
AQMD
South Coast Air Quality Management District
Technology Advancement Office
Clean Fuels Program
2009 Annual Report and
2010 Plan Update
March 2010

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EXECUTIVE SUMMARY

2009 Annual Report

The South Coast Air Quality Management District (SCAQMD) executed 68 new projects or studies and modified 6 continuing projects adding additional dollars during Calendar Year (CY) 2009 toward research, development, demonstration and deployment (RDD&D) of alternative fuel and clean fuel technologies. Table 2 (page 19) lists these 74 projects or studies, which are further described in this report. The SCAQMD contributed more than $6.25 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.

These projects or studies 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 Technology (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 2009, 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 2009 included continued development of hybrid and battery electric vehicle technologies, development and demonstration of hydrogen technology and infrastructure; further expansion of natural gas alternative refueling infrastructure and vehicle deployment; and continued demonstrations of emission control technologies on off-road equipment as well as emission studies.

Twenty-five research, development, demonstration and deployment projects or studies and 25 outreach and technology transfer or assistance contracts were completed in 2009, as listed in Table 7 (page 50). Appendix C comprises two-page summaries of the technical projects completed in 2009. 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, 2009, after approval by the SCAQMD Governing Board.

2010 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 so near- and mid-term reductions 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;
- 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 8 (page 61) lists the potential projects across the core technologies identified in this report. Potential projects for 2010 total nearly $16.5 million, with anticipated leveraging of more than $116 million. The proposed projects may also be funded by revenue sources other than the Clean Fuels Program, especially VOC and incentive projects. The higher project costs projected for 2010 compared to 2009 reflect $78.5 million the SCAQMD has been awarded to date through the American Recovery and Reinvestment Act (ARRA) as well as other federal grant programs.

CLEAN FUELS PROGRAM
2009 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.

2009 Overview

This report summarizes the progress of the SCAQMD Clean Fuels Program for CY 2009. This SCAQMD program co-sponsors projects to develop and demonstrate 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, 2009, the SCAQMD executed 68 new projects or studies and modified 6 continuing projects adding additional dollars during CY 2009 that support clean fuels and advanced low-emission technologies. The SCAQMD contribution for these projects was more than $6.25 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. Notably, in 2009 the SCAQMD applied for and was awarded more than $78.5 million in funds through the American Recovery and Reinvestment Act and other federal funding programs. The projects for which these funds were awarded complement and enhance the technology development and demonstration efforts already being undertaken through the Clean Fuels Program. The SCAQMD will continue to pursue funding opportunities in 2010 to amplify leveraging.

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 and VOC emissions inventory is shown in Figure 1. Based on the 2007 AQMP, significant reductions are necessary to demonstrate attainment with the federal standards.

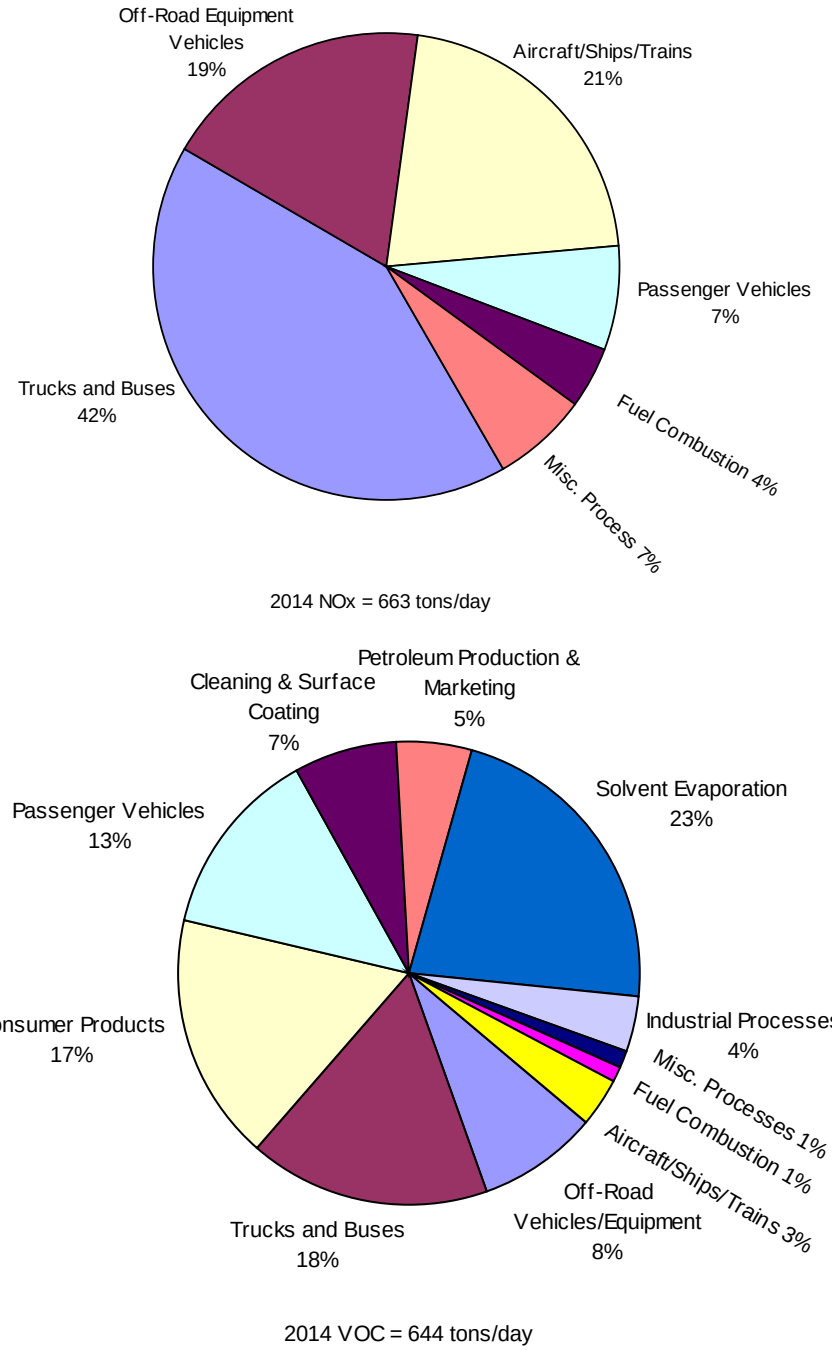


Figure 1: Major Source Contributions (2014)

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 new 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.

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.

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.

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 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 reinstated the five percent administrative cap.

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 2009 the funds available through each of these mechanisms were as follows:

- Mobile sources (DMV revenues) $12,088,772
- Stationary sources (emission fee surcharge) $544,610

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 22) lists the supplemental grants and revenues recognized in 2009, which total $984,000.

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 more than $3 of outside funding for each $1 of SCAQMD funding. For 2009, the Clean Fuels Program leveraged each $1 to more than $4 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 2009 are listed in Table 1 (page 11).

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 Technologies
- 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 may continue into 2011. 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 AQMP needs for achieving clean air are briefly described blow.

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. A Technology Review of the California Zero Emission Vehicle (ZEV) regulation conducted by CARB in the fall of 2007 resulted in some changes to the regulation adopted on March 27, 2008 and updated test procedures adopted on January 23, 2009, that were submitted to the Office of Administrative Law on February 2, 2009. While the volume of fuel cell vehicles to be supplied by the major automakers by 2011 (2,500) is still expected, an alternative strategy can meet the 2012-2014 requirements with additional "silver plus" vehicles, such as plug-in hybrid electric vehicles (PHEVs) and hydrogen-fueled internal combustion engine (ICE) vehicles. CARB requested staff to propose additional changes for 2015 and beyond that would re-focus the ZEV regulation on encouraging technology advancements for zero emission vehicles, potentially moving implementation of most "silver" ATPZEV hybrid and alternative fuel vehicles to the new low carbon fuel standard regulation and plug-in hybrid vehicles as a greenhouse gas reduction strategy for AB 32 implementation.

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).

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. 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 Technologies

Medium- and heavy-duty on-road vehicles contributed approximately 36 percent of the Basin's NO_x based on 2005 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 1.2 g/bhp-hr (combined NO_x and VOC emissions) and there is currently only one commercially available heavy-duty natural gas engine with demonstrated NO_x emissions levels at 0.2 g/bhp-hr (Cummins 8.9L). 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.

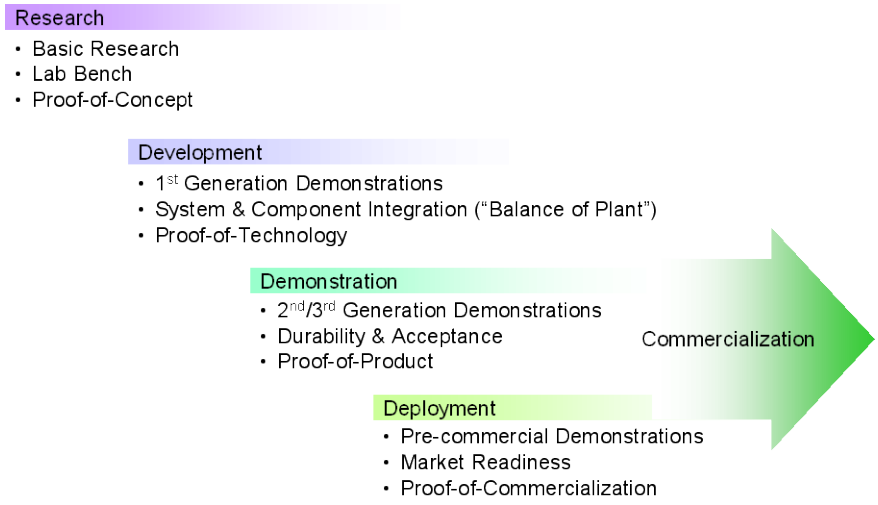


Figure 2: Stages of Clean Fuels Program Projects

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 Innovations: ISX 15L (LNG)
- 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; and
- Commercial Stationary Fuel Cell Demonstration with UTC and SoCalGas (first of its kind).

➢ 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; and
- Plug-in Hybrid Electric Van with EPRI, DaimlerChrysler and SCE.

➢ Aftertreatment Technologies for Heavy-Duty Vehicles
- Johnson Matthey and Engelhard trap demonstrations on buses and construction equipment; 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 2009 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 2009 Project Summaries contained within this report.

Table 1: SCAQMD Major Funding Partners in CY 2009

Research Funding Organizations	Major Manufacturers/Providers
California Air Resources Board	Air Products and Chemicals Inc.
California Energy Commission	Clean Energy Fuels Corporation
Mobile Source Air Pollution Reduction Review Committee	Electric Power Research Institute
National Renewable Energy Laboratory	ISE Corporation
U.S. Department of Energy	Waste Management Inc. & Affiliates

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 2009. 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 development and demonstration of hydrogen infrastructure; (b) the further development and demonstration of fuel cell, plug-in hybrid and electric vehicle technologies; and (c) remote sensing measurements of heavy-duty on-road emissions.

Plug-In Hybrid and Electric Vehicles

The SCAQMD has sponsored the development and demonstration of a medium-duty PHEV to determine its potential operating cost reduction, emission reduction and fossil fuel displacement potential. This demonstration program will consist of the design and development of a medium duty gasoline plug-in hybrid electric vehicle. The demonstration vehicle will be based on Ford's F-550 chassis, with the plug-in drive system developed by Eaton. Once built, and initially qualification tested by Eaton, the vehicle will be comparatively emission tested on a chassis dynamometer to quantify tailpipe emissions and fuel economy in a controlled laboratory setting. Additional field testing will be conducted by Southern California Edison on a controlled driving loop, with the vehicle ultimately being deployed with an Area Fleet Manager at a U-Haul facility in the South Coast Air Basin.

All stages of testing during the demonstration program shall also include a current technology, conventionally driven gasoline and diesel Ford F-550 to provide comparative test data. The conventionally driven vehicles will be tested on the same chassis dyno drive cycle as the plug-in demonstration vehicle and driven on the same controlled driving loop at SCE. During evaluation by U-Haul, the three vehicles will be alternately rotated between different driving loops and drivers to provide a comparative in-use evaluation.

Figure 3: F-550 Chassis

Hydrogen Infrastructure Development

Air Products has been selected by CARB to install a new 5,000/10,000 PSI hydrogen refueling station at Orange County Sanitation District (OCSD) which will be supplied by 100% renewable hydrogen and 100% renewable electricity produced utilizing a molten carbonate fuel cell. The hydrogen produced will be further purified using a hydrogen purification system. The molten carbonate fuel cell system and purification system will be installed at the water treatment facility under a Department of Energy (DOE) Cooperative Agreement. The hydrogen fueling station, which will be operated by the National Fuel Cell Research Center (NFCRC) and the University of California, Irvine (UCI), will be co-located with an existing, publicly accessible CNG fueling station, and will be designed to dispense 100 kg/day of hydrogen (Figure 4).

Figure 4: CNG Refueling Station & Future Site of Hydrogen Station

The fueling station will dispense hydrogen generated from a renewable resource, anaerobic digester gas, renewably generated from the wastewater treatment facility at OCSD (Figure 5). The digester gas will be converted into hydrogen using a Hydrogen Energy Station capable of producing heat, power and hydrogen. The digester gas will be cleaned and conditioned before it is used by the Hydrogen Energy Station. The Hydrogen

Energy Station will incorporate Fuel Cell Energy's Direct Fuel Cell (DFCÒ) technology. The DFCÒ unit is a molten carbonate-based fuel cell system capable of simultaneously reforming hydrocarbon feedstocks to syngas (hydrogen, CO and CO2), while producing power and process heat. The syngas produced by the DFCÒ is further processed into purified hydrogen using Air Products' hydrogen purifier.

Figure 5: OCSD Wastewater Digester Tank

A special dimension of the project will be the NFCRC's data collection and analysis system which will characterize and monitor the facility's performance and operation. Based on extensive experience in the development and application of thermodynamic and dynamic models to fuel cell components and systems, the NFCRC will analyze the electrical, thermal, and hydrogen co-production technology for this particular application of a carbonate fuel cell operating on digester gas. Data acquired from the installation will be analyzed and presented in the context of the insights provided by the models. Complete data analysis and reports will be made available to the SCAQMD.

Demonstration of MiniE Cooper

BMW North America is conducting a 450-vehicle demonstration program, deploying MiniE electric vehicles in the Los Angeles and New York areas to collect user feedback. The demonstration program may be used to assist in developing vehicle requirements for an upcoming electric vehicle that BMW has announced to be in development. The SCAQMD is participating in this demonstration program by leasing five MiniE Coopers. To support the five MiniE's, the SCAQMD purchased a GPS-based data acquisition system from Racelogic. The GPS data acquisition system will be used to characterize driving behavior when evaluating advanced technology transportation options, such as the MiniE. The ability to analyze driver behavior will allow intelligent conclusions to be drawn with respect to a vehicles operating range and energy utilization when conducting field trials. This tool will allow an evaluator to quantify the influence of driver behavior rather than simply attributing variability in a data set to statistical scatter. The SCAQMD also purchased a power meter to be installed on the electric vehicle chargers servicing the BMW MiniE's. The meter will be used to measure the energy demand that is associated with the use of the MiniE vehicles. This data stream, coupled with driving distance, will allow for the energy and emissions footprint of the vehicle to be evaluated. As part of this demonstration, the SCAQMD also installed seven EV chargers to support the use of the MiniE's. BMW supplied the charger as part of the demonstration program; however, the SCAQMD was

Figure 7: EV Charger Installed at SCAQMD HQs

Figure 6: MiniE Coop at SCAQMD HQs

responsible for all work that was required upstream of the charger including running cable, trenching, setting charger pedestals and pouring concrete. The information obtained by participating in this demonstration program will be a valuable tool in assisting the vehicle manufacturer to better understand the consumer's expectation and experience with electric drive vehicles. This information will also be valuable in creating the specifications for future mass-produced electric vehicles.

