 2007 AQMP as a potential control strategy.

Emission Control Technologies

Proposed Project: Develop and Demonstrate Advanced Aftertreatment Technologies

Expected SCAQMD Cost: $525,000

Expected Total Cost: $5,000,000

Description of Technology and Application:

There are a number of aftertreatment technologies which have shown substantial emission reductions in diesel engines. These technologies include diesel particulate filters (DPFs), oxidation catalysts, selective catalytic reduction (SCR) systems and NO_x adsorbers. 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, NO_x, CO, carbonyl and hydrocarbon emissions in retrofit and new applications. With the increasing focus on zero and near-zero emission goods movement technologies, this category should examine idle reduction concepts and technologies that can be employed at ports and air ports.

Possible projects include advancing the technologies for on-road retrofit applications such as heavy-duty line-haul diesel engines, street sweepers, waste haulers and transit buses. Applications for non-road may include construction equipment, yard hostlers, gantry cranes, locomotives, marine vessels, 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 emissions 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 SCR and NO_x adsorbers, could also have NO_x reductions of up to 90%.

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

Expected SCAQMD Cost: $250,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

Heavy-duty on-road 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 require a repower (engine exchange) to only meet the same emissions standards as the engine being retired. Unfortunately, this does not take advantage of recently developed clean technologies.

Exhaust gas cleanup strategies, such as SCR, 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 in off-road applications including yard hostlers, switcher locomotives, gantry cranes, waste haulers and construction equipment;
- implementing lower emission engines in repower applications for both on-road and off-road applications; and
- application of stationary best available control technologies, such as SCR, scrubbers, baghouses and electrostatic precipitators, to appropriate on- and off-road applications, such as idling locomotives, marine vessels 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 non-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.

Electric/Hybrid Technologies

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

Expected SCAQMD Cost: $1,000,000

Expected Total Cost: $2,000,000

Description of Technology and Application:

All of the major automobile manufacturers are currently developing and commercializing hybrid-electric vehicles, which now come in a variety of fuel economy and performance options. These commercial hybrid EVs integrate a small internal combustion engine, battery pack and electric drive motors to improve fuel economy (e.g., Honda Insight) or performance (e.g., Lexus RX400h).

The SCAQMD has long supported the concept of using increased batteries to allow a portion of the driving cycle to occur in all-electric mode for true zero emission miles. This battery dominant strategy is accomplished by incorporating an advanced battery pack initially recharged from the household grid or EV chargers. This "plug-in" hybrid EV strategy allows reduced emissions and improved fuel economy. In 2009, CARB adopted Plug-In Hybrid Electric Vehicle Test Procedure Amendments and Aftermarket Parts Certification and several automobile manufacturers have announced demonstration or early production plans of "blended" plug-in hybrid electric, extended-range electric vehicles (E-rEV), or highway capable battery electric vehicles (BEVs). Electric utilities refer to PHEVs, E-rEVs and BEVs as plug-in electric drive vehicles (PEVs) and are working with automakers to support PEVs. The recent adoption of revised recommended practice SAE J1772 will enable vehicles to charge from 120V (Level 1) or 240V (Level 2) using a common conductive connector overnight or in a few hours. Japan has adopted a Fast DC charging standard that could charge a passenger car in 30 minutes or less, and demonstrations will help provide data to adopt a recommended practice in the U.S.

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 way that significantly reduces emissions of pollutants and greenhouse gases.

At recent auto shows, automakers have displayed concept plug-in fuel cell vehicles. Development and demonstration of dual fuel, zero emission vehicles could expand the acceptance of battery electric vehicles and accelerate the introduction of fuel cells in vehicle propulsion.

This project category is to develop and demonstrate: 1) various PEV architectures; 2) anticipated costs for such architectures; 3) customer interest and preferences for each alternative; 4) prospective commercialization issues and strategies for various alternatives; 5) integration of the technologies into prototype vehicles and fleets; 6) infrastructure (especially in conjunction with the DOE and the Los Angeles Department of Water & Power) to demonstrate the potential clean air benefits of these types of vehicles; and 7) support for local government outreach and charging installation permit streamlining.

Potential Air Quality Benefits:

The 2007 AQMP identifies zero- or near zero-emitting vehicles as a key attainment strategy. HEV technologies have the potential to achieve near-zero emissions but with the range of a conventional gasoline-fueled vehicle, a factor expected to enhance consumer acceptance. Given the variety of PEV systems under development, it is critical to determine the true emissions and performance of PEVs.

Demonstration of optimized prototypes would enhance the deployment of near-ZEV and ZEV technologies.

Expected benefits include the establishment of criteria for emissions evaluations, performance requirements, customer acceptability of the technology, etc. This will help both regulatory agencies and OEMs to expedite introduction of near-zero and zero emitting vehicles in the South Coast Basin, which is a high priority of the AQMP.

Proposed Project: Develop and Demonstrate Medium- and Heavy-Duty Hybrid Vehicles and Infrastructure

Expected SCAQMD Cost: $4,000,000

Expected Total Cost: $8,000,000

Description of Technology and Application:

Hybrid technologies have gained momentum in the light-duty sector with commercial offerings by most all of the automobile manufacturers. Unfortunately, the medium- and heavy-duty platforms are where most emissions reductions are required, especially for the in-use fleet due to low turnover. This project category is to investigate the use of hybrid technologies to achieve similar performance as the conventional fueled counterparts while achieving both reduced emissions and improved fuel economy. Development and validation of emission test procedures is needed, but is complicated due to the low volume and variety of medium- and heavy-duty vehicles.

Platforms to be considered include utility trucks, delivery vans, shuttle buses, transit buses, waste haulers, construction equipment, cranes and other off-road vehicles. Innovations that may be considered for demonstration include: advancements in the auxiliary power unit, either ICE or other heat engine; battery-dominant hybrid systems utilizing off-peak re-charging, with advanced battery technologies such as lithium-ion; and hydraulic energy storage technologies where applicable. Alternative fuels are preferred in these projects, e.g., natural gas, LPG, hydrogen, GTL and hydrogen-natural gas blends, but conventional fuels such as gasoline, clean diesel, or even biodiesel may be considered if the emissions benefits can be demonstrated as equivalent or superior to alternative fuels. Both new designs and retrofittable technologies and related charging infrastructure will be considered.

Federal recovery act funding combined with state and local support has accelerated the development and demonstration of medium-duty plug-in hybrid electric truck platforms. Analysis of project data and use profiles will help optimize drive systems, target applications for early commercialization and fill gaps in product offerings.

Potential Air Quality Benefits:

The 2007 AQMP identifies zero- or near zero-emitting vehicles as a key attainment strategy. Hybrid technologies have the potential to redirect previously wasted kinetic energy into useable vehicle power. This proposed project category will evaluate various hybrid systems and fuel combinations to identify their performance and emissions benefits. Given the variety of hybrid systems under development, it is critical to determine the true emissions and performance of these prototypes, especially if both emissions and fuel economy advantages are achieved.

Expected benefits include the establishment of criteria for emissions evaluations, performance requirements and customer acceptability of the technology. This will help both regulatory agencies and OEMs to expedite introduction of near-zero emitting vehicles in the South Coast Basin, which is a high priority of the AQMP.

Proposed Project: Demonstrate Alternative Energy Storage

Expected SCAQMD Cost: $300,000

Expected Total Cost: $2,000,000

Description of Technology and Application:

The SCAQMD has been involved in the development and demonstration of energy storage systems for electric and hybrid-electric vehicles, mainly li-ion chemistry battery packs. Over the past few years, additional technology consisting of nickel sodium chloride, lithium-ion and lithium iron phosphate batteries have shown robust performance. Other technology manufacturers have also developed energy storage devices including flywheels, hydraulic systems and ultracapacitors. Energy storage systems optimized to combine the advantages of ultracapacitors and advanced batteries could yield further benefits. This project category is to apply these advanced storage technologies in vehicle platforms to identify best fit applications, demonstrate their viability (reliability, maintainability and durability), gauge market preparedness and provide a pathway to commercialization.

The long-term objective of this program is to decrease fuel consumption and resulting emissions without any changes in performance compared to conventional vehicles. This program will support several projects for development and demonstration of different types of low-emission hybrid vehicles using advanced energy 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.

Potential Air Quality Benefits:

Certification of low-emission vehicles and engines and their integration into the Basin's transportation sector is a high priority under the 2007 AQMP. This program is expected to develop hybrid technologies that could be implemented in medium- and heavy-duty trucks, buses and other applications. Benefits will include proof of concept for the new technologies, diversification of transportation fuels and lower emissions of criteria, toxic pollutants and greenhouse gases.

Proposed Project: Develop and Demonstrate Electric Container Transport Technologies

Expected SCAQMD Cost: $1,000,000

Expected Total Cost: $5,000,000

Description of Technology and Application:

Advanced transportation systems can be used to transfer cargo containers from ports to both local and "distant" intermodal facilities, thereby significantly reducing emissions from on-road trucks and locomotives and also reducing traffic congestion in local transportation corridors. Such systems could be stand-alone systems that use magnetic levitation (maglev), linear synchronous motors or linear induction motors on dedicated guideways. A more near-term design could use existing roadways that are electrified with catenary electric lines or linear electric motors to move containers on modified trucks equipped to run on electricity. In both scenarios, containers are transported relatively quietly and without direct emissions. The footprints for such systems are similar to conventional rail systems but have reduced impact on adjacent property owners including noise and fugitive dust. These systems can even be built above or adjacent to freeways or on the berm of or elevated above existing river flood control channels. These container freight systems are not designed to carry any operators on the guideways, where the over-the-roadway system may require the operator to actively control the transport of the containers.

One of the container transportation concepts the AQMD is considering is the Linear Synchronous Motor (LSM) technology developed by General Atomics to transport cargo containers with zero tailpipe emissions using electromagnetic propulsion system. The LSM system is derived from the maglev technology without its levitation component and is estimated to move a fully loaded 40-ft container at a top speed of 50 mph for approximately 3 kw-hr of electricity per mile. This LSM technology can be potentially adapted to trucking operations where an electric truck with the container on a trailer is moved by linear motors embedded in the road. In addition to the LSM technology, there are other technology options for electric container applications such as dual-mode locomotives or trucks using wayside power, e.g., a third rail or catenary, hybrid electric technologies with battery storage, a battery tender car, magnetic levitation, and fuel cell propulsion system. This program will evaluate all available technology options to determine whether their systems can be successfully developed and deployed, financially viable, and reliably operated on a long-term basis.

Potential Air Quality Benefits:

On-road heavy-duty diesel truck travel is an integral part of operations at the ports moving cargo containers into the Basin and beyond. The 2007 AQMP proposes to reduce emissions from this activity by modernizing the fleet and retrofitting NO_x and PM emission controls on older trucks. An alternative approach, especially for local drayage to the nearby intermodal facilities, is to use advanced container transport systems that use electric propulsion for the containers on fixed guideways or modified trucks able to operate on electricity which will eliminate local diesel truck emissions. The emission benefits have not yet been estimated because the fate of the displaced trucks has not been determined.

Engine Systems

Proposed Project: Develop and Demonstrate Advanced Alternative Fuel Medium- and Heavy-Duty Engines and Vehicles

Expected SCAQMD Cost: $1,000,000

Expected Total Cost: $20,000,000

Description of Technology and Application:

The objective of this proposed program is to support development and certification of near commercial prototype low-emission heavy-duty alternative fuel engine technologies and demonstration of these technologies in on-road vehicles. The NO_x emissions target for this program area is 0.2 g/bhp-hr and lower and the PM emissions target is below 0.01 g/bhp-hr. To achieve these targets, an effective emission control strategy must employ advance fuel or alternative fuels, engine design features, improved exhaust or recirculation systems, and aftertreatment devices that are optimized using a system approach. This program is expected to result in several projects, including:

- demonstration of advanced engines in medium-duty and heavy-duty vehicles;
- development of durable and reliable retrofit technologies to convert engines and vehicles from petroleum fuels to alternative fuels; and
- anticipated fuels for these projects include but are not limited to CNG, LNG, LPG, emulsified diesel and GTL fuels. The program proposes to expand field demonstration of these advanced technologies in various vehicle fleets operating with different classes of vehicles.

The use of alternative fuel in heavy-duty trucking applications has been demonstrated in certain local fleets within the Basin. These vehicles typically require 200-300 horsepower engines. Higher horsepower alternative fuel engines are beginning to be introduced. However, vehicle range, lack of experience with alternative fuel engine technologies and limited selection of appropriate alternative fuel engine products have made it difficult for more firms to consider significant use of alternative fuel vehicles. For example, in recent years, several large trucking fleets have expressed interest in using alternative fuels. However, at this time the choice of engines over 350 HP or more is limited. Continued development of cleaner dedicated natural gas or other alternative fuel engines such as natural gas-hydrogen blends over 350 HP would increase availability to end-users and provide additional emission reductions.

Potential Air Quality Benefits:

This program is intended to expedite the commercialization of low-emission alternative fuel heavy-duty engine technology in California, both in the Basin and in intrastate operation. The emission reduction benefit 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 1400 lb/yr of NO_x. Clean alternative fuels, such as natural gas, or natural gas blends with hydrogen can also reduce heavy-duty engine particulate emissions by over 90 percent compared to current diesel technology. This program 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 program to comply with SCAQMD fleet regulations.

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

Expected SCAQMD Cost: $500,000

Expected Total Cost: $1,500,000

Description of Technology and Application:

Although new conventional 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, gas-to-liquid (GTL), bio-diesel and ultra low-sulfur diesel. The potential vehicle projects may include:

- certification of CNG light-duty sedans and pickup trucks used in fleet services;
- resolution of higher concentration ethanol (E-85) affect on vehicle fueling system ("permeation issue");
- certification of E85 vehicles to SULEV standards; and
- assessment of "clean diesel" vehicles, including hybrids and their ability to attain SULEV standards.

Other fuel and technology combinations may also be considered under this category.

Potential Air Quality Benefits:

The 2007 AQMP identifies the use of alternative clean fuels in mobile sources as a key attainment strategy. Pursuant to AQMP goals, the SCAQMD 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 program is expected to lead to increased availability of low-emission alternative-and conventional-fueled vehicles for fleets as well as consumer purchase.

Hydrogen Infrastructure & Fuel Cell Technologies

Proposed Project: Develop and Demonstrate Distributed Hydrogen Production and Fueling Stations

Expected SCAQMD Cost: $1,750,000

Expected Total Cost: $6,000,000

Description of Technology and Application:

Alternative fuels, such as hydrogen and the use of advanced technologies, such as fuel cell vehicles, 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 an infrastructure to support the refueling of vehicles, cost-effective production and distribution and clean utilization of these new fuels.

A major challenge to the entry and acceptance of direct-hydrogen fuel cell vehicles is the limited number of hydrogen refueling sites. This program 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, other strategic refueling locations and increased dispensing pressure of 10,000 psi and compatibility with existing CNG stations may be considered.
- *Energy Stations*: Multiple-use energy stations that can produce hydrogen for fuel cell vehicles or for stationary power generation are considered an enabling technology with the potential for costs competitive with large-scale reforming. System efficiency, emissions, hydrogen throughput, hydrogen purity and system economics will be monitored to determine the viability of this strategy for hydrogen fueling infrastructure deployment and as a means to produce power and hydrogen from renewable feedstocks (biomass, digester gas, etc.).
- *Home Refueling Appliances*: Home refueling/recharging is an attractive advancement for alternative clean fuels due to the limited conventional refueling infrastructure. Similar to the natural gas home refueling appliance currently commercially available, this project would evaluate a hydrogen home refueler for cost, compactness, performance, durability, emission characteristics, ease of assembly and disassembly, maintenance and operations. Other issues such as building permits, building code compliance and UL ratings for safety would also be evaluated.

Potential Air Quality Benefits:

The 2007 AQMP identifies the use of alternative clean fuels in mobile sources as a key attainment strategy. Pursuant to AQMP goals, the SCAQMD 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. Fuel cell vehicles constitute the cleanest alternative-fuel vehicles today. Since hydrogen is a key fuel for fuel cell vehicles, this program 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 NO_x, VOC, CO, PM and toxic compound emissions from vehicles.

Proposed Project: Develop and Demonstrate Fuel Cell Vehicles

Expected SCAQMD Cost: $250,000

Expected Total Cost: $4,000,000

Description of Technology and Application:

This proposed project would support the demonstration of promising fuel cell technologies for applications using direct hydrogen in proton exchange membrane (PEM) fuel cell technologies. Battery fuel cell hybrids are another potential technology being mentioned by battery experts as a way of reducing costs and enhancing performance of fuel cell vehicles.

With the implementation of the California Hydrogen Highway Network, supplemented by the existing and planned hydrogen refueling stations in the Southern California area, pre-production vehicles are planned for demonstration in controlled fleets, such as local cities, transit authorities and airports. Some of these pre-production vehicles include light-duty trucks as well as small to full size transit and shuttle buses. Fleets are useful demonstration sites because economies of scale exist in central refueling, in training skilled personnel to operate and maintain the vehicles, in the ability to monitor and collect data on vehicle performance and for manufacturer technical and customer support. 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. This category may include projects in the following applications:

On-Road:
- Light-Duty Vehicles
- Transit Buses
- Shuttle Buses
- Medium-Duty Trucks (Utility or Other)

Off-Road:
- Vehicle Auxiliary Power Units
- Construction Equipment
- Lawn and Garden Equipment
- Cargo Handling Equipment

Potential Air Quality Benefits:

The 2007 AQMP identifies the need to implement zero-emission vehicles. SCAQMD 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 zero-emission fuel cells operating on hydrogen fuel. The proposed projects have the potential to accelerate the commercial viability of fuel cell vehicles. 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 widescale implementation of zero-emission fuel cell vehicles 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.

Health Impacts Studies

Proposed Project: Evaluate Ultrafine Particle Health Effects

Expected SCAQMD Cost: $250,000

Expected Total Cost: $3,000,000

Description of Technology and Application:

Reducing diesel exhaust from vehicles has become a high priority in the South Coast Air Basin since CARB identified the particulate phase of diesel exhaust as a surrogate for all of the toxic air contaminant emitted from diesel exhaust. Additionally, recent health studies indicate that the ultrafine portion of particulate matter 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 ultrafine particles 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 the new technologies and the health effects of these emissions, an evaluation and comparison of ultrafine particulate matter and the potential impacts on community exposures are necessary.

In this program, measurements and chemical composition of ultrafine particulates will be done, as well as studies conducted to characterize their toxicity. The composition of the particulates 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 ultrafine particulate matter, PAH and other relevant toxic emissions from different types of fuels such as CNG, low-sulfur diesel, etc. These tests may also include comparisons with the application of particulate matter retrofit traps. This program needs to be closely coordinated with the development of technologies for alternative fuels, aftertreatment and new engines in order to determine the health benefits of such technologies.

Potential Air Quality Benefits:

The Air Quality Management Plan for the South Coast Basin relies on significant penetration of low-emission vehicles to attain federal clean air standards . Reduction of particulate 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 amount of ultrafine particulates generated by different types of fuels and advanced control technologies as well as provide information on potential health effects of ultrafine particles. 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 SCAQMD Cost: $250,000

Expected Total Cost: $1,000,000

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, distribution centers and freeways is important to identify the emissions exposure to the surrounding communities and provide the data to then conduct the health impacts due to these sources. This project category would identify other areas of interest to conduct ambient air monitoring, conduct the emissions monitoring, analyze the data and assess the health impacts from mobile sources. The projects would need to be at least one year in duration in order to properly assess the air quality impacts in the area.

Potential Air Quality Benefits:

The proposed project will assist in the 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; 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 SCAQMD Cost: $250,000

Expected Total Cost: $300,000

Description of Technology and Application:

Previous studies of ambient levels of toxic air contaminants, such as the MATES series of studies, have found that diesel exhaust is the major contributor to health risk from air toxics. Analyses of diesel particulate matter in ambient samples have been based on measurements of elemental carbon. While the bulk of particulate elemental carbon in the South Coast Air 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 South Coast Air Basin. Analysis of particulate bound organic compounds was utilized as tracers to estimate levels of ambient diesel particulate matter as well as estimate levels of particulate matter 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.

The measurement of organic compounds as tracers from specific sources is a technique that has been used in numerous source apportionment studies and published within the scientific literature. The resulting data on levels of tracers can be evaluated using Chemical Mass Balance Models and other source apportionment techniques, such as Positive Matrix Factorization, to estimate source contributions to particulate matter. The resulting estimates of ambient diesel particulate matter can then be used to assess potential health risks.

It is anticipated that in CY 2012 MATES IV related studies and assessments will be initiated. Additionally, other related studies may be conducted, such as toxicity assessment based on age, source (heavy-duty, light-duty engines) and composition (semi-volatile or non-volatile fractions) to better understand the health effects and potential community exposures.

Potential Air Quality Benefits:

Results of this work will provide a more robust, scientifically sound estimate of ambient levels of diesel particulate matter as well as levels of particulate matter from other significant combustion sources. This will allow a better estimation of potential exposures to and health effects from toxic air contaminants from diesel exhaust in the South Coast Air Basin. This information in turn can be used to determine the health benefits of promoting clean fuel technologies.

Stationary Clean Fuel Technologies

Proposed Project: Develop and Demonstrate Reliable, Low Emission Monitoring Systems and Test Methods

Expected SCAQMD Cost: $250,000

Expected Total Cost: $500,000

Description of Technology and Application:

Currently, the inability of air/fuel ratio control (AFRC) systems to keep rich-burn engines in compliance contributes significantly to air pollution in the basin. Reliable, low-cost emission monitoring systems are needed for small-to-intermediate size combustion devices, including stationary engines, boilers, heaters, furnaces and ovens that are not large enough to justify a continuous emission monitoring system (CEMS). This class of combustion device is often permitted on the basis of a single demonstration or periodic demonstrations of NO_x and CO emissions meeting SCAQMD rule requirements or a RECLAIM concentration limit. However, SCAQMD-unannounced tests on engines and boilers have found that in many cases NO_x and/or CO levels have increased significantly above levels that have been initially or periodically demonstrated due to equipment malfunction and/or inadequate operator attention. It is suspected that the same may be true of heaters, furnaces and ovens.

Demonstrations of newer technologies in recent years could result in a commercially viable alternative to CEMs that is both reliable and feasible in terms of lower costs. For example, manufacturers of flue gas analyzers have, in recent years, developed low-cost multi-gas analyzers suitable for portable or stack-mounted use. Some preliminary testing of a new type of AFRC, which uses a different type of O2 sensor known as a wide-band O2 sensor, is another alternative that can be analyzed. A more technical approach might to deploy technology utilizing the O2 signature of a post-catalyst O2 sensor and additional control concepts being developed by manufacturers. Since an underlying problem has been that engine, catalyst and AFRC manufacturers have developed systems independently, a system being co-developed to perform continuous diagnostics to assist operators in keeping rich-burn engines in compliance is possibly another alternative for demonstration.

Potential Air Quality Benefits:

The 2007 AQMP indicates that in 2010 stationary sources, i.e., stationary engines, boilers, heaters, furnaces and ovens, will account for about 11 percent of total NO_x emissions and about 6 percent of total CO emissions. There has been a long-standing compliance problem with rich-burn IC engines in the basin and evidence indicates that many of these devices are operating with NO_x and/or CO emissions above levels required in their permits. Projects could potentially reduce a significant class of NO_x and CO emissions that are in excess of the assumptions in the AQMP and further enhance SCAQMD's ability to enforce full-time compliance.

Proposed Project: Develop and Demonstrate Clean Stationary Technologies

Expected SCAQMD Cost: $250,000

Expected Total Cost: $750,000

Description of Technology and Application:

Stationary sources, including VOC sources such as large printing facilities and furniture manufacturers, have become cleaner and cleaner due to the regulatory requirements for low emissions and the advancements in technology to meet those requirements. Best Available Control Technology (BACT) regulations, however, are only required for new, modified, or relocated sources. This project category is to develop and demonstrate new technologies that can provide emissions reductions in new installations or as retrofit modifications. Possible technology examples include:

- low NO_x technologies (burners and ICEs);
- low-Btu gas technologies (e.g., digester, landfill, or diary gases);
- alternative fuels and hydrogen blends;
- alternative diesel fuels (emulsified, gas-to-liquids, biodiesel with aftertreatment);
- low-emission refinery flares;
- catalytic combustion;
- cost-effective fuel cell and fuel cell hybrid distributed generation;
- fumes-to-fuel technology to replace thermal oxidizers and capture VOC emissions for electricity generation while ensuring no emission of air toxics; and
- boiler optimization design and strategies to improve efficiencies.

Depending on the technology, a proof-of-concept project, demonstration, or pre-commercial deployment would be considered to garner further information on the technology. Issues to investigate include viability (reliability, maintainability and durability) of the technology, cost-effectiveness and operator ease-of-use in order to assess commercialization.

Potential Air Quality Benefits:

The SCAQMD has a substantial number of older, small, stationary source technologies within its jurisdiction. Since these devices are not subject to continuous emissions monitoring system requirements, evidence suggests that these devices may not be operating at their permitted NO_x, CO, hydrocarbon and PM emissions levels. Replacing these devices with cleaner and more reliable technologies or technology/fuel combinations can have dramatic reductions in all of these criteria pollutants. VOC emission reductions may also be achieved at larger stationary VOC sources to achieve the new federal ozone and $PM_{2.5}$ standards.

Proposed Project: Develop and Demonstrate Renewables-Based Energy Generation Alternatives

Expected SCAQMD Cost: $200,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

The objective of this proposed program is to support the development and demonstration of clean energy, renewable alternatives in stationary and mobile applications. The technologies to be considered include thermal, photovoltaic and other solar energy technologies; wind energy systems; energy storage and conservation; 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-fired pumps. Besides renewable technologies, electrolyzer technology could be used to generate hydrogen, a clean fuel. Hydrogen, when used in regular engines, can substantially reduce tail-pipe emissions, 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 program 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 user friendliness and identify markets that could expedite the implementation of successful technologies.

Potential Air Quality Benefits:

The 2007 AQMP identifies the development and ultimately the implementation of non-polluting power generation. To 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.

The proposed program 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.

Outreach and Technology Transfer

Proposed Project: Assessment and Technical Support of Advanced Technologies and Information Dissemination

Expected SCAQMD Cost: $500,000

Expected Total Cost: $800,000

Description of Project:

This program 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 program is to expedite the transfer of technology developed as a result of Technology Advancement projects to the public domain, industry, regulatory agencies and the scientific community. This program is a fundamental element in the SCAQMD's outreach efforts to expedite the implementation of low-emission and clean fuels technologies and to coordinate these activities with other organizations.

This program 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;
- emissions studies and assessments of zero-emission alternatives;
- advanced technology vehicle demonstrations
- preparation of reports, presentations at conferences, improved public relations and public communications of successful demonstrations of clean technologies;
- participation in and coordination of workshops and various meetings;
- support for training programs related to fleet operation, maintenance and refueling of alternative fuel vehicles;
- publication of technical papers, reports and bulletins; and
- production and dissemination of information, including web sites.

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 and associated infrastructure.

Potential Air Quality Benefits:

SCAQMD adopted fleet regulations requiring public and private fleets within the Basin to acquire alternatively fueled vehicles when making new purchases. Expected benefits of highlighting success stories in the use of advanced alternatively fueled vehicles could potentially expedite the acceptance and commercialization of advanced technologies by operators seeking to comply with the provisions of the recently adopted SCAQMD fleet rules. The resulting future emissions benefits will contribute to the goals of the AQMP.

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

Expected SCAQMD Cost: $400,000

Expected Total Cost: $400,000

Description of Project:

This program supports the implementation of zero-emission vehicle incentives program, the Carl Moyer incentives program and the school bus incentives program. Implementation support includes application approval, grant allocation, documentation to the CARB, verification of vehicle registration and other support as needed. Information dissemination is critical to successful implementation of a coordinated and comprehensive package of incentives. Outreach will be directed to vehicle dealers, individuals and fleets.

Potential Air Quality Benefits:

As described earlier, the SCAQMD will provide matching funds to implement several key incentives programs to reduce diesel emissions in the Basin. Furthermore, the SCAQMD recently adopted fleet regulations requiring public and private fleets within the Basin to acquire alternatively fueled vehicles when making new purchases. Expected benefits of highlighting zero-emission vehicle incentives could potentially expedite the acceptance and commercialization of advanced technologies by operators seeking to comply with the provisions of the recently adopted SCAQMD fleet rules. The resulting future emissions benefits will contribute to the goals of the AQMP. The school bus program and the Carl Moyer incentives program will also reduce large amounts of NO_x and PM emissions in the basin in addition to reducing toxic air contaminants.

Appendix A

SCAQMD Advisory Groups

Technology Advancement Advisory Group

Tom Cackette/Bob Cross	California Air Resources Board
Martin Schlageter	Coalition for Clean Air
Dr. Blair Folsom	Independent Consultant in Combustion Technology
James Uihlein	Chevron
John D. Harper, Jr.	Small Business Coalition
Philip J. Hodgetts	Clean Air Now
Patrick Davis.	U.S. Department of Energy
Tim Olson	California Energy Commission
Lee Wallace/R. Steve Simons	Sempra Energy
Ed Kjaer/Jordan Smith	Southern California Edison

SB 98 Clean Fuels Advisory Group*

Martin Schlageter	Coalition for Clean Air
Dr. Blair Folsom	Independent Consultant in Combustion Technology
Dr. John Froines	UCLA Center for Occupational and Environmental Health/UCLA School of Public Health
Dr. Fritz Kalhammer	Independent Consultant in Energy and Process Technology
Dr. Melanie Marty	Office of Environmental Health Hazard Assessment
Dr. Wayne Miller	Center for Environmental Research and Technology University of California, Riverside
Dr. Vernon Roan	Center for Advanced Studies in Engineering University of Florida
Dr. Scott Samuelsen	Combustion Laboratory/National Fuel Cell Research Center/University of California, Irvine
Dr. George Sverdrup	National Renewable Energy Laboratory
Dr. Nicholas Vanderborgh	Independent Consultant in Fuel Cell Technologies
Michael Walsh	Independent Consultant in Motor Vehicle Pollution Control

*Two appointments pending

Appendix B

Open Clean Fuels Contracts as of January 1, 2012

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Infrastructure and Deployment						
05250	Downs Commercial Fueling, Inc.	Purchase & Install New L/CNG Fueling System at Commercial Fueling Station in Temecula	11/04/05	04/30/14	$203,137	$833,333
06028	Consolidated Disposal Service, LLC	Purchase & Install CNG Fueling System at Long Beach Waste Transfer Station	11/23/05	07/31/14	222,038	740,127
06031	R.F. Dickson Company, Inc.	Upgrade CNG Station at Bellflower Facility	04/13/06	12/31/12	211,148	703,828
06084	Clean Energy	Upgrade Existing LNG Facility to L/CNG at Riverside County Waste Management Dept's Aqua Mansa Facility in Riverside	04/13/06	02/28/16	120,000	400,000
06091	City of Whittier	Purchase & Install New Public Access CNG Fueling Station at City Yard	03/18/06	12/31/13	150,000	450,000
06237	Whittier Union High School District	Upgrade Existing Public Access Station with New Dispenser and Card Reader	10/02/06	12/31/12	15,921	31,842
06238	Gas Equipment Systems Inc.	Purchase & Install New CNG Fueling Systems at City of San Fernando Public Works Dept Yard	12/15/06	12/31/12	73,200	410,000
07051	City of Pasadena	Purchase & Install New Public Access CNG Fueling Station	12/28/06	12/31/12	165,000	550,000
07149	City of San Bernardino	Purchase & Install New Public Access LNG-L/CNG Station at City of San Bernardino Municipal Service Yard	06/25/07	12/31/12	164,861	1,399,110
07151	Menifee Unified School District	Purchase & Install New Public Access CNG Station	01/25/07	12/31/12	75,000	414,500
07152	Newport-Mesa Unified School District	Purchase & Install New Limited Public Access CNG Station	05/16/07	12/31/12	150,000	375,000
07153	Foothill Transit	Purchase & Install New Public Access CNG Refueling Station in Irwindale	11/02/09	12/31/12	250,000	3,350,000
07243	City of Commerce	Purchase & Install New Public Access L/CNG Station	05/16/07	12/31/12	250,000	1,300,000
07244	SunLine Transit Agency	Upgrade Existing Public Access CNG Stations in Thousand Palms & Indio	04/04/07	12/31/12	90,000	180,000
07245	USA Waste of California, Inc., dba L.A. Metro	Purchase & Install New LNG Production Facility using Landfill Gas from Altamont Landfill in Livermore	07/11/08	12/31/13	300,000	13,000,000
07246	USA Waste of California, Inc., dba L.A. Metro	Purchase & Install New LNG Storage Tank at Long Beach LNG Refueling Station	12/24/08	12/31/13	200,000	440,000
07320	Orange County Transportation Authority	Install New CNG Station in the City of Santa Ana	12/21/07	12/31/12	350,000	5,841,729
08043	University of California Los Angeles	Public Access CNG Refueling Station Upgrade for UCLA Transportation	05/02/08	12/31/13	140,000	350,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Infrastructure and Deployment (cont'd)						
08044	Beaumont Unified School District	Install Limited Access CNG Refueling Station	03/05/09	12/31/13	288,000	615,994
08098	Redlands Unified School District	Purchase & Install New CNG Refueling Station	01/25/08	12/31/13	525,000	700,000
08101	Pupil Transportation Cooperative	Upgrade Existing Public Access CNG Station	01/04/08	12/31/13	187,154	300,000
08271	Los Angeles Unified School District	Purchase & Install New CNG Refueling Station	06/03/08	12/31/13	617,480	1,747,000
09165	California Cartage Company	Deployment of 2010 Emissions Standards Compliant LNG Trucks	10/31/08	07/31/16	358,000	11,880,000
09218	Rim of the World Unified School District	Install Mountain Safety Equipment on Five New CNG School Buses	01/05/10	12/31/16	65,850	65,850
09348	AFV Fleet Services	Demonstrate Two Natural Gas Powered Police Vehicles	04/03/09	03/18/12	75,000	75,000
09364	Rim of the World Unified School District	Construct & Install a CNG Fueling Station	12/30/10	12/31/14	257,000	425,000
10034	California Cartage Company	Install LNG Fueling Station at the Ports	01/26/10	11/01/14	532,500	1,065,000
10054	Applied LNG Technologies Inc.	Upgrade & Perform Emergency Repairs of L/CNG Refueling Facility	10/30/09	12/31/14	113,359	226,719
10055	Waste Management Collection & Recycling	New Public Access CNG Refueling Station in Santa Ana	12/11/09	12/31/14	250,000	1,622,558
10067	Rim of the World Unified School District	Install Mountain Safety Equipment on Seven New CNG School Buses	12/21/09	12/31/16	92,190	92,190
10640	Yellow Cab of Greater Orange County	Conversion of 45 Taxicabs to Natural Gas Power for Deployment as Airport Ground Transportation	04/23/10	06/01/12	337,500	675,000
11559	Ace Parking Management	Purchase Six Natural Gas-Powered Cutaway-Type Shuttle Vans	05/06/11	07/31/13	96,200	600,950
11561	Supershuttle International	Purchase and Convert 20 Gasoline-Powered Passenger Vans to CNG-Powered Passenger Shuttle Vans	06/01/11	07/31/13	320,600	954,600
12135	Placentia-Yorba Linda Unified School District	Upgrade CNG Fueling Station	11/18/11	11/30/17	60,000	60,000
Fuels/Emission Studies						
08320	University of Denver	Remote Sensing Measurements of On-Road Emissions from Heavy-Duty Diesel Vehicles	02/06/09	01/31/13	161,041	161,041
09290	University of California Riverside	Evaluate Emissions Impacts from Natural Gas Blends on Vehicle Emissions	01/30/09	09/30/12	50,000	450,000
10066	National Renewable Energy Laboratory	CRADA – Loan of 70 MPa Hydrogen Quality Sampling Apparatus to AQMD	11/02/09	12/30/15	0	0

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Fuels/Emission Studies (cont'd)						
10095	University of California Davis-Intelligent Transportation Systems	Cosponsor Sustainable Transportation Pathways Program	06/29/10	07/31/12	120,000	2,310,000
10722	University of California Riverside/CE-CERT	Re-Establish Testing Facility & Quantify PM Emission Reductions from Charbroiling Operations	08/06/10	03/31/12	60,000	60,000
11611	West Virginia University Research Corporation	In-Use Emissions Testing and Demonstrate Retrofit Technology of On-Road Heavy-Duty Engines	07/08/11	10/07/12	734,742	894,647
11612	University of California Riverside	In-Use Emissions Testing and Demonstrate Retrofit Technology of On-Road Heavy-Duty Engines	07/08/11	10/07/12	689,742	708,524
Emission Control Technologies						
07236	National Renewable Energy Laboratory	Investigate the Role of Lubricating Oil on Particulate Matter Emissions from Vehicles	03/23/07	12/30/15	100,000	446,887
08246	Griffith Company	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	5/14/08	12/31/12	191,450	297,450
08252	City of Culver City	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	07/08/08	03/31/12	38,900	138,475
08318	ServoTech Engineering Inc.	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	07/08/08	12/15/12	320,000	990,420
08321	Environmental Systems Products	Remote Sensing Measurements of On-Road Emissions from Heavy-Duty Diesel Vehicles	08/12/08	01/31/12	38,000	38,000
09000	Shimmick Construction	Demonstrate NO_x & PM Emissions Control Technologies on Diesel Powered Construction Equipment	09/11/09	03/31/12	38,900	38,900
10069	Johnson Matthey, Inc.	Develop & Demonstrate SCRT for NO_x and PM Emissions Control	06/18/10	10/13/13	300,000	1,480,000
10696	Johnson Matthey, Inc.	Optimize & Demonstrate SCRT for NO_x and PM Emissions Control	07/09/10	03/31/12	300,000	2,818,449
10697	Johnson Matthey, Inc.	Optimize & Demonstrate SCCRT for NO_x and PM Emissions Control	07/09/10	03/31/12	300,000	2,818,449
10112	Sanitation Districts of Los Angeles County	Showcase: Retrofit Select Catalytic Reduction System & Diesel Particulate Filters on Off-Road Construction Equipment	02/26/10	02/21/12	116,450	116,450
11136	ServoTech Engineering	Demonstrate NO_x and PM Emissions Control Technology on Diesel-Powered Construction	10/15/10	05/31/12	132,000	432,000
12113	Southern Counties Terminals dba Griley Air Freight	Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/13/11	03/31/14	15,000	45,000
12114	South Bound Express, Inc.	Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/13/11	03/31/14	15,000	54,623

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Emission Control Technologies (cont'd)						
12118	National Ready Mixed Concrete	Retrofit 13 Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/13/11	03/31/14	65,000	239,806
12120	Standard Concrete Products	Retrofit 40 Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/13/11	03/31/14	200,000	596,665
12121	Challenge Diary Products, Inc.	Retrofit Three Heavy-Duty Diesel Trucks with Diesel Particulate Filters	11/18/11	03/31/14	15,000	46,845
12122	Bear Trucking, Inc.	Retrofit One Heavy-Duty Diesel Truck with Diesel Particulate Filter	10/14/11	03/31/14	5,000	13,555
12123	RRM Properties	Retrofit 107 Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/06/11	03/31/14	535,000	1,481,067
12124	Gaio Trucking, Inc.	Retrofit Nine Heavy-Duty Diesel Trucks with Diesel Particulate Filters	09/28/11	03/31/14	45,000	165,669
12125	Spragues Ready Mix	Retrofit Four Heavy-Duty Diesel Trucks with Diesel Particulate Filters	10/14/11	03/31/14	20,000	62,953
12175	RRM Properties	Retrofit Seven Heavy-Duty Diesel Trucks with Diesel Particulate Filters	12/08/11	03/31/14	35,000	84,812
12186	Pipeline Carriers Inc.	Retrofit 25 Heavy-Duty Diesel Trucks with Diesel Particulate Filters	12/16/11	03/31/14	125,000	455,750
Electric/Hybrid Technologies						
99109	Toyota	Lease Two Toyota RAV4 Electric Vehicles for CY 2011	04/04/99	02/01/11	7,902	7,902
05260	Energy Control Systems Engineering, Inc.	Conversion of Light-Duty Vehicle to Plug-In Hybrid Vehicles	09/09/05	03/31/12	215,000	940,000
08063	Quantum Fuel Systems Technologies Worldwide, Inc.	Develop & Demonstrate 20 Plug-In Hybrid Electric Vehicles	01/22/08	12/15/14	2,095,613	2,815,266
08067	Calstart	Demonstrate Hydraulic-Hybrid Shuttle Bus	10/30/07	03/31/12	250,000	1,210,000
08219	A123Systems Inc.	Develop & Demonstrate Ten Plug-In Hybrid Electric Vehicles	06/05/09	06/04/15	622,667	962,667
09345	South Bay City Council of Governments	Demonstrate Medium-Speed Electric Vehicles	06/19/09	04/30/13	178,825	178,825
09360	BMW of North America LLC	Lease of Five Mini Cooper Electric Vehicles for CY 2011	05/05/09	12/25/12	51,063	51,063
10738	Foothill Transit	Demonstrate Quick-Charge Infrastructure for Electric Buses	10/29/10	06/28/13	290,000	6,790,000
11204	AC Propulsion	Develop & Demonstrate Electric Drive Conversion for Fleet Vehicles	12/24/10	10/30/12	300,000	755,767
11205	Calstart	Implement Hybrid Truck and Bus Voucher Incentive Program	12/02/10	03/31/12	1,500,000	1,500,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Electric/Hybrid Technologies (cont'd)						
11606	Odyne Systems, LLC	Develop and Demonstrate Plug-In Hybrid Electric Drive System for Medium- and Heavy-Duty Vehicles	07/08/11	07/07/13	494,000	2,599,000
11725	Puente Hills Nissan	Lease of Three Nissan Leaf Vehicles for 39 Months	05/27/11	08/26/14	60,222	82,722
12024	ECOtality North America	Install Electric Charging Infrastructure	11/04/11	05/03/13	70,000	70,000
12028	Electric Vehicle International, Inc.	Demonstrate and Replace UPS Diesel Delivery Trucks with Zero-Emission Medium-Duty Trucks	09/09/11	09/08/17	1,400,000	4,872,000
Engine Systems						
11485	Waste Management Collection & Recycling, Inc.	Demonstrate Refuse Truck Retrofitted with Cummins ISL-G Natural Gas Engine	03/18/11	01/31/12	75,000	300,876
Mobile Fuel Cell Technologies						
10501	American Honda Motor Company, Inc.	Lease a Clarity Fuel Cell Vehicle for Three Years	01/21/10	0120/13	24,001	24,001
10650	SunLine Transit Agency	Demonstrate Advanced Fuel Cell Bus (American Fuel Cell Bus)	06/04/10	06/03/13	400,000	10,214,843
10714	University of California Irvine	Develop Fuel Cell Gas Turbine Hybrid System for On-Board Locomotive Applications	12/02/11	12/01/13	78,000	156,000
11656	Bevilacqua-Knight, Inc.	Participate in California Fuel Cell Partnership for Calendar Year 2011 and Provide Support for Regional Coordinator	01/01/11	12/31/11	137,800	1,632,600
Hydrogen Technologies and Infrastructure						
04011	Air Products and Chemicals, Inc.	Install & Demonstrate an Industrial Pipeline-Supplied Hydrogen Fueling Station in Torrance	08/03/05	02/28/12	489,051	944,761
04185	Quantum Fuel Systems Technologies Worldwide	Develop & Demonstrate Hydrogen Internal Combustion Engine Vehicles	10/18/04	08/31/12	2,182,851	3,328,631
10046	Air Products and Chemicals Inc.	Develop & Demonstrate Renewable Hydrogen Energy and Refueling Station	12/21/09	05/31/13	750,000	8,436,735
10061	Hydrogenics Corporation	Maintenance & Data Management for the AQMD Hydrogen Refueling Station	10/30/09	06/30/12	238,000	238,000
11150	Hydrogen Frontier, Inc.	Maintenance & Operation of City of Burbank Hydrogen Fueling Station	11/24/10	01/24/15	200,000	1,060,000
10482	California State University Los Angeles	Install and Demonstrate PEM Electrolyzer, Providing Hydrogen Fueling for Vehicles and Utilizing the Technology in the Engineering Technology Curriculum at the University	03/04/11	10/03/17	250,000	1,662,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Health Impacts Studies						
09307	California Air Resources Board	In-Vehicle Air Pollution Exposure Measurement & Modeling	09/01/08	06/28/12	250,000	500,000
11527	University of Southern California	Conduct Study on Sources, Composition, Variability and Toxicological Characteristics of Ultrafine Particles in Southern California	07/24/11	07/24/14	470,969	470,969
Stationary Clean Fuels Technology						
09303	Permacity Solar	Install 40kW (AC) Crystalline Silicon System at AQMD HQs	01/30/09	01/29/15	387,162	387,162
09304	Solar Integrated Technologies Inc.	Install Turnkey Rooftop 40 kW Building Integrated Photovoltaic System	12/20/08	12/19/14	390,695	390,695
Outreach and Technology Transfer						
00069	Walsh Consulting	Technical Assistance Relating to the Use of Alternative Fuels in Mobile Sources	02/17/00	02/28/12	35,000	35,000
02308	Sperry Capital, Inc.	Evaluate Financial Stability of Potential Contractors	06/25/02	12/31/13	50,000	50,000
04049	Engine, Fuel & Emissions Engineering Inc.	Technical Assistance for Alternative Fuels Engine Technology	11/21/03	04/30/13	120,000	120,000
05126	St. Croix Research	Development, Outreach & Commercialization of LNG, CNG and Hydrogen Fuels	03/15/05	03/31/13	25,000	25,000
05127	Protium Energy Technologies	Development, Outreach & Commercialization of Hydrogen and Fuel Cell Technologies	03/14/05	03/31/12	60,000	60,000
05128	Mid-Atlantic Research Institute LLC	Development, Outreach & Commercialization of Advanced Heavy-Duty and Off-Road Technologies	08/08/05	03/31/11	40,000	40,000
05198	Don Stedman	Technical Assistance for Remote Sensing Programs for Light-Duty Vehicles and Locomotives	05/30/05	11/30/12	25,000	25,000
07059	Dowling Associates, Inc.	Technical Assistance Related to Air Quality Impacts of Regional Goods	12/19/06	11/30/12	68,000	68,000
07060	Don Breazeale and Associates, Inc.	Technical Assistance Related to Air Quality Impacts of Regional Goods Movement	11/15/06	11/30/12	58,000	58,000
07062	The Tioga Group, Inc.	Technical Assistance Related to Air Quality Impacts of Regional Goods	12/19/06	11/30/12	58,000	58,000
07129	Breakthrough Technologies Institute, Inc.	Technical Assistance with Fuel Cell Technology	12/01/06	03/31/12	40,000	40,000
07314	Engine, Fuel and Emissions Engineering, Inc.	Technical Assistance with Advanced Heavy-Duty and Off-Road Technologies	06/25/07	12/31/13	60,000	60,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Outreach and Technology Transfer (cont'd)						
08210	Sawyer Associates	Technical Assistance on Mobile Source Control Measures and Future Consultation on TAO Activities	02/22/08	02/28/12	25,000	25,000
08254	Maria Robles, R.N.	Administrative Assistance in Organizing Two Air Quality & Health-Related Conferences	05/02/08	07/31/12	149,760	149,760
08311	CALSTART	Technical Assistance with Development, Outreach, and Commercialization of Advanced Technology to Transit, Port & Other Activities	07/11/08	05/31/12	75,000	75,000
09183	Gary Full	Technical Assistance on Remote Sensing Measurement Technologies as Applied to Auto, Heavy-Duty Diesel and Other Mobile Sources	02/20/09	06/30/12	20,000	20,000
09185	Clean Fuel Connection Inc.	Technical Expertise on the CARB EMFAC Mobile Emissions Model and Other Related Mobile Source Issues	05/08/09	06/30/12	50,000	50,000
09252	JWM Consulting Services	Technical Assistance with Review & Assessment of Advanced Technologies, Heavy-Duty Engines, and Conventional & Alternative Fuels	12/20/08	06/30/12	30,000	30,000
09253	Nexant, Inc.	Technical Assistance on Alternative Fuels Life-Cycle Analyses	01/02/09	06/30/12	20,000	20,000
09255	Stan Lisiewicz	Technical Assistance with Caltrans	01/29/09	12/31/12	10,000	10,000
09337	Mark Weekly, CPA	Follow-Up Assessment of AQMD's Compliance with Special Revenue Funds	03/03/09	01/31/13	35,000	35,000
10056	Advanced Transportation Technology & Energy, San Diego Community College District	Enhanced Training Technology Program	05/27/10	12/31/13	500,000	500,000
10062	TIAX LLC	Technical Assistance for Implementation of Proposition 1B Goods Movement Program and Truck Replacement Program	11/13/09	12/31/21	200,000	575,000
10700	TIAX LLC	Technical Assistance for Advanced, Low- and Zero-Emissions Mobile & Stationary Source Technologies	07/23/10	05/31/12	120,000	120,000
10662	Gladstein, Neandross & Associates	Technical Assistance for Implementation of Proposition 1B Goods Movement and Truck Replacement Program	05/12/10	12/31/13	175,000	175,000
10663	Clean Fuel Connection	Technical Assistance for Implementation of Proposition 1B Goods Movement Program	05/12/10	12/31/12	250,000	350,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Outreach and Technology Transfer (cont'd)						
11028	Martin Kay	Technical Assistance on Stationary Source Control Measures & Future Consultation on TAO Activities	08/04/10	12/31/12	40,000	40,000
11117	Clean Fuel Connection, Inc.	Technical Assistance for Alternative Fuels, Renewable Energy and Electric Vehicles	09/17/10	12/31/12	50,000	50,000
11144	San Diego Community College District on behalf of Advanced Transportation Technology and Energy	Natural Gas-Powered Vehicle Training and Safety and Fuel Cylinder Inspection Program	12/10/10	05/31/13	130,000	130,000
11148	Joseph C. Calhoun, P.E. Inc.	Technical Assistance for Development, Outreach & Commercialization of Advanced Low-Emission Vehicle	10/08/10	12/31/12	35,000	35,000
11182	Tech Compass	Technical Assistance with Alternative Fuels, Fuel Cells, Emissions Analysis & Aftertreatment Technologies	11/19/10	12/31/12	75,000	75,000
11484	Gladstein, Neandross & Associates, LLC	Develop and Implement Two Customer Centers to Provide Education and Outreach to Truck Owners and Operators	01/27/11	05/31/12	150,000	150,000
12104	Three Squares, Inc.	Development, Initiation & Implementation of a Clean Vehicle Outreach Project	09/23/11	09/22/12	100,000	100,000

Appendix C

Final Reports for 2011

SCAQMD Contract #06029 **December 2011**

Upgrade CNG Fueling Station at SoCalGas Santa Monica Facility

Contractor
Clean Energy

Cosponsor
South Coast Air Quality Management District (SCAQMD)

Project Officer
Larry Watkins

Background
This contract provided funding to offset the capital costs of equipment to upgrade the CNG station at 1701 Stewart Street in Santa Monica. Total station cost was approximately $604,941; the SCAQMD's cost share represented approximately 30% of the total project cost.