Remote Sensing Measurements of On-Road Emissions from Heavy-Duty Vehicles

Heavy-duty diesel vehicles (HDDV) are significant contributors to the on-road vehicle emission inventory in the South Coast Air Basin (Basin). There is a need for high quality historical on-road HDDV emissions data over the next several years to track the impacts of new on-road mobile source regulations which are expected to significantly alter current in-use on-road heavy-duty emissions levels. Specifically, CARB's Drayage Truck Regulation and Statewide Truck and Bus Regulation will significantly change the on-road fleet beginning in 2010. This multi-year study is designed to obtain on-road HDDV emissions baseline and to examine how HDDV emissions are impacted by changing fleet regulations and new HDDV emission standards over the next few years. Another objective of the study is to investigate the correlation between a commercial remote sensing device (RSD) and a research RSD.

The study is co-funded by the National Renewable Energy Laboratory and the SCAQMD. Field measurements are conducted by the University of Denver (DU) at two locations in the Basin, one at the Peralta Weigh Station on California State Route 91 and the other at the Water Street exit from the Port of Los Angeles. Elevated truck exhausts are remotely sampled for carbon monoxide, hydrocarbons, nitric oxide, nitrogen dioxide, ammonia, sulfur dioxide, and particulate matter using one research RSD developed by DU in parallel to one commercial RSD provided by Environmental Systems Products Holdings, Inc (ESP). The first year of data collection began in April 2008, with more than 3200 trucks at the weigh station and more than 1500 trucks at the Port. The second year's measurements were completed in May 2009, with more than 2500 trucks at the weigh station and more than 1900 trucks at the Port location. Results show accelerated retirement programs in operation at the Ports of Los Angeles and Long Beach have already resulted in large changes in the age of the heavy-duty fleet at the port and the fuel mix that they are operating on since the 2008 measurements. Potentially significant reductions in the levels of particulate matter and NO_x emissions are anticipated in 2010 and beyond.

Figure 8: Measurement at the Weigh

Figure 9: Measurement at the Port of LA

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 2009 reporting period illustrate the impact of the SCAQMD's technology deployment and commercialization efforts.

Natural Gas Vehicle Deployment

The commercial availability of alternative-fueled vehicles and other advanced emissions control technologies is important for continued progress in air quality goals and reductions in air toxic exposure. Recent petroleum reduction goals and emphasis on reducing greenhouse gas emissions have resulted in a greater demand for alternative-fueled vehicles. Several cities have placed natural gas vehicles into police service. However, earlier generations of natural gas vehicles were not used as pursuit vehicles given their performance under such conditions.

In 2009 a contract was executed with AFV Fleet Services Solutions to convert two gasoline-powered police interceptors to operate on natural gas. These natural gas-powered police cars will be used in demonstration programs within the cities of Redlands and South Pasadena to assess the viability of natural gas vehicles in police interceptor applications.

Figure 10: Police Vehicle

To further support the demonstration of natural gas powered police interceptors, a contract was also executed with BAF Technologies to convert a Los Angeles County Sheriff's Department gasoline-powered police interceptor to operate on natural gas. After the conversion, vehicle upgrades will be made to optimize performance and the police interceptor will be evaluated through the Los Angeles County Sheriff's Department Law Enforcement Vehicle Test and Evaluation Program, a nationally recognized vehicle testing program. The Sheriff's Department evaluation will include testing the vehicle on a city street pursuit course, a high speed driving course, an acceleration performance test, and a brake test. SCAQMD staff anticipates that a positive evaluation of this vehicle model, along with the demonstrations in Redlands and South Pasadena, will facilitate accelerated commercialization of CNG police interceptors by law enforcement agencies located throughout the SCAQMD's jurisdiction and beyond.

Plug-In Hybrid Vehicles

The SCAQMD has actively sponsored the development of PHEVs for light- and medium-duty platforms, but heavy-duty applications are also important. Beginning in 2009 for passenger vehicle applications, the SCAQMD cost-shared a project with A123 to develop and demonstrate ten Hymotion plug-in hybrid electric vehicle conversion systems using advanced lithium-ion battery systems and controls. The vehicles will plug into a conventional outlet for charging overnight, and can be refueled with gasoline for longer trips. One vehicle is equipped with a data logger to provide more detailed information. At least one vehicle will demonstrate prototype Level 2 or faster charging capability, with additional fast charging system. The SCAQMD will partner with several local fleets to demonstrate these vehicles in typical operations for up to five years.

Figure 11: Fast Charger Example

Figure 12: A123 Hymotion Plug-In Hybrid Electric

A123 has received a CARB Executive Order Exemption to convert up to 500 vehicles to plug-in. This plug-in hybrid system has the potential to increase distance traveled without engine operation and helps prepare local fleets to better understand the benefits and impacts of plug-in hybrid electric vehicles.

Demonstrate Natural Gas-Powered Concrete Mixer Truck

The concrete mixer truck population in the South Coast Air Basin is estimated at 4,700 vehicles out of a total heavy-duty vehicle fleet of 54,645. These trucks are typically powered by 350 horsepower (hp) diesel-fueled engines. As a result, concrete mixer trucks represent 3% of the total vehicular NO_x emissions and 4% of the total vehicular PM emissions in the South Coast Air Basin. A distinctive feature of concrete mixer trucks is their continual engine operation and their significantly high proportion of idling time. The engine in a concrete mixer truck is operating continuously from the time it leaves the ready-mix facility to the time it completes delivery of the product. The mixer drum is powered by the vehicle's engine via a power take-off device and constant drum rotation is necessary to maintain product viability. As such, the engine continues to operate when the vehicle is at rest as evidenced during delivery of the concrete at the jobsite. The concrete mixer truck industry estimates that these vehicles spend 36% of their operating time at idle.

McNeilus Truck and Manufacturing Company, a major builder of concrete mixer trucks, undertook development of a prototype natural gas-powered concrete mixer truck and then sought assistance from the SCAQMD to complete the prototype for demonstration and emissions testing in the Basin. The project vehicle used a Kenworth chassis and was powered by the Cummins-Westport ISL G engine rated at 320 HP and 1,000 lb-ft. torque. With the cooperation and participation by resident concrete mixing operations such as Robertsons Ready Mix, CalPortland, and Cemex, the vehicle has logged more than one year's worth of demonstration use in and around the Basin and has recorded favorable responses from operators. The project will determine necessary fueling capacity needs and fuel tank placements to ensure real-world operating capability. The project will also entail emission testing of the vehicle in idling mode and will be compared with a comparable diesel version. The success of this demonstration is expected to produce additional interest from the concrete mixer industry, purchase orders by local concrete ready-mix companies, and provide OEMs with real-world information to facilitate factory building of these vehicles.

2009 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, 2009.

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, 2009, a total of 74 contracts, projects or studies that support clean fuels were executed or amended, as shown in Table 2. The major technology areas summarized are: hybrid/electric technologies, infrastructure and deployment, hydrogen technology and infrastructure, mobile fuel cell technologies, emission control technologies, engine technologies, fuels/emission studies, stationary clean fuel technologies, health impacts studies, outreach and technology transfer. The distribution of funds based on technology area is shown graphically in Figure 13. 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 2009 reporting period are shown below with the total projected project costs:

- SCAQMD Clean Fuels Fund Contribution $6,254,868
- Total Cost of Clean Fuels Projects $27,239,113

Each year, the SCAQMD Governing Board approves funds to be transferred to the General Fund Budget for Clean Fuels administration. For 2009, 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, 2009, are included within this report. Any portion of the Clean Fuels Funds not spent by the end of Fiscal Year 2009-10 ending June 30, 2010, 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 $984,000 is listed within Table 3. Appendix B lists all Clean Fuels Fund contracts, totaling 137, that were open and active as of January 1, 2010.

For Clean Fuels executed and amended contracts and projects in 2009, the average SCAQMD contribution is approximately 20 percent of the total cost of the projects, identifying that each dollar from the SCAQMD was leveraged with more than four dollars of outside investment.

During 2009, the SCAQMD executed contracts, projects, studies or contract amendments with additional funding of more than $6.25 million for Clean Fuels projects. The distribution of funds is shown in Figure 13 below.

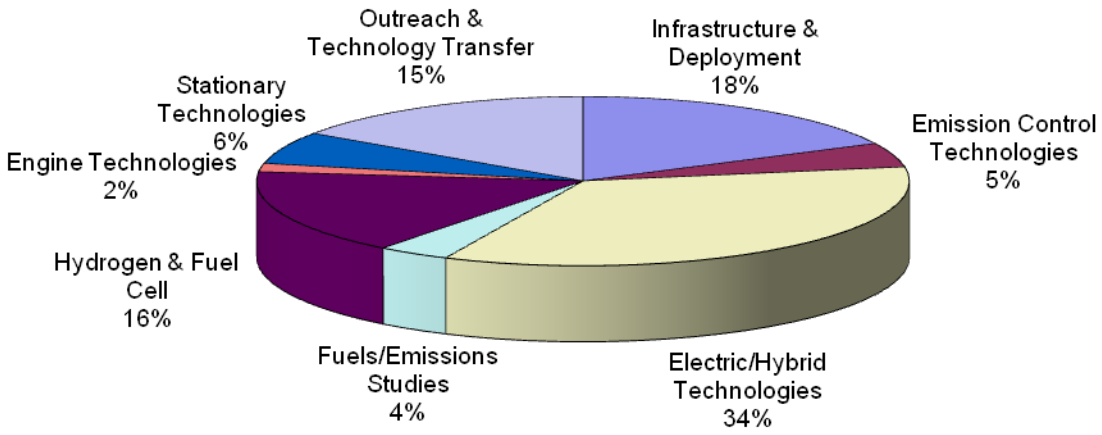


Figure 13: Distribution of Funds for Executed Clean Fuels Projects CY 2009 ($6.25 million)

2009 was a remarkable year of federal funding opportunities through the American Recovery and Reinvestment Act. The SCAQMD applied for and was awarded more than $78.5 million in funds through ARRA and other related funding programs. The projects for which these funds were awarded align well with and enhance the technology development and demonstration efforts already being undertaken through the Clean Fuels Program. The SCAQMD will continue to pursue funding opportunities as these become available. Table 4 (page 22) summarizes these funds and identifies the projects for which they are intended. It is anticipated that contracts drawn against these federal funds will be executed throughout 2010 and reflected in next year's annual report.

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, 2009, 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 74 new and continuing contracts, projects and studies that received SCAQMD funding in 2009 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, 2009

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Infrastructure and Deployment						
07153	Foothill Transit	Purchase & Install New Public Access CNG Refueling Station in Irwindale	11/02/09	12/31/12	$250,000	$3,350,000
08044	Beaumont Unified School District	Install Limited Access CNG Refueling Station	03/05/09	12/31/13	288,000	615,994
09348	AFV Fleet Services	Demonstrate Two Natural Gas-Powered Police Vehicles	04/03/09	03/18/12	75,000	75,000
10051	BusWest	Lease Buses in Support of Mountain Area CNG Demonstration Program	10/09/09	12/31/10	80,000	161,928
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
10181	BAF Technologies	Demonstrate Natural Gas-Powered Police Vehicle	12/31/09	08/31/10	34,500	34,500
Purchase Order	Various	Install Additional Equipment to Enhance Operation at AQMD's Fast-Fill CNG Refueling Station	02/03/09	06/30/10	15,000	15,000
Fuels/Emissions Studies						
08320	University of Denver	Remote Sensing Measurements of On-Road Emissions from Heavy-Duty Diesel Vehicles	02/06/09	01/31/12	161,041	322,092
09290	University of California Riverside	Evaluate Emissions Impacts from Natural Gas Blends on Vehicle Emissions	01/30/09	08/31/10	50,000	450,000
10066	National Renewable Energy Laboratory	CRADA – Loan of 70 MPa Hydrogen Quality Sampling Apparatus to AQMD	11/02/09	12/31/10	0	0
Purchase Order	Anaheim Fullerton Towing	Transport 40-Foot Buses to Southwest Research Institute for Emissions Testing	09/11/09	09/11/09	12,500	12,500
Emission Control Technologies						
08246	Griffith Company	Showcase: Demonstrate NO_x & PM Emissions Control Technologies on Diesel-Powered Construction Equipment	05/14/08	08/24/11	116,450	116,450
08253	Tiger 4 Equipment Leasing	Showcase: Demonstrate NO_x & PM Emissions Control Technologies on Diesel Powered Construction Equipment	01/13/09	08/24/11	17,600	17,600
09000	Shimmick Construction	Showcase: Demonstrate NO_x & PM Emissions Control Technologies on Diesel Powered Construction Equipment	09/11/09	03/24/11	38,900	38,900
09374	California State University Long Beach	Develop & Assess Humid Air System for Diesel NO_x Reduction	05/25/09	10/31/09	17,500	175,000

Table 2: Contracts Executed or Amended (w/$) Between January 1 & December 31, 2009

Emission Control Technologies (continued)

10125	University of California Riverside	Demonstrate Projects for Renewable Feedstock to Energy and Fuel Technologies	12/11/09	01/10/11	$101,369	$211,883

Electric/Hybrid Technologies

99109	Toyota Motor Credit Corporation	Three-Year Lease of One RAV4 Electric Vehicle	04/04/99	02/01/10	7,794	7,794
08219	A123Systems Inc.	Develop & Demonstrate Ten Plug-In Hybrid Electric Vehicles	06/05/09	06/04/15	622,667	962,667
09023	ISE Corporation	Develop & Demonstrate a Battery Electric Transit Bus	08/07/09	05/31/11	290,000	2,285,000
09301	Electric Power Research Institute	Develop & Demonstrate Plug-In Hybrid Electric Vehicle Delivery Vehicle	06/30/09	03/31/11	964,320	2,164,320
09345	South Bay City Council of Governments	Demonstrate Medium-Speed Electric Vehicles	06/19/09	07/31/11	178,825	178,825
09360	BMW of North America LLC	Lease of Five MiniE Cooper Electric Vehicles for One Year	05/05/09	05/04/10	600	600
09427	City of Santa Monica	Demonstrate Battery Electric Class 4 Utility Truck	12/15/09	06/14/11	87,205	210,910
Purchase Order	VBOX	Purchase of VBOX Equipment for Data Collection for MiniE Cooper Demonstration Program	08/05/09	08/05/09	2,710	2,710
Purchase Order	Dent Instruments	Purchase Dent Instruments ElitePro Data Logger for MiniE Cooper Demonstration Program	11/05/09	11/05/09	1,644	1,644
Direct Pay	Clean Fuel Connection Inc.	EV Charger Installations for MiniE Cooper Demonstration Program	11/25/09	12/18/09	4,940	4,940