Project Objective
The intention of this award was to upgrade the existing publicly accessible CNG facility and fueling station at 1701 Stewart Street, Santa Monica through the addition of a new compressor and dispenser.

Technology Description
The facility is comprised of:

- Two IMW compressors rated at 700 scfm (standard cubic feet per minute);
- Cascade storage system (28,500 scf at 4,800 psi (pound-force per square inch));
- One dual-hose Greenfield dispenser with a Multiforce CRIND (cardreader in dispenser) with one hose providing 3,000 psig fueling and the other providing 3,600 psig fueling; and
- One regenerative dryer capable of keeping fuel moisture content at or below 0.5 lbs/MMscf (million scf).

Status
Construction began during the week of September 19, 2005. The station was commissioned on March 6, 2006. On average, this facility is dispensing approximately 200 gallons of fuel per day. Currently, the station is providing fuel to Santa Monica/Malibu Unified School District, Yellow Cab, Beverly Hills Cab, City Cab, Super Shuttle, City of Los Angeles Parking Enforcement and residents living/traveling in West Los Angeles. Verizon plans to fuel over 80 CNG vans at the site and the City of Santa Monica utilizes the station as a redundant backup fueling site to their private station.

Results
The goal of this project was to increase the throughput and reliability of this facility. This was achieved through the installation of a significantly larger compressor and bank of storage vessels. This facility has demonstrated the ability to reliably fuel its current users, as well as helped enable the anticipated addition of the Verizon fleet.

Benefits
As a fueling station, this facility does not provide any direct emission reduction benefits; however, indirect benefits do result from a strategically located station such as this facility in Santa

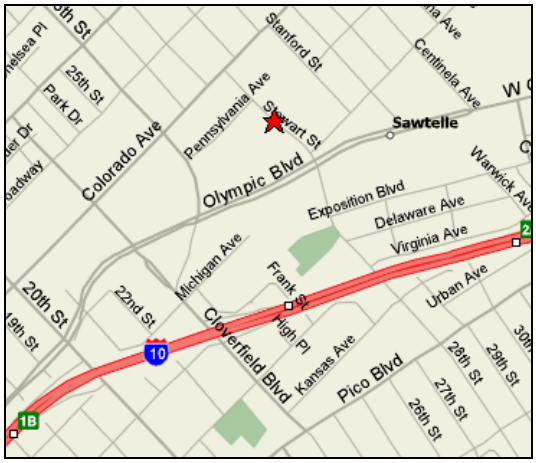
Monica. The benefits resulting from this facility derive from the vehicles that are able to continue to operate and the additional vehicles that are capable of being deployed because there is a reliable source of natural gas fuel available. Thus far, an average of 200 gallons of petroleum fuel has been displaced on a daily basis due to the construction of this facility. We anticipate an increase in this amount as the station's fueling base increases.

Project Costs

Total station cost is approximately $604,941; SCAQMD's cost share of $181,482 represents 30% of the total project cost. At the time of proposal, the projected station cost was listed at $634,500, so the project came in under budget.

Commercialization and Applications

Clean Energy recognizes the benefits of using natural gas as a vehicle fuel relative to the emission reduction goals of the SCAQMD and believes that reliable and easily accessible infrastructure is key to making natural gas fuel usage a reality.



SCAQMD Contract #06030 **December 2011**

Purchase & Install CNG Fueling Station at Foothill Transit's Pomona Facility

Contractor
Clean Energy

Cosponsors
Clean Energy
South Coast Air Quality Management District (SCAQMD)

Project Officer
Larry Watkins

Background
Air quality in the South Coast Air Basin is negatively affected by the vast numbers of conventionally fueled vehicles that travel daily on area highways and surface streets. The deployment of natural gas vehicles as replacement vehicles for gasoline or diesel is key to reducing harmful tailpipe emissions. However, for many potential drivers, the proximity of fueling infrastructure relative to home or work is problematic. The purpose of this project was to construct a new public-access CNG facility at the Foothill Transit base facility at 200 South East End Avenue in Pomona.

Project Objective
Foothill Transit currently operates a fleet of natural gas buses; however, the existing station did not include public-access fueling. The goal of this project was to carve out space for a public- access fueling dispenser for third-party natural gas vehicle operators to fuel at the Foothill Transit, Pomona facility without infringing on the operation or security of the Foothill Transit fleet. The public access dispensers will be tied into the existing compression equipment with necessary upgrades being made to ensure fast, reliable fueling for all users.

Technology Description
The existing compression equipment is comprised of (3) dual compressors with a total capacity of over 2,000 gallons per hour; 60,000 standard cubic feet (SCF) of ASME high pressure storage vessels; and a regenerative dryer capable of meeting SAE J1616 moisture requirements. New equipment installed includes one (1) dual-hose dispenser capable of providing 3,000 and 3,600 psi fill pressure with an anticipated afterflow rate of no less than 4 gallons per minute.

Status
The public access carve-out commenced fueling operations on November 27, 2006. Since inception, this facility has displaced 6,963 gallons of fuel.

Results
Emission reductions are achieved by vehicles deployed as a result of a reliable source of low-emission fuel. Assuming an equal distribution of natural gas taxis and shuttles over the 5-year life of the contract, based on current fuel consumption, emission reductions achieved as a result of this facility are approximately five (5) tons of NO_x annually. Vehicles that fuel with natural gas achieve the same fuel economy as their gasoline counterparts; however, due to the cleaner nature of the fuel being used, generally natural gas vehicles require less maintenance. The decreased maintenance and fuel costs are key selling points for these vehicles when marketing to fleet managers.

Benefits

As noted above, fueling stations do not directly create emission reductions; however, their existence is necessary to ensure the continued use and deployment of natural gas vehicles, a direct source for quantifiable emission reductions. It is conservatively estimated that five (5) tons of tailpipe emissions will be reduced annually as a result of the fuel dispensed from this station. As additional vehicles are deployed, tailpipe emissions will be further reduced. The presence of public-access CNG facilities, such as the one commissioned as a result of this funding, is a key factor in convincing fleet operators to consider natural gas vehicles during their annual procurement schedules.

Project Costs

Prior to the start of construction of the public-access carve-out, Clean Energy had invested over $3 million in the construction of private-access fueling for Foothill Transit, Pomona. A wall was constructed to ensure the security of Foothill Transit's operations and the new public access dispenser was tied into the existing compression equipment. Total public access cost was $396,677. The cost share provided by this SCAQMD contract represents 23% of the total budget or $92,506. Clean Energy provided the remaining capital or $304,171.

Commercialization and Applications

Clean Energy staff continue to market the benefits of using compressed natural gas to fleet operators throughout the South Coast Air Basin. Additionally, their employee base includes a staff member whose focus is to educate the public on the economic benefits of the natural gas Honda Civic GX. All fueling stations are listed on Clean Energy's website and in its natural gas fueling directory which is produced biannually. The Clean Energy Team is charged with reminding consumers that natural gas is here today and that in addition to being a viable solution to reaching emission reduction goals, it is also a stepping stone to hydrogen, often referred to as the fuel of the future.

SCAQMD Contract #06042 **December 2011**

Upgrade Existing CNG Public Access Station with Dispenser & Card Reader

Contractor

University of California, Los Angeles (UCLA), Fleet & Transit Services

Cosponsor

South Coast Air Quality Management District (SCAQMD)
MSRC / AB2766 Discretionary Fund

Project Officer

Larry Watkins

Background

UCLA was an early adopter of compressed natural gas (CNG) as a fleet fuel. The station selected for upgrade under the terms of Contact #06042 was a first-generation system, installed in 1993. The original set-up of the station included public use; however, its primary user was the UCLA fleet.

Project Objective

UCLA now operates 62 CNG fleet vehicles, including 14 CNG campus shuttle buses. To meet growing fuel demands of the UCLA fleet and public users, the facility required a system upgrade. UCLA was awarded $15,921 from the South Coast Air Quality Management District (SCAQMD) and matching funds of the same amount from the Mobile Source Air Pollution Reduction Review Committee (MSRC) to replace the existing dispenser and card reader located at the CNG Fueling Station at Fleet Services. UCLA was subsequently awarded $140,000[1] from SCAQMD to replace the entire CNG Fueling Station at Fleet Services in partnership with Clean Energy Fuels, Inc. The proposed upgrade would bring this first generation system to the fueling capacity and reliability level found in the state-of-the-art CNG systems installed today.

[1] SCAQMD will pay 'once' on the dispenser and card reader replacement costs; therefore the award amount is net of the $15,921 initially awarded.

Technology Description

Station construction included the installation of a Greenfield compressor with a minimum capacity of 175 SCFM (standard cubic feet per minute), a 4500 psi storage vessel, a split priority panel, a Greenfield video dispenser, and a catwalk around the compressor enclosure. Station start-up processes occurred in early August and included the fueling of test vehicles.

The completed facility meets all required codes and passed a Fire Marshall safety inspection prior to the public opening.

Figure 1. UCLA's new station provides 24/7 public access.

Status

Station construction commenced in May 2008 with the Grand Opening ceremony taking place on August 28, 2008. The final report was submitted to the SCAQMD for consideration on December 12, 2008.

Results

Fueling infrastructure does not provide direct emission reduction benefits or improved air quality on its own. Those benefits are achieved

from the natural gas vehicles that fuel at reliable stations such as this. The UCLA CNG station provides the UCLA fleet and private West Los Angeles users with a reliable source of fuel for their vehicles.

We believe this project to have been a success as the station was effectively upgraded from its original first-generation equipment to new state-of-the-art equipment. Since completion of the facility upgrade, the UCLA station has displaced an average of 2,500 gallons of fuel per month. The facility is technically capable of reaching the throughput requirement of 150,000 GGE (gasoline gallons equivalent) annually by its third year of operation.

Benefits

The upgraded facility located at 741 Charles Young Drive is now technically capable of reaching the throughput requirement of 150,000 GGE annually by its third year of operation, a milestone beyond the capacity of the original station.

Clean Energy provides its customers with turn-key solutions for natural gas transportation fuel. As a result, station construction and upgrade is able to be standardized. Adjustments are easily managed by a team of engineering professionals.

Project Costs

At the time of contracting, the project budget was estimated at $350,000 with the SCAQMD contributing $140,000, or 40% of the project cost. At the close of construction, the total project cost was $397,152. The $140,000 contributed by the SCAQMD represents 35% of the total budget (less than the 40% as originally considered).

Commercialization and Applications

Compressed natural gas as a vehicle fuel is commercially available on a limited basis throughout the South Coast Air Basin. This project expanded the fueling capacity of an existing CNG station to allow greater user access, thus expanding the viability of this alternative fuel in the West Los Angeles area.

Clean Energy recommends that the SCAQMD continue to support and fund natural gas fuel projects as a strong network of publicly accessible infrastructure which will help to support the capacity of CNG as an alternative fuel in the South Coast Air Basin. At present, natural gas is the cleanest available fuel technology and provides its users and the communities in which they travel with improved air quality via reduced tailpipe emissions.

SCAQMD Contract #06043 **December 2011**

Purchase & Install CNG Fueling Station at Joint Water Pollution Control Plant in Carson City

Contractor

County Sanitation Districts of Los Angeles County

Cosponsor

South Coast Air Quality Management District (SCAQMD)
MSRC / AB2766 Discretionary Fund

Project Officer

Larry Watkins

Background

The Los Angeles County Sanitation Districts (LACSD) has always been in the forefront of implementing advanced technology for improving air quality relating to their landfill operations. The LACSD began their alternative fuel program in 1993 and are now aggressively pursuing the integration of alternative fueled vehicles into their fleet. This fueling facility is located at the LACSD's Joint Water Pollution Control Plant (JWPCP) in the City of Carson close to a busy freeway and major cross streets. The location of the fueling station is ideal for fueling of the Sanitation Districts' fleet and for other fleets in the area. The number of vehicles that travel through the area and easy freeway access makes the JWPCP an ideal location for a fueling station.

Project Objective

The project objectives of constructing a CNG fueling facility at the LACSD's Joint Water Pollution Control Plant (JWPCP) under this grant program are:

- An integrated fueling infrastructure to fulfill demands of the LACSD's fleet.
- A convenient fueling location for local fleets and public access.
- Improve air quality in the SCAQMD region by eliminating extra trips for fueling.
- Promote and support purchase of alternative-fuel vehicles for local fleets who cannot afford to build their own fueling infrastructure.

Technology Description

The station is designed with two GreenField Model C3U209, skid-mounted, electric-driven compressors. Both compressors have a rated flow capacity of 300 SCFM (standard cubic feet per minute) with a supplied gas pressure of 116 psig (pound-force per square inch gauge). Combined, the compressors can provide a total rated flow capacity of 600 SCFM. This design along with three pressure storage vessels (10,000 scf each) will more than meet the needs of the LACSD's fleet of compressed natural gas (CNG) vehicles as well as other local fleet operators.

The major equipment used for this station is:

- Two GreenField, Model C3U209, electric-driven compressors
- One electronic buffer/ESD priority panel
- One Xebec inlet model STR20NGX-AutoDew dryer (regenerating)
- Three 10,000 scf ASME high-pressure buffer storage vessels
- Two dual-hose dispensers with card readers

Status

The station construction was completed in October 2006. This project started with a Notice to Proceed in September 2005 and groundbreaking took place in April 2006. The station equipment was delivered on-site early May 2006. Electrical and gas lines were installed during most of June, July and August. Southern California Edison and the Los Angeles County Fire Department inspected the station during August and September. The start-up activities took place during the early part of October. The station officially opened on October 26.

On-site personnel receive at least one day training on the basic operations and maintenance of the compressors, dryers, dispensers, and storage vessels, including the monitoring and warning systems.

This station will benefit many fleet operators and will help enhance the market for CNG vehicle purchases.

Results

The goal of this project is to provide CNG fuel to the LACSD's CNG vehicles and other local fleets. For the first seven weeks after the station opened, the station dispensed over 10,000 gallons gasoline equivalent (gge) of CNG. This usage will increase once the public is aware of the station.

To promote use of the station, Clean Energy will continue to contact local fleets. A Grand Opening event was also being planned which will also help the marketing strategy.

Benefits

This project will benefit the environment of the South Coast Air Basin in several ways, especially in the reduction of diesel particulate emissions and the increased efficiency of having a CNG fueling facility on-site and near this major traffic area. The location of the fueling station is ideal for fueling of the Sanitation Districts' fleets and other major fleet operators such as City of Carson, local disposal haulers, local Yellow Cab company, and the Palos Verdes Peninsula Transit Authority (PVPTA). The PVPTA operates shuttle buses and has been one of the major users of the station.

Project Costs

The total cost of this turnkey project is $1,182,298, which is higher than the projected cost of $850,000 as listed in the proposal. The official bid price received was $1,170,000. Two change orders for painting walls around the station and sealing asphalt were issued in the amount of $12,298.

The other sponsor for funding this project is the MSRC at $150,000. LACSD is funding the balance of the project cost at $782,298.

SCAQMD Contract #06074 **December 2011**

Purchase & Install New Public Access CNG Fueling Station at City Yard

Contractor
City of Sierra Madre

Cosponsors
South Coast Air Quality Management District (SCAQMD)
Los Angeles County Metro Transit Authority (LACMTA)

Project Officer
Larry Watkins

Background
In 2001, the SCAQMD and the California Air Resources Board (CARB) began to adopt regulations that mandate public agencies to embark on effectively reducing vehicle particulate matter (PM) and oxides of nitrogen (NO_x) emissions.

These rules and regulations prompted the City of Sierra Madre staff to explore the alternative fuel market and the City began to purchase CNG fueled vehicles when replacements to the aging fleet were necessary.

Project Objective
The objective of this project was to construct a limited-access facility to support clean natural gas power vehicles and equipment for the Cities of Sierra Madre, Arcadia and Monrovia, the School Districts of Arcadia and Pasadena and Foothill Transit vehicles to utilize the facility for fueling their fleet vehicles. The location of the station is 621 E. Sierra Madre Blvd., Sierra Madre, California.

Additionally, it was the objective of this project to assist the cities, school districts and Foothill Transit to comply with regulations as they provide vital services for the general public. Finally, the effort was undertaken to promote the use of alternative fuels for the universally recognized benefits of area air quality.

Technology Description
The City of Sierra Madre installed two (2) 50 SCFM (standard cubic feet per minute) compressors for a total rating of 100 SCFM at 20psig. The project also included the installation of a FuelMaker FM 350A 12 gallon fast-fill module, one regenerative dryer, and two (2) dual-hose time fill posts. This equipment and associated installation complied with various codes, regulations, and testing including the California Code of Regulations (Title 8), NFPA 52, NFPA 60 and NFPA 70, ASME Boiler and Pressure Vessel Code, ASME B31.3, Uniform Building Code, and various other State and Federal Regulations.

CNG Station Full View

CNG Fast-Fill Module

Status

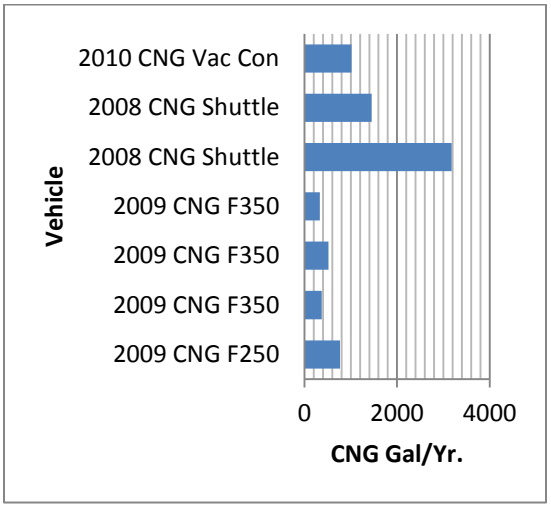
The project was completed and the CNG fueling infrastructure became operational in the summer of 2008. All necessary permits and documents are in place.

The new equipment has been observed to be relatively problem-free. One equipment failure was noted in late 2010 when the electric motor that operates the compressor stopped working and had to be replaced. The use of the station by agencies other than the City of Sierra Madre has been inconsistent and less than hoped for, as additional stations have been built that are more convenient for those agencies.

Results/Benefits

The City of Sierra Madre has replaced six (6) vehicles with CNG fueled new vehicles since 2008. This includes two (2) heavy- use community transportation vans. The new fueling station has resulted in significant cost savings in staff and contractor time that would have been needed for off-site CNG fueling, as well as mileage associated with off-site fueling and the cost of the fuel.

The City of Sierra Madre was also able to purchase a CNG fueled Vac-Con Sewer cleaner/vacuum vehicle that incorporated the first CNG fueled chassis built by industry leader Freightliner Trucks.



Of the seven vehicles that have converted to CNG, a total of 7,630 gallons were obtained at the fueling facility by Sierra Madre vehicles. Shuttle consumption was the highest and represents the highest benefit of the project. These shuttles are used 6 days a week and provide important mobility services for seniors, disabled, and youth in the community.

Project Costs

The project expenditures totaled $311,733, of which $73,776 came from local matching funds from the SCAQMD. The remainder of the funding was from Federal sources.

Commercialization and Applications

The City of Sierra Madre plans to operate this facility for many years. As the existing aged fleet comes up for replacement considerations, City policy dictates that CNG be incorporated into all new vehicle purchases wherever possible. Recently, staff has been following the technical developments in the field, and is exploring the possibility of expanding the CNG consideration to public safety vehicles (police vehicles, fire trucks, ambulances, etc.) as well.

SCAQMD Contract #06082 **December 2011**

Purchase & Install New 24-Hour Public Access CNG Fueling Station at SoCalGas's Canoga Park Facility

Contractor

Clean Energy

Cosponsors

South Coast Air Quality Management District (SCAQMD)
MSRC / AB2766 Discretionary Fund
Southern California Gas Company (SoCalGas)

Project Officer

Larry Watkins

Background

This contract provides $250,000 to offset the capital cost of equipment for a new, publicly accessible compressed natural gas (CNG) fueling station at 7711 Canoga Avenue, Canoga Park (base of the Southern California Gas Company). Total station cost is approximately $868,387; thus the SCAQMD's cost share represents 29% of the total project cost.

Project Objective

The intention of the award is to expand the network of natural gas fueling stations throughout the South Coast Air Basin. This station, located in the San Fernando Valley will increase and advance the visibility of natural gas for current and future users in the area. This project followed a standardized procedure for constructing natural gas fueling stations in the South Coast Air Basin, transitioning smoothly between engineering, permitting and construction.

Technology Description

The facility is comprised of:

- Two IMW compressors rated at 350 scfm (standard cubic feet per minute) each;
- Three ASME high pressure storage vessels capable of providing 30,000 scf of high pressure storage;
- One dual-hose Greenfield dispenser with a Multiforce CRIND (card reader in dispenser) capable of supplying no less than four gallons of fuel per minute with one hose providing 3,000 psig fueling and the other providing 3,600 psig fueling;
- One regenerative dryer capable of keeping fuel moisture content at or below 0.5 lbs/MMscf; and
- A canopy to protect station users and equipment from the sun and inclement weather.

Overall, the planning, permitting and construction of this facility ran smoothly. A delay was encountered during the permitting phases due to concerns raised by the Los Angeles County Fire Department regarding safety and fire issues. Our engineering team addressed their concerns by educating key personnel about the use of natural gas as a vehicle fuel. This education session assuaged their concerns and the project was allowed to move forward. This delay is not viewed as unusual and typically does not create a significant change in cost or the project schedule.

Status

Construction began in early August 2005 and was completed on November 23, 2005. In the first few months of operation, this facility is dispensing approximately 200 gallons of fuel per day. We expect that these volumes will increase significantly as more NGV users become aware of this station and begin accessing it. At the time of the grant application, we had received fueling commitments from SuperShuttle and City Cab. These fleet users had deemed the station as an integral part of their San Fernando Valley operation and are excited to have access to fuel in this part of the Valley.

Results

The goals of the project are met in that infrastructure has increased with the commissioning of this publicly accessible fueling station. Further, this project will provide indirect air quality results when clean burning, natural gas vehicles are deployed and operated throughout the area.

Benefits

As a fueling station, this facility does not provide any direct emission reduction benefits; however, indirect benefits do result from a strategically located station such as this facility in Canoga Park. The benefits resulting from this facility derive from the vehicles that are able to continue to operate and the additional vehicles that are capable of being deployed because there is a reliable source of natural gas fuel available. Thus far, an average of 200 gallons of petroleum fuel has been displaced on a daily basis due to the construction of this facility. We anticipate an increase in this amount as the station's fueling base increases.

Project Costs

Total station cost is approximately $868,387; thus the SCAQMD's cost share of $250,000 represents 29% of the total project cost. At the time of proposal, the project station cost was $842,050. This increase in cost from proposal date (12/2003) to project completion date (11/2005) can be attributed to the increasing cost of equipment and labor.

Commercialization and Applications

Clean Energy recognizes the benefits of using natural gas as a vehicle fuel relative to the emission reduction goals of the SCAQMD and believes that reliable and easily accessible infrastructure is key to making natural gas fuel usage a reality.

SCAQMD Contract #06139 **December 2011**

Purchase & Install New Public Access CNG Fueling Station at Maintenance Yard

Contractor

Lake Elsinore Unified School District (LEUSD)

Cosponsors

South Coast Air Quality Management District (SCAQMD)
Lower Emission School Bus Program AB 923
Carl Moyer Program AB 923

Project Officer

Larry Watkins

Background

LEUSD operates over 90 transit and special needs buses in the Elsinore Valley, which encompasses the communities of Lake Elsinore, Wildomar, Canyon Lake, and portions of the outlying communities of Perris, Corona, Murrieta, and Temecula. LEUSD provides home-to-school transportation for qualified students as well as transportation for extracurricular activities such as field and sports trips. Last year the District clocked 1.6 million miles transporting students.

Faced with record growth, an aging fleet, and compliance with SCAQMD Rule 1195, LEUSD adopted a long-term plan to ultimately replace the existing diesel fleet with cleaner burning CNG school buses. This decision would benefit the health of students and help to decrease toxic diesel emissions in the valley.

Project Objective

In order to realize the goal of a CNG school bus fleet, LEUSD decided that infrastructure for CNG would be necessary, as the closest fueling station was beyond a 20 mile radius from the transportation facility. The infrastructure project would be done in two phases: phase one would accommodate fueling 30 CNG buses total. Phase two would be built to accommodate future expansion of the CNG bus replacement program, and to offer CNG fueling to neighboring school districts for CNG vehicles.

The development and expansion of both the CNG infrastructure and fleet are paramount to LEUSD's goal of providing pupil transportation that is both beneficial to student health and is environmentally responsible within the South Coast Air Basin.

Technology Description

LEUSD went out for bid on Phase One of the infrastructure project and accepted the proposal from Gas Equipment Systems, Inc. (GESI) as this particular bid included the desired state-of-the-art technology paired within the financial parameters set forth by the District.

The LEUSD CNG fueling facility installed by GESI includes:

- 2X60 SCFM 40 HP Ingersoll Rand Compressors skid mounted with a fueling capability of 1 dge/minute (diesel gallon equivalent);
- Five fill posts with dual filling hoses mounted on k-rails with one fuel post set-up for a quasi fast-fill. Phase one k-rails are built to expand as the diesel fleet is replaced by CNG vehicles.
- Southern California Gas Company provided and installed the main gas supply line to accommodate both phases of infrastructure operation.
- A fast fill storage tank is planned for installation in phase two.

Status

GESI and Southern California Gas Company, working closely with LEUSD personnel, completed the CNG fueling infrastructure project in September 2005 and the equipment was put to work immediately fueling the newly acquired

seven 84-passenger CNG school buses. The fueling facility runs efficiently and is utilized on a daily basis by Transportation staff. LEUSD has contracted a preventative maintenance agreement with GESI to insure that if problems occur, minimal down time will result.

Benefits

The infrastructure project has produced immediate benefits for LEUSD and it is anticipated that the long-term benefits of the project will be substantial not only to the District, but to the community at large.

The most obvious immediate benefit of the CNG project has been the cost savings from CNG vs. diesel. Although the infrastructure has only been completed and running since September 2005, estimates are that approximately 2000 gallons of diesel fuel are displaced monthly; seven diesel buses have been removed from operation through this program, and have been replaced with cleaner burning CNG at lower fuel and operating costs. Additionally the NO_x and HC emissions are decreased as is particulate matter caused by the burning of diesel fuel. This is of particular importance in the Riverside County area as air quality in this region is often unhealthy during the warmer months of May to October due to local/regional industry and transportation.

The long-term benefits of a CNG school bus fleet would be the expectation of significantly reducing toxic air pollutants in the South Coast Air Basin, and also to have a positive impact on student health. The EPA cites health concerns in connection to diesel exhaust, and students transported on diesel powered buses would have greater exposure to diesel emissions.

LEUSD is the pioneer in southwest Riverside County with its CNG project and invites any school district in the Southland to visit its facility to observe its operation and to discuss the transition.

Project Cost

The total cost of the CNG infrastructure project as of September 2005 was $367,420. The cost includes: consultant services, bid advertisements, design and installation, electrical subcontractors, and final testing of equipment.

The allocated SCAQMD grant funds for the CNG infrastructure totaling $128,000 cover 42% of the project cost. An additional grant in the amount of $35,000 was funded by SCAQMD from the Clean School Bus Program. All additional cost exceeding grant funding was paid for by LEUSD.

Vehicle Operating Cost

Savings to LEUSD will come from two main sources while operating CNG school buses:

- Reduced fuel costs
- Reduced maintenance and repair costs

The District has already realized a cost savings benefit as the sharp rise in diesel prices has kept pace with the spiraling price of gasoline. Although natural gas prices spiked following the Katrina disaster, comparatively speaking CNG remained the more affordable energy source to diesel as diesel prices, along with gasoline, were affected by the hurricane as well.

Reduced maintenance and repair costs are anticipated from the CNG fleet as well because CNG is a cleaner burning fuel, thus requiring less frequent engine service.

Recommendation

LEUSD is excited about being pioneers with CNG school bus operation in southwest Riverside County. The District takes great pride in the accomplishments in bringing together a functioning CNG fueling station and the acquisition of seven new 84- passenger CNG school buses.

For school districts throughout California, the availability of monetary grants through agencies such as SCAQMD, MSRC, and the EPA make alternative fuel programs viable and even attractive when considering long-term financial and environmental goals.

Through partnership with SCAQMD, MSRC, and consultant Herbert Burnett, LEUSD has been able to secure the necessary funding, technology, and assistance needed to move forward with a plan that would not have been possible without being awarded grant funds. Therefore, it is recommended that these grant programs continue so that interested school districts throughout the South Coast Air Basin have an opportunity to receive the financial backing necessary to implement alternative fuel programs for their vehicle fleets.

SCAQMD Contract #08033-1 **June 2011**

Demonstrate LPG Stop-Fill Unit

Contractor

California Air Resources Board (CARB)

Cosponsors

CARB
South Coast Air Quality Management District (SCAQMD)

Project Officer

Larry Watkins

Background

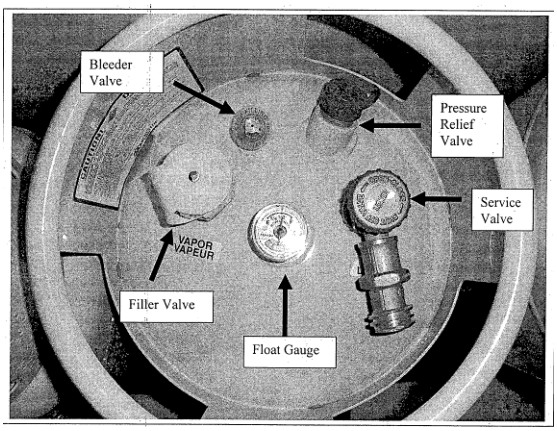
The Maximus™ (SFI) is an innovative stop-fill instrument using cutting-edge acoustic sensing to reduce emissions and conserve valuable energy resources during the filling of LP Gas tanks. This solution gives the LP Gas industry a cost effective, simple-to-use and reliable tool that will improve the way tanks are filled. The Maximus™ technology grew out of work done at Los Alamos National Laboratory (LANL), to measure liquid levels of hazardous liquids. Adept Science & Technologies, LLC (ASCENT) adapted the technology to develop and utilize a proprietary acoustic method to non-invasively detect the presence of either liquid or gas at a specific point in an LP Gas tank. (US: 6,286,370 B1). As liquid reaches a predetermined maximum fill point, the acoustic signal received by the sensor changes indicating the presence of liquid on the other side of the tank wall and that refueling should be stopped.

Project Objective

This project was to adapt and develop an acoustic sensing instrument that could significantly reduce the amount of hydrocarbon emissions during LP Gas cylinder refills. During the course of the project, different acoustic sensing methods were developed to cope with the particular challenge of determining liquid position while filling. The project included extensive work to measure and determines gas and liquid phase LP Gas emissions through a fixed maximum liquid level gauge which typically are released to ambient during filling of LP Gas cylinders. Finally, the project included field testing and collection of feedback from LP Gas filling personnel and the LP Gas industry to make the product user-friendly and commercially viable.

Technology Description

Prior to the ICAT project, field tests proved one sensing aspect of the Maximus™ technology (e.g. its ability to detect the presence of liquid or gas on the other side of the cylinder wall) to work effectively in bus fleet re-filling applications. Commercialization of the Maximus™ for this purpose was underway. One of the main goals of the ICAT project was to confirm emissions estimates via on-site source testing by SCAQMD personnel. Another goal was to show the Maximus™ device's effectiveness to the targeted end-users through hands-on demonstrations and to educate the industry and the public about this technology.



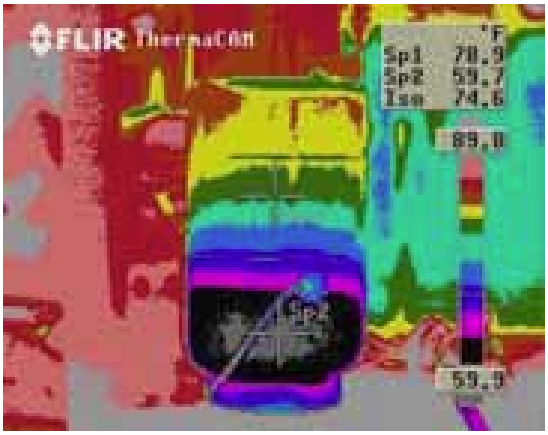
Status

AQMD staff conducted emissions estimates for total emissions impact in the South Coast Air Basin. These estimates indicate that the emissions impact is on the order of several tons per day. Testing verified the emission rates to be used for these calculations for the gaseous and liquid venting portions of these filling events in units of grams per second of total hydrocarbons and VOC emissions less methane and ethane.

Total hydrocarbon emissions to atmosphere during propane tank gravity filling were determined in two parts. First, the displaced gas from the open bleeder valve was measured by a calibrated flow meter. From the outlet of the flowmeter the gas was collected in a canister and

speciated in the laboratory to determine molecular weight for mass emission calculations.

For the second part of the test, liquid propane from the bleeder valve was vaporized into a gas. The gas flow was then measured and analyzed as in part one of the test.



Results/Benefits

VOC emission results for the test runs during the gaseous emission phase of tank filling varied between 1.62 and 2.53 g/sec. It is thought that the variation was caused by variations in pressure and temperature of the large tank filling the forklift tank.

Once the forklift tank was full by gravity filling, an average of 8.94 g/sec total hydrocarbon mass emissions was measured by AQMD. During previous testing by the Adept Group and witnessed by the AQMD, it was determined that 10.9 g/sec of total hydrocarbon emissions was measured during pressure filling.

Depending on the sources used for determining a total population of forklift LP tanks within the SCAB, the annual daily mass release of LP gas may range from 16.94 to 18.50 tons per day.

Project Costs

The project expenditures totaled $550,900, of which $25,000 came from local matching funds from the SCAQMD. The remainder of the funding was from ICAT ($202,000), Propane Education Research Council - PERC ($274,200) and ADEPT Group, Inc. ($74,700) the project proponent.

Commercialization and Applications

The public health concerns and economic costs of evaporative emissions through outage gauges are a growing concern for air quality regulators and the LP Gas industry. Due to the lack of reliable level-sensor technology, green-house gas (GHG) and regulated VOC emissions (including a significant amount of reactive gases) are released every time a residential LP Gas tank is re-filled. These significant emissions present both environmental and economic challenges. Not only are end-users charged for a product they never get, but the State of California loses a valuable clean energy resource. Each ton of VOC emissions reduced in California by the Maximus™ instrument will cost $22/ton. This is a very low price to pay for each eliminated ton of VOCs. Use of the Maximus™ will make LP Gas a more desirable commodity by lowering the health and safety risks inherent in its delivery.

In summary, by eliminating ~98% of LP Gas emissions generated while refueling tanks, the Maximus™ stop-fill technology will provide significant environmental benefits to California while enhancing health, safety and economic well-being.

SCAQMD Contract #10181 **March 2011**

Demonstrate Natural Gas Powered Police Vehicle

Contractor

BAF Technologies Inc

Cosponsors

South Coast Air Quality Management District (SCAQMD)

Project Officer

Lori Berard

Background

Further progress in the attainment of air quality goals depends upon the commercial availability of alternate-fueled vehicles and fueling infrastructure. One way to advance this goal is for public fleets to lead by example, including having law enforcement agencies within SCAQMD's geographic jurisdiction purchase and place CNG-powered patrol vehicles (that are CARB SULEV certified) into service.

Project Objective

Past efforts to place CNG-powered patrol vehicles into service have largely been unsuccessful due to unsatisfactory performance of older-generation CNG-powered vehicles under extreme police pursuit conditions. In order to demonstrate that these issues have been overcome with currently available CNG vehicle technology, the SCAQMD contracted with BAF Technologies, Inc. to convert a Crown Victoria Police Interceptor to operate on CNG. This vehicle was then evaluated by the Los Angeles County Sheriff's Department for use as a patrol vehicle.

Technology Description

The current generation of CNG-powered vehicles provides a clean alternative to a comparable gasoline-powered vehicle. Unlike previous CNG-powered vehicles, current CNG conversions provided by BAF Technologies and its authorized upfitters are fully integrated into the vehicle engine control systems, and feature sequential fuel injection for improved drivability and full on-board diagnostics (OBD-II) compliance. BAF's CNG conversions are only available on vehicles equipped with Ford's "Gaseous Fuel Capable" engines, which, unlike previous generation CNG vehicles, allow for the same factory warranty as a comparable gasoline-powered vehicle. The test vehicle also included several suspension and braking upgrades. These upgrades were intended to compensate for the increase in vehicle weight and change in weight distribution that occurred when the vehicle's original gasoline tank was removed and replaced with CNG cylinders during the conversion process.

Status

The project was considered to be completed on March 31, 2011 with submission of BAF Technologies' Final Report to the SCAQMD. A photo of the finished vehicle is shown below (at left):

A brief summary of project milestones is presented below:

- January 19, 2010 – Contract awarded to BAF Technologies
- April 1, 2010 – Gasoline-powered Crown Victoria Police Interceptor made available to BAF for conversion by Los Angeles County Sheriff's Department
- April 19, 2010 – Vehicle CNG conversion complete at A1 Alternative Fuel Systems
- August 3, 2010 - Vehicle handling modifications complete at JBA Performance
- November 18, 2010 - The CNG-powered vehicle with upgraded suspension participates in the Los Angeles County Sheriff's Department's Law Enforcement

Vehicle Test and Evaluation Program for the 2011 model year (the "Program")

- March 30, 2011 - The Los Angeles County Sheriff's Department issues its report of the 2011 model year

Results

The excellent handling, braking and subjective performance results exhibited by the test vehicle during the Vehicle Test and Evaluation Program indicated that there is definite potential in the use of CNG-powered police patrol vehicles. The CNG-powered test vehicle satisfactorily completed all portions of the Program, finishing near the top of all vehicles tested in braking performance and ahead of the Chevrolet Tahoe (which has been used as a patrol vehicle throughout the United States for several years) in the High Speed and Pursuit sections of the Program. The CNG-powered vehicle also successfully completed the Heat, Serviceability, Communications and Ergonomics portions of the Program. Unfortunately, the CNG-powered vehicle did not perform as well in the Acceleration portion of the Program, as tested in 0-60 mph and ¼-mile acceleration. The CNG-powered vehicle was able to successfully complete the Acceleration portion of the program however, in that the vehicle did reach 100 MPH during the test. These results seem inconsistent with subjective comments made during earlier portions of the test Program, indicating a possible calibration issue with the test vehicle.

Benefits

The goal of this project was met in that the CNG-powered vehicle did successfully demonstrate that natural gas could be an acceptable fuel for police pursuit vehicles. While not specifically addressed as a result of this project, benefits of CNG-powered vehicles as compared to their gasoline-powered counterparts are well documented. CNG-powered vehicles emit much less carbon dioxide than equivalent gasoline-powered vehicles, resulting in a 25-30% lower carbon footprint. In addition, 98% percent of all natural gas consumed in the United States is produced in North America, which has the potential to greatly reduce foreign oil imports and support energy independence. Also, natural gas is typically much less costly that gasoline on an energy equivalent basis.

Project Costs

Total project cost was $30,872. The individual expenditures related to this project are summarized below:

- CNG conversion costs = $14,814
- Vehicle handling and braking upgrades = $10,058
- Report preparation and analysis = $6,000

Original project costs had been estimated at $34,000. The main difference between estimated and actual costs is that the scope of the vehicle handling and braking modifications was reduced to not include upgraded wheels and tires.

Commercialization and Applications

As noted previously, this project does help demonstrate that a natural gas-fueled vehicle is a viable choice for law enforcement patrol use. Accurate estimates of a production cost for a CNG-powered Crown Victoria Police Interceptor are not possible due to the cancellation of this vehicle by Ford Motor Company. However, construction of a CNG-powered law enforcement version of an appropriate new vehicle can be roughly estimated at the same ~$14,800 encountered during this project. Should additional modifications be deemed necessary in order to make the vehicle appropriate for law enforcement use, these would have to be estimated separately. For planning purposes, it is estimated that the cost of replicating the handling and braking improvements made to the test vehicle would be approximately $7,000 in a fleet volume setting.

SCAQMD Contract # 07181 **April 2011**

Physical, Chemical, and Toxicological Assessment of the Semi-Volatile and Non-Volatile Fraction of PM from Heavy-Duty Vehicles

Contractor

California Air Resources Board (CARB)

Cosponsors

CARB
South Coast Air Quality Management District (SCAQMD)

Project Officer

Jean Ospital

Background

Current emissions control technologies for particulate matter effectively remove the non-volatile, or solid, fraction of emissions. However, they may not be as effective in removing the volatile precursors for ultrafine particles. In fact, some studies have indicated that the removal of the solid portion of emissions can increase the concentration of the volatile fraction and enhance the formation of ultrafine particles from condensation of the more volatile fraction. There is growing evidence that ultrafine particles may have a higher toxicity than larger particles, and this project will provide information on the toxicity of ultrafine particles from motor vehicles.

Project Objective

The objective of this project was to assess the physical, chemical, and toxicological properties of semi-volatile and non-volatile fractions of particulate matter from heavy vehicles operating with and without advances emission control technologies.

This is among the first research projects that combine an assessment of the chemical and physical properties of particle emissions with biological outcomes that are relevant to health effects.

Technology Description

This study assessed the PM-related oxidative activity from a variety of diesel vehicles with and without advanced PM emission control technologies. Different driving cycles were investigated, since engine operation is known to affect the concentration, relative amounts and chemical composition of the nucleation and accumulation PM modes emitted. Three driving cycles, i.e. steady state cruise (50mph), transient [EPA urban dynamometer driving schedule (UDDS)] and idle were tested to simulate various real-world driving conditions. The test vehicles comprised four heavy-duty diesel vehicles in seven configurations. A heavy duty diesel vehicle (HDDV) 1998 Kenworth truck served as a baseline vehicle, without any emission control technology The same Kenworth truck was also tested with three different control technologies: a Continuously Regenerating Technology [CRT], consisting of a diesel oxidation catalyst (DOC) followed by an uncatalyzed trap; CRT in combination with a selective catalytic reduction system [Zeolite (Z-SCRT) or vanadium based(V-SCRT) Selective catalytic reduction system(SCRT)] for NOx emissions control. The other three test vehicles were a diesel hybrid electric bus fitted with a catalyzed continuously regenerative trap (CCRT), a school bus fitted with an electric particle filter (EPF), and a truck fitted with a DPX particle filter. Detailed physical,-chemical and toxicological characteristics of emitted PM were measured for each vehicle and driving cycle. These included physical properties (e.g. PM mass and size distribution), chemical (EC, OC, organic compounds, trace elements, inorganic ions) and toxicological [dithiothreitol (DTT) and macrophage reactive oxygen species (ROS) assays] characterization of the collected PM samples.

Status

This project has been completed. The final report (Sioutas, C. Physicochemical and Toxicological Assessment of the Semi-Volatile and Non-Volatile Fractions of PM from Heavy- Duty Vehicles Operating With and Without Emissions Control Technologies, 2011) is available at http://www.arb.ca.gov/research/apr/past/05-308.pdf.

Results

Substantial reduction in PM mass emissions (>90%) was accomplished for the HDDV operating with advanced emission control technologies. This reduction was not observed for particle number concentrations under cruise conditions, with the exceptions of the Hybrid-CCRT and EPF vehicles, which were efficient in controlling both mass and number emissions. In general, significant nucleation mode particles (<50nm) were formed during cruise cycles in comparison with the UDDS cycles, which emit higher PM mass in the accumulation mode. The nucleation mode particles (<50nm) were mainly internally mixed, and evaporated considerably between 150 to 230^{o} C.

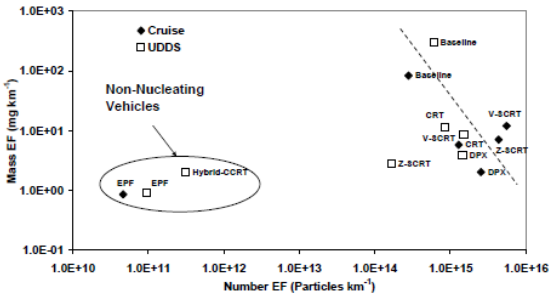


Figure Number and mass emission factors

Significant reductions in the emission of major chemical constituents (TC, OC, EC, and organic compounds) were achieved by the introduction of retrofits. V-SCRT and Z-SCRT effectively reduced PAHs, hopanes and steranes, n-alkanes and acids by more than 99%, and often to levels below detection limits for both cruise and UDDS cycles. The CRT technology also showed similar reductions with SCRT for medium and high molecular weight PAHs, acids, but with slightly lower removal efficiencies for other organic compounds. Sulfate dominated the PM composition in vehicle configurations (V-SCRT-UDDS, ZSCRT- Cruise, CRT, DPX) with considerable nucleation mode and TC was dominant for the configurations with less (ZSCRT-UDDS) or insignificant (CCRT, Horizon) nucleation.

An increase in the intrinsic activity (both DTT and ROS, per PM mass basis) of exhaust PM with use of most control technologies was observed. However, the overall activity when expressed per km or per hr was substantially reduced for retrofitted configurations compared to the baseline vehicle. Significant reduction in DTT activity (by 50-100%) was observed for thermally-denuded PM from vehicles with retrofitted technologies (PM with significant semi-volatile fraction). On the other hand, Chelex treatment of undenuded PM samples removed a substantial (≥70 %) fraction of the ROS activity. Correlation analysis performed between measured activity and the chemical constituents showed that DTT activity is strongly associated (R=0.94) with the water soluble organic carbon (WSOC), while the ROS activity was mostly driven by the Fe content of the PM samples.

Benefits

This project provides information on the relative emissions and toxicity of fine and ultrafine particles from conventional and advanced technology vehicles. This data will allow a determination of the emissions reduction and health benefits of using advanced technologies the South Coast Air Basin. Motor vehicles are a major source of ultrafine particles, and the highest levels have been found on or near busy roadways. Southern Californians can spend up to 2 -3 hours per day exposed to high levels of ultrafine particles during their daily commutes.

Project Costs

The total cost of this project was $677,950, of which $338,975 was provided by CARB and $338,975 provided by SCAQMD.

SCAQMD Contract #08263 **December 2011**

Evaluate Emissions Impacts from Diesel Biofuel Blends

Contractor

University of California, Riverside
Bourns College of Engineering–Center for Environmental Research and Technology
(UC Riverside, CE-CERT)

Cosponsors

South Coast Air Quality Management District (SCAQMD)

Project Officer

Brian Choe

Background

California currently has several legislative initiatives that promote increased use of alternative fuels to reduce oil dependency, greenhouse gases, and air pollution. Biodiesel is an alternative diesel fuel that has the potential to reduce greenhouse gas emissions, other pollutants, and can partially offset our use of petroleum-based fuels. Although biodiesel has been studied extensively over the past 20 years, knowledge gaps still exist and further research is needed to fully characterize the impact biodiesel has on oxides of nitrogen (NO_x) emissions and the effects various feedstocks have on various emissions. To develop regulations relating to biodiesel, a technical evaluation of the emissions impacts was needed. This program was a comprehensive emissions study comparing biodiesel, and to a lesser extent renewable diesel fuels, to California Air Resources Board (CARB) diesel fuel.

Project Objective

The paper describes a major collaborative study between CARB, UC Riverside, UC Davis, SCAQMD, and other institutions that is one of the most comprehensive studies of biodiesel to date. The focus of this research study is on understanding and, to the extent possible, mitigating any impact that biodiesel has on NO_x emissions, and also understanding the impacts of biodiesel on toxic emissions.

Technology Description

The testing included engine dynamometer testing of heavy-duty, on-highway engines and off-road engines, and chassis dynamometer testing of heavy-duty, on-highway vehicles. The full test matrix included testing on 2 heavy-duty engines, 4 heavy-duty vehicles, and 2 off-road engines. The testing included a baseline CARB ultralow sulfur diesel (ULSD) fuel, two biodiesel feedstocks (one soy-based and one animal-based) tested on blend levels of B5, B20, B50, and B100, a biomass-to-liquid (BTL) or renewable diesel, and a gas-to-liquid (GTL) diesel fuel tested at 20%, 50%, and 100% blend levels. For the on-highway engine and chassis dynamometer testing, several test cycles were also utilized to evaluate the impact of biodiesel on emissions under different operating conditions and loads.

Status

This project was completed in October of 2011. The results for the first of several publications have been submitted for publication in a peer review journal.

Results

A 2006 Cummins ISM and 2007 MBE4000 engine equipped with a diesel particle filter (DPF) were tested at CE-CERT. For both the 2006 Cummins engine and 2007 MBE4000 engine, the average NO_x emissions show increasing trends with increasing biodiesel blend level. The NO_x increases for biodiesel ranged from 1.5% to 6.9% for B20 blends, from 6.3% to 18.2% for B50, and from 5.3% to 47.1% for B100, with a few fuel/cycle combinations showing no statistically significant increase. The magnitude of the effects did differ between the different biodiesel feedstocks. The soy-based biodiesel blends showed a higher increase in NO_x emissions for essentially all blend levels and test cycles in comparison with the animal-based biodiesel blends. Soy-based biodiesel blends showed increases of NO_x emissions ranged from 2.6% to 47.1%, while animal-based biodiesel showed

increases of 1.5% to 39.4%, through all the engines and cycles. For the 2006 Cummins engine, the trends for other emissions components were similar to those from previous studies, with biodiesel providing reductions in THC and PM. The CO emissions results on this engine showed consistent reductions for the animal-based biodiesel, but not for the soy-based biodiesel. For the 2007 MBE4000, the PM, THC, and CO emissions were all well below certification limits and the emissions levels for the 2006 engine due to the DPF, and generally did not show strong fuel impacts. CO_2 emissions showed a slight increase of 1-5% for B100 and some B50 combinations. Fuel consumption increased with increasing levels of biodiesel, with increases of 5-10% for the B100 blends.

For the renewable and GTL diesel fuels in the 2006 Cummins, the results showed a steady decrease in NO_x emissions with increasing levels of renewable/GTL diesel fuel. For the renewable diesel fuel, these reductions ranged from 2.9% to 4.9% for R20, 5.4% to 10.2% for R50, and 9.9% to 18.1% for R100 through all the cycles. For the GTL fuel the reductions were 5.2% and 8.7%, respectively, for GTL50 and GTL100 for the FTP cycle. In comparison with the biodiesel feedstocks, the levels of NO_x reduction for the renewable and GTL fuels are less than the corresponding increases in NO_x seen for the soy-based biodiesel, but are more comparable to the increases seen for the animal-based biodiesel blends. This suggests that the renewable and GTL diesel fuel levels need to be blended at higher levels than the corresponding biodiesel in order to mitigate the associated NO_x increase, especially for the soy-based biodiesel blends. The renewable and GTL fuels also provided reductions in PM and CO emissions, with the GTL fuel also providing reductions in THC. The renewable and GTL fuels provided a slight reduction in CO_2 emissions at the higher blends, with a slight, but measurable, increase in fuel consumption.