Engine Technologies

10041	McNeilus Truck and Manufacturing	Develop Prototype Natural Gas-Powered Concrete Mixer Truck and Demonstrate its Performance and Emissions	11/06/09	11/05/10	100,000	380,000

Mobile Fuel Cell Technologies

09436	Bevilacqua-Knight Inc.	Participate in California Fuel Cell Partnership for Calendar Year 2009 and Provide Support for Regional Coordinator	01/01/09	12/31/09	137,800	1,668,200

Hydrogen Technology and Infrastructure

09410	California Hydrogen Business Council	Participate in California Hydrogen Business Council	06/01/09	05/30/10	290,000	405,500
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 SCAQMD Hydrogen Refueling Station	10/30/09	10/29/11	88,000	88,000
Purchase Order	Air Products and Chemicals Inc.	Purging and Removal (in 2008) of Original Five Cities Burbank Hydrogen Station	12/24/09	12/24/09	14,918	14,918

Table 2: Contracts Executed or Amended (w/$) Between January 1 & December 31, 2009

Hydrogen Technology and Infrastructure (continued)

Purchase Order	City of Burbank	Reimbursement of Utility Expense for Seven Months in Support of Temporary Hydrogen Station at City of Burbank	12/18/09	07/30/09	$7,000	$7,000

Stationary Clean Fuel Technologies

09303	PermaCity Solar Corporation	Install 40kW (AC) Crystalline Silicon System at SCAQMD HQs	01/30/09	01/29/15	387,162	387,162

Outreach and Technology Transfer

02308	Sperry Capital, Inc.	Evaluate Financial Stability of Potential Contractors	06/25/02	12/31/11	15,000	15,000
07165	Clean Fuel Connection Inc.	Technical Assistance with Compliance of Carl Moyer Program Guidelines	02/07/09	12/31/10	50,000	50,000
07177	TIAX LLC	Technical Assistance with Evaluation of Project Proposals for Carl Moyer Program	01/27/07	12/31/10	50,000	50,000
08251	Gladstein, Neandross & Associates, Inc.	Technical Assistance, Outreach and Implementation of the SOON and the Goods Movement Program	06/06/08	05/30/10	50,000	150,000
09183	Gary Full	Technical Assistance on Remote Sensing Measurement Technologies as Applied to Auto, Heavy-Duty Diesel and Other Mobile Sources	02/20/09	06/30/10	20,000	20,000
09184	University of California Riverside	Technical Assistance on Advanced, Low- and Zero-Emission Technologies and Implementation Activities	01/23/09	08/30/11	60,000	60,000
09185	Clean Fuel Connection Inc.	Technical Expertise on the CARB EMFAC Mobile Emissions Model and Other Related Mobile Source Issues	05/08/09	06/30/10	50,000	50,000
09253	Nexant, Inc.	Technical Assistance on Alter-native Fuels Life-Cycle Analyses	01/02/09	06/30/10	20,000	20,000
09255	Stan Lisiewicz	Technical Assistance with Caltrans	01/29/09	12/31/10	10,000	10,000
09292	Clean Air Now	Provide Funding Support to the Clean Air Challenge Curriculum Project	01/30/09	04/30/10	60,000	150,000
09371	CALSTART	Technical Assistance for Chairman's Initiative Green Tech Connect Forum	04/19/09	10/31/09	20,000	20,000
09337	Mark Weekly, CPA	Follow-Up Assessment of SCAQMD's Compliance with Special Revenue Funds	03/03/09	01/31/11	15,000	15,000
09372	Three Squares Inc.	Outreach Assistance for Chairman's Initiative Green Tech Connect Forum	05/29/09	12/31/09	41,000	41,000
10062	TIAX, LLC	Technical Assistance for Implementation of Proposition 1B Program	11/31/09	12/31/10	150,000	150,000
Transfer	Transfer from Clean Fuels	Host Chairman's Initiative Green Tech Connect Forum August 2009	02/06/09	06/05/09	150,000	380,000

Table 2: Contracts Executed or Amended (w/$) Between January 1 & December 31, 2009

Outreach and Technology Transfer (continued)

Transfer	Hartford	Annual Insurance for AQMD Alternative Fuel Vehicles	05/13/09	05/12/10	$11,481	$11,481
Direct Pay	Various	Cosponsor 19 Conferences, Workshops & Events, plus 4 Memberships & Subscriptions	Various	Various	195,583	1,651,083

Table 3: Supplemental Grants/Revenue Received Between January 1 & December 31, 2009

Revenue Agreement	Revenue Source	Project Title	Contractor	SCAQMD Project	Total
09160	Dept. of Energy	Plug-In Hybrid Electric Urban Delivery Truck Technology Demonstration	Electric Power Research Institute	Contract #09301	$984,000

Table 4: Summary of Federal Funding Awarded Between January 1 & December 31, 2009

Awarding Entity or Program	Award Date	Purpose	Contractors	Total
CARB (from U.S. EPA/DERA Program)	05/22/09	Placement of up to 43 aftertreatment devices (retrofit traps) on public school buses operating on diesel fuel	3 School Districts	$ 898,000
U.S. EPA/DERA Program	07/10/09	Implement Heavy-Duty Diesel Drayage Truck Replacement Program	Various	7,500,000
Dept. of Energy/ Transportation Electrification Program	09/11/09	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	Electric Power Research Institute & Eaton	45,443,332
California Energy Commission	09/11/09	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	Electric Power Research Institute & Eaton	5,000,000
U.S. EPA/DERA Program (Emerging Technologies)	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	Johnson Matthey	4,000,000
Dept. of Energy/ Clean Cities Program	10/31/09	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)	UPS	5,591,611
Dept. of Energy/ Clean Cities Program	11/30/09	Implement a natural gas drayage truck replacement program	Various	9,408,389
Dept. of Energy/ Clean Cities Program	12/31/09	Ontario LNG Station Upgrade	Advanced LNG Technologies, Inc.	150,000
Dept. of Energy/ Clean Cities Petroleum Reduction Technologies Program	12/31/09	Implement buydown program for natural gas-powered taxicabs and shuttles	Yellow Cab & Prime Time Shuttle	500,000
		*includes CEC pass-through funding of $5,152,000		$78,491,332

Project Summaries by Core Technologies

The following represents summaries of the contracts, projects and studies executed or amended with additional dollars in 2009. 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

07153: Purchase & Install New Public Access CNG Refueling Station in Irwindale

Contractor: Foothill Transit	SCAQMD Cost-Share	$ 250,000
	Cosponsor:	
	Clean Energy	3,100,000
Term: 11/02/09 – 12/31/12	Total Cost:	$ 3,350,000

This project will provide long-term air quality improvements by developing critical CNG infrastructure that will serve the growing high-mileage heavy duty fleets throughout Southern California, specifically the San Gabriel Valley. Convenient accessibility to CNG in the Arcadia/ Irwindale area will allow increased use of NGVs in and around Southern California. The existing private CNG station at Foothill Transit, owned and operated by Clean Energy, is not accessible to outside users. This new publicly accessible CNG station will complete a public access development on the perimeter of the property so vehicles traveling throughout the area can access CNG 24-hours-per-day.

08044: Install Limited Access CNG Refueling Station

Contractor: Beaumont Unified School District	SCAQMD Cost-Share	$ 288,000
	Cosponsors:	
	AES Settlement Fund	150,000
	Beaumont USD	177,994
Term: 03/05/09 – 12/31/13	Total Cost:	$ 615,994

While the SCAQMD's Lower-Emission School Bus Replacement Program provides up to 10 percent of bus purchase awards for CNG refueling infrastructure, the cost of CNG refueling infrastructure and necessary garage upgrades remain quite burdensome for school districts. Consequently, in 2007 the Board made several school district awards for refueling infrastructure. Beaumont was one of the awardees, seeking funds to build a CNG station with a total of 150 SCFM compressors, 8-dual time-fill posts, and 16 hoses and nozzles. The station would fuel CNG buses for Beaumont USD as well as the City of Beaumont. Although equipment and funding issues delayed execution of this contract, construction has been completed and the station put into operation.

09348: Demonstrate Two Natural Gas-Powered Police Vehicles

Contractor: AFV Fleet Services	SCAQMD Cost-Share	$ 75,000
Term: 04/03/09 – 03/18/12	Total Cost:	$ 75,000

At its February 6, 2009 meeting, the Board approved the execution of a contract with AFV Fleet Services Solutions to convert two gasoline-powered police cars to operate on natural gas. These natural gas-powered police cars will be used in demonstration programs with the Cities of Redlands and South Pasadena to assess the viability of natural gas-powered vehicles in a police interceptor application.

10051: Lease Buses in Support of Mountain Area CNG Demonstration Program

Contractor: BusWest	SCAQMD Cost-Share	$ 80,000
	Cosponsor:	
	MSRC/AB2766 Discretionary Fund	81,928
Term: 10/09/09 – 12/31/10	Total Cost:	$ 161,928

As an element of its FY 2006-07 Work Program, the MSRC funded the demonstration of CNG school buses at Bear Valley Unified School District. This project includes the lease of two CNG school buses and the lease of a portable CNG refueling station. A new refueling station vendor was retained for the project and approved by the MSRC at its December 2008 meeting. Due to the change in contractor for installation and maintenance of a temporary refueling infrastructure, the lease agreements for the CNG buses were set to expire before the one-year demonstration was completed. To ensure the continuation of the project, the SCAQMD came on board to cost-share funding for the lease extension and demonstration for an additional one year for two CNG school buses. This effort will demonstrate the viability of natural gas school buses at altitude and in cold climates.

10054: Upgrade & Perform Emergency Repairs of L/CNG Refueling Facility

Contractor: Applied LNG Technologies Inc.	SCAQMD Cost-Share	$ 113,359
	Cosponsor:	
	Applied LNG Technologies Inc.	113,360
Term: 10/30/09 – 12/31/14	Total Cost:	$ 226,719

Applied LNG Technologies, Inc. (ALT) owns and maintains a publicly accessible LNG fueling station in Ontario, CA. The station is open 24/7, 365 days a year for public and private fleets. This site is at a critical location as it is located at the juncture of Interstate 10 & Interstate 15 at the Ontario Airport and provides fueling for large commercial fleets, municipalities, and the general public. Due to the stations' age there had been a number of outages that have caused the station to shut down, creating a major inconvenience for regular and occasional customers as no back-up station is nearby. Station usage is very high, with a minimum of 20,000 gallons of LNG being used per day. ALT requested emergency funding assistance from the SCAQMD to help defray the capital costs for repairing and upgrading the station at that location. Emergency funds were necessary for purchasing a new PLC control panel, new dual dispenser hoses, new cascade CNG bottles and a new CNG odorizing system.

10055: New Public Access CNG Refueling Station in Santa Ana

Contractor: Waste Management Collection & Recycling	SCAQMD Cost-Share	$ 250,000
	Cosponsor:	
	Waste Management Collection & Recycling	1,372,558
Term: 12/11/09 – 12/31/14	Total Cost:	$ 1,622,558

Waste Management Collection & Recycling (WM) owns and maintains a property for waste hauling trucks located in Santa Ana, California. WM is currently constructing a time-fill natural gas fueling station for its refuse vehicles. WM intends to provide third party access to other public and private vehicles and requested emergency funding assistance from the SCAQMD to help defray the capital costs for installing a new fast-fill fueling island that would be made accessible to the other public and private vehicles during normal business hours at that location.

10181: Demonstrate Natural Gas-Powered Police Vehicles

Contractor: BAF Technologies	SCAQMD Cost-Share	$ 34,500
Term: 12/31/09 – 08/31/10	Total Cost:	$ 34,500

The Los Angeles County Sheriff's Department Annual Law Enforcement Vehicle Test and Evaluation Program, a nationally recognized vehicle testing program, has expressed interest in evaluating a CNG-powered Police Interceptor at their test facilities. The Sheriff's Department evaluation will include testing the vehicle on a city street pursuit course, a high speed driving course, an acceleration performance test, and a brake test. The Sheriff's Department is providing an existing gasoline-powered police interceptor which will be converted by BAF Technologies to run on CNG. BAF Technologies' natural gas conversion system has been CARB certified as a super ultra-low emission vehicle. Vehicle upgrades would also be made to optimize performance during testing in the Sheriff's Department Annual Law Enforcement Vehicle Test and Evaluation Program.

Purchase Order: Install Additional Equipment to Enhance Operation at AQMD's Fast-Fill CNG Refueling Station

Contractor: Various	SCAQMD Cost-Share	$ 15,000
Term: 02/03/09 – 06/30/10	Total Cost:	$ 15,000

The SCAQMD currently operates a CNG fueling station to accommodate the growing alternative fuel vehicle fleet and limited fueling for the general public. The station requires periodic preventive maintenance and management services to ensure efficient and continuous operation of the station. In order to allow greater convenience for public fueling, the AQMD has purchased and is in the process of installing enhanced night vision cameras, gate operators and miscellaneous security and monitoring equipment to provide 24-hour station access.

Fuels/Emissions Studies

08320: Remote Sensing Measurements of On-Road Emissions from Heavy-Duty Diesel Vehicles

Contractor: University of Denver	SCAQMD Cost-Share	$ 161,041
	Cosponsor:	
	National Renewable Energy Laboratory	161,041
Term: 02/06/09 – 01/31/12	Total Cost:	$ 322,092

Potentially significant reductions in the levels of regulated pollutants from heavy-duty diesel powered trucks are anticipated due to new standards for particulate matter and NO_x emissions of heavy duty trucks beginning in 2007 and 2010. In addition, California has also enacted legislation that will eventually lead to an accelerated turnover of its on-road heavy-duty truck fleet. In anticipation of these changes, the SCAQMD and the National Renewable Energy Laboratory have funded the University of Denver to begin a multi-year remote sensing measurement campaign at two locations in the South Coast Air Basin. The two locations are at a weigh station on California State Route 91 and at an exit from the Port of Los Angeles. The first year of data collection began in April 2008, with more than 3200 trucks at the weigh station and more than 1500 trucks at the Port. The second year's measurements were completed in May 2009, with more than 2500 trucks at the weigh station and more than 1900 trucks at the Port location.

09290: Evaluate Emissions Impacts from Natural Gas Blends on Vehicle Emissions

Contractor: University of California Riverside	SCAQMD Cost-Share	$ 50,000
	Cosponsor:	
	California Energy Commission	400,000
Term: 01/30/09 – 08/31/10	Total Cost:	$ 450,000

In December 2007, the Governing Board approved a contract to evaluate the emission impacts of varying natural gas blends. The study will be conducted by the University of California at Riverside, College of Engineering Center for Environmental Research and Technology (CE-CERT). Natural gas engines have been commercialized and have demonstrated success in reducing emissions in a wide variety of applications. However, domestic sources of natural gas may not be able to keep pace with future demand. The supply-demand gap will likely be bridged through the importation of LNG from foreign sources. These sources typically have a more diverse compositional make-up and higher heat content than domestic sources. The broader compositional range of imported LNG has the potential to impact both the performance and emissions of natural gas fueled engines.