Several NO_x mitigation formulations were evaluated on the 2006 Cummins engine, including those utilizing renewable and GTL diesel fuels, and additives. Successful formulations included those with higher levels of renewable diesel (R80 or R55) with a B20-soy biodiesel. Blends of 15% renewable or GTL diesel were also found successful in mitigating NO_x for a B5 soy blend, giving a formulation more comparable to what might be implemented with the Low Carbon Fuel Standard. A 1% di tertiary butyl peroxide (DTBP) additive blend was found to fully mitigate the NO_x impacts for a B20 and B10 soy biodiesel, while 2-ethylhexyl nitrate (2-EHN) blends had little impact on improving NO_x emissions. It was found that the level of renewable or GTL diesel fuels needed for blending can be reduced if a biodiesel fuel with more favorable NO_x characteristics, such as animal-based biodiesel, is used, or if an additive with more favorable NO_x characteristics, such as DTBP, an additive evaluated in this study, is used. For the MBE4000, only two blends were tested, CARB80/R15/B5-S and B-5 soy with a 0.25% DTBP additive. Of these two, only the B-5 soy with a 0.25% DTBP additive provided NO_x neutrality. Overall, it appears that different strategies will provide mitigation for different engines, but that the specific response varies from engine to engine.

Benefits

The information obtained from this program will be very valuable in evaluating and mitigating any potential air quality impacts from the increased use of alternative fuels, and in particular biodiesel. By understanding the impacts of alternative fuels on vehicle emissions, we can better ensure these fuels can be implemented in a way that preserves or improves air quality, while at the same time meeting goals for petroleum displacement and reductions in greenhouse gases.

Project Costs

Total funding for this project was $200,000 from the SCAQMD.

Commercialization and Applications

This research will have important implications for the expanded use of biodiesel in commercial vehicles, and what impacts this might have vehicle performance. Currently, there is insufficient information available to allow the widespread use of biodiesel in diesel vehicles to meet the Low Carbon Fuel Standard.

SCAQMD Contract #10693 **August 2011**

Provide Transportable Laboratory Testing to Quantify Emissions from SCR Technology

Contractor

West Virginia University Research Foundation

Cosponsor

South Coast Air Quality Management District (SCAQMD)

Project Officer

Adewale Oshinuga

Background

Heavy-duty diesel engine manufacturers have been required to meet more stringent emissions standards during the last decade. As standards have tightened, manufacturers have not been able to meet these requirements using in-cylinder combustion control techniques. This has created demand for newer aftertreatment technologies to be implemented into vehicle fleets in order to meet U.S. EPA compliance criteria. One solution has been the combination of a Diesel Particulate Filter (DPF) coupled with Selective Catalytic Reduction (SCR). This combination of technologies has also been implemented as a retrofit for legacy vehicles in order to reduce their regulated emissions production. Presented herein are the results from a study that was conducted in order to quantify the difference in NOx reduction between freshly de-greened and aged SCRT systems implemented as retrofit applications.

Project Objective

The objective of the study is to assess the performance of an SCRT retrofit aftertreatment system in controlling emissions of particulate matter (PM) and oxides of nitrogen (NOx) from a legacy diesel engine. Specific objectives included the evaluation of the differences in performance of a new and an aged SCRT system in order to understand the effect of aging on the performance of the aftertreatment system.

Technology Description

The SCRT system developed by Johnson Matthey is a combination of a diesel oxidation catalyst (DOC), catalyzed DPF and a Urea SCR system. The catalyzed DPF is capable of passive regeneration and the urea injection for NOx reduction in the SCR system is active for temperatures over 250 Deg C.

The system is designed to work as a retrofit unit on legacy diesel engines and hence consists of an independent control unit capable of monitoring key aftertreatment parameters and control of SCR operation.

Status

The project was completed in October 2010 and the final report dated April 13, 2011 has been submitted.

Figure 1. Test Vehicle during chassis dynamometer testing.

Figure 2. SCRT system installed on the test vehicle.

Results

The study was conducted in three phases, namely baseline (without retrofit system), with aged SCRT system and with new SCRT system. The vehicle was tested over the UDDS and a 30 MPH steady state cycle.

Figure 3 shows the NOx emission comparison of the different exhaust configurations. Over the transient Urban Dynamometer Driving Schedule (UDDS) cycle a 70% reduction in NOx emissions was observed with the new SCRT system and a 67% reduction in NOx emissions by the aged SCRT system. Similarily, during the 30 MPH steady state the new and aged SCRT systems reduced NOx emissions by 67% and 71% respectively.

Figure 4 shows the PM emission comparison of the different exhaust configurations. The PM filtration efficiencies were ranging between 87-96% for the new SCRT system and 98-99% for the aged SCRT system. The results showed a continuous increase in filtration efficiency for the new SCRT system during the course of the testing.

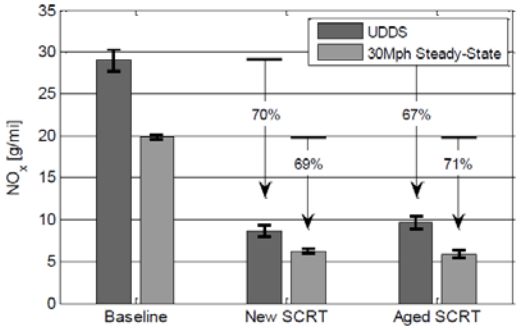


Figure 3. Results of NOx emissions from baseline, new SCRT and aged SCRT configurations.

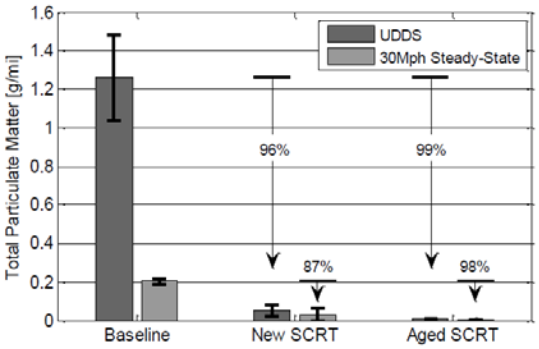


Figure 4. Results of TPM emissions from baseline, new SCRT and aged SCRT configurations.

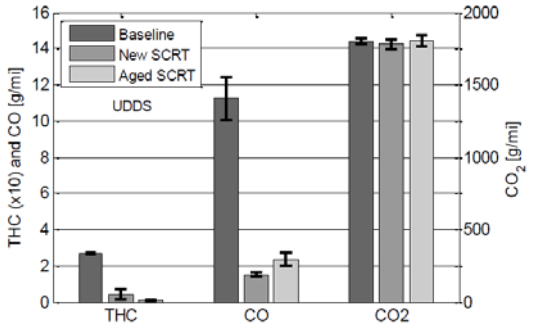


Figure 5. Regulated emissions comparison from different exhaust configurations over the UDDS cycle.

Results shown in Figure 5 show the effectiveness in the retrofit system in reducing emissions of THC and CO on an average by about 90%. The results also show a minimal impact on CO_2 emissions indicating no change in vehicle fueling as a result of the retrofit installation.

Benefits

The tested SCRT retrofit system was very effective in significant reductions in emissions of total particular matter (TPM) and NOx. This is a viable technology that can be implemented on legacy diesel engines and subsequently reduces fleet average emissions of NOx and TPM from such vehicles.

Project Costs

SCAQMD provided full funding in the amount of $76,000 for the SCRT testing.

SCAQMD Contract #11519 **June 2011**

Evaluate Protocols for Measuring Emissions from Cleaning of Application Equipment and Surfaces using Solvents

Contractor

University of California, Riverside
Bourns College of Engineering–Center for Environmental Research and Technology
(UC Riverside, CE-CERT)

Co-sponsors

W.M. Barr Corporation
South Coast Air Quality Management District (SCAQMD)

Project Officer

Naveen Berry

Background

SCAQMD adopted Rule 1143 – Consumer Paint Thinners and Multi-Purpose Solvents in 2009 to address emissions of volatile organic compounds (VOC) from the use, storage, and disposal of these specific consumer products. This rule called for these solvents to have a VOC content of less than 25 g/L by January 2011. The cleaning of surfaces prior to painting and of paint application equipment are thought to be major uses of these solvents. There are, however, no data available on the relative amounts of emissions caused by these operations or the potential amount of ozone these VOCs may generate.

Project Objectives

One objective was to develop an approach to measure mass emissions from cleaning paint brushes and surface cleaning using five different low vapor pressure (LVP) solvents, as well as acetone and a commercially-available lacquer thinner formulated with 95% acetone and 5% methyl soyate. The other objective was to determine the relative amount of solvent used, and then calculate the total ozone formation potential of each solvent based on its established Maximum Incremental Reactivity (MIR) value.

Technology Description

Draft protocols to measure VOC mass emission rates were written based on draft protocols supplied by WM Barr Company for brush and wipe cleaning. These were tested in the CE-CERT laboratory and the results were used to identify improvements. The protocols were revised based on comments from the SCAQMD and W.M. Barr staff. Brushes were weighed, used to apply paint, and then cleaned by rinsing separately in two different solvent containers containing the solvent being tested. They were then weighed again immediately after rinsing and again after drying for 24 hours. The solvent emitted was determined by weighing it before and after the cleaning and rinsing operation. The test was replicated five times with five different brushes.

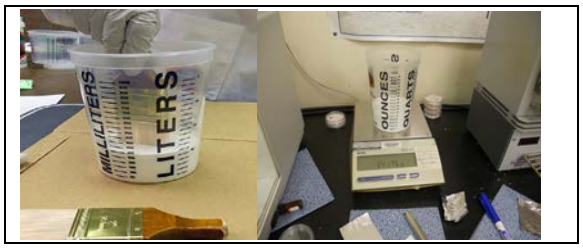
A china marker was used to mark a grid with ¾ inch spacing on a dry erase board that served as the panel. Cotton cleaning cloths were weighed initially, soaked with 10 ml of solvent, used to wipe the panels clean, and weighed again. Additional cloths were used as necessary to remove the markings. The mass of solvent emitted was the difference between the mass of solvent placed on the cleaning cloths and the amount remaining on them. The test was replicated five times for each solvent tested.

The following solvents were used for measuring mass emission rates from both the paint brush and panel cleaning tests: Aromatic 200, acetone, Conosol, benzyl alcohol, methyl soyate, dipropylene glycol butyl ether (DnPB), and lacquer thinner. The reactivity of these solvents to form ozone was based on the MIR scale developed by researchers at the University of California, Riverside. The MIR units are in gO_3/gVOC.

Status

This project was completed as of May 5, 2011 and the final report is on file with complete technical details of the project. No unanticipated problems

were encountered during the project. Protocols were written, tested and revised prior to mass emission testing of solvents. The mass emission tests were independently conducted by two technicians independently to estimate the reliability of the method.



Results

The amount of solvent used in cleaning brushes is shown in Table 1 for each solvent. Each value is the average of ten tests, five replicates from each of two technicians. Except for acetone and lacquer thinner the emissions averaged between the two technicians was 1.9g with a standard deviation of 0.8g. The standard deviation is a measure of the precision of the method and therefore the amount measured is only twice the measurement uncertainty. For acetone and lacquer thinner the majority of the solvent evaporated by the time the brushes were weighed.

Table 1. Summary of the amount of solvent used in brush cleaning

	Aromatic			Benzyl	Methyl		Lacquer		
	200	Acetone	Conosol	Alcohol	Soyate	DnPB	Thinner		
Brush Cleaning	**Wt, g**	**Wt, g**	**Wt, g**	**Wt, g**	**Wt, g**	**Wt, g**	**Wt, g**	**Average**	**ST Dev**
Total Solvent Used T-1	26.5	61.4	27.3	38.2	25.3	27.0	64.7	**38.6**	**17.3**
Total Solvent Used, T-2	47.5	56.9	30.1	32.2	31.8	40.2	44.0	**40.4**	**9.9**
Solvent Evap Before Drying (combined) T-1	0.6	53.4	0.7	-0.1	0.8	-0.5	51.4	**15.2**	**25.4**
Solvent Evap Before Drying (combined) T-2	0.2	31.4	1.4	0.8	0.4	0.5	21.0	**8.0**	**12.8**
Solvent Evap After Drying (combined) T-1	1.8	59.7	1.9	1.5	1.4	-0.1	62.3	**18.3**	**29.2**
Solvent Evap After Drying(combined) T-2	3.0	59.4	3.3	2.8	1.6	1.5	40.9	**16.1**	**23.9**
Total Solvent Used: Average	**37.0**	**59.2**	**28.7**	**35.2**	**28.5**	**33.6**	**54.3**	**39.5**	**13.6**
Solvent Evap Before Drying (combined): Average	**0.4**	**42.4**	**1.0**	**0.4**	**0.6**	**0.0**	**36.2**	**11.6**	**19.1**
Solvent Evap After Drying(combined): Average	**2.4**	**59.6**	**2.6**	**2.1**	**1.5**	**0.7**	**51.6**	**17.2**	**26.5**

The amount of solvent used in cleaning panels is shown in Table 2 for each solvent. Each value is the average of ten tests, five replicates from each of two technicians. Except for acetone and lacquer thinner, only about two tenths of a gram was shown to be evaporated by the time cleaning cloths were weighed, the bulk remained in the cleaning cloths. Approximately half the mass of the acetone and lacquer thinner had evaporated by the time the cloths were weighed.

Table 2. Summary of the amount of solvent used in panel cleaning.

	Aromatic	Acetone	Conosol	Benzyl	Methyl	DnPB	Lacquer	Average	Average
Panel Wiping	**200, g**	**g**	**g**	**Alcohol, g**	**Soyate, g**	**g**	**Thinner, g**	**Wt, g**	**St Dev, g**
Weight solvent used in cleaning	9.85	8.10	16.38	10.33	17.57	9.06	8.27	11.37	0.11
Weigh solvent in cleaning cloths (combined)	9.60	5.14	16.14	10.03	17.27	8.87	5.18	10.32	0.34
Weigh solvent in cleaning cloths (separately)	9.48	5.13	16.10	10.04	17.27	8.88	6.15	10.43	0.27
Weight Solvent Evaporated (combined)	0.25	2.96	0.24	0.30	0.31	0.19	3.10	1.05	0.36
Weight Solvent Evaporated (separately)	0.37	2.97	0.28	0.29	0.31	0.19	2.12	0.93	0.27

The ozone forming potential from cleaning brushes is shown in Table 3 for each solvent while that from cleaning panels is shown in Table 4. These values were obtained by multiplying the mass emission rates in Tables 1 and 2 by the MIR for each solvent.

Table 3. The maximum amount of expected ozone formation from brush cleaning.

	Aromatic	Acetone	Conosol	Benzyl	Methyl	DnPB	Lacquer
Brush Cleaning	**200, g O_3**	**g O_3**	**g O_3**	**Alcohol, g O_3**	**Soyate, g O_3**	**g O_3**	**Thinner, g O_3**
Total Solvent Used: Average	**143.5**	**21.3**	**20.1**	**179.7**	**45.1**	**58.1**	**19.6**
Solvent Evap Before Drying (combined): Average	**1.5**	**15.3**	**0.7**	**1.9**	**0.9**	**0.0**	**13.0**
Solvent Evap After Drying(combined): Average	**9.3**	**21.4**	**1.8**	**10.9**	**2.3**	**1.2**	**18.6**

Table 4. The maximum amount of expected ozone formation from panel cleaning.

	Aromatic	Acetone	Conosol	Benzyl	Methyl	DnPB	Lacquer
Panel Wiping	**200, g O_3**	**g O_3**	**g O_3**	**Alcohol, gO_3**	**Soyate, gO_3**	**g O_3**	**Thinner, gO_3**
Weight solvent used in cleaning	38.2	2.9	11.5	52.8	27.8	15.7	3.0
Weight Solvent Evaporated (combined)	1.0	1.1	0.2	1.5	0.5	0.3	1.1

Benefits

One benefit of this project was that standardized protocols for measuring evaporative emissions from cleaning brushes and panels were developed and evaluated. The other benefit is that emission rate data has been obtained for the first time for these procedures using a wide variety of solvents. These values can be used to estimate emission inventories and to estimate the cost/benefit of control measures, although additional information concerning the ultimate fate of the solvent retained on the brushes and cloths should also be considered.

Project Costs

Total project cost was $47,425. This amount was split evenly between the SCAQMD and W.M. Barr Corporation.

SCAQMD Contract #08068 **July 2011**

Develop & Demonstrate SCR Technology for NO_x and PM Emissions

Contractor
Johnson Matthey Inc

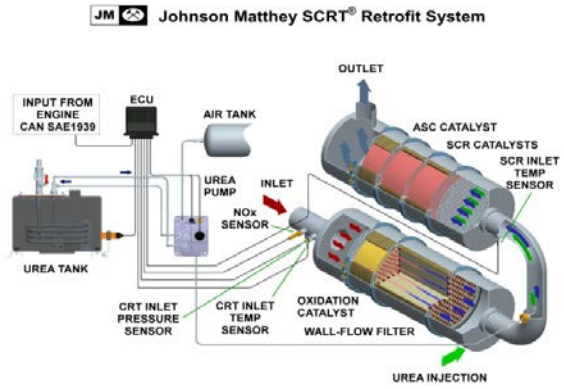
Cosponsors
South Coast Air Quality Management District (SCAQMD)

Project Officer
Adewale Oshinuga

Background
The during the development of the fleet emission limits for commercial vehicle operators in the State of California the use of retrofit technology was considered as a means of meeting the Fleet emission limits for Particulate Matter (PM) and Oxides of Nitrogen (NO_x). There is a great deal of test data and field experience that demonstrate the performance and reliability of passive technologies for the reduction of PM. There has been little data collected that demonstrates the performance and impact on fleet operations of the newer retrofit NO_x reduction technologies using SCR. A demonstration of the emission reduction and the impact on fleet operations of these new technologies is necessary to evaluate the potential impact of the retrofit option in the ARB fleet Rule.

Project Objective
This project was undertaken to demonstrate the real world emission reduction performance possible with the use of a retrofit 4-way emission control technology. Since SCR based NO_x reduction is effected by exhaust temperature, special attention was paid to the relationship between system performance and exhaust temperature profile. Of secondary concern is the impact that such a technology will have on the operation of a fleet from an operation and maintenance standpoint.

Technology Description
Johnson Matthey has developed a product that combines their Continuously Regenerating Technology (CRT) with Urea based Selective Catalytic Reduction (SCR) to be retrofit on Heavy Duty Diesel vehicles. The SCRT® consists of several subsystems; CRT, SCR Catalyst module and urea dosing system.



The CRT was previously verified by ARB as a level 3 PM control device (>85% reduction) that also meets the 20% NO2 requirement for 1998-2002 MY heavy duty diesel engines. The SCR system uses NH3, carried on the vehicle as urea, to reduce NO_x over a vanadium based catalyst. The precise air assisted injection of urea is performed using an OE dosing pump controlled by an ECU that was developed by JM.

Status
All but one of the project activities is complete. The Final report is still in draft form with a projected completion date of March 2012. The phases of this project that have been completed are:

- 14 systems were installed on trucks operating out of the Ralph's Grocery distribution center in Riverside California. The trucks were equipped with Caterpillar C12 or DDC Series 60 engines and built between 1998 and 2001.

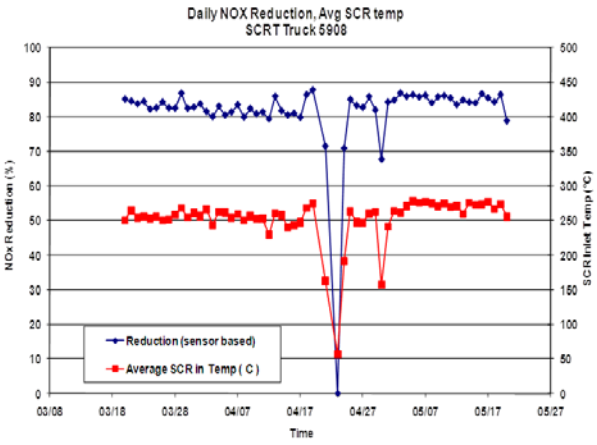
- The trucks were operated with the systems for periods ranging from one year to three years.
- Emission testing was conducted on two systems; one system with less than 30 hours of operation and a second system with more than 2500 hours of operation.

- 11 of the 14 systems have been removed and the trucks were returned to their original configuration.

There were some issues that caused delays in the program but none that caused a milestone to be abandoned. There was a delay in the delivery of the NO_x sensors used by the system to calculate the urea dose. And once they were delivered they were found to be configured incorrectly and had to be re-programmed before they could be installed in the vehicles.

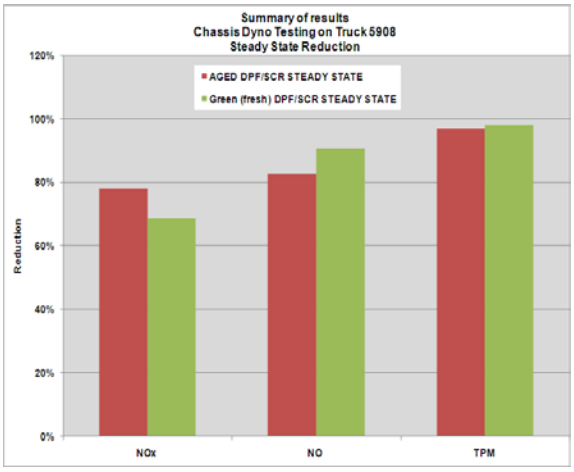
Results

Emissions data was gathered in two ways; using NO_x sensors to compare system out and engine out NO_x levels during actual operation and a chassis dyno to measure emissions over known cycles. The daily operational NO_x reduction was as high as 85% as seen below:



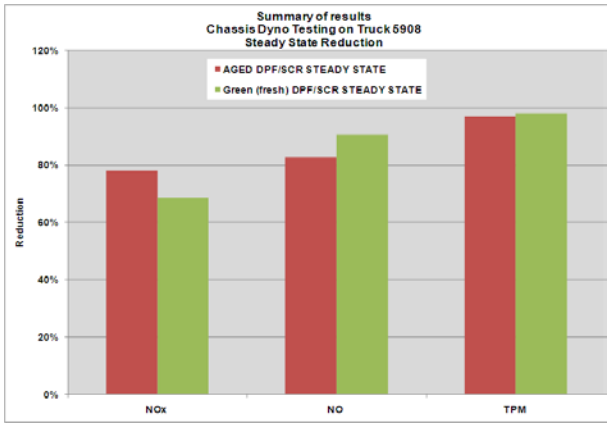
Daily NO_x reduction during SCRT durability trial

The emission testing was conducted over the UDDS cycle on a fresh and aged system. The system showed 67-70% NO_x reduction over the cycle.



SCRT emission test results UDDS cycle

The system also demonstrated 68-78% NO_x reduction during a 30 mph steady state test.



SCRT Emission test Results Steady State operation.

Other information generated by the project included:

- Verification that the temperature measured at the CRT inlet needs to be over 240°C for 40 % of the operating time if the system is to be expected to achieve 70% NO_x reduction.
- On engines with certified NO_x emissions of 4.0 g-bhp/hr the urea is consumed at a rate of 6% of fuel consumption – 6 gallons of urea is consumed for every 100 gallons of fuel used.
- The system had no measureable impact on the fuel use of the vehicle.

Benefits

Besides the percentage of NO_x reduction shown above, the data gathered during this program was able to show that that almost 1000 lbs of NO_x per truck could be removed by the system in 1500 hours of operation. That equated to 3.6 lbs of NO_x removed per day per truck.

Project Costs

Total project costs were $731,500. Johnson Matthey and its partners contributed $401,500 in-kind, SCAQMD provided $254,000 in direct funding, and SCAQMD provided $76,000 to West Virginia University to provide transportable laboratory testing for this project.

Commercialization and Applications

This demonstration program identified areas in the system that needed improvement like the wiring harness to increase the system reliability. It also highlighted a need for larger diameter catalysts to minimize the back pressure caused by the system. The customized nature of the system meant that it took months to design and build, which was seen as a barrier to wide spread use of the product. The system design has since been revised to be independent of the vehicle. This allowed for the system to be assembled with common parts and the price of the system to be lowered because the brackets can be purchased in large quantities. The improvements to the system that resulted from this program are being used by SCAQMD in three new programs funded by the EPA emerging technologies program.

SCAQMD Contract #08261 **March 2011**

Showcase: Demonstration of NO_x and PM Emissions Control Technology on Diesel-Powered Construction Equipment

Contractor

Community Recycling and Resource Recovery Inc

Cosponsors

South Coast Air Quality Management District (SCAQMD)
MSRC / AB2766 Discretionary Fund
Nett Technologies

Project Officer

Richard Carlson

Background

Off-road equipment represents an important source of emissions in the South Coast Air Basin. Based on the California Air Resources Board (CARB), there were approximately 68,600 diesel powered construction equipment in the Basin in 2006 which together produced approximately 120 tons per day of NO_x and 7.5 tons per day of PM emissions.

The Showcase is a cooperative program between the SCAQMD, MSRC and CARB as well as participating off-road equipment fleets and control technology providers to demonstrate the effectiveness and durability of emission control technologies for off-road construction equipment. On March 7, 2007, the MSRC issued an RFQ to manufacturers of emission control systems and a Program Announcement for owners of off-road diesel construction equipment. The MSRC subsequently awarded contracts to install non-verified control devices on 198 off-road vehicles. Some quotations were received for NOx and PM control devices which SCAQMD agreed to fund using Clean Fuel funds.

On October 5, 2007, the SCAQMD Board awarded a contract to Community Recycling to participate in the "Showcase" demonstration of NO_x and PM control technologies. The original award to Community Recycling was $363,250 for nine off-road vehicles. Unfortunately, only two off-road vehicles could be retrofitted with devices due to their mechanical condition, configuration, or the withdrawal of selected device manufacturers from the Showcase.

Project Objective

The objective of this project was to demonstrate after-treatment DPF-SCR emission control systems for off-road construction vehicles. The control system consisted of a diesel particulate filter (DPF) for control of PM emissions and selective catalytic reduction (SCR) system for control of NO_x emissions. The demonstration included the following:

- Exhaust temperature measurements to confirm suitable exhaust temperatures.
- No interference with operator visibility, access or safety.
- Equipment performance and functionality equivalent to non-retrofitted configuration.
- Operation for a minimum of 1,000 hours with CARB monitoring.