10066: CRADA – Loan of 70 MPa Hydrogen Quality Sampling Apparatus to SCAQMD

Contractor: National Renewable Energy Laboratory	SCAQMD Cost-Share	$ 0
Term: 11/02/09 – 12/31/10	Total Cost:	$ 0

The U.S. Department of Energy (DOE) is supporting the development of an ISO standard for hydrogen fuel quality for PEM fuel cell applications in road vehicles. As a key part of this effort, the DOE is working closely with Committee D03 of the ASTM to develop and validate analytical procedures and instrumentation to verify that hydrogen fuel meets the specifications of such a standard. One of the key apparatus that allows sampling of hydrogen from fueling stations is the Hydrogen Quality Sampling Apparatus, or HQSA. This instrument receives hydrogen fuel samples at ambient conditions after a pressure step down process, from hydrogen fueling stations and at hydrogen production facilities at both 350 bar and 700 bar. Samples are taken as a slipstream at reduced pressure from a hydrogen delivery line at vehicle fueling stations. Samples are then collected, taken to a lab and analyzed. DOE is allowing the SCAQMD to test the HQSA for the next year under this agreement.

Purchase Order: Transport 40-Foot Buses to Southwest Research Institute for Emissions Testing

Contractor: Anaheim Fullerton Towing	SCAQMD Cost-Share	$ 12,500
Term: 09/11/09 – 09/11/09	Total Cost:	$ 12,500

The transportation of buses to Southwest Research Institute in San Antonio Texas is part of an ongoing project with the National Renewable Energy Laboratory called Collaborative Lubricating Oil Study on Particulate Matter Emissions (CLOSE). The vehicles involved in the test include CNG, diesel and gasoline powered vehicles (light and heavy duty), which will be tested on a dynamometer and their emissions analyzed to determine the contribution lube oil has on particulate emissions. This is accomplished by adding a tracer to the oil in order to separate out the particulates in the tailpipe emissions. As of the fourth quarter of 2009, the gasoline light-duty vehicles, CNG heavy-duty and one of the diesel heavy-duty vehicles have been tested. Next, the emissions collected will be analyzed by the Desert Research Institute and Elemental Analysis, Inc.

Emission Control Technologies

08236: Showcase: Demonstrate NO_x & PM Emissions Control Technologies on Diesel-Powered Construction Equipment

Contractor: Griffith Company	SCAQMD Cost-Share	$ 116,450
Term: 05/14/08 – 08/24/11	Total Cost:	$ 116,450

In March 2007 the MSRC issued a Request for Qualifications to manufacturers of diesel emission control systems and a Program Announcement for owners for off-road diesel construction equipment. Thirty diesel emission control devices were submitted by 16 manufacturers and 21 applications with a total of 230 pieces of off-road construction equipment were received from 18 fleet owners. The construction equipment includes scrappers, excavators, dozers, loaders, backhoes, crawler tractors and forklifts powered by diesel engines ranging in sizes from 17 to 692 HP. In September 2007 the MSRC approved a total of $3,641,013 to fund all but 11 projects with 198 pieces of construction equipment. On October 5, 2007, the Governing Board awarded a total of $1,245,750 to 11 fleets to demonstrate SCR system and DPF technologies on 32 pieces of diesel-powered construction equipment with the goal of verifying the technologies through CARB at the end of the project. One of the awards was granted to Griffith Company to demonstrate this technology on two pieces of construction equipment. In 2009 this contract was

modified to add additional dollars and three additional pieces of construction equipment for participation as a result of other fleets dropping out of the Showcase Program. These five pieces of construction equipment must be powered by either Tier 0 or Tier 1 diesel engines and rated at 107 bhp or more.

08253: Showcase: Demonstrate NO_x & PM Emissions Control Technologies on Diesel-Powered Construction Equipment

Contractor: Tiger 4 Equipment Leasing	SCAQMD Cost-Share	$ 17,600
Term: 01/13/09 – 08/24/11	Total Cost:	$ 17,600

Like Griffith Company above, a Showcase award was granted to Tiger 4 Equipment Leasing to demonstrate this technology on one piece of construction equipment powered by either a Tier 0 or Tier 1 diesel engine but rated at 134 bhp or more.

09000: Showcase: Demonstrate NO_x & PM Emissions Control Technologies on Diesel-Powered Construction Equipment

Contractor: Shimmick Construction	SCAQMD Cost-Share	$ 38,900
Term: 09/11/09 – 03/24/11	Total Cost:	$ 38,900

Like the two projects above, a Showcase award was granted to Shimmick Construction Company to demonstrate this technology on one piece of construction equipment. The equipment must be a loader powered by either a Tier 0 or Tier 1 diesel engine rated at 200 HP or more.

09374: Develop & Assess Humid Air System for Diesel NO_x Reduction

Contractor: California State University Long Beach	SCAQMD Cost-Share	$ 17,500
Term: 05/25/09 – 10/31/09	Total Cost:	$ 17,500

The SCAQMD provided funding to cosponsor a student project conducted through the California State University Long Beach Foundation to develop and assess humid air system for diesel NO_x reduction. The investigation was to focus on adding humidity to the intake air of a high-speed diesel engine with the goal of reducing its NO_x emissions for both low-sulfur diesel fuel and a biodiesel fuel. Humidity would be achieved by adding distilled water. For diesel trucks, distilled water can be supplied in the form of a tank and with slight modifications to the engine intake air system NO_x reduction can be achieved. The project was funded and completed in 2009. There were some problems controlling the amount of water in the intake air, but overall for diesel fuel the average decrease in NO_x emissions at saturation was approximately 25% while the decrease for the biodiesel was about 40%. Further investigations will be performed to develop a continuous system to maintain the level of humidity in the intake air according to the engine load.

10125: Demonstrate Projects for Renewable Feedstock to Energy and Fuel Technologies

Contractor: University of California Riverside	SCAQMD Cost-Share	$ 101,369
	Cosponsor:	
	Viresco Energy LLC	110,514
Term: 12/11/09 – 01/10/11	Total Cost:	$ 211,883

The University of California Riverside (UCR) will conduct a bench scale demonstration project using the steam hydro-gasification reaction (SHR) process that UCR has developed and a water-gas shift (WGS) reactor to produce natural gas from biomass and biosolids feedstock containing high moisture. The SHR can currently produce syngas from coal and it will be modified to handle biomass and biosolids feedstock. The WGS will be designed and constructed by UCR. This bench scale project is estimated to handle approximately five lbs/day of feedstock on a dry basis. Upon successful demonstration of the UCR'S project, the technology is intended to be used on a larger scale at local wastewater treatment facilities using biosolids (sewage sludge) to produce natural gas for mobile source and stationary source applications. The partners in this project are SCAQMD, Viresco Energy LLC, and the City of Riverside, Public Works Department.

Electric/Hybrid Technologies

99109: Three-Year Lease of One RAV4 Electric Vehicle

Contractor: Toyota Motor Credit Corporation	SCAQMD Cost-Share	$ 7,794
Term: 04/04/09 – 02/01/10	Total Cost:	$ 7,794

The lease of two Toyota RAV4 battery electric vehicles is extended for use in the Technology Advancement Office's Advanced Technology Demonstration Program.

08219: Develop & Demonstrate Ten Plug-In Hybrid Electric Vehicle

Contractor: A123Systems Inc.	SCAQMD Cost-Share	$ 622,667
	Cosponsors:	
	SCAQMD Area Fleets	240,000
	A123Systems & AeroVironment	100,000
Term: 06/05/09 – 06/04/15	Total Cost:	$ 962,667

At its November 3, 2006 meeting, the Governing Board approved RFP #P2007-14 to design, engineer, convert, test, certify, demonstrate, and maintain for 60 months 30 plug-in hybrid electric vehicles with supporting infrastructure at up to 15 demonstration sites in the South Coast Air Basin. At the March 2, 2007 meeting, the Governing Board awarded funding to A123Systems Inc. (formerly Hymotion, Inc.) to convert ten new Toyota Prius vehicles to plug-in hybrid electric vehicles using advanced lithium-ion battery systems and controls. The vehicles will plug into a conventional outlet for charging overnight, and can be refueled with gasoline for longer trips. At least one prototype will demonstrate Level 2 or faster charging capability, with

additional fast charging system. The total cost for this project is $962,667 with AQMD cost share not to exceed $622,667 from the Clean Fuels Fund.

09023: Develop & Demonstrate a Battery Electric Transit Bus

Contractor: ISE Corporation	SCAQMD Cost-Share	$ 290,000
	Cosponsors:	
	Los Angeles Metropolitan Transportation Authority	275,000
	California Air Resources Board	290,000
	ISE Corporation	770,000
	Others	660,000
Term: 08/07/09 – 05/31/11	Total Cost:	$ 2,285,000

ISE Corporation proposes to develop and demonstrate the first commercially viable forty foot battery electric transit bus with 150 mile range and recharge time of less than four hours. ISE has pioneered several heavy duty electric and hybrid-electric vehicles. A 750kWh lithium battery pack with a fully integrated energy storage system will be developed to meet the 2.5 kWh/mile bus demand. This battery will be incorporated in the electric drive system and performance optimized in various terrains and temperatures, using a North American Bus Industries (NABI) bus chassis. ISE will be partnering with Siemens for the electric drive system optimization and Los Angeles Metropolitan Transportation Authority (LAMTA) for the chassis and maintenance support. Lithium battery pack development will begin in 2008, bus drive system integration and testing in 2009, and project completion in 2010.

09301: Develop & Demonstrate Plug-In Hybrid Electric Vehicle Delivery Vehicle

Contractor: Electric Power Research Institute	SCAQMD Cost-Share	$ 964,320
	Cosponsor:	
	Electric Power Research Institute	1,200,000
Term: 06/30/09 – 03/31/11	Total Cost:	$ 2,164,320

This project will design, build and demonstrate a medium-duty PHEV to evaluate its operating costs and emissions in a delivery vehicle application. The PHEV delivery truck will be built on a gasoline-powered, medium-duty Ford chassis. The development of the plug-in hybrid drive system will leverage existing work done by Eaton in the development of a diesel PHEV for the utility industry. The vehicle will ultimately be tested in a controlled laboratory setting and in a real-world demonstration with U-Haul to quantify fuel economy and tailpipe emissions.

09345: Demonstrate Medium-Speed Electric Vehicles

Contractor: South Bay City Council of Governments	SCAQMD Cost-Share	$ 178,825
Term: 06/19/09 – 05/04/10	Total Cost:	$ 178,825

In February, 2009, the SCAQMD awarded a contract to South Bay Cities Council of Governments to demonstrate a Medium Speed Electric Vehicle (MSEV) program in the South Bay. For many residents within the South Coast Air Basin, commutes and short trips can be accomplished solely on residential streets at speeds below 35 mph. This project will promote MSEVs, also called Neighborhood Electric Vehicles, to residents, select businesses, municipalities and government entities and establish a website with driver's information. This demonstration project is for a period of up to 18 months.

09360: Lease of Five MiniE Cooper Electric Vehicles for One Year

Contractor: BMW of North America LLC	SCAQMD Cost-Share	$ 600
Term: 05/05/09 – 05/04/10	Total Cost:	$ 600

The SCAQMD leased five MiniE 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 may be used to assist in developing vehicle requirements for an upcoming electric vehicle that BMW has announced to be in development.

09427: Demonstrate Battery Electric Class 4 Utility Truck

Contractor: City of Santa Monica	SCAQMD Cost-Share	$ 87,205
	Cosponsors:	
	City of Santa Monica	102,205
	Electrorides	9,000
	EV Innovations	7,500
	Vehicle Velocity Group	5,000
Term: 12/15/09 – 06/14/11	Total Cost:	$ 210,910

The City of Santa Monica will deploy and demonstrate a zero emission 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. The purpose of this project is to examine both the utility and the cost effectiveness of zero-emission electric technologies in municipal fleet operations. This project will examine the lifecycle cost of the vehicle and charging infrastructure before making a recommendation for additional deployments within the City. The vehicle is targeted at the medium-duty diesel truck sector and offers the fleet user a zero-emission vehicle with performance and operations comparable to a conventional medium-duty vehicle. Based on the Isuzu "N" series platform, the truck features include a lithium polymer battery, high efficiency 100 kW electric motor, automatic transmission, 65 to 75 mile range with speeds up to 50 mph, an on-board charger and a regenerative braking system.

Purchase Order: Purchase of VBOX Equipment for Data Collection for MiniE Cooper Demonstration Program

Contractor: VBOX	SCAQMD Cost-Share	$ 2,710
Term: 08/0509 – 08/05/09	Total Cost:	$ 2,710

The SCAQMD purchased a GPS-based data acquisition system from Racelogic. The GPS data acquisition system will be used to characterize driving behavior when evaluating advanced technology transportation options, such as the MiniE. The ability to analyze driver behavior will allow intelligent conclusions to be drawn with respect to a vehicle's operating range and energy utilization when conducting field trials. This tool will allow an evaluator to quantify the influence of driver behavior rather than simply attributing variability in a data set to statistical scatter. This will also be a valuable tool in evaluating drive cycles for the placement of future advanced technology vehicles in demonstration programs.

Purchase Order: Purchase Dent Instruments ElitePro Data Logger for MiniE Cooper Demonstration Program

Contractor: Dent Instruments	SCAQMD Cost-Share	$ 1,644
Term: 11/05/09 – 11/05/09	Total Cost:	$ 1,644

The SCAQMD purchased a power meter to be installed on the electric vehicle chargers that are servicing the BMW MiniE electric vehicles. This meter will be used to measure the energy demand that is associated with the use of the MiniE vehicles. This data stream, coupled with driving distance, will allow for the energy and emissions footprint of the vehicle to be evaluated.

Direct Pay: EV Charge Installations for MiniE Cooper Demonstration Program

Contractor: Clean Fuel Connection Inc.	SCAQMD Cost-Share	$ 4,940
Term: 11/25/09 – 12/18/09	Total Cost:	$ 4,940

The SCAQMD installed seven electric vehicle chargers to support the use of the electric Mini Coopers that are being leased through BMW. BMW supplied the charger as part of the demonstration program; however, the SCAQMD was responsible for all work that was required upstream of the charger. The additional work that was required included: running cable, trenching, setting charger pedestals and pouring concrete.

Engine Technologies

10141: Develop Prototype Natural Gas-Powered Concrete Mixer Truck and Demonstrate its Performance and Emissions

Contractor: McNeilus Truck and Manufacturing	SCAQMD Cost-Share	$ 100,000
	Cosponsor:	
	McNeilus Truck and Manufacturing	280,000
Term: 11/06/09 – 11/05/10	Total Cost:	$ 380,000

The project includes the purchase and retrofit of a Kenworth diesel-powered Class-8 concrete mixer truck with a 2009 CNG-fueled Cummins-Westport ISLG engine, fuel tank replacement, and body modifications to address commercial use of the vehicle. The project includes a minimum six-month demonstration of the vehicle under real-world conditions and will be used by vehicle operators from resident concrete mixing companies, development of an owner's manual, and an emission testing of both the CNG vehicle and a comparable diesel vehicle. The project is

expected to provide support for the commercialization of CNG concrete mixer trucks and help demonstrate emission reductions. A distinctive feature of concrete mixer trucks is their continual engine operation and their significantly high proportion of idling time.