Technology Description

A Caterpillar 330B excavator was equipped with the Nett Technologies BlueMax Plus SCR system with a passively regenerated DPF. A Kawasaki 95Z rubber-tired loader was equipped with a Nett Technologies BlueMax Ultra SCR system with an actively regenerated DPF. The SCR components were the same in both systems and consisted of a urea tank, a urea dosing pump and injection nozzle, a SCR catalyst, sensor for NO_x emissions, air flow, and exhaust temperature, a proprietary computer, and an auxiliary air pump. The passive DPF consisted of a DPF with catalyst coating and backpressure sensor. The active DPF consisted of a diesel fuel burner, controller, temperature and pressure sensors, a DPF with catalyst coating, and a computer to regulate the fuel burner. The burner operates at idle when regeneration is needed.

Figure 1. DPF and SCR Catalyst on Loader

Figure 2. DPF/SCR Components on Excavator

Status

The excavator was equipped with the BlueMax Plus SCR with passive DPF in December 2008. Over 6,000 hours were accumulated on the system although some components were replaced. At 3,000 hours, the DPF housing and mounting hardware showed fatigue cracking and was replaced. Standard plastic urea and fuel lines were replaced with steel lines after some lines failed during operation.

The rubber-tired loader was equipped with the BlueMax Ultra SCR with active DPF in October 2010. Over 2,000 hours were accumulated on the system. No significant operational problems have been encountered.

Results

The major components of the system demonstrated durability for considerably more than 1,000 hours. However, the demonstration also identified deficiencies in the design of some components that were not rugged enough for off-road service. These design improvements were incorporated in subsequent systems installed in other fleets. No emission measurements were performed on these systems because CARB was unable to provide a portable emission measurement system as originally planned.

Benefits

This project has provided annual emission reductions from the two off-road vehicles of approximately 1.5 tons NO_x and 0.05 ton PM. In addition, valuable design and operating experience was obtained. There are significant potential emission reductions from future applications of these technologies to additional off-road equipment operating in the South Coast Air Basin.

Project Costs

Total Project	SCAQMD	Nett Technologies
$104,590	$77,700	$26,890

Contract funds were paid by the contractor to the technology provider. No SCAQMD funds were retained by the Contractor. Nett provided a $26,890 discount from commercial pricing. Additional non-monetary cost share was provided by the Contractor by providing the equipment used during this demonstration contract and by Nett for maintenance and upgrade of the systems.

Commercialization and Applications

CARB verification is required for commercialization. The technology provider is currently pursing CARB verification for off-road equipment on stationary engine applications. A stand alone SCR system is verified by EPA for certain off-road engines.

SCAQMD Contract #10125 **March 2011**

Demonstrate Projects for Renewable Feedstock to Energy and Fuel Technologies

Contractor

University of California, Riverside
Bourns College of Engineering–Center for Environmental Research and Technology
(UC Riverside, CE-CERT)

Cosponsors

South Coast Air Quality Management District (SCAQMD)
Viresco Energy LLC

Project Officer

Joseph Impullitti

Background

To meet growing demand for natural gas as a clean transportation fuel, there is potential strategic value in diversifying supply and developing more sustainable sources of natural gas. Thermo-chemical production of Substituted Natural Gas (SNG) from renewable sources offers a viable solution for concerns of natural gas supply.

Project Objective

This project's objective was to demonstrate the technologies to develop a new thermo-chemical process based on Steam Hydrogasification Reaction (SHR) for producing Substituted Natural Gas (SNG) from the co-mingled feedstock of biosolids and biomass.

Technology Description

SHR, which has been developed at the University of California, Riverside to produce a various form of energy products from carbonaceous resources, can handle wet feedstock without drying, does not require expensive oxygen plants, and operates at lower temperature than any other conventional gasification processes. This technology has been demonstrated to be the most efficient and economic process compared to existing technologies.

Status

The project was completed March 31, 2011. The final report is on file with complete technical details of the project.

The bench scale SHR gasifier, which had been previously used for a lignite study, was modified. In order to increase methane production, a new water gas shift reactor was developed, interfaced and operated.

Potential SNG production in California using available biomass and biosolid resources was estimated.

Figure 1. Picture of SHR-WGS systems. SHR (left) was modified and new WGS (right) was added.

Results

Co-mingled feedstock of biomass and biosolids was pretreated to increase pumpability. Up to 46% of pumpable mixture of the feedstock slurry was demonstrated.

Figure 2. From left to right, Biomass, Biosolid, Mixture of biomass and biosolid, Formation of pumpable mixture of biomass and biosolid after the hydrothermal pretreatment (43% solid loading).

The SHR-WGS reactor can produce up to 90% concentrated SNG from the pumpable, co-mingled feedstock.

With these result, production of SNG with HHV of 13.9 GJ/day can be estimated at a feedstock flow rate of 1.0 ton/day.

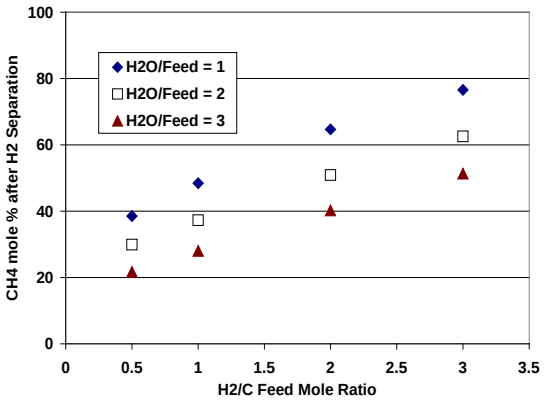


Figure 3. Methane concentration in final product gas. It can be seen that the final product gas contains significant quantities of methane, which is up to ~80 molar %, or up to ~90 mass % at the optimum process condition, which is 1:1 ratio of water to feedstock mass ratio.

Benefits

Estimates of green waste and biosolid resources in California that can be technically converted to SNG were performed. If the entire technical available portion of feedstock is used for SNG production via proposed technology, it can replace about 4.9% of the natural gas consumption in California.

Project Costs

The total project cost was $101,369. Viresco Energy LLC provided the in-kind contribution via laboratory space and operating cost support for the gasifier.

Commercialization and Applications

A preliminary economic analysis model is established for a 3500 BDT/day (bone dry tons) SNG plant using biosolids and green waste as feedstock. Based on the analysis results, the SNG production cost is 4.39 $/MMBTu with an internal rate of return (IRR) of 16.68% while feedstock cost and feedstock delivery cost are not taken into consideration.

For recommendation of a next phase, demonstration in the Bubbled Fluidized Bed (BFB) Reactor, which is currently developing with PIER funds is suggested. The size of the BFB reactor is 10 times bigger than the current Bench Gasifier (0.1 tons per day). SNG from the BFB will be coupled to a 5KW CNG generator to demonstrate electricity production from the renewable feedstock.

SCAQMD Contract #11655 **December 2011**

CSULB CEERS Student Education Study to Assess the Effects of an Exhaust Scrubber on Diesel Emissions

Contractor

California State University, Long Beach Foundation (CSULB)

Cosponsors

South Coast Air Quality Management District (SCAQMD)

Project Officer

Alfonso Baez

Background

Air misting (e.g. wet scrubbing) has long been used to remove dust particles in the air. In general, fogging and air misting can reduce concentration of large particles of 2-10 microns but not smaller ones. One effective method for removing small particles is an electrostatic scrubber. In this method, the droplets entering the scrubber region are electrically charged, which results in attraction of the particles to the droplets and their sedimentations. Figure 1 shows a schematic of an electrostatic charging nozzle (Law [1978]).

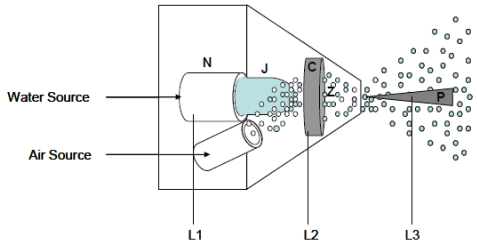


Figure 1. Schematic of electrostatic nozzle

Here, the supplied water is atomized using compressed air. L1, L2, and L3 are conductors and depending on how these conductors are connected to the voltage source, various charging phenomena (corona charging, contact charging, and induction charging) can be achieved. Electrostatic charging has been used extensively in painting and agricultural industries for quality painting and pesticide spraying of agricultural products.

Project Objective

The present investigation focused on reducing PM emissions of diesel engines with an electrostatic fog. Initial investigation focused on a feasibility study of incorporating an electrostatic fog as part of an emission reduction system. Further development will include development of a system onboard the diesel engine that could use the exhaust heat for generating fog from distilled water and an effective electrostatic device for the generated fog and a collecting device for capturing the PM emissions.

Technology Description

A Vanguard 3-cylinder naturally aspired liquid-cooled diesel engine connected to an electric dynamometer with a maximum output power of 20 bhp (brake horsepower) at 3600 rpm (revolutions per minute) was used for the proposed investigation. The emission measurements were performed with a Horiba PG-250 emission analyzer for gaseous emissions and a TSI Dustrak Model 8520 for PM measurements. Both equipment have up-to-date calibration to minimize measurement errors.

A small dilution tunnel was designed using PVC pipes. Figure 2 shows the experimental set-up. It constitutes a T-connector with 5.08 cm (2 inch) ID (inside diameter), followed by a 76.2 cm (30 inch) straight pipe of similar ID. The straight pipe was connected to a 12.7 cm (5 inch) diameter flexible steel pipe.

Figure 2. Experimental set-up

The intake of the tunnel was connected to the exhaust of the diesel engine, using a 5.08 cm (2 inch) ID high temperature flexible tube. The diesel exhaust volume flow rate was approximately 0.6 m^3/min, which corresponds to an approximate mean velocity of 14.84 m/sec.

A Rosco fog machine Model 3000 with distilled water was used to generate the fog. The fog was generated at a liquid volume flow rate of 0.25 l/min. The exhaust nozzle was 1 mm diameter and was connected to the dilution tunnel via the T-connector, using a PVC adaptor. The fog was injected perpendicular to the direction of the exhaust.

The electrostatic charge was generated using an AC high voltage electrostatic rod placed downstream of the fog generator nozzle. The rod is 8.2 mm in diameter and tapered from the mid-section to a 2.7 mm diameter. It was inserted into the T-connector such that the tip is perpendicular to the generated fog at the midsection of the tube.

In order to capture the exhaust PM, six iron rods of 3.81 mm diameter were placed inside the straight tube spanning the inside diameter at 25.4 com (10 inch) downstream of the T-connector. The rods were placed in a spiral format at 10 diameter spacing from each other. The distance between the T-connector and the rods allowed mixing of the electrostatic fog with the exhaust.

Status

The project has been completed and the final report was submitted on December 30, 2011.

Results

Table 1 shows the normalized averaged values of the exhaust gases and the PM with both conditions: with fog and with electrostatic fog. Here the exhaust values with fog (f) and with electrostatic fog (ef) have been normalized with the corresponding averaged values from the raw exhaust. Injecting fog only results in about 3% reduction in PM and 5-8% reductions in other exhaust gases. However, when electrostatic fog is injected, the reductions are increased to where the PM reduction is now just under 7% and the reductions in the other exhaust gases ranged from just over 15% to 19%.

It should be noted that our repeated measurements with this approach have resulted in variations in emissions reductions. Table 2 shows the normalized averaged PM from another series of tests conducted which indicate significant PM reductions with both the injected fog and the electrostatic fog. The variation in PM reduction could be related to the method of generating electrostatic fog and possibly with the volume of the fog present in the exhaust. The magnetic field generated around this conductor is in the form of concentric circles and its effect decreases with distance away from the conductor. Thus with this device, it was difficult to generate a uniform magnetic field.

	PM	Nox	CO	CO2
(ppm-X)fog.avg/ (ppm-X)exh.avg	0.9768	0.9469	0.9135	0.9594
(ppm-X)fog+elc.avg/ (ppm-X)exh.avg	0.9329	0.8239	0.8026	0.8436

Table 1. Averaged normalized emission values

	PM
(ppm-X)fog.avg/ (ppm-X)exh.avg	0.6751
(ppm-X)fog+elc.avg/ (ppm-X)exh.avg	0.5549

Table 2. Averaged normalized PM

Benefits

Results of the present experiments have shown that the electrostatic fog is a viable option for reducing diesel engine PM emissions. However, further exploratory research is needed to develop an effective device that can produce a uniform magnetic field. Reduction of PM emissions could significantly improve air quality in the Los Angeles / Long Beach ports area and in the greater Southern California region.

Project Costs

The project was completed with funding from the SCAQMD in the amount of $28,000. Cost-share contributions from CSULB were in the form of space and laboratory equipment and additional person-hours.

Commercialization and Applications

Further phases of the investigation should be completed before technology development and commercialization.

SCAQMD Contract #09017 **October 2011**

Develop & Demonstrate Hydraulic-Hybrid Shuttle Bus

Contractor

U.S. Environmental Protection Agency (EPA)

Cosponsors

National Automotive Center-U.S. Army; Navistar/IC Bus; Champion Bus; Delphi; Eaton; FEV; Southwest Research Institute; and South Coast Air Quality Management District (SCAQMD)

Project Officer

Jeff Cox

Background

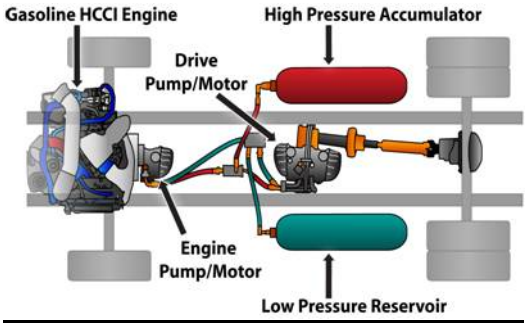
Significantly reducing greenhouse gases (achieving very high fuel efficiency) from commercial hybrid vehicles operating in urban environments while meeting California's continuing need for lower criteria emissions is a major technical and engineering challenge. Series hydraulic hybrid technology coupled with advanced low emission technology has great potential as a cost-effective solution for clean commercial vehicles operating in California.

Project Objective

The project objective was to demonstrate real-world emissions reduction and significant fuel economy improvement benefits of combining series hydraulic hybrid and a gasoline full Homogeneous Charge, Compression Ignition (HCCI) engine technology in urban commercial trucks.

Technology Description

Using its unique series hydraulic hybrid technology, EPA has demonstrated improvements in city fuel economy of large vehicles by 35-150 percent (depending on driving conditions) and reduction of CO_2 greenhouse gas emissions by 25-50+ percent. Series hydraulic hybrid technology is able to maximize fuel efficiency by using high rates of regenerative braking (up to 70 percent energy recovery), by nearly always running the engine at its best efficiency, and by shutting the engine off when it is not needed.



HCCI, or Homogenous Combustion Charge Ignition, unlike conventional gasoline engines, relies on compression to cause ignition in the combustion chamber like diesel engines. However, it is unlike a diesel engine in that ignition does not occur from fuel being rapidly injected into the cylinder. The mixture of air and gasoline is calibrated such that combustion will occur at the apex of the compression cycle. This leads to a uniform burning of fuel and air, increasing efficiency and reducing emissions. The HCCI engine burns gasoline cleanly in a diesel-like cycle that controls engine-out NO_x emissions without costly NO_x and particulate matter aftertreatment.

Status

The innovative series hydraulic hybrid and gasoline HCCI engine technology used in the shuttle was designed, fabricated, installed and tested by EPA engineers at EPA's National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan. The EPA prototype series hydraulic hybrid components were installed in a

Navistar/IC Bus 3200 HC chassis with a shuttle body by Champion Bus. The gasoline HCCI engine adapted from a 2008 Navistar MaxForce 6.4 liter diesel engine, which also was the baseline engine for this project. The initial testing was complete in late 2011. The remaining project activities include some continuing research/optimization of the control system to improve fuel efficiency and reduce cold starting emissions, showcasing the shuttle to bus fleets and manufacturers, and completing the final report.

Results

As expected, the fuel economy improvement (mpg) varied by the intensity of the stop-go driving. The fuel economy improvement is very good for the city cycles when the engine is warm; suburban (EPA LA4 37%), city (EPA LA4 bag2 64%), transit bus (Manhattan Bus 137%), and connector shuttle (Denver Bus 182%).

	Fuel Economy			
	Stock 2008 Baseline	Gasoline HCCI Hydraulic Hybrid		
Drive Cycle	Diesel Average FE	Diesel-Equiv Avg FE	FE Improvement	Comment
HWFET	10.20	9.25	-9%	drivetrain optimized for city driving
cold LA4	7.36	9.46	28%	
cold LA4 bag 1	7.24	7.65	6%	cold start strategy not optimized yet
cold LA4 bag 2	7.48	12.06	61%	
warm LA4	7.51	10.26	37%	
warm LA4 bag 1	7.54	8.73	16%	
warm LA4 bag 2	7.48	12.25	64%	
Manhattan Bus	4.35	10.30	137%	
Denver Bus	3.16	8.92	182%	

The engine/hybrid calibration still needs some more refinement to improve the fuel economy when the engine is operating cold (or cool) such as with the cold LA4 bag 1 (6%). In this case the fuel economy was sub-optimal because we have not yet optimized the calibration of the engine's "warm-up" mode which uses spark plugs before switching to HCCI mode. More optimization was planned for a phase 2 of the project.

We expected the mpg improvement for the highway fuel economy test (HWFET -9%) to not show improvement over the baseline diesel because this gasoline HCCI engine and hybrid drivetrain were optimized for shuttle bus type city driving. We expect with more calibrating during a phase 2 should improve it some.

As anticipated, the NO_x measurements are 70-90% lower than those from the conventional pre-2008 standards diesel engine. The measurements are in line with 2010 emission standards for NO_x, but without the need for costly diesel aftertreatment. The engine startup strategy still needs a bit of refinement to improve the NO_x reduction when the engine is cold (or cool) as shown in the LA4 bag 1 tests (**71%**). We are confident that the engine cold startup strategy can be improved during a phase 2 of the project.

	NOx (gm/mi)		
Drive Cycle	2008 stock	HCCI	change
HWFET	2.670	0.392	-85%
cold LA4	3.780	0.972	-74%
cold LA4 bag 1	4.593	1.320	-71%
cold LA4 bag 2	4.548	0.655	-86%
warm LA4	3.758	0.769	-80%
warm LA4 bag 1	2.968	0.864	-71%
warm LA4 bag 2	4.548	0.682	-85%
Manhattan Bus	8.176	0.830	-90%
Denver Bus	8.124	1.004	-88%

The CO emissions for the vehicle were well within 2010 standards. The HC emissions for the vehicle varied depending on operating conditions of the engine. When the engine was hot enough, the net increase in HC is small and within the 2010 standards for HC. However, when the oxidation catalyst was either cold (as in the cold LA4), or not hot enough to operate effectively (such as during bus cycles with slow speed and frequent engine shutoff) the HC measurements show an increase. We are confident that HC emissions calibration issues can easily be dealt with in a phase 2 of the project by installing a close-coupled resistively-heated catalytic system.

Benefits

The results clearly demonstrate that series hydraulic hybrid commercial vehicles powered by a gasoline HCCI engine can significantly reduce GHGs (by increasing fuel efficiency) while meeting 2010 emission standards without costly NOx and PM aftertreatment systems.

Project Costs

This first-of-its-kind technology assessment cost about $2.0M with most of the funding coming from EPA ($1.5M) and SCAQMD ($0.5M).

Commercialization and Applications

The technology is suitable for application in many urban based vehicles including transit and shuttle buses, refuse trucks, delivery vehicles, school buses, work trucks, and vans. When produced in high volume, this technology can easily pay for itself using fuel savings in two to three years. Commercial sales of production HHVs has begun in the refuse truck sector and will soon begin in the delivery vehicle market. Gasoline HCCI engines need a pre-production trial to pilot its use before it can be commercialized.

SCAQMD Contract #09427 **December 2011**

Demonstrate Battery Electric Class 4 Utility Truck

Contractor
City of Santa Monica

Cosponsors
City of Santa Monica
South Coast Air Quality Management District (SCAQMD)

Project Officer
Joseph Impullitti

Background

The City of Santa Monica (CSM) applied to the SCAQMD's Technology Advancement Program to request support for the deployment of one "zero emission" fully electric medium-duty truck with an advanced lithium ion battery pack. This utility vehicle will be used by the Water Resources Division of the Public Works Department for maintenance, repairs, and customer service visits throughout the city. CSM does not currently operate any medium-duty electric vehicles within its fleet and thus seeks to deploy an electric vehicle instead of a typical diesel replacement. This deployment will consist of one "Zero Truck" manufactured by ZeroTruck Corp (formerly Electrorides).

Project Objective

This project will allow CSM to evaluate the potential of converting an additional 10 medium-duty trucks to electric vehicles for similar applications, and evaluate the potential for other applications. With modifications, the ZeroTruck could eventually replace as many as 30 medium-duty vehicles in this fleet. CSM wishes to take on this project in an effort to further comply with local, state and federal mandates for NO_x & PM reduction in fleet operations and to further progress toward meeting the goals of switching municipal fleets to alternative fuels, increasing efficiencies, and reducing operating costs.

Technology Description

ZeroTruck solution has multiple applications and brings to market years of research, analysis, and engineering expertise. ZeroTruck moves beyond the standard light-duty electric vehicle offerings to target medium-duty diesel replacements and offers the everyday fleet user a zero-emission vehicle with performance and operations comparable to a conventional medium-duty vehicle. Designed to eliminate emissions and create energy independence, the ZeroTruck, offered in low cab forward design, brings the latest in electric drive technology. Based on the industry-leading medium-duty Isuzu truck, features include: 350-400-volt lithium battery pack from Dow Kokam (2,500 cycle life batteries, 8-10 years) and high efficiency 100-kilowatt electric motor from UQM Technologies.

Figure 1: City of Santa Monica, Water Resources Division's ZeroTruck

Results

Overall performance, range, functionality was very positive. The fit and finish, layout of the systems all were professionally assembled. The trucks range of approximately 60-65 miles was sufficient to operate on all routes and locations (note the City is only 8 miles square). Performance of the truck when fully loaded was also sufficient to climb grades and accelerate at speed within the traffic flow. The truck was able to be plugged in overnight and be ready for use during the day with a standard 220v30a outlet.

Reliability was negatively affected due to these component failures as the truck was out of service for several months. The major failure was a gearbox failure. The supplier failed to respond in a timely manner and it was replaced by a completely new design with a new supplier. The charger failed and it was removed and replaced by a liquid cooled unit from a new supplier. The brake system vacuum pump valve failed and the crane on the service body

experienced two issues that took the crane out of service but not the truck.

A big challenge with this technology is the relative few suppliers of components and small number of parts manufactured. Having spare parts on hand would have reduced downtime and improved the overall experience for the operators of the vehicle.

Benefits

This project shows that medium-duty electric vehicles will do the same work and that they are a viable alternative to using an internal combustion engine powered vehicle. Environmental benefits include eliminating exhaust emissions, including NO_x, CO, NMOG, and HCHO, evaporative HC, as well as greenhouse gas (GHG) emission. Waste and expense are reduced by eliminating tune up parts, air filters, oil, oil filters and extended brake life because of regenerative braking.

Project Costs

	Planned	Actual
SCAQMD	$87,205	$87,205
CSM	$102,205	$102,205
EV Innovations	$7,500	$7,500
Velocity Group	$5,000	$5,000
ZeroTruck	$9,000	$59,000
Project Total	210,910	260,910

ZeroTruck's contribution was increased by $50,000 due to having to re-design a second automatic transmission and other component failures. The costs did not increase for the CSM or other partners in this project.

Commercialization and Applications

The ZeroTruck can be outfitted with any style body used on this type chassis such as service/utility, dump body, box van, stake bed, tow, sweeper, and refuse. Airports, municipalities, college campuses and many private fleets are good candidates for ZeroTrucks. The market size is projected to be several thousand trucks in California alone. Advancements in the works include improving component supply chain and development of a CVT gearbox to increase the efficiency of the electric drive system and reduce costs.

The biggest barrier to commercialization is the initial cost of the technology.

While the electric technology has additional up-front costs over a typical diesel replacement vehicle, the long-term fuel savings, reduced maintenance and emissions reductions help balance these costs. Incentives that cover part of the incremental costs will help bring this technology to market faster.

AQMD Contract # 08192 **June 2011**

Development and Demonstration of 2010 Compliant LNG Heavy-Duty Truck

Contractor

Westport Power Inc

Cosponsors

California Energy Commission (CEC)
South Coast Air Quality Management District (SCAQMD)

Project Officer

Adewale Oshinuga

Background

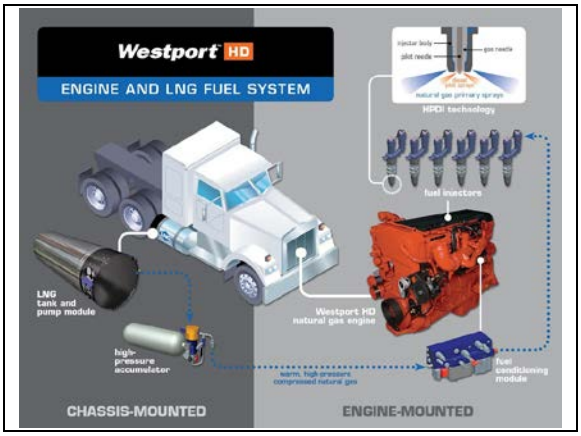
In November 2006, the Ports of Los Angeles and Long Beach adopted a 5-year Clean Air Action Plan (CAAP) establishing several control measures and programs to reduce emissions from port-related operations. One such measure (HDV1) included the replacement of approximately 16,000 drayage trucks serving the ports to meet the clean truck standard, which was defined as the Environmental Protection Agency (EPA) 2007 on-road emissions standard, and included engines fueled by diesel and Liquefied Natural Gas (LNG). A portion of the drayage trucks could be replaced with LNG trucks powered by Westport Power low NO_x High Pressure Diesel Injection (HPDI) engines; the Westport Power model year 2007 HPDI engines were certified at a NO_x level of 0.8 g/bhp-hr.

Project Objective

To develop, demonstrate and certify an LNG HPDI engine used in Class-8 heavy-duty truck applications at or below 0.6 g/bhp-hr NO_x and 0.01 g/bhp-hr PM in early 2008 (Project Phase 1), and 0.2 g/bhp-hr NO_x and 0.01 g/bhp-hr PM emissions in mid-2009 (Project Phase 2).

Technology Description

Westport HPDI technology uses natural gas as the primary fuel, with a small amount of diesel as a pilot ignition source. Compared to a conventional diesel truck, HPDI replaces up to 97% of the fuel (by energy) with natural gas, depending on engine operating condition. On Class 8 trucks the natural gas is held as LNG in cryogenic tanks to achieve sufficient energy density for heavy-duty trucking.



Status

Phase 1 focused on calibration improvements using the existing engine hardware, as well as development of processes in conjunction with Kenworth Truck Company to make the LNG truck available as a Kenworth product. This included development of a new higher-volume production facility for Westport systems which opened in February 2007. Phase 1 was completed with the Kenworth truck offering in February 2009.

Phase 2 included the development of new 2010 system architecture leading to certification and on-road demonstration of the 0.2g NOx solution. A draft version of the final report task was submitted to SCAQMD in December 2011 and the final version will be completed by the end of February 2012.

Results

Due to limitations of the engine hardware the sub-0.6 g/bhp-hr NO_x calibration developed during Phase 1 was considered not robust enough for certification and with the agreement of SCAQMD, a different (0.68g NO_x) calibration was introduced as a running change. This solution still offered benefits over the current product at that time,

including a 0.1g/bhph reduction in NO_x over the transient cycle representative of urban driving and a 3.3% fuel economy improvement over the steady-state cycle representative of highway driving.

For the 0.2g NO_x solution, the new system architecture and in particular the addition of the SCR to the aftertreatment system required wide-ranging calibration development. This included improving fuel system control algorithms and diagnostics and further fine-tuning of the Auxiliary Emissions Control Devices (AECDs). Following extensive engine dynamometer and vehicle testing the system was certified at a third-party facility to the following emissions levels, comfortably exceeding the EPA regulations.

Regulated Emissions (g/bhp-hr)			
CO	NOx	nmHC	PM
0.13	**0.14**	**0.02**	**0.004**

A six-month field trial of three trucks equipped with the 0.2g NO_x engine was completed in March 2011 and accumulated 167,000 miles. The vehicles selected as the demonstration fleet operated as port drayage trucks between the Port of Long Beach and locations within the Southern California Basin. The field trial offered the following benefits to the development of the product:

- early issue resolution
- collection of data on fuel economy and Diesel Exhaust Fluid (DEF) usage
- compilation of driver feedback
- study of fuelling and DEF refill practices

Benefits

Although it did not meet the original target for NO_x reduction, the advantages of the running change calibration are still noteworthy. Based on 1000 LNG trucks, and dependent on vehicle mileage, they are:

- NO_x reductions of between 112 and 206 tons/year compared to diesel. Of this, the running change provided 14 to 18 tons/year reduction (9% to 14% additional NO_x reduction over the previous LNG truck calibration).
- GHG (equivalent CO2) reductions of between 18800 and 34000 tons/year. Of this, the running change provided 800 to 900 tons/year (3% to 4% additional CO2 reduction over the previous LNG truck calibration).

The product delivered in Phase 2 of the project delivered significant further reductions in regulated emissions and met the EPA legislative requirements. In addition fuel economy and total GHG emissions were improved over the Phase 1 running change product. Emissions of ammonia and N_2O as a result of adding the SCR system were found to be negligible.

Westport continues to work with Kenworth Trucks and also with the Peterbilt Truck Company to deliver LNG trucks resulting from the development of the 2010 engine.

Project Costs

The initial proposed scope of work covered by this multiple phase project assumed joint funding from the SCAQMD and from the CEC. The project was structured so that the funding from the two sources covered separate deliverables. Whereas the original estimated spend, established at the beginning of 2008, was $9.98 million; the project expenses concluded with a spend of $12 million.

	AQMD Deliverables	CEC Deliverables	Total
Total Costs	$11,084,000	$916,000	$12,000,000
Funding Share	$1,750,000	$421,000	$2,171,000

Commercialization and Applications

With its launch in 2010, the Westport GX 15L engine in the Kenworth T800 became the first commercially available LNG-fuelled truck meeting the EPA2010 on-road heavy-duty emissions standards. As of January 2012, over three hundred of these trucks have been put into service in the US, surpassing the sales of the pre-2010 version developed in Phase 1. Sales are projected to increase in 2012 and the next few years as LNG fuelling infrastructure is expanded across the country. Westport continues to work on refinements and cost-reduction initiatives to further improve the product.

SCAQMD Contract #10041 **June 2011**

Develop Prototype Natural Gas-Powered Concrete Mixer Truck and Demonstrate Performance and Emissions

Contractor
McNeilus Truck and Manufacturing Company

Cosponsors
McNeilus Truck and Manufacturing Company
South Coast Air Quality Management District (SCAQMD)

Project Officer
Phil Barroca

Background
There are an estimated 4,700 concrete mixer trucks operating in the South Coast Air Basin, accounting for 8% of this region's total heavy-duty vehicle inventory. These trucks are diesel-powered and represent 3% of the total vehicular NOx emissions and 4% of the total vehicular PM emissions in the South Coast Air Basin. The engine of a concrete mixer truck also turns the vehicle's mixer drum, an important requirement to maintain product viability. The concrete mixer truck industry estimates that these vehicles spend 36% of their operating time at idle (stationary) between loading and unloading concrete at the batch plant and job site, respectively, representing significant localized emissions.

McNeilus Truck Company developed a prototype CNG concrete mixer truck based on a Kenworth chassis and the Cummins-Westport ISLG CNG engine. McNeilus approached the AQMD in mid 2008 for funding to complete vehicle modifications with the objective of commercialization and to support demonstration of the vehicle to local fleet operators. Vehicle modifications included CNG fuel storage capacity and positioning, exhaust stack, and weight modifications. Vehicle demonstration included developing a "hands-on" program for fleet operators to use the vehicle under normal and varied working conditions including unpaved roads, freeways, hills and grades.

Technology Description
The technology used in this project is a dedicated CNG-fueled heavy-duty spark-ignited engine. The engine is a 2008 Cummins-Westport ISLG; 8.9 liter displacement. It is rated at up to 320 horsepower (hp) and 1,000 lb.-ft. torque and is CARB certified at 0.1 g-NOx/bhp-hr and 0.009 g-PM/bhp-hr. To achieve these emission levels the ISLG uses cooled stoichiometric exhaust gas recirculation (EGR) combustion which allows for the use of a three-way catalyst (TWC). TWCs are simple, passive aftertreatment devices packaged as part of the muffler that provide consistent performance and are maintenance-free. The ISLG does not require active aftertreatment such as a diesel particulate filter (DPF) or selective catalytic reduction (SCR) to reach EPA 2010 emissions standards for PM or NOx, respectively. The vehicle was outfitted with Type III light-weight CNG storage tanks with a 53 diesel gallon equivalent (DGE) fuel capacity. Fuel tank placement and light weight fuel tank brackets were installed by AFV.

Status
Modifications, demonstration and emissions testing have been completed. The prototype vehicle continues to be demonstrated and McNeilus reports no significant problems with the vehicle. The vehicle is commercially available and to date at least five have been purchased by private companies.

Results
Vehicle modifications were completed prior to demonstration. A minimum of eight different local concrete batch plant companies demonstrated the vehicle from July 2008 through October 2009, all

with favorable comments on the vehicle's overall performance (the vehicle continues to be demonstrated both locally and nationally). The vehicle met or exceeded all vehicle operators' performance requirements. Vehicle operators averaged 65 miles per day and the vehicle averaged 2.6 miles per DGE; the miles-per-DGE range was 0.7 to 4.6 mpg. McNeilus noted that vehicle operators unfamiliar with CNG systems were uncomfortable with allowing the fuel tank to get below 1,000 psig or one-third full, out of concern for keeping the mixer drum turning. The vehicle consumed approximately 40% to 50% of its fuel in a stationary mode.

Emission Testing

Emission testing was performed on two stationary vehicles: the 2008 demonstration vehicle and a comparable 2005 diesel-powered concrete mixer truck, equipped with a diesel particulate filter (DPF). The diesel test vehicle was supplied by Robertson's Ready Mix Company and was considered representative of the inventory of concrete mixer trucks operating in the Air Basin. Stationary mode testing was selected because concrete mixer trucks spend up to 50% of their operating time in a stationary mode, and consume up to 40% of the fuel significant amount fuel, resulting in a significant amount of localized emissions. Emissions' testing was performed for NOx, HC, CO, CO2 and PM under the following four modes: idle, high idle, low idle with power-take-off (PTO) engaged on an unloaded and rotating mixer drum, and low and high idle with PTO engaged on a loaded and rotating mixer drum, using comparable loads in each vehicle's mixer drum. Preliminary results show the CNG powered vehicle having negligible PM emissions, significantly lower than the DPF equipped diesel vehicle. The CNG vehicle also had lower NOx than the diesel vehicle in all test modes, including loaded and unloaded idling conditions. The total hydrocarbon emissions were higher for the CNG vehicle only due to methane inclusion. However, non-methane hydrocarbon emissions from the CNG vehicle were also very low as methane accounts for 90% of typical CNG fuel composition in this region.

Benefits

The benefits of this demonstration project include advancing the technology and expanding the commercial availability of alternative fuel heavy-duty vehicles, particularly in the private sector. During this project two heavy-duty chassis manufacturers, Kenworth and Peterbilt, began producing a Class 8 chassis with the Cummins Westport ISLG engine. The use of alternative fuel-powered heavy-duty engines in the concrete mixer truck industry is important because of the significant amount of localized emissions generated from the vehicle during payload delivery, particularly in populated areas such as residential communities. This demonstration program has presented the concrete batch plant industry with a commercially available alternative means of complying with NOx and PM emission schedules, and an alternative to dependency on petroleum based fuels.

Project Costs

The total cost for the project is $380,000 with SCAQMD cost share not to exceed $100,000. Costs for this project have not exceeded this amount.

Commercialization and Applications

The project has resulted in the commercial availability of a CNG-powered concrete mixer truck. McNeilus offers both Bridgemaster and Standard mixers on either the Kenworth W900 or T800 chassis. Other chassis manufacturers' CNG platforms are pending. Two factors impeding its deployment are the continuing economic conditions and company's hesitation to invest in new equipment. The local concrete mixer truck industry has reduced its inventory dramatically over the course of this project, in part due to the economy and in part due to regulatory requirements and meeting CARB DPF regulations. However, with economic recovery, the industry is expected to commence purchasing of new equipment and vehicles. The combination of economic recovery and continued low costs for CNG fuel can support industry to purchase CNG powered mixer trucks. The accompanying photo (below) is one of two CNG- powered McNeilus concrete mixer trucks purchased in 2011 by Ferrara Bros. Building Materials Corp., Flushing NY that have been deployed to the reconstruction efforts of the World Trade Center in New York, NY.

SCAQMD Contract #11656 **December 2011**

Participate in California Fuel Cell Partnership for CY 2011 & Provide Support for Regional Coordinator

Contractor

Bevilacqua-Knight Inc

Cosponsors

8 automakers; 2 energy providers; 6 government agencies; 1 technology provider; and 14 associate members

Project Officer

Lisa Mirisola

Background

Established with eight members in 1999, the California Fuel Cell Partnership (CaFCP) is a collaboration in which private and public entities are independent participants. It is not a joint venture, legal partnership, or unincorporated association. Therefore, each participant contracts with Bevilacqua-Knight, Inc. for their portion of CaFCP administration. SCAQMD joined the CaFCP in April, 2000, and the CaFCP currently includes 31 organizations interested in demonstrating fuel cell vehicle and fueling infrastructure technology.

Project Objective

There were several goals for 2011:

- Establish and maintain a common vision for the market transition of FCV's in California;
- Facilitate the deployment of commercial fueling stations and coordinate with OEM vehicle plans;
- Support practical codes and standards development;
- Prepare communities for vehicles and fueling stations, and train first responders;
- Coordinate with other fuel cell vehicle demonstration programs worldwide; and
- Enhance public awareness and understanding through technology demonstrations and outreach.

Status

The members of the CaFCP intend to continue their cooperative demonstration efforts and have set goals through 2012, subject to a budget approved annually. This final report covers the SCAQMD contract 11656 for 2011 membership. This contract was completed on schedule in 2011.

Technology Description

The CaFCP members together or individually are demonstrating fuel cell passenger cars and transit buses and associated fueling infrastructure in California. The passenger cars include Daimler's B Class F-Cell, GM's Chevy Equinox, Honda's FCX Clarity, Hyundai's Tucson, Nissan's XTrail, Toyota's FCHV-ADV, and Volkswagen's HyMotion. The fuel cell transit buses include 12 placed at AC Transit (Van Hool buses with UTC fuel cells) and 3 placed at Sunline Transit (1 UTC/ISE, and 1 Ballard/New Flyer, and 1Ballard/BAE). Proterra has also placed a battery dominant FC hybrid bus at the City of Burbank and Hydrogenics/BAE has placed one bus with SF MTA.

Results

Specific accomplishments include:

- Automotive members placed over 400 fuel cell passenger vehicles on California roads from 1999 through 2011, including the first retail customers starting in 2005;

- Transit agency members have demonstrated 13 fuel cell buses since 1999, with 4 still currently in operation (see technology description);
- There are now 6 open access hydrogen fueling stations in operation in California. There are also 15 additional private stations clustered in regional networks in northern and southern California;
- CaFCP staff and members continue to train local fire departments and work with emergency response organizations to coordinate with other state and national efforts;
- The CaFCP organized or participated in several ride & drive events, especially the AltCar Expo in Santa Monica.
- The CaFCP continued to upgrade its comprehensive up-to-date website focusing on efforts in California, participated in technical and educational conferences, and helped prepare for hydrogen station openings.

Benefits

Compared to conventional vehicles, fuel cell vehicles can offer zero or near-zero smog-forming emissions, reduced water pollution from oil leaks, higher efficiency, and much quieter and smoother operation. If alternative or renewable fuels are used as a source for hydrogen, fuel cell vehicles will also encourage greater energy diversity and lower greenhouse gas emissions (CO2).

By combining efforts, the CaFCP can accelerate and improve the commercialization process. The members have a shared vision about the potential of fuel cells as a practical solution to California's environmental issues and similar issues around the world. The CaFCP provides a unique forum where technical and interface challenges can be identified early, discussed, and potentially resolved through cooperative efforts.

Project Costs

Auto members provide vehicles, the staff and facilities to support them. Energy members engage in fueling infrastructure activities. The CaFCP's annual operating budget is about $2 million, and includes facility operating costs, program administration, joint studies, public outreach and education. Each member makes an annual contribution of approximately $88,000 towards the common budget. Some government agencies contribute additional in-kind products and services. SCAQMD provides an additional $50,000 annually to support a Southern California Regional Coordinator and provides office space for additional staff in-kind at SCAQMD.

Commercialization and Applications

While research by multiple entities will be needed to reduce the cost of fuel cells and improve fuel storage and infrastructure, the CaFCP can play a vital role in demonstrating fuel cell vehicle reliability and durability, fueling infrastructure and storage options, and increasing public knowledge and acceptance of the vehicles and fueling.

From 2010-2012, CaFCP's goals relate to Building Market Foundations through coordinated individual and collective effort.

SCAQMD Contract #05165 **June 2011**

Install & Demonstrate Three Electrolyzers (Burbank, Riverside & Santa Monica) and Two Mobile Fuelers (Santa Ana & Ontario)

Contractors

Air Products and Chemicals Inc.

Cosponsors

South Coast Air Quality Management District (SCAQMD)

Project Officer

Larry Watkins

Background

The implementation of zero-emission vehicles (ZEVs) is a key component in the effort to achieve healthful air quality in the South Coast Air Basin. Fuel cell vehicle (FCV) technology is emerging at an accelerated pace and may play a crucial role in this effort. CARB is promulgating revisions to the Clean Fuel Outlet Regulations requiring fuel vendors to provide hydrogen as FCV vehicle populations are met.

Project Objective

The SCAQMD allocated a total of $3.9 million towards funding the Five Cities project for the installation and operation of a network of five hydrogen fueling stations throughout the Basin to support the operation of FCVs and electric-hybrid internal combustion engine vehicles converted to use hydrogen fuel, for up to five years. The CARB experimental permit for the hydrogen vehicles was later extended for 18 months until March 2012.

Technology Description

Air Products has designed, built, and installed stationary fueling sites supplied by an integral proton exchange membrane (PEM) electrolyzer system for Riverside, Burbank, and Santa Monica, and a self-contained, transportable fueling unit that can be refilled at an Air Products hydrogen production facility for Santa Ana and Ontario. These stations have been supplied in support of the SCAQMD program to serve hydrogen ICE vehicles in the South Coast Air Basin.

Status

All of the stations under the "Five Cities" project have been completed. The following table summarizes the opening dates of the stations.

Station	Date Fully Operational
Santa Ana	January 11, 2006
Ontario	January 11, 2006
Riverside	January 17, 2006
Burbank	January 31, 2006
Santa Monica	June 15, 2006

Results

During the period of performance, the hydrogen fuel stations provided over 5,300 fills, dispensing 7,000 kilograms of hydrogen. Maintenance of the stations was manageable and rarely caused disruption to the users.

Benefits

This project is an important step toward the use of renewable energy sources, particularly hydrogen. The installation of the projects allowed SCAQMD to monitor the fueling patterns at each of the sites and provide practical outreach on how a hydrogen fueling station is run. The projects have successfully demonstrated the use of electrolysis, which if supplied with a renewable source of electricity, is a clean way to produce hydrogen.

Project Costs

The original contract value for the installation of the five stations plus the first year of hydrogen fueling was $2,982,000. An amendment in 2008 added an additional $903,332 for maintenance of the three electrolyzer stations and lease and fueling costs for the two mobile fueler stations, for a total contract value of $3,885,332. Air Products completed the work under Tasks 1 through 4 for each of the three electrolyzer stations and two mobile fueler stations, and has

identified cost additions beyond the original scope of work related to station operation and maintenance. Contract scope changes required installation of flame and gas detection systems at Santa Monica and Riverside and underground piping associated with the Riverside installation.

Commercialization and Applications

The stations in the Five Cities program were all designed to support small fleets of vehicles (less than 10 cars). However, the mobile fuelers and the electrolyzer stations were available for commercial applications such as transit buses. As the number of hydrogen vehicles on the road increases, different products with larger capacities, such as liquid hydrogen or pipeline supply and larger compressors, would need to be installed. Consideration should also be given to the use of renewable electricity generation such as solar for the electrolyzers, due to the significant impact on operational costs and greenhouse gas emissions.

As part of a partnership with the Department of Energy, BP, and Daimler-Chrysler, BP built a 700 bar station using a steam methane reformer at Burbank. This station opened in 2009 and dispenses hydrogen at 350 bar and 700 bar. Once the program ended, BP transferred ownership of the station to Burbank. The SCAQMD, CARB, DOE and CEC provided combined funding of $1 million to support operation and maintenance of the facility. Hydrogen Frontiers currently operates and maintains the Burbank station so that it can continue to provide fueling to hydrogen vehicles and fuel cell buses in the area.

SCAQMD Contract #10149 **November 2011**

Cosponsor Feasibility, Design and Development of 70 Mpa Hydrogen Home Fueling Appliance

Contractor

NextEnergy Center (NEC)

Cosponsors

U.S. Department of Energy (US DOE); National Renewable Energy Laboratory (NREL); South Coast Air Quality Management District (SCAQMD); ITM Power (ITM); Gas Technology Institute (GTI)

Project Officers

Larry Watkins

Background

Fuel Cell Vehicles (FCVs) are one of the cleanest options for zero emission vehicles (ZEVs), with energy efficiencies up to 60% compared with ~30% for internal combustion engine (ICE) vehicles, and emit only water. Auto manufacturers are introducing FCVs that use 70 MPa (megapascal) H_2 storage systems. In 2007, NEC was approached by several vehicle original equipment manufacturers (OEMs) to form a Steering Committee to provide technical oversight on the development of a 70 MPa (10,000 psi) small-scale H_2 fueling appliance (SHFA), urgently needed to: 1) Fill gaps in H_2 infrastructure; 2) Provide a pathway for H_2 fueling from distributed and/or renewable sources; and 3) Align with the intent of the Memorandum of Understanding (MOU) in 2009 by six OEMs to roll out FCVs by 2015. As part of NEC's Congressional Award (DE-AC36-99GO10337) by US DOE, the initial phases of the SHFA are underway.

Project Objective

The primary objective for Phase 2a is to design a high pressure (10,000 psi), scalable down (to 5,000 psi) H_2 fueling station that can be sited in a consumer's home garage and fulfills these functional objectives:

- H_2 Generation: nominally 5 kg/week.
- Storage: nominally 5 kg (scalable).
- Slow Fill—3-5 kg in 6-8 hours.
- Fast Fill—1-4.5 kg in 1-2 hours.
- Safety: Conform to all state and national codes, especially to Michigan and California.
- Adaptability: Able to be coupled with renewable energy sources in future designs.
- "Downgradable" compatibility with lower-pressure on-board vehicle storage in future.

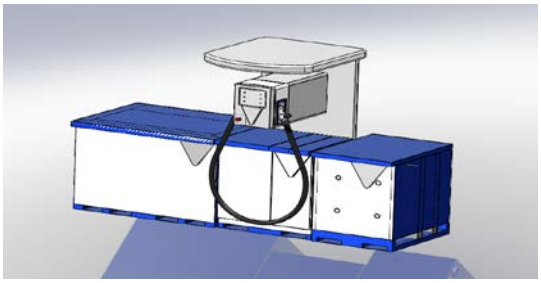
Technology Description

The main scenario requires the SHFA to dispense a full fill every week for a single light-duty vehicle (with maximum on-board storage of 5 kg) with the flexibility to dispense one kg at a time (i.e. more than enough to make an average daily commute), the full five kg overnight in 6-8 hours during a slow fill (i.e. Sun. night to have fuel for the week), or 1-4.5 kilograms in one to two hours for a fast fill. This is accomplished using an electrolyzer, a robust compressor and a combination of cascade refueling and bulk storage.

Status

The Phase 1 report – a Feasibility Study to determine if designing and eventually building a 70 MPa SHFA would be feasible and if so, which H_2 generation technology would be most ideal (steam methane reformation, electrolysis, etc.) – was accepted by SCAQMD in Jan. 2011. The Phase 2a work – designing a 70 MPa SHFA – was awarded to ITM Power and completed in June 2011 and is discussed here. Phases 2b through 5 (Alpha 70 MPa SHFA build out, testing, and validation thru Beta system testing, validation, and UL or equivalent certification) are currently unfunded.

Picture of Phase 2a 70/35 MPa SHFA Design



Results

Key Performance Characteristics

Characteristic	Initial Target	Final Target
Electrolyzer size	5kg/week	1kg/day generated over a 12hr period
Compression	70MPa	Unchanged
H_2 Storage	Small or no storage	70MPa bulk H_2 storage for partial cascade (fast) refueling
Fuelling profile	Slow direct fill via compressor	Combination of fast cascade then slow direct fill
Location	In or outside	Unchanged
Cost analysis of system	Not included within scope	To include target to 100,000 units

Public acceptance will depend mainly upon convenience and price. Until a reliable infrastructure for H_2 exists, there is a need for home-based refuelers; and, once the infrastructure is established, will still offer convenience. Acceptability could be adversely affected by high SHFA cost, especially in early adoption. Cost is dependent on: 1) those elements that can be improved upon by volume demand, such as mechanical components and labor, and 2) those controlled by commodity pricing, such as the platinum catalysts in the stack, reactor catalysts in the gas purification O_2 reactor unit, etc. The former will see improvement over time, as volume demand leads to improved manufacturing and economies of scale; the latter may be addressed by ongoing research into improved catalysts, and siting manufacture in the country of material origin.

Benefits

SHFA benefits are summarized below.

Benefits
Independence from imported oil (energy security)
Environmental credentials and compatibility with various renewable power in electricity networks
Ease of refueling
Long-term refueling solution under control of householder
Enables use of H_2 vehicle if local refueler is not available
Affords opportunity to buy an FCV plus SHFA package

Additional benefits include:

- "Downgradable" with lower pressure on-board vehicle storage in future designs.
- Weather-resistant operation: frost protection of the electrolyzer and capability of functioning through heavy snow-storms.
- Compressor noise minimal with insulation.
- Internal system leakage dilution.

Project Costs

The project was estimated to cost $417,600 originally in US DOE co-funding for Phase 1 and Phase 2a of the 70/35 MPa SHFA, with $41,000 provided in other co-funding, excluding the SCAQMD co-funding commitment of $63,400 ($23,400 for Phase 1 plus $40,000 for Phase 2a). The actual amounts spent for both US DOE co-funding and other co-funding exceeded these original estimates. The actual cost is $578,718 in US DOE funding for both Phase 1 and Phase 2a combined. Of this, Phase 1 cost US DOE $222,125, and Phase 2a cost US DOE $356,593. Non-federal co-funding was provided by NEC, SCAQMD, and project partners in the amount of $173,374 for *both* Phase 1 and Phase 2a. Of this, SCAQMD provided $23,400 for Phase 1 and (upon acceptance of this final report) will provide an additional $40,000 for Phase 2a. NEC and subcontractor GTI provided a total of $54,391 in cost share for Phase 1. NEC and subcontractor ITM provided a total of $55,583 in cost share for Phase 2a.