Mobile Fuel Cell Technologies

09436: Participate in California Fuel Cell Partnership for Calendar Year 2009 and Provide Support for Regional Coordinator

Contractor: Bevilacqua-Knight Inc.	SCAQMD Cost-Share	$ 137,800
	Cosponsors:	
	8 automakers; 2 energy providers; 7 government agencies; 2 fuel cell providers, and 11 associate members	1,530,400
Term: 01/01/09 – 12/31/09	Total Cost:	$ 1,668,200

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. for their portion of CaFCP administration. In 2009, 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 Technology and Infrastructure

09410: Participate in California Hydrogen Business Council

Contractor: California Hydrogen Business Council	SCAQMD Cost-Share	$ 20,000
	Cosponsors:	
	Silver & Platinum Members	367,500
	Individual Members	38,000
Term: 06/01/09 – 05/30/10	Total Cost:	$ 405,500

The California Hydrogen Business Council (CHBC) was established in 1997 to provide a link between various organizations committed to business development related to hydrogen. The CHBC is engaged in activities to broaden the knowledge of and applications of hydrogen and will pursue the commercialization opportunities for hydrogen production, utilization and service/supply industries. CHBC is active in providing information, reports and standards recommendations to the hydrogen industry. CHBC is also involved in developing an understanding of the regulatory needs and the promotion of appropriate guidelines for legislation. SCAQMD's membership participation at the Platinum level will assist the CHBC's ongoing efforts to conduct outreach to various stakeholder groups on technology implementation as well as disseminating information on technology advancement, funding opportunities, industry meetings and more. Other Platinum and Silver members include: Ballard, HyRadix, Industrial Service Group, LA Community College District, ATTEI, Hydrogenics Corp, ISE Corp,

SoCalGas, Clean Energy, Linde, Intelligent Energy, BAAQMD, Earth Energy Fuels Inc, NREL, UTC Power, QuantumSphere Inc, SCE, Honda, CALSTART, and National Hydrogen Association. Individuals members include: General Physics Corp, H2XOP Inc, ECD Inc, Intelligent Hydrogen Inc, Clear Edge Power, SKJ Holdings Inc, City of Santa Clarita, Quantum Fuel Systems Technology, Hydrogen Ventures, Burbank Transportation Mgmt Org, Cosgrove Computer Systems, General Atomic, Hyundai, Community Environmental Srvs, UCI, Longitude 122 West Inc, Golden State Energy, Arcana Sciences Inc, Mazda, DG Technologies, Richard Cromwell III & Assoc, Georgelle, Rips Consulting, Ebus Inc, Jake's Associates Inc, VPC Energy, The Leighty Foundation, EPC, Third Orbit Power Systems, Energy Independence Now, and California Fuel Cell Partnership.

10046: Develop & Demonstrate Renewable Hydrogen Energy and Refueling Station

Contractor: Air Products and Chemicals Inc.	SCAQMD Cost-Share	$ 750,000
	Cosponsors:	
	California Air Resources Board	2,700,000
	Department of Energy	2,700,000
	Fuel Cell Energy	51,979
	Air Products and Chemicals	2,857,472
Term: 12/21/09 – 05/31/12	Total Cost:	$ 8,436,735

Air Products has been selected by CARB to install a new 5,000/10,000 PSI hydrogen refueling station at Orange County Sanitation District which will be supplied by 100% renewable hydrogen and 100% renewable electricity produced utilizing a molten carbonate fuel cell. The hydrogen produced will be further purified using a hydrogen purification system. The molten carbonate fuel cell system and purification system will be installed at the water treatment facility under a Department of Energy Cooperative Agreement. The hydrogen fueling station will be operated by the National Fuel Cell Research Center and the University of California, Irvine, will be co-located with an existing, publicly accessible CNG fueling station, and will be designed to dispense 100 kg/day of hydrogen.

10061: Maintenance & Data Management for SCAQMD Hydrogen Refueling Station

Contractor: Hydrogenics Corporation	SCAQMD Cost-Share	$ 88,000
Term: 10/30/09 – 10/29/11	Total Cost:	$ 88,000

The SCAQMD currently operates a hydrogen fueling station to accommodate the demonstration and deployment of fuel cell vehicles. Further maintenance of the station is required while upgrade plans are in process. This contract is to provide maintenance and data management for a one-year period. An RFP was released in 2009 to solicit bids to upgrade the station, and SCAQMD is currently evaluating the proposals that were received. Maintenance and data management include repairing unsafe or inoperable equipment or parts for the fueling system, training SCAQMD staff on the proper use of the fueling dispenser, card-lock system and vehicle fueling procedures; and providing detailed vehicle fueling reports and overall monthly station reports.

Purchase Order: Purging and Removal (in 2008) of Original Five Cities Burbank Hydrogen Station

Contractor: Air Products and Chemicals Inc.	SCAQMD Cost-Share	$ 14,918
Term: 12/24/09 – 12/24/09	Total Cost:	$ 14,918

Under the Five Cities Project in 2006 a hydrogen station was constructed at the City of Burbank using proprietary technology by Air Products and Chemicals, Inc. (APCI), which was also the continuous operator of the station after it was installed. In August 2008 APCI purged and dismantled the original five cities station at SCAQMD's request because due to space limitations the Burbank location could not accommodate both the original five cities station and BP/DOE's higher capacity station. However, the existing contract with APCI under which maintenance of the five cities stations was funded did not provide funding for this "purging and removal." Since the station involved proprietary technology and ownership of key assets by APCI coupled with their unique experience, APCI was the only contractor who could perform this work.

Purchase Order: Reimbursement of Utility Expense for Seven Months in Support of Temporary Hydrogen Station at City of Burbank

Contractor: City of Burbank	SCAQMD Cost-Share	$ 7,000
Term: 12/18/09 – 07/30/09	Total Cost:	$ 7,000

Air Products and Chemicals, Inc. designed, constructed and operated a hydrogen refueling facility under contract and funded by BP and the US-DOE Daimler-Chrysler (DCX) Hydrogen to the Highways program, Award DE-FC36-04GO14285. The hydrogen refueling facility is capable of storing and dispensing approximately 108 kg of hydrogen per day for use in fuel cell vehicles and hydrogen-ICE vehicles and is located at the City of Burbank Public Works Yard. The hydrogen refueling facility consists primarily of a steam methane reformer (SMR), a hydrogen storage system, vehicle dispensing apparatus for both 350 bar and 700 bar, and was operating for approximately one year. On September 30, 2009, the DOE commitment expired and station ownership was transferred to the City of Burbank. Burbank will now act as the operator of the fueling station but does not have the required funds or expertise to operate or maintain the system and asked for funding assistance from the SCAQMD. The funds provided will defray the cost of utilities required to operate the SMR and fueling facility.

Stationary Clean Fuels Technologies

09303: Install 40kW (AC) Crystalline Silicon System at SCAQMD HQs

Contractor: PermaCity Solar Corporation	SCAQMD Cost-Share	$ 387,162
Term: 01/30/09 – 01/29/15	Total Cost:	$ 387,162

The SCAQMD currently owns and operates four solar electric systems, including an 80 kW (AC) photovoltaic (PV) system on the rooftop and a 20 kW PV system on a carport located in the parking lot. Two new PV systems were installed in the spring of 2009 on another area of the AQMD rooftop: a 43 kW building integrated photovoltaic (BIPV) and a 44 kW crystalline silicon PV system. This project will add to this solar capacity and generate additional clean, renewable electricity for the facility. The project involves a demonstration of two different PV technologies

on the same roof above the Conference Center. PermaCity Corp will test the performance and reliability of the two systems under similar light conditions for a period of at least five years. The two PV systems will include: 1) a Building Integrated Photovoltaic (BIPV) system consisting of thin film laminates applied to a single-ply roofing membrane and 2) a conventional PV system consisting of crystalline silicon solar panels. Each system will be rated at approximately 40 kW (AC) and use the same inverter (SMA America ST 42) to avoid any inverter effects when comparing the power output of the two PV systems. This contract is to install a turnkey rooftop crystalline silicon PV system and requires PermaCity to: 1) obtain all permits/approvals for the crystalline silicon PV system, including the final approval for interconnection to the grid, 2) provide the required information to complete the application process for the California Solar Initiative (CSI) rebate for the BIPV and crystalline silicon systems, 3) install a turnkey crystalline silicon system rated at approximately 40 kW (AC) and 4) install a kiosk and Fat Spaniel data monitoring system that separately monitors the performance of all of the SCAQMD rooftop solar PV installations. The total cost for the two PV systems shall not exceed $777,857, of which $387,162 is allocated for PermaCity Corp's work. The SCAQMD is eligible for a rebate through CSI program. The CSI rebate monies, estimated to be $193,076, will be returned to the Clean Fuels Fund.

Outreach and Technology Transfer

02308: Evaluate Financial Stability of Potential Contractors

Contractor: Sperry Capital, Inc.	SCAQMD Cost-Share	$	15,000
Term: 06/25/02 – 12/31/11	Total Cost:	$	15,000

Sperry Capital, Inc. is an independent financial and investment advisory firm that specializes in providing California local agencies with both municipal financial advisory services and independent consulting services for short-term, fixed income obligations. The company has investment banking and financial advisory experience in the areas of health care, transportation, small businesses, and other governmental entities. Under this contract, Sperry Capital, Inc. provides financial advice on the financial stability of potential contractors. With the increased number of contracts resulting from the various Clean Fuels and incentive programs, staff has identified the need to provide financial evaluation of potential contractors and the risks associated with contracting with new and small technology innovation companies.

07165: Technical Assistance with Compliance of Carl Moyer Program Guidelines

Contractor: Clean Fuel Connection Inc.	SCAQMD Cost-Share	$	50,000
Term: 02/07/09 – 12/31/10	Total Cost:	$	50,000

The SCAQMD receives funding from state agencies to provide incentives for fleet operators to reduce emissions of construction equipment and medium- and heavy-duty vehicles. This funding allows businesses to modify or replace equipment with low- or zero-emitting equipment. An important goal is to keep fleet operators, industry groups, and trade organizations apprised of emerging low- and zero-emissions technologies and opportunities to purchase them. Clean Fuel Connection has considerable familiarity with EPA and CARB emission regulations and has worked extensively on state incentive programs including on-road and off-road emissions reductions programs. Under this contract, Clean Fuel Connection will provide their expertise in technical evaluation including on- and off-road vehicle emissions analyses and cost-effectiveness under the SCAQMD Carl Moyer Program as well as other incentive programs which complement the goals and objectives of the Clean Fuels Program.

07177: Technical Assistance with Evaluation of Project Proposals for Carl Moyer Program

Contractor: TIAX LLC	SCAQMD Cost-Share	$ 50,000
Term: 01/27/07 – 12/31/10	Total Cost:	$ 50,000

On May 5, 2006, the Board approved release of an RFP to solicit proposals to provide technical assistance and public outreach support for advanced low-, and zero-emission mobile and stationary source pollution control technologies. At the October 6, 2006 Board meeting, TIAX, LLC was awarded $50,000 to provide expertise in evaluating project proposals for technology incentive programs. On March 7, 2008, the Board approved an amendment to this project, with additional funding in the amount of $100,000. This first amendment provided technical assistance necessary for the outreach and implementation of the SOON and Goods Movement Programs. At the July 10, 2009 Board meeting, authorization was given to release Program Announcement #2010-02 for the replacement of heavy-duty diesel drayage trucks with new diesel or alternative fuel trucks, otherwise known as the Proposition 1B Clean Truck Program. A total of 1,600 applications were received. To assist SCAQMD staff and expedite the processing of these applications, a second amendment was awarded to TIAX, LLC, with additional funding in the amount of $200,000. Mr. Jon Leonard, TIAX Project Manager, has over 24 years experience with low- and zero-emission mobile source technologies, emissions testing, and alternative fuel vehicles. The total cost for this project is $350,000 with costs not to exceed $300,000 from the Carl Moyer Fund and $50,000 from the Clean Fuels Fund.

08251: Technical Assistance, Outreach and Implementation of the SOON and the Goods Movement Program

Contractor: Gladstein, Neandross & Associates, Inc.	SCAQMD Cost-Share	$ 50,000
	Cosponsor:	
	Carl Moyer Fund	100,000
Term: 06/06/08 – 05/30/10	Total Cost:	$ 150,000

To promote, fund, manage, and expedite the development and demonstration of such advanced technology projects, SCAQMD relies on expert input and consultation. Gladstein, Neandross & Associates (GNA) has provided their expertise involving the deployment of low emission fuels and clean alternative fuel technologies since 1993. This is a technical assistance contract to provide assistance with implementation of SCAQMD incentive programs to deploy lower-emitting heavy-duty vehicles and advanced transportation technologies. This contract was awarded through a competitive bid process. GNA has extensive experience and professional knowledge about the feasibility and inner workings of incentive programs to reduce NO_x and PM emissions from mobile sources in the goods movement sector.

09183: Technical Assistance on Remote Sensing Measurement Technologies as Applied to Auto, Heavy-Duty Diesel and Other Mobile Sources

Contractor: Gary Full	SCAQMD Cost-Share	$ 20,000
Term: 02/20/09 – 06/30/10	Total Cost:	$ 20,000

Mr. Gary G. Full will provide technical expertise for remote sensing measurement technologies as applied to automotive, heavy-duty diesel, and other mobile sources in an amount not to exceed $20,000. Mr. Full has over 20 years of industry experience with gasoline and diesel research and performance testing, development of on-board engine controllers, emissions measurement development and compliance testing systems, automotive diagnostic equipment development, and development and application of remote sensing measurement technologies as applied to automotive, diesel and other off-road mobile sources.

09184: Technical Assistance on Advanced, Low- and Zero-Emission Technologies and Implementation Activities

Contractor: University of California Riverside	SCAQMD Cost-Share	$ 60,000
Term: 01/23/09 – 08/30/11	Total Cost:	$ 60,000

On November 2, 2007, the Board approved release of an RFP to solicit proposals to provide technical assistance and public outreach support for advanced, low- and zero-emission mobile and stationary source pollution control technologies. On March 7, 2008, the Board awarded the University of California Riverside, CE-CERT, a contract in the amount of $60,000 for technical assistance with the development and evaluation of low-emission and alternative fuels emissions impacts. CE-CERT has extensive experience in emissions measurement for light- and heavy-duty vehicles, container handling equipment, marine vessels, and aircraft. CE-CERT has worked with SCAQMD, EPA, CARB and CALTRANS on emissions studies since 1991.

09185: Technical Expertise on the CARB EMFAC Mobile Emissions Model and Other Related Mobile Source Issues

Contractor: Clean Fuel Connection Inc.	SCAQMD Cost-Share	$ 50,000
Term: 05/08/09 – 06/30/10	Total Cost:	$ 50,000

Clean Fuel Connection, Inc. will provide technical assistance with CARB EMFAC mobile emissions model, on-board diagnostics II systems, fuel permeation effects, in-use emissions, and inspection and maintenance program in an amount not to exceed $50,000. Mr. Mark Carlock currently has a contract through St. Malo Solutions in the amount of $115,000. Mr. Carlock, formerly the Branch Chief for CARB's Mobile Source Analysis Branch, is a nationally recognized expert on emissions inventory development and validation. Mr. Carlock was lead authority in developing the inventories of mobile source emissions which are the foundation of the AQMP.