Commercialization and Applications

Various sources predict strong growth in FCV sales from 2015 to 2025 – with annual production rates over 1 million vehicles by 2020, assuming cost reductions on the order of 90% to 2020. With a few exceptions (Germany, Japan, California), few countries have made commitments to building H_2 infrastructures by 2015, potentially constricting early FCV sales and adopters from buying FCV. Although the initial costs will be high, the SHFA should be viewed as an enabler for building the FCV market. High net worth individuals (HNWIs) are expected to form a substantial proportion of FCV and SHFA purchasers in the early years after launch. There are 12 countries with high levels of HNWIs as prospective early adopters for FCV, and only Germany and Japan have committed to a large scale H_2 infrastructure; but several countries have FCV developers and increasing penetrations of renewable power sources, positive drivers for SHFA deployment.

SCAQMD Contract #08033-4 **June 2011**

Spatiotemporal Analysis of Air Pollution and Mortality in California Based on the American Cancer Society Cohort

Contractor

California Air Resources Board (CARB)

Cosponsors

CARB
South Coast Air Quality Management District (SCAQMD)

Project Officer

Jean Ospital

Background

Fine particulate matter exposures are associated with a variety of adverse health effects, including increases in mortality rates. However, California specific studies have presented mixed results. One study of Southern California residents found higher health effects from exposure to particulate matter than studies using national cohorts, but another California study reported no effects on total mortality risks. This study, conducted by the University of CA, Berkeley, used a larger number of study subjects residing in major cities throughout the state in addition to those in Southern California from the previous study, to provide a larger study population and a longer study period.

Project Objective

The objective of this research project was to conduct an assessment of the health effects from particulate and gaseous air pollution on all-cause as well as cause-specific mortality in California based on a cohort recruited by the American Cancer Society ACS) for the Cancer Prevention Study (CPS-II).

Technology Description

This study followed more than 76,000 California subjects in the ACS cohort to serve as the study population. These subjects were widely distributed across California, giving comprehensive coverage for much of the population of the state (i.e., 54 of 58 California counties have ACS subjects). The study subjects were recruited in 1982, and mortality was followed through 2000.

As a basis for exposure assessment, several approaches were utilized including interpolation estimates of air pollution levels measured at air quality monitoring stations, geostatisical kriging, advanced remote sensing coupled with atmospheric modeling, land use regression (LUR), and Bayesian models capable of assessing space-time patterns in exposure to improve exposure assignment. A comprehensive set of 20 individual risk factor variables similar to those used in previous studies was also employed. These variables control for lifestyle, dietary, demographic, occupational, and educational influences that may confound the air pollution-mortality association. Additional ecological variables in the neighborhoods of residence to control for "contextual" neighborhood confounding (e.g., unemployment) were used.

The study assessed the association between air pollution and several causes of death, including cardiovascular (CVD), ischemic heart disease (IHD), respiratory, lung cancer, and other causes, as well as all-cause mortality.

The association between air pollution and death was assessed using standard and multilevel Cox proportional hazards models. Control was also applied for residence in the five largest urban conurbations in the state, which potentially have different mortality rates than non-metropolitan areas. We also assessed spatial autocorrelation in the health effect estimates.

Status

The project has been completed, and the final report (Jerrett, M. Spatiotemporal Analysis of Air Pollution and Mortality in California Based on the American Cancer Society Cohort: Final Report, 2011) is available at

http://www.arb.ca.gov/research/apr/past/06-332.pdf.

Results

Key results are summarized below.

1. Cardiovascular disease (CVD) deaths, especially those from ischemic heart disease (IHD), are consistently and robustly associated with measures of fine particulate and traffic-related air pollution. The effects on CVD and IHD in California are virtually identical to those found in the national study of the CPS-II cohort.

2. All-cause mortality is significantly associated with PM2.5 exposure, but the results are sensitive to statistical model specification and to the exposure model used to generate the estimates. Only the model that applied control for residence in the largest urban conurbations, and employed the land use regression (LUR) model, were significantly elevated effects found on all-cause mortality. In the opinion of the researchers, this model specification with land use regression exposures and control for residence in the large conurbations is the most likely to produce scientifically valid results. Many of the other results presented were included to satisfy contractual requirements to investigate methodological issues of interest to the Air Resources Board. When the fully specified models were used, the effect sizes found were the same as those in the national study (see Table for a comparison).

3. The strongest and most consistent effects are observed when there is finer-scale spatial resolution in the exposure predictions. In models using the LUR estimate that serve as markers of relatively local variation in pollution, effects on all-cause mortality from NO2 and PM2.5 were found.

Table: Comparison of Relative Risk Estimates from the California and National American Cancer Society Cohorts for PM2.5 using a 10 µg/m3 Exposure Increment

	Hazard Ratio (95% CI)	
	California*	**National Level****
All-cause	1.08 (1.001.15)	1.08 (1.041.11)
Cardiovascular Disease	1.15 (1.041.28)	1.17 (1.111.24)
Ischemic Heart Disease	1.28 (1.121.47)	1.29 (1.181.40)

* California study uses residential address with a Land Use Regression estimate of exposure with statistical control for individual and ecologic covariates and residence in the five largest conurbations in California.

**National level study uses metropolitan area of residence with the average of all $PM_{2.5}$ monitors within the metropolitan area as the exposure estimate; source for the National estimate for all-cause and IHD from Krewski et al. 2009 Extended Analysis of the American Cancer Society Study of Particulate Air Pollution and Mortality. 2009, Health Effects Institute.

The results from this investigation indicate consistent and robust effects of PM2.5 and NO2 – a pollutant commonly found in the combustion-source mixture with PM2.5 − on deaths from CVD and IHD. We also found significant associations between PM2.5 and all causes of death, although these findings were sensitive to model specification and were statistically significant only for the model using Land Use Regression estimates of pollutant exposures.

Benefits

The results of this study provide a robust estimate of air pollution and mortality risk using a California specific population. The findings are directly relevant to determining the appropriate level of PM2.5 that will protect public health and will provide more specific estimates of the benefits of reducing emissions related to PM2.5.

Project Costs

The cost of this project was $749,976. SCAQMD's contribution was $374,988, and the CARB contribution was $374,988.

SCAQMD Contract #08033-5 **June 2011**

Extended Analysis of Air Pollution and Cardiovascular Disease in the California Teachers Study Cohort

Contractor

California Air Resources Board (CARB)

Cosponsors

CARB
South Coast Air Quality Management District (SCAQMD)

Project Officer

Jean Ospital

Background

The California Teacher Study is an ongoing cohort health study of over 100,000 female school teachers. Previous studies of this cohort have found associations of long-term exposure to PM2.5, CO, and NO2 with increased risk of heart attacks and stroke, and well as an association of PM2.5 with mortality.

Project Objective

The objective of this study, conducted by the California Department of Public Health, Environmental Health Investigations Branch, was to extend the previous analyses using different exposure periods, include additional disease categories, and examine associations of disease and death with specific components of PM2.5 such as elemental carbon, nitrates, and sulfates. In addition, the study assesses the relation of metrics related to traffic emissions and adverse health effects.

Technology Description

A statistical analysis was conducted using Cox proportional hazard regression models, adjusting for smoking status, total pack-years (for current and former smokers), body mass index, marital status, alcohol consumption, second-hand smoke exposure at home, dietary fat, fiber and calories, physical activity, menopausal status, hormone use, and several Census-derived contextual (neighborhood) variables (income, income inequality, education, population size, racial composition, unemployment).

The exposure assessment in the PM2.5 constituents analysis was more limited than in the main analysis because there were only eight monitors available that were collecting data on PM2.5 mass and selected constituents as part of the U.S. Environmental Protection Agency's Speciation Trends Network (U.S. EPA 2008). These monitors went online at different times; the data for this analysis were collected once all were operative - from June 1, 2002 through July 31, 2007. Eight monitors were insufficient to create statewide pollutant exposure estimates. Therefore, monthly exposure values were assigned to each participant based on measurements taken at the monitor nearest the geocoded residential address. For these analyses our sample was restricted to women living within 30 km of one of the monitors.

Status

This project has been completed. The final report (Lipsett, M. Extended Analysis of Air Pollution and Cardiovascular Disease in the California Teachers Study Cohort, 2011) is available at http://www.arb.ca.gov/research/apr/past/06-336.pdf

Results

Selected highlights of the results follow.

Most point estimates of relative risks for PM2.5 exposure were greater than unity, however only that for ischemic heart disease (IHD) mortality was significantly elevated (HR = 1.20, 95% CI 1.02-1.41)

IHD mortality was significantly associated with NOx (HR = 1.25, 95% CI = 1.00-1.55), and the risk of cardiovascular mortality was elevated with

a weaker association (HR = 1.13, 95% CI = 0.98-1.31). In contrast, the association between ozone and IHD mortality was of borderline significance (HR = 1.06, 95% CI = 0.99-1.14), with no corresponding increase in the HR for cardiovascular disease in toto. However, when the ozone analysis was restricted to summers only, the HR for IHD mortality was significantly elevated (HR = 1.09, 95% CI = 1.01-1.19).

In the PM2.5 analysis restricted to women who were post-menopausal at baseline, the results were similar to those for the cohort as a whole, except that the Hazard Ratio (HR) for stroke incidence increased and became statistically significant (HR = 1.19, 95% CI = 1.02-1.38).

For the PM2.5 constituents analysis, the pollutants (organic and elemental carbon, nitrate, sulfate, potassium, iron, silicon and zinc) were all strongly inter-correlated, with the majority of correlation coefficients greater than 0.7. Significant associations were observed for PM2.5 mass, sulfate and nitrate exposures in relation to cardiopulmonary mortality, with a more modest association for silicon. PM2.5 mass and all of its components were associated with mortality from IHD, while none was associated with respiratory mortality. For IHD, the largest effect estimates were observed for elemental carbon (EC) and sulfate, although estimates were fairly similar among all the constituents except silicon and organic carbon, which had somewhat lower Hazard Ratios.

The highest decile of traffic density was associated with all-cause, cardiopulmonary and cardiovascular mortality. For vehicle density, the 25th to 49th percentile category was associated with cardiovascular mortality, HR = 1.17 (95% CI = 1.01-1.37. The other traffic metrics showed no association with these outcomes.

This study provides evidence that long-term exposure to PM2.5, PM10, NOx, and ozone were all associated with increased risks for IHD mortality. However, the apparent increased risk of IHD mortality associated with long-term ozone exposure was most likely due to its correlation with particulate matter, while that for NOx was based on relatively small numbers of observations, and may also have been due to correlation with PM. That both PM measures were associated with incident stroke provides support for the notion that these pollutant mixtures may play an etiologic role in the development of circulatory disease.

Selected associations of pollutant exposures with relative risk of mortality are shown in the figure below.

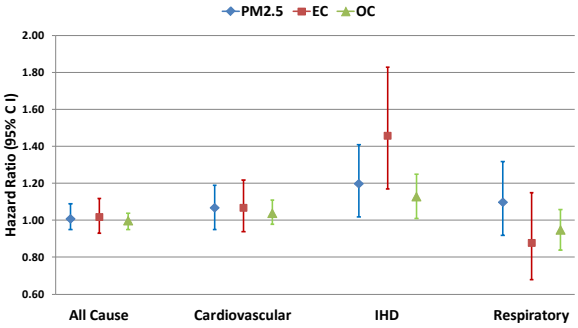


Figure: Association of Mortality with PM2.5 and selected constituents with relative risk of mortality for all cause (non-traumatic) and specific disease category causes. EC = elemental carbon, OC = organic carbon

Benefits

The results from this study can be used to assess the effects of air pollution on health in Californians, and can be used to assess the effects of components of PM2.5. This provides information useful for determining the benefits of emissions controls for PM2.5 and specific PM2.5 components.

Project Costs

Total funding for this project was $284,652. The CARB share was $142,326, and the SCAQMD share was $142,326.

SCAQMD Contract #05207 **June 2011**

Install 80 kW Solar Panel System at SCAQMD Headquarters

Contractor

SolSource Energy

Cosponsors

South Coast Air Quality Management District (SCAQMD)
California State CPUC Self-Generation Incentive Program (SGIP)

Project Officer

Ranji George

Background

Solar technologies provide many benefits including: clean, renewable power generation, decreased consumption of electricity generated from fossil fuels, and insulation against rising electricity costs. Photovoltaic systems, in particular, can produce electricity with zero carbon dioxide (CO_2) emissions, zero VOC, NO_x, SO_x emissions and zero surface and ground-water discharges.

To demonstrate these benefits, SCAQMD has provided funds to encourage solar energy projects in the South Coast Air Basin by offering help to offset its initial cost of installation.

Project Objective

This project involved installing 80 kW of solar panels on top of the SCAQMD headquarters building in Diamond Bar, CA.

The objective is to harness the output from the solar system to provide partial power to an electrolyzer at the facility to generate hydrogen fuel. This hydrogen is dispensed, through SCAQMD's hydrogen refueling station, to refuel advanced fuel cell vehicles currently under demonstration at SCAQMD.

Over time, the system is expected to reduce electricity costs to the SCAQMD. Since conventional electricity costs are anticipated to rise in future, these cost savings are expected to grow with each year of operation.

Status

This SCAQMD 80 kW solar roof project has been completed.

On December 3, 2004, SCAQMD Board approved the release of RFP #2005-18. This RFP solicited bids for the detailed design and engineering, identification, and selection of code-compliant components, materials and equipment for the installation of an 80 kW AC turn-key solar photovoltaic (PV) system, at its facility located at 21865 Copley Drive in Diamond Bar, CA.

On April 1, 2005, the SCAQMD Board authorized the execution of a contract with the successful bidder, Sol Source Energy, to perform this task.

Before installation began, the SCAQMD roof was thoroughly examined in terms of weight, compatibility, and shading effects, if any. By March 2006, the solar panels were installed on top of the headquarters building.

The 80 kW installed system consists of 344 solar Schott Solar modules, made of semi-crystalline silicon. These modules are mounted on a non-penetrating, free-standing mounting system. Combiner boxes were installed at various points to collect and combine the DC energy of the individual rooftop modules, and feed this DC energy down to the main electrical room. Here, a DC-to-AC inverter was mounted to convert the DC energy into AC energy, which is then fed back into the main SCAQMD's electrical system.

SolSource Energy, jointly with the SCAQMD project officer, got the building permit, obtained approval of the interconnect agreement with Southern California Edison, and collected the CPUC rebate from the Gas Company.

SolSource Energy guaranteed that the installed system would produce 550,000 kWh of energy during its first five years of operation at the facility.

As an optional feature, a kiosk was installed by PermaCity in the lobby to monitor and publicize the performance of the solar panels. Below is an example of the display screen highlighting the electricity produced by the solar panels on a given day.

Results

The solar system has produced over 650,000 kwh in zero-emission electricity since its inception.

Project Costs

- Total Project Cost: $709,947
  - CPUC Rebate: $360,000
  - SCAQMD Cost: $349,947
  - $8.87/watt (Total Cost)
  - $4.37/watt (SCAQMD $)

SCAQMD estimates a return on investment in about 15 years. This payback period may be reduced if electricity prices go up. After the payback period of 15 years, this portion of the electricity will be free of cost to SCAQMD for another 10 years, assuming a panel lifetime of 25 years.

Commercialization

In a bid to encourage the market success of renewable energy, the CPUC offered substantial incentives in the early years of the Self-Generation Incentive Program. Since the cost of solar panels was expected to decline steadily, the program reduced these incentives over time, which meant early adopters received more incentives than later adopters.

Relative to 2002 prices, prices of individual solar panels have in fact substantially declined, mainly due to economies of scale associated with large-scale manufacturing of solar panels, reduced raw material costs, and the recent entry of solar panels made in China. Though state incentives have been sharply scaled back, the market is being sustained by these lowered panel prices. In the not too distant future, solar panels are expected to survive in the market without state incentives.

California has adopted an aggressive Renewable Portfolio Standard (RPS) that requires 33% of all electricity in 2020 to be generated from renewable energy. As prices steadily decline, in the years to come, solar and wind energy are expected to play a greater role to meet this RPS goal.

SCAQMD Contract #10114 **September 2011**

Retrofit Digester Gas Engine with Fuel Gas Clean-up and Exhaust Emission Control Technology

Contractor

Orange County Sanitation District

Cosponsors

Orange County Sanitation District
South Coast Air Quality Management District (SCAQMD)

Project Officer

Alfonso Baez

Background

SCAQMD Rule 1110.2 - Emissions from gaseous- and liquid-fueled engines significantly reduces emission limits for NO_x, VOCs, and CO for internal combustion (IC) engines, effective July 1, 2012. The amended rule also requires biogas-fueled engines to meet lower emission limits. This rule applies to the digester gas-fueled IC engines at the two OCSD wastewater treatment plants, Plants 1 and 2. Since the SCAQMD Board recognized the new rule as technology-forcing, they directed assessments to be conducted to determine if cost-effective, commercially-available technologies exist to achieve the new lower limits. This pilot study was performed as part of this assessment.

Project Objective

The SCAQMD Board approved a contract with OCSD in October 2009 to support a pilot test study at Plant 1 Engine 1 to evaluate the effectiveness of a combined catalytic oxidizer and selective catalytic reduction system (Cat Ox/SCR) along with a digester gas cleaning system (DGCS) in meeting the requirements of the amended rule.

Technology Description

Plant 1 has three 2.5 MW IC engines. Under the pilot study, Engine 1 at Plant 1 was equipped with a catalytic oxidizer at the engine exhaust to remove CO and VOCs, followed by an SCR system with urea injection to remove NO_x (both supplied by Johnson Matthey). Due to space limitations at Plant 1, a platform was constructed 14 feet above an onsite access road to accommodate the catalytic oxidizer and SCR systems. Engine 1 is fueled primarily by digester gas, supplemented by natural gas. A digester gas cleaning system (DGCS) was installed (supplied by Applied Filter Technology) to remove contaminants known to degrade engines (e.g., siloxanes, sulfur compounds, and VOCs) from the digester gas prior to combustion. DGCS inlet and outlet concentrations of siloxanes, H2S, VOCs, and TRS were measured using industry standard and SCAQMD methods.

OCSD Plant 1 Engine 1 Cat Ox/SCR System 1

Catalytic oxidizer inlet and SCR outlet concentrations of CO, NO_x, and VOCs were measured using a portable analyzer and U.S. EPA and SCAQMD compliance methods to determine the potential reductions in emissions due to the Cat Ox/SCR system. Continuous emissions monitoring system (CEMS) data (15-minute averages) were collected at the engine exhaust (inlet to Cat Ox system) for NOx and at the stack exhaust for NO_x, CO, and O2. Sampling was performed for formaldehyde, acetaldehyde, and acrolein as required by the Research Permit for the study.

Status

The construction and installation of the study equipment began in October 2009. Data collection for the pilot testing began on April 1, 2010 and ended on March 31, 2011.

Results

1. The average NO_x concentration was approximately 7 ppmv, below the amended Rule 1110.2 11 ppmv emission limit. The lowest NO_x stack exhaust concentration consistently achieved under all valid conditions was 16 ppmv. However, there were 181 out of a total of 21,285 15-minute operating periods (approximately 5,321 hours) of valid NO_x stack exhaust excursions above 11 ppmv. These periods occurred during 61 separate events and accounted for 0.9% of the total measurement periods. Excursions were considered valid when they occurred during periods/events when the percentage of natural gas increased to above 5% of the fuel blend, when engine loads exceeded the loads mapped during the SCR system commissioning, or during periods/events not attributable to engine start-up or operational /system adjustments. An implication of these excursions is that the 11 ppmv limit is too conservative and may warrant a higher value and/or a specified percentage of allowable excursions.

2. SCR systems are commercially available for combustion units fueled by single-component fuels, such as natural gas. Although the SCR system did not consistently meet the 11 ppmv limit with the digester gas/natural gas fuel blend in the pilot study, it did demonstrate a significant reduction of NO_x emissions.

3. The free ammonia concentration at the stack exhaust was measured below 0.5 ppmv during all testing events using either SCAQMD Method 207.1 or Draeger® tubes.

4. The maximum CO concentration at the stack exhaust was 42.2 ppmv, well below the limit of 250 ppmv.

5. The maximum VOC concentration was 4.95 ppmv; well below the 30 ppmv limit.

6. The DGCS system removed siloxanes from the digester gas to below detection and significantly reduced sulfur compounds and VOCs, successfully reducing catalyst masking, which should lead to extended catalyst life. Additional benefits of the contaminant removal were significantly improved engine maintenance requirements and lower O&M costs.

Benefits

The use of the combined Cat Ox/SCR system resulted in significant reductions in CO, VOC, and NO_x. CO and VOCs were determined to be well below the amended Rule 1110.2 limits. On average, NO_x concentrations were below the lower limits, with some NO_x excursions about the 11 ppmv limit using 15-minute block averaging. The DGCS system removed contaminants from the digester gas, thereby maintaining the performance of the catalyst.

Project Costs

The total capital cost (to design, procure, and install a DGCS to clean the digester gas for all Plant 1 engines and a Cat Ox/SCR system with auxiliary equipment for Engine 1) is estimated at $2,300,000. The annual O&M cost for these systems at Plant 1 is approximately $59,000. Assuming a 20-year lifespan, the total annualized cost (capital cost plus O&M) is $227,000.

The cost effectiveness analysis (dollars per ton of NO_x and VOC emissions reduced) was developed for two scenarios: Scenario 1 assumed that the uncontrolled emissions were based on current permit limits, and Scenario 2 assumed that the uncontrolled emissions were based on the results from the 2011 Annual Compliance Test. Controlled emissions were based on the Rule 1110.2 limits of 11 ppmv for NO_x and 30 ppmv for VOCs. Under these assumptions, the cost effectiveness for Scenarios 1 and 2 are $7,987 and $17,585, respectively, per ton of NO_x plus VOCs reduced. Calculations for cost and emissions reduced were based on operating each engine for a maximum of 6,000 hours per year.

Appendix D

List of Acronyms

LIST OF ACRONYMS

AFRC—air/fuel ratio control
APCD—Air Pollution Control District
AQMD—Air Quality Management District
AQMP—Air Quality Management Plan
ARB—Air Resources Board
ARRA-American Recovery & Reinvestment Act
BACT—Best Available Control Technology
BSNOx—brake specific NOx
CAAP—Clean Air Action Plan
CAFR—Comprehensive Annual Financial Report
CARB—California Air Resources Board
CCF—California Clean Fuels
CEC—California Energy Commission
CEMS—continuous emission monitoring system
CFD—computational fluid dynamic
CNG—compressed natural gas
CO_2—carbon dioxide
CO—carbon monoxide
CY—calendar year
DCM—dichloromethane
DDC—Detroit Diesel Corporation
DEG—diesel equivalent gallons
DGE—diesel gallon equivalents
DF—deterioration factor
DMS—Division of Measurement Standards
DMV—Department of Motor Vehicles
DOC—diesel oxidation catalysts
DOE—Department of Energy
DOT—Department of Transportation
DPF—diesel particulate filters
DRI—Desert Research Institute
ECM—emission control monitoring
EPRI—Electric Power Research Institute
ESD—emergency shut down
EV—electric vehicle
FCV—fuel cell vehicle
FTP—federal test procedures
g/bhp-hr—grams per brake horsepower per hour
GC/MS—gas chromatography/mass spectrometry
GGE—gasoline gallon equivalents
GHG—Greenhouse Gas
GTL—gas to liquid
H&SC—California Health and Safety Code
HCCI—Homogeneous Charge Combustion Ignition
HCNG—hydrogen-compressed natural gas (blend)
HEV—Hybrid electric vehicle
HPDI—High Pressure Diesel Injection
ICE—internal combustion engine
ICEV—internal combustion engine vehicle
ICTC—Interstate Clean Transportation Corridor
LCFS—Low-Carbon Fuel Standard
Li—lithium ion
LIMS—Laboratory Information Management System
LNG—liquefied natural gas
LPG—liquefied petroleum gas or propane
MATES—Multiple Air Toxics Exposure Study
MECA—Manufacturers of Emission Controls Association
MPFI—Multi-Port Fuel Injection
MSRC—Mobile Source Air Pollution Reduction Review Committee
MTA—Metropolitan Transportation Authority
NAFA—National Association of Fleet Administrators
NGV—natural gas vehicle
NMHC—non-methane hydrocarbon
NOx—oxides of nitrogen
NREL—National Renewables Energy Lab
OBD—On-Board Diagnostics
OCTA—Orange County Transit Authority
OEM—original equipment manufacturer
PAH—polyaromatic hydrocarbons
PbA—lead acid
PCM—powertrain control module
PHEV—plug-in hybrid vehicle
PM—particulate matter
PM2.5—particulate matter ≤ 2.5 microns
PM10—particulate matter ≤ 10 microns
PPM—parts per million
RDD&D—research, development, demonstration, and deployment
RTA—Riverside Transit Agency
SCAB—South Coast Air Basin or "Basin"
SCAQMD—South Coast Air Quality Management District
SCE—Southern California Edison
SCR—selective catalytic reduction
SI—spark ignited
SULEV—super ultra-low emission vehicle
TC—total carbon
THC—total hydrocarbons
TO—task order
U.S.EPA—United States Environmental Protection Agency
ULEV—ultra low emission vehicle
VOC—volatile organic compounds
WVU—West Virginia University
ZEV—zero emission vehicle