09253: Technical Assistance on Alternative Fuels Life-Cycle Analyses

Contractor: Nexant, Inc.	SCAQMD Cost-Share	$ 20,000
Term: 01/02/09 – 06/30/10	Total Cost:	$ 20,000

Nexant, Inc. has been deeply involved with alternative fossil and renewable fuel processes such as gas-to-liquids, hydrogen production, and is currently working with NREL to examine hydrogen transportation and distribution technologies. In addition, Nexant has examined post-combustion emission technologies, including CO_2 separation, capture, and sequestration. Nexant has worked with the California Energy Commission and the Electric Power Research Institute on CO_2 emissions analyses for the West Coast

Carbon Sequestration Partnership. Under this contract, Nexant will provide technical expertise for alternative fuel life-cycle analyses of total South Coast Air Basin emissions, including greenhouse gas quantification.

09255: Technical Assistance with Caltrans

Contractor: Stan Lisiewicz	SCAQMD Cost-Share	$ 10,000
Term: 01/29/10 – 12/31/10	Total Cost:	$ 10,000

In August 2005 the SAFETEA LU Act was passed, which included $2M for a Diesel Emission Reduction Program to be administered by the SCAQMD. The Federal Highway Authority gave the funds to Caltrans, District 7, to pass through to the SCAQMD. While Caltrans has been working with SCAQMD staff to process the application for funds, their grant process is quite complex and requires a series of approvals both through their LA offices and Sacramento Headquarters. Consequently, the SCAQMD retained Stan Lisiewisz for technical assistance with Caltrans. He has over 40 years of experience working for Caltrans, working his way up from staff engineer to Deputy Director in both the Los Angeles and Riverside/San Bernardino Caltrans districts. Through his many years of experience he has developed a thorough understanding of the structure of Caltrans and has intimate knowledge of the methods and processes. Mr. Lisiewisz was also the key person in expediting the Caltrans encroachment permits for the HEROS program.

09292: Provide Funding Support to the Clean Air Challenge Curriculum Project

Contractor: Clean Air Now	SCAQMD Cost-Share	$ 60,000
	Cosponsors:	
	City of Riverside	10,000
	Clean Air Now or others	80,000
Term: 01/30/09 – 04/30/10	Total Cost:	$ 150,000

As part of the BP/ARCO Settlement Funds, the Board approved co-funding for development of the Clean Air Challenge program to train middle and high school science teachers about air quality, health effects, and cleaner technologies. The Clean Air Challenge program held eight workshops and trained 232 middle and high school science teachers and 27,840 students in the district with co-funding from AQMD, Shell, and the City of Riverside. The workshops that were held in our area had waiting lists, and Clean Air Now would like to provide training for more teachers. Clean Fuels co-funding will be used to continue and expand the Clean Air Challenge Program.

09371: Technical Assistance for Chairman's Initiative Green Tech Connect Forum

Contractor: CALSTART	SCAQMD Cost-Share	$ 20,000
Term: 04/19/09 – 10/31/09	Total Cost:	$ 20,000

On February 6, 2009, the Board approved the Chairman's "Helping Hand Initiative for 2009" which highlighted a Clean Air Technology Conference. The conference, which was held August 3-4, 2009, brought developers of clean air technologies and venture capitalists together to accelerate the introduction of new, low-emission technologies. CALSTART has worked with

businesses and the public sector to develop and implement clean, efficient transportation solutions. CALSTART's partner network includes industry, government, and nongovernmental organizations that share a commitment to clean, efficient transportation. CALSTART has a proven track record that demonstrates its ability to provide assistance to manufacturers by evaluating the feasibility and marketability of new technologies and to organize the necessary components, businesses, and public agencies to move new technologies forward. As such, CALSTART provided the unique experience of identifying new technology opportunities, securing funding, and establishing manufacturing resources to move forward to commercialization. CALSTART also provided technical assistance in identifying companies that offered a new, emerging technology which would be of interest to venture capitalists.

09337: Follow-Up Assessment of SCAQMD's Compliance with Special Revenue Funds

Contractor: Mark Weekly, CPA	SCAQMD Cost-Share	$ 15,000
Term: 03/03/09 – 01/31/11	Total Cost:	$ 15,000

Mr. Mark Weekly, CPA, is providing consultant services to conduct a follow-up assessment of SCAQMD's compliance with special revenue funds. In the past few years SCAQMD has received significantly more restricted funds, and the staff work and number of contracts issued with those funds has increased dramatically. With the increased activity resulting from the various Clean Fuels and incentive programs, it is necessary to obtain financial evaluation and reporting of internal contract and accounting practices. Mr. Weekly formerly held the position of SCAQMD Controller/Accounting Manager for 18 years. He has previously performed an independent review of SCAQMD's revenue generating work program activities (e.g., Clean Fuels, Carl Moyer, Prop 1B, AB2588 "Hot Spots," etc.). This follow-up assessment will assist staff in refining existing processes, as well as developing new processes to ensure compliance with the various fund / program regulations and restrictions.

09372: Outreach Assistance for Chairman's Initiative Green Tech Connect Forum

Contractor: Three Squares Inc.	SCAQMD Cost-Share	$ 41,000
Term: 05/29/09 – 12/31/09	Total Cost:	$ 41,000

On February 6, 2009, the Board approved the Chairman's "Helping Hand Initiative for 2009" which highlighted a Clean Air Technology Conference to link clean technology companies with potential investors. Three Squares, Inc. is a specialist in producing "green" events and making sure that all aspects of the event (from planning process through tear-down) are conducted in a sustainable fashion. Three Squares Inc. will provide an online screening application for technology companies. They will design, develop and, implement a website for the Green Tech Connect Forum and an E-mail Marketing Program as well as develop and implement an overall greening plan for the Forum. Three Squares Inc. will also implement and maintain a social networking (e.g., Facebook, Twitter, My Space, Linked In) outreach effort. Lastly, Three Squares Inc. will provide assistance with event logistics, including registration, exhibitors, sponsorships, technology partners, and fund partners.

10062: Technical Assistance for Implementation of Proposition 1B Program

Contractor: TIAX LLC	SCAQMD Cost-Share	$ 150,000
Term: 11/13/09 – 12/31/10	Total Cost:	$ 150,000

Mobile sources emit the majority of air pollution in the South Coast Air Basin. In particular, heavy-duty diesel vehicles emit high levels of NO_x, a precursor to photochemical smog, as well as diesel particulate exhaust, which has been categorized by CARB as a toxic air contaminant. A key objective of the AQMP is to decrease NO_x and particulate emissions from in-use heavy-duty vehicles. Toward this objective, SCAQMD administers contracts worth millions of dollars annually to assist owners of older heavy-duty vehicles and equipment with purchasing and deploying newer, much lower-emitting vehicles and equipment through incentive programs. In May 2009, CARB authorized the re-initiation of the Proposition 1B–Goods Movement Emission Reduction Program and directed $49 million to the Ports of Los Angeles and Long Beach to replace heavy-duty diesel drayage trucks. Shortly thereafter, the SCAQMD was asked to administer the program by both CARB and the Ports. At the June 5, 2009 Board meeting, the Board agreed to administer the Ports' Proposition 1B Clean Truck Program. TIAX has previously assisted SCAQMD with implementing a wide-array of incentive programs to deploy lower-emitting heavy-duty vehicles and advanced transportation technologies. Under this Contract, TIAX is providing expert technical assistance to SCAQMD to implement the Prop 1B Clean Truck incentive program as it complements the goals and objectives of the Clean Fuels Program.

Transfer: Host Chairman's Initiative Green Tech Connect Forum August 2009

Contractor: Transfer from Clean Fuels	SCAQMD Cost-Share	$ 150,000
	Cosponsors:	
	Sponsors & Exhibitors	180,000
	Registration Fees	50,000
Term: 02/06/09 – 06/05/09	Total Cost:	$ 380,000

On February 6, 2009, the Board approved a work plan, estimated expenses, and revenues from the Clean Fuels Program and sponsorships proposed to implement the Chairman's "Helping Hand Initiative for 2009." One of the initiatives was a Clean Air Technology Conference to link clean technology companies with potential investors. The February 6, 2009, Board action allocated $150,000 Clean Fuels Program funding for this conference. On June 5, 2009, the Board approved a $380,000 budget for The Green Tech Connect Forum & Expo. The event was conducted on August 3-4, 2009, at the Pasadena Convention Center, with a pre-conference workshop "Tools to Develop a Green Technology Business Plan and Identify Funding" offered at no cost on Sunday, August 2. The event was very successful with more than 700 attendees and significant involvement of technology partners and venture capital firms.

Transfer: Annual Insurance for SCAQMD Alternative Fuel Vehicles

Contractor: Hartford	SCAQMD Cost-Share	$ 11,481
Term: 05/13/09 – 05/12/10	Total Cost:	$ 11,481

In order to showcase and demonstrate advanced, low-emission technologies, the SCAQMD often leases and/or purchases clean alternative fuel vehicles to educate public and private organizations on the benefits of advanced technologies, as well as provide valuable in-use test data to the manufacturers. These vehicles are displayed at outreach events and conferences, used in Ride-and-Drive demonstrations, and are part of the SCAQMD carpool fleet. Private insurance is obtained for these advanced technology vehicles to ensure proper coverage.

Direct Pay: Cosponsor 20 Conferences, Workshops & Events, plus 4 Memberships & Subscriptions

Contractor: Various	SCAQMD Cost-Share	$ 195,583
	Cosponsors:	
	Various	1,455,500
Term: Various	Total Cost:	$ 1,651,083

The SCAQMD regularly participates in and hosts or cosponsors conferences, workshops and events. These funds provide support for the 19 events during 2009, plus 4 business council/association memberships and subscriptions. The 19 conferences, workshops and events are as follows: 2009 Target 2030 Conference; 9th Annual Clean Heavy-Duty Vehicle Conference; 7th ASME Fuel Cell Science, Engineering and Technology Conference; Faster Freight Cleaner Air Conference; ICEPAG 2009; 10th Annual Western Riverside COG's Advancing the Choice Event; 19th Annual CRC On-Road Vehicle Emissions Workshop; 20th Annual U.S. Hydrogen Conference; Plug-In 2009; Western States Section of the Combustion Institute Fall 2009 Meeting; 3rd Clean Air Car Show and Film Festival; CRC Life Cycle Analysis Workshop of Biofuels; 2009 EPA Clean Air Initiative Technical Meeting; 2009 Bio-Methane Summit; Symposium on Aviation Noise & Air Quality; Southern California Transportation & Logistics Summit; 5th Annual Clean Air Car Showcase; attendance and exhibitor participation at eight events; and Clean Fuels Advisory Retreats. General memberships for the California Hydrogen Business Council and National Hydrogen Business Council and subscriptions to Green Car Journal and Automotive News.

PROGRESS IN 2009

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 7 (page 50) provides a list of 50 projects and contracts completed in 2009. 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.

Demonstrate GTL Fuel in Transport Refrigeration Units with Emission Control Device

Transport refrigeration units (TRUs) are refrigeration systems designed to refrigerate or heat perishable products that are transported in various containers, including semi-trailers, box trucks, vans, shipping containers, and rail cars. TRUs are powered primarily by diesel internal combustion engines. Although TRU engines are relatively small, ranging from 9 to 36 horsepower (hp), significant numbers of vehicles with these engines can be found congregating at distribution centers, truck stops, and other facilities. They can thus pose significant health risks to people who live and work nearby. CARB estimates that there are 40,200 TRUs operating in California at any one time, and together they consume more than 20 million gallons of diesel fuel annually. CARB also estimates that PM and NO_x emissions from TRUs are 2 and 20 tons per day, respectively. The TRU emissions inventory and CARB's identification of diesel PM as a toxic air contaminant have led to CARB's adoption of an Airborne Toxic Control Measure (ATCM) for TRUs and TRU generator sets (gensets). The ATCM includes a phased compliance schedule based upon the TRU's model year; older units must comply sooner. The three principal methods of compliance include: replacing the existing TRU engine with a certified engine meeting applicable on-road or off-road emissions standards, equipping the engine with a required level of Verified Diesel Emission Control Strategy (VDECS), or operating a TRU or TRU gen set meeting one of several alternative technology options. The alternative technology options include fuel cells, electric standby, cryogenic temperature control systems, alternative fuels with a VDECS, and alternative diesel fuels that have been verified as a VDECS. Examples of alternative diesel fuels include biodiesel and gas-to-liquid (GTL) synthetic diesel. Studies have shown that GTL diesel fuel reduces PM emissions in on-road engines without accompanying increases in other regulated emissions. The near-zero sulfur content of GTL fuel can also enable exhaust aftertreatment and might allow this equipment to be operated at higher efficiencies.

The SCAQMD, DOE, NREL and CARB collaborated through a Cooperative Research and Development Agreement (CRADA) to explore strategies for mitigating PM emissions from TRUs. Compliance options under the CARB ATCM include the use of alternative diesel fuel or VDECS. This project aimed to evaluate the performance and feasibility of two options: GTL and advanced emission controls. The primary objectives of this project were twofold: to characterize the reductions in particulate matter enabled by using GTL diesel, and to assess the operability of TRUs fueled with GTL diesel in a 6-month field evaluation of in-use vehicles.

Figure 14: Thermo King Transport Refrigeration Unit

This project tested a TRU in a model year 2004 Thermo King brand SB-200 30 model, mounted to a 48-foot trailer. The engine is a Yanmar 2.2-liter, four-cylinder in-line diesel that utilizes mechanically direct injection and is naturally aspirated. Sasol Chevron provided the test fuels used in this project. The baseline testing was completed on CARB ultra-low-sulfur diesel (ULSD) fuel. The Level 2 VDECS used in this testing was a Thermo King pDPFTM, a type of diesel particle filter (DPF). The Thermo King pDPF was verified by CARB as a Level 2 device, meaning that it achieves a ≥50% reduction in diesel PM. In addition, the Thermo King pDPF was found not to increase NO_2 emissions more than 20% when compared with the baseline. The TRU was tested in situ as a complete operational unit. The unaltered TRU was controlled using the Thermo King user interface, which controls the load placed on the diesel engine by varying the cooling command to the refrigerant compressor. Steady-state conditions were achieved by cooling the trailer box to a low temperature and then adjusting the cooling set point upward; this resulted in a stabilized and repeatable engine load. The stabilized mode was verified by monitoring several parameters rather than performing direct load measurements. The testing involved two fuels, two engine operating speeds, and two exhaust configurations. A total of eight combinations were tested in duplicate test runs. Two runs per test configuration were conducted, and the results were averaged. Two NO_x analyzers were used to measure total NOx and NO. NO_2 and the ratio of NO/NO_2 were calculated. The second NO_x analyzer failed during test runs of the GTL diesel fuel with the pDPF; therefore, results for NO are designated as not measured (NM).

In comparison to the baseline condition (CARB diesel and a stock muffler), significant reductions of gaseous emissions and PM were possible when using GTL diesel, a Thermo King pDPF, or a combination of the two approaches. Table 5 presents the percentage changes measured in each case.

Table 5: Emissions Reductions with GTL Diesel and/or Thermo King pDPF

Engine Speed	NO_x	NO	NO_2	CO	CO_2	THC	PM	Fuel Consumption
Reductions with GTL diesel as replacement for CARB diesel								
High	-12.8%	-13.7%	-8.3%	-19.2%	-0.8%	-21.7%	-26.8%	+2.9%
Low	-15.6%	-18.3%	-6.5%	-17.4%	-6.8%	-42.9%	-40.4%	-6.4%
Reductions with pDPF as replacement for muffler								
High	+0.5%	-11.8%	+68.1%	-98.8%	+9.7%	-95.8%	-20.6%	+2.0%
Low	-2.8%	+9.4%	-44.3%	-66.2%	+3.2%	-29.8%	-57.3%	-9.3%
Reductions with both GTL diesel and pDPF								
High	-11.6%	NM	NA	-99.7%	+3.5%	-97.1%	-48.1%	-2.2%
Low	+11.1%	NM	NA	-97.8%	-11.1%	-76.2%	-72.1%	-14.4%

Note: Figures preceded by a minus sign (e.g., -12.8%) denote a reduction from baseline, while those preceded by a plus sign (e.g., +2.9%) denote an increase.

CARB diesel with GTL diesel yielded PM reductions of 27%–40%, depending on the engine speed. Replacing the OEM muffler with a Thermo King pDPF resulted in PM reductions of 21%–57%, depending on the engine speed. The application of both GTL diesel fuel and a Level 2 VDECS resulted in impressive, if not purely additive, reductions in PM of 48%–72%. Replacing CARB diesel with GTL diesel yielded NO_x reductions of 13%–16%, depending on the engine speed. The ratio of NO/NO_2 was approximately the same across the two fuels. Replacing the OEM muffler with a Thermo King pDPF resulted in a slight increase in NO_x at high-speed engine operation and a marginal decrease at low speed. The ratio of NO/NO_2 decreased at high engine speed (a larger NO2 fraction), but increased at low engine speed (a smaller NO_2 fraction). The reason for this is unknown, although it can be presumed that low-speed engine operation does not sufficiently light off the pDPF catalyst, resulting in a smaller oxidized NO_x (NO_2) fraction. The application of both GTL diesel fuel and a Level 2 VDECS resulted in a decrease in NO_x of 12% at high engine speed but an increase of 11% at low engine speed.

These in situ tests characterize the emissions from integrated TRUs rather than from just the diesel engine. This methodology may yield relevant real-world TRU emissions profiles and thus provide better insight into the contribution of TRUs to emissions inventories. The integration of emissions over a period of time, including relative weighting of high and low idle times, is a logical extension of this work. Using GTL diesel fuel as a replacement for CARB diesel fuel can reduce gaseous emissions and PM at both high and low engine speeds. Replacing the stock muffler with a Thermo King pDPF can also reduce some gaseous emissions and PM at both high and low TRU engine speeds. Compounded reductions, significant in the case of CO and THC, were obtained when GTL diesel fuel was combined with the Thermo King pDPF.

Develop & Demonstrate Stationary Emission Control System for Marine Vessels (AMECS)

The Port of Long Beach (the port or POLB) is a major international gateway for commerce entering California and the United States and is one of the world's busiest seaports. The demand for goods moving through the San Pedro Bay region is expected to double before the year 2020. POLB's ability to accommodate the growth in trade will depend upon their ability to address adverse environmental impacts on air quality. In the South Coast Air Basin, 11% of particulate matter (PM) emissions, 5% oxides of nitrogen (NO_x) emissions, and 32% oxides of sulfur (SO_x) emissions are attributed to port-related emissions from the POLB.

Figure 15: Bulk Cargo Vessel, the Queen Lily

Advanced Cleanup Technologies, Incorporated's (ACTI) Advanced Maritime Emissions Control System (AMECS) is designed to significantly reduce harmful exhaust pollutants from the auxiliary engines and auxiliary boilers of ocean-going vessels while at berth or anchored within the port before they are exhausted into the surrounding environment. AMECS consists of two major components: a) the Exhaust Capture System (ECS), which is the interface with the ship; and b) the Emissions Treatment System (ETS). The ECS captures the exhaust from the vessel and directs it through a duct into an emissions treatment system.

In 2007, preliminary testing of AMECS was conducted on the Western Seattle, a Handymax class, 45,630 dwt Bulk Cargo Vessel, using an Octagonal Capture Bonnet. The successful test led to the testing of AMECS on two bulk cargo vessels, the Queen Lily (see Figure) and the Angela, on May 26 and July 19, 2008, respectively, for this project. Table 6 summarizes the overall average control efficiencies resulting from the demonstration testing by an independent SCAQMD approved testing company of AMECS at the POLB.

Table 6: Summary of AMECS Pollutant Control Efficiencies

	NOx	PM	VOC	SO_2	CO
Overall Average Control Efficiency	>99.1%	95.0%	96.3%	99.8%	43.8%

Develop & Demonstrate Natural-Gas Hybrid-Electric Transit Bus

This project was initiated because several key transit properties in the south coast region have already invested heavily in CNG infrastructure and wanted to lower their operating costs as well as further limit fleet emissions by employing hybrid-electric vehicles fueled by CNG. As part of this project, ISE developed, installed and optimized a CNG hybrid drive system using Siemens components and an ISE energy storage and vehicle control systems, which was modified to include a CNG-fueled engine. The CNG hybrid bus entered into revenue service by San Diego Metropolitan Transit System (MTS) for a minimum of one year; its performance was evaluated and compared to that of a conventionally powered CNG bus.

The series hybrid drive system used in this project is based on ISE's proven gasoline-hybrid design and incorporates a fuel burning engine that turns a generator to produce electrical power. This power runs electric motors that drive the vehicle wheels. On-board electrical energy storage provides an "energy buffer" that improves vehicle performance and efficiency. ISE provides the necessary software, system controllers and additional components such as cooling systems, braking resistors, air and hydraulic compressors, etc.

Figure 16: The CNG hybrid bus in revenue service at San Diego MTS

The CNG hybrid drive system was successfully developed and installed on an existing CNG bus chassis provided by San Diego MTS. The vehicle was in revenue service at San Diego MTS from April 2008 through July 2009. This project has direct

commercialization potential in replacing conventional CNG vehicles in transit service, leading to increased fuel economy, lower emissions and ultimately decreased vehicle operating costs.

Electric Tow Tractor Demonstration

In 2006, the SCAQMD in cooperation with CARB, EPA and the San Pedro Bay Ports planned to cut diesel related particulate matter (PM) by more than 47% and smog forming Nitrogen Oxide (NOx) emissions by more than 45% within five years. An integral part of the plan supports projects to increase utilization of electric and hybrid vehicles in applications in and around the ports. Keeping with this objective, in December 2006, the SCAQMD Board approved a joint project with the Port of Los Angeles and Balqon Corporation (Balqon) to assess the viability of using electric truck tractors for transportation of containers in marine terminals and short-haul applications. This project required Balqon to develop a zero-emission tractor that can transport fully loaded containers with weight of 60,000 lb load at speeds of up to 25 mph with a range of 50 miles on a single charge and the ability to be charged between shifts.

In January 2008, the completed electric truck was delivered to the Port of Los Angeles for design verification and field testing for a period of sixty days. The truck was tested with 68,000 lbs of trailer load and a maximum speed of 35mph was recorded. Fuel consumption tests conducted at an average speed of 15 mph indicated that fuel consumption in terms of kWhr/mile was 78 percent lower against published mpg fuel consumption of diesel trucks during continuous range test. Test results concluded the vehicle range to be 27 miles under full load in on-road applications with 10% grade.

Figure 17: Balqon Tow Tractor

This vehicle equipped with lead acid batteries verified that the propulsion technology was adequate to address off-highway applications but requires additional development of higher-capacity controller technology in production units to address on-highway short-haul applications. In addition, the duty cycle in certain marine terminal applications required vehicle to be charged during break times to meet range requirements. In future designs, new battery technology needs to be investigated for large marine terminal applications to increase energy capacity by approximately 30 percent. It is estimated that in the South Coast Air Basin, replacement of all diesel powered truck tractors with electric tractors can potentially reduce 4,000 tons of emission every year. SCAQMD's contribution to this project was $263,000 and the total project cost was $527,000.

As a follow-up to this project, in April 2008, SCAQMD Board approved a $300,000 award to Balqon to purchase an electric truck tractor to be used in a loaner program to allow multiple marine terminal operators to test the vehicle. Each participant in this program can use the tractor for a thirty- to forty-five-day period. This program is being implemented, and the tractor has been tested in Canada and is currently being tested in the South Coast Air Basin.

Develop, Demonstrate & Certify Heavy-Duty Natural Gas Engine

The SCAQMD has long recognized the adverse air quality and health impacts of diesel exhaust and the majority of heavy-duty vehicles operating in the South Coast Basin are powered by diesel engines that specifically contribute significant emissions of NO_x and particulate matter. To address these adverse air quality impacts, the SCAQMD has implemented various measures to facilitate the use of alternative fuels, including introduction of low-emission natural gas engine platforms.

Consistent with these efforts, this project was initiated for Emissions Solutions, Inc. to develop and certify a heavy-duty natural gas engine model meeting 2010 model-year emission standards (0.2 g/bhp-hr NO_x and 0.01 g/bhp-hr PM). Emission Solution's natural gas engine utilized for this project is based on the diesel-powered International 7.6 liter DT 466 engine, which is one of the leading heavy-duty engines in use in diesel fleets. This design feature should help facilitate the commercialization and use of this natural gas engine especially in school bus applications, and for similar reasons, this natural gas engine model could potentially be used in a number of other applications including utility and delivery trucks.

One of the design objectives of this project was to design and manufacture a natural gas engine without the use of exhaust gas recirculation (EGR), thereby eliminating the problems being experienced by the industry with regard to heat generation caused by the EGR system. Thus, elimination of the EGR system would help lower the operating temperature of the engine, extending the life expectancy of the engine and all major components. Another design objective was to evaluate all necessary combustion cooling techniques (CCT) in combination with all required emission control hardware, including a three-way catalytic convertor. Finally, a new electronic control unit (ECU) and dedicated firmware/software was researched as part of this project to determine the feasibility of incorporating and optimizing stoichiometric, turbocharged and closed-loop adaptive learn combustion technology as part of the overall emissions control strategy to achieve 2010 emission standard levels.

Figure 18: 7.6L NG Engine

The final engine design met all of the design objectives, including the elimination of EGR. The use of high pressure fans to cool intake air into the combustion chamber was also evaluated, but it was determined that the engine could meet 2010 emission standard levels without the use of fans. CARB approved the Executive Order for the 7.6 liter natural gas-powered Phoenix Engine on July 7, 2009.

Combustion Exhaust & Respiratory Health of Port Community Children

To assess potential health associations between traffic-related air pollutants and living or going to school near heavily traveled roadways, 2,687 schoolchildren (1,539 kindergarten and 1,148 fifth grade students, nominal ages 5.7 and 10.8 years, respectively) were recruited through public school classrooms in communities adjacent to the Ports of Los Angeles and Long Beach. Parent-completed residential and medical history questionnaires provided information about historical and current subject health status. A separate study provided estimates for several markers of combustion exhaust (elemental carbon, ultrafine particle number, and nitrogen dioxide). Dispersion model estimates of contributions from local traffic emissions, based on neighborhood streets and community roadways, were used to investigate the influence of proximal roadway traffic on reported symptoms and airway disease.

As a group, the prevalent asthma rate among all port community study subjects (~17%) was elevated but not dramatically higher than those reported in previous Children's Health Study (CHS) communities. Compared to previous CHS cohorts, port community kindergartners had slightly higher asthma rates. Exposure to 24-hr average levels of elemental carbon (EC) was associated with increased respiratory symptoms (bronchitis, cough, and phlegm); these effects were more apparent in fifth-graders. Health effects were associated with exposures at homes and schools.

No consistent response was observed with respect to road type or road proximity. Children living close to or attending schools near busy roadways did not report higher rates of asthma or more respiratory symptoms. Respiratory symptoms were associated with higher community levels of

EC, a combustion exhaust component associated with on-road vehicles as well as ship engines, industrial boilers, refinery processes, rail, harbor craft, and off-road activities. The results indicate that combustion exhaust (from a wider range of combustion processes than on-road traffic alone) is measurably affecting the respiratory health of young children who live and go to school in the port communities.

Table 7: Projects Completed Between January 1, 2009 & December 31, 2009

Contract	Contractor	Project Title	Date
Infrastructure and Deployment			
03098	Taormina Industries	Develop LNG-L/CNG Refueling Station	Jul-09
04085	City of Banning	Construct Natural Gas Refueling Station in Banning	Aug-09
06017	Fuelmaker Corporation	Incentive Buydown Program for CNG Home Refueling Appliances	Dec-09
Fuels/Emission Studies			
00188†	University of California Riverside	Testing Support & Emissions Assessment	Dec-09
06157	City of Santa Monica	Develop & Demonstrate Biodiesel Fuel with Selective Catalytic Reduction	Jun-09
07020†	California Air Resources Board	Analysis of Liquefied Petroleum Gas Samples	Jun-09
07196†	California Air Resources Board	Environmental Justice Saturation Monitoring of Selected Pollutants in Wilmington, CA	Dec-09
Emission Control Technologies			
01173†	National Renewable Energy Laboratory	In-Use Demonstration of Gas-to-Liquid Fuel in Transport Refrigeration Units with Emission Control Device	Dec-09
09150	Advanced Cleanup Technologies, Inc.	Develop & Demonstrate Stationary Emission Control System for Marine Vessels (AMECS)	Feb-09
09374	California State University Long Beach	Develop & Assess Humid Air System for Diesel NO_x Reduction	Oct-09
Electric/Hybrid Technologies			
06182†	ISE Corporation	Develop & Demonstrate a Natural Gas Hybrid-Electric Transit Bus	Dec-09
07265	Descanso Gardens	Demonstrate a Battery Electric Tram	Jan-09
07293	Balqon Corporation	Develop & Demonstrate Electric Tow Tractor for Transporting Containers from Shipping Terminals	Jun-09
Engine Technologies			
07306	Emission Solutions, Inc.	Develop, Demonstrate & Certify Heavy-Duty Natural Gas Engine Meeting 2010 Emission Standards	Aug-09
08037	Thomas Built Buses, Inc.	Integrate & Demonstrate Cummins Westport ISL G Natural Gas Engine in School Bus	Mar-09
08146	Blue Bird Corporation	Integrate & Demonstrate Cummins Westport ISL G Natural Gas Engine in School Bus	Mar-09
08224	BAF Industries	Develop & Certify Natural Gas-Powered Pickup Trucks	Jan-09

Table 7: Projects Completed Between January 1, 2009 & December 31, 2009

Contract	Contractor	Project Title	Date
Mobile Fuel Cell Technologies			
04004	Mercedes-Benz USA, LLC	Demonstrate Two Fuel Cell Vehicles at SCAQMD HQs in Diamond Bar	Jun-09
08301†	American Honda Motor Company, Inc.	Lease of Two Honda Fuel Cell Electric Vehicles	Jun-09
08335	Bevilacqua-Knight, Inc.	Participate in California Fuel Cell Partnership in FY 2008 & Provide Support for Regional Coordinator	Jul-09
09436	Bevilacqua-Knight Inc.	Participate in California Fuel Cell Partnership in FY 2009 & Provide Support for Regional Coordinator	Dec-09
Hydrogen Technologies and Infrastructure			
03201	University of California Irvine	Install & Demonstrate Two Bulk Delivery-Type Hydrogen Fueling Stations in Orange County	Nov-09
04111†	Hydrogenics Corporation	Maintenance & Data Management for the AQMD	Feb-09
Health Impacts Studies			
05037†	California Air Resources Board	Enhanced Exposure Assessment of Health Effects of PM	May-09
07359	University of Southern California	Study on Combustion Exhaust & Respiratory Health of Port Community Children	Aug-09
Outreach and Technology Transfer			
97113†	JME Inc.	Review & Assess Technical Proposals re: ATTB Ultracapacitor Systems	Aug-09
02295†	Synchroenergies, Inc.	Technical Assistance on Lubricants, Fuels, Combustion, Alt Energy Sources and High Performance Fluid Technologies	Jun-09
02335†	Neil C. Otto	Technical Assistance on Fuel Cell Technology	Jun-09
04053†	Marathon Technical Services	Technical Assistance for Alternative Fuels Infrastructure	Dec-09
06173†	Maria Robles	Administrative Assistance Services Related to Organization of International Conferences on Asthma and Port Emissions Control Technologies	Aug-09
07028†	TIAX LLC	Technical Assistance for Air Quality Impacts and Mitigation of Regional Goods Movement	Aug-09
07314†	Engine, Fuel and Emissions Engineering, Inc.	Technical Assistance with Advanced Heavy-Duty and Off-Road Technologies	Dec-09
07342†	Douglas R. Lawson	Technical Assistance for Mobile Source Technologies	Aug-09
08337	Gladstein, Neandross & Associates, Inc.	Coordinate the Southern California Clean Vehicle Technology Expo	Jan-09

Table 7: Projects Completed Between January 1, 2009 & December 31, 2009

Contract	Contractor	Project Title	Date
Outreach and Technology Transfer (continued)			
09136†	Coordinating Research Council, Inc.	Cosponsor the Mobile Source Air Toxics Workshop	Jul-09
09159†	Manufacturers of Emission Controls Association	Cosponsor the Ultrafine Diesel Particles & Retrofit Technologies for Diesel Engines Course	Jan-09
09239†	CALSTART	Cosponsor the 2009 Target 2030 Conference	Aug-09
09291†	CALSTART	Cosponsor the 9th Annual Clean Heavy-Duty Vehicle Conference	Aug-09
09312†	American Society of Mechanical Engineers	Cosponsor the 7th ASME Fuel Cell Science, Engineering and Technology Conference	Dec-09
09313†	Gladstein, Neandross & Associates, Inc.	Co-Host Faster Freight, Cleaner Air 2009 Conference	Aug-09
09235†	University of California Irvine	Cosponsor ICEPAG 2009	Aug-09
09327†	Western Riverside Council of Governments	Cosponsor the 10th Annual Western Riverside COG's Advancing the Choice Event	May-09
09341†	Coordinating Research Council, Inc.	Cosponsor the 19th Annual CRC On-Road Vehicle Emissions Workshop	Sep-09
09347†	National Hydrogen Association	Cosponsor the 20th Annual U.S. Hydrogen Conference	Oct-09
09371†	CALSTART	Technical Assistance for Chairman's Initiative Green Tech Connect Forum	Oct-09
09372†	Three Squares Inc.	Outreach Assistance for Chairman's Initiative Green Tech Connect Forum	Dec-09
09409†	Silicon Valley Leadership Group	Cosponsor Plug-In 2009	Dec-09
09411†	University of California Irvine	Cosponsor the Western States Section of the Combustion Institute Fall 2009 Meeting	Dec-09
09437†	City of South Pasadena	Cosponsor the 3rd Clean Air Car Show and Film Festival	Aug-09
10044†	Coordinating Research Council, Inc.	Cosponsor the CRC Life Cycle Analysis Workshop of Biofuels	Dec-09

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

CLEAN FUELS PROGRAM
2010 PLAN UPDATE

Technology Funding Priorities for 2010

The Clean Fuels Program continually seeks to support the deployment of lower emitting technologies. 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 year has been especially difficult for technology partnering due to the dramatic global economic downturn, which has shifted national research and development priorities and opportunities. For example, the SCAQMD was able to leverage several American Recovery and Reinvestment Act (ARRA) funding opportunities to support specific technology areas which allowed redirection of SCAQMD funds to other areas. The challenge for the SCAQMD is 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 AQMP for the Basin and the Governing Board's directives to protect the health of residents of Southern California. The 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 proposed regulations. 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. This 2010 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 AQMP.

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 2010 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 2012. Projects are also proposed that may involve developing 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 2013 or later.
- More mature technologies, those ready to begin field *demonstration* in 2010, are expected to result in a commercial product in the 2011-12 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, it is government's role to support and offset any incremental cost to ensure the transition and use of the cleaner technology. The sustained use and proliferation of these cleaner technologies often depends on this initial support and funding.

Technical Priorities

The SCAQMD program maintains flexibility to address dynamically evolving technologies and incorporating the latest progress. The major technical program areas are identified below with specific project categories discussed in more detail in the following section.

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 are underway to support the deployment of natural gas vehicles. CNG and LNG refueling stations are being positioned to support public and private fleet applications as incentives for natural gas vehicles are made available to fleet operators. Upgrades are also needed to refurbish some of the stations installed five years ago, especially to ensure growth of alternative fuels throughout the South Coast Air Basin and beyond.

Besides these technologies, some key issues that must be overcome for public acceptance involve the development of fire and safety codes and standards, cost and economics of the new fuels, public education and training and emergency response capability. Some of the projects expected to be developed and co-funded for infrastructure development include:

- Development and demonstration of natural gas as a vehicle fuel from renewable feedstocks and biowaste;
- Development and demonstration of advanced, cost effective CNG and LNG stations;
- Deployment of natural gas home refueling appliances for light-duty vehicles;

- Investigation of LNG manufacturing and distribution technologies; and
- Early commercial deployment of alternative fuel light-duty vehicles.

Emissions, Fuels and Health Impacts Studies

The monitoring of pollutants in the Basin is extremely important, especially when focused on a particular sector of the emissions inventory (to identify the technology responsibility) or receptor in the 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:

- demonstrate remote sensing to target different high emission applications and sources;
- conduct studies to identify the health risks associated with ultrafines and ambient particulate matter;
- in-use emissions studies to determine the impact of PHEVs and EVs on local air quality; and
- lifecycle energy and emissions analyses to evaluate conventional and alternative fuels.

Emission Control Technologies

Although engine technology 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 (PM 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 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

There has been a resurgence of interest and activities on electric drive technologies for PHEVs and BEVs. 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.

There also remains high interest by the major automobile manufacturers for hybrid electric technologies in both light-duty 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 and medium-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 hybrid vehicles including hydraulic and series hybrid concepts; and
- development and demonstration of hybrid and electric technologies for goods movement, e.g., linear inductive motors, magnetic levitation and battery-powered container tugs.

Engine Technologies

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 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;
- demonstration of low- and zero-emission engines for cargo handling activities;
- development and demonstration of clean alternative fuel engines for off-road applications; and
- evaluation of alternative engine systems such as compressed air propulsion and hydraulic plug-in hybrid vehicles.

However, as the 2010 federal limit approaches, the focus by manufacturers has shifted from engine development to deployment in various applications as described in the Infrastructure and Deployment section.

Hydrogen Technologies and Infrastructure

Hydrogen use as a vehicle fuel offers an attractive combination of benefits including zero-tailpipe emissions, petroleum displacement and greenhouse gas emissions reduction, with unmatched driving range (longest) and refueling time (shortest) amongst 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. The SCAQMD supports hydrogen 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. 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.

Furthermore, in order to realize nearer-term air quality benefits, the SCAQMD is actively investigating "bridging" technologies which can fill the gap until fuel cell vehicles become commercially viable. Future projects are expected to include the following:

- development and demonstration of hydrogen-CNG vehicles for medium- and heavy-duty vehicle applications as well as stationary power applications; and
- 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.

Mobile Fuel Cell Technologies

As mentioned in the previous section, fuel cell vehicles are of high interest due to their zero-tailpipe emissions, petroleum independence and reduced greenhouse gas emissions. 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 is actively working with the California Fuel Cell Partnership and the California Hydrogen Highway Network to further the commercialization of mobile fuel cells. The 2010 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 cross-cutting fuel cell applications (e.g. plug-in hybrid fuel cell vehicles);
- development and demonstration of fuel cells in off-road 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, there are areas where cleaner 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. Projects conducted under this category may include:

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

Target Allocations to Core Technology Areas

Figure 19 below presents the potential allocation of available funding, based on SCAQMD projected program costs of $16.5 million for all potential projects. The expected actual project expenditures for 2010 will be much 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 2010 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.

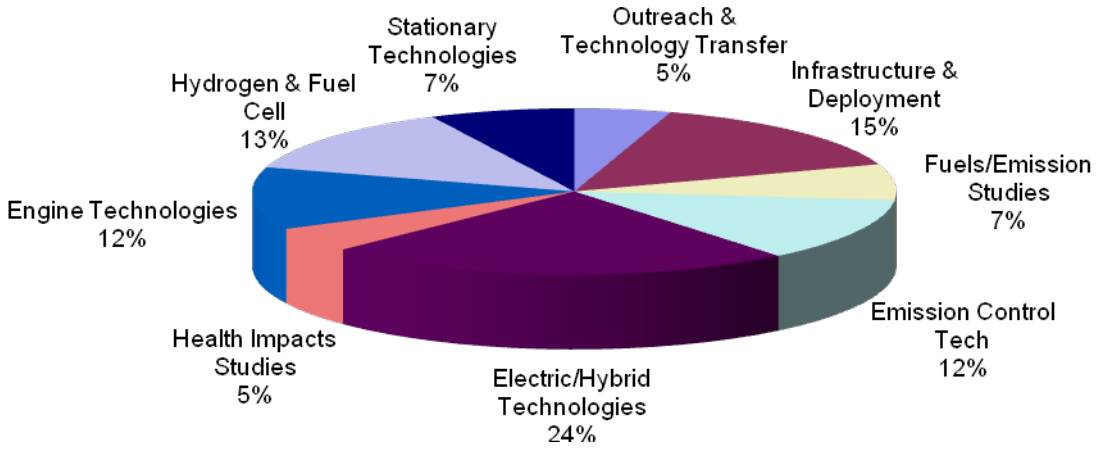


Figure 19: Projected Cost Distribution for Potential SCAQMD Projects 2010 & Beyond ($16.5M)

PROGRAM PLAN UPDATE FOR 2010

This section presents the Clean Fuels Program Plan Update for 2010. 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.

In 2009 the SCAQMD was awarded nearly $78.5 million in funds through the American Recovery and Reinvestment Act and other federal funding sources:

- $50.4 million for EV technologies to develop U.S. manufactured next-generation batteries and electric vehicles and to fully integrate plug-in hybrid electric vehicle systems for medium-duty utility and delivery trucks and shuttle buses;
- $5.6 million for expansion of an LNG corridor from Ontario to Las Vegas, which would include both vehicles and infrastructure and be implemented in conjunction with UPS
- $16.9 million for a natural gas drayage truck replacement program;
- $4 million for two major selective catalytic reduction (SCR) projects;
- $898,000 for placement of aftertreatment devices on public school buses operating on diesel fuel;
- $500,000 to implement a buydown program for natural gas-powered taxicabs and shuttles; and
- $150,000 to upgrade a high-traffic LNG station in Ontario.

These awards are reflected in the higher project costs within Table 1 which summarizes potential projects for 2010 as well as in the redistribution of AQMD costs in some areas. For example, the allocation of SCAQMD funds for emissions control technologies has been reduced because of the DERA and EPA funds received as a result of the ARRA awards.

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 8.

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 8: Summary of Potential Projects

Proposed Project	Expected SCAQMD Cost $	Expected Total Cost $
Infrastructure and Deployment		
Deploy Natural Gas Vehicles in Various Applications	750,000	5,000,000
Upgrade Natural Gas Infrastructure	1,000,000	1,000,000
Demonstrate Advanced Natural Gas Systems Refueling Stations	200,000	4,000,000
Demonstrate Manufacturing and Distribution Technologies Including Renewables	500,000	7,000,000
Subtotal	$2,450,000	$17,000,000
Fuels/Emission Studies		
In-Use Emissions Studies for Advanced Technology Vehicle Demonstrations	500,000	1,000,000
Conduct Emissions Studies on Biofuels	150,000	1,300,000
Identify and Demonstrate In-Use Fleet Emissions Reductions	250,000	2,000,000
Perform Study of Comparative Emissions of Alternative Fuel and Conventional Fuel Engines	250,000	1,000,000
Subtotal	$1,150,000	$5,300,000
Emission Control Technologies		
Develop and Demonstrate Advanced Aftertreatment Technologies	1,550,000	5,200,000
Demonstrate On-Road Technologies in Off-Road and Retrofit Applications	500,000	1,000,000
Subtotal	$2,050,000	$6,200,000
Electric/Hybrid Technologies		
Demonstrate Light-Duty Plug-In Hybrid & Battery Electric Vehicles and Infrastructure	1,500,000	10,000,000
Develop and Demonstrate Medium- and Heavy-Duty Hybrid Vehicles and Infrastructure	1,500,000	45,000,000
Demonstrate Alternative Energy Storage	250,000	2,600,000
Transfer and Demonstrate Hybrid and Electric Technologies to Conventional Applications	150,000	500,000
Develop and Demonstrate Electric Container Transport Technologies	500,000	5,000,000
Subtotal	$3,900,000	$63,100,000
Engine Technologies		
Develop and Demonstrate Advanced Alternative Fuel Medium- and Heavy-Duty Engines and Vehicles	1,500,000	3,000,000
Develop and Demonstrate Alternative Fuel and Clean Conventional Fueled Light-Duty Vehicles	250,000	700,000
Develop and Demonstrate Clean Container Transport Technologies	150,000	1,200,000

Table 8: Summary of Potential Projects

Proposed Project	Expected SCAQMD Cost $	Expected Total Cost $
Engine Technologies (continued)		
Evaluate, Develop and Demonstrate Compressed Air Vehicle Technology	100,000	250,000
Subtotal	$2,000,000	$5,150,000
Hydrogen Technologies and Infrastructure		
Develop and Demonstrate Hydrogen Vehicles	150,000	2,000,000
Develop and Demonstrate Distributed Hydrogen Production and Fueling Stations	1,750,000	6,000,000
Subtotal	$1,900,000	$8,000,000
Mobile Fuel Cell Technologies		
Develop and Demonstrate Fuel Cells in Vehicle Applications	250,000	4,000,000
Subtotal	$250,000	$4,000,000
Health Impacts Studies		
Evaluate Ultrafine Particle Health Effects	300,000	3,000,000
Conduct Monitoring to Assess Environmental Impacts	250,000	1,000,000
Assess Sources and Health Impact of Particulate Matter	250,000	300,000
Subtotal	$800,000	$4,300,000
Stationary Clean Fuel Technologies		
Develop and Demonstrate Low-Cost Emission Monitoring Systems	200,000	500,000
Develop and Demonstrate Clean Stationary Technologies	500,000	750,000
Develop and Demonstrate Renewable-Based Energy Generation Alternatives	500,000	1,000,000
Subtotal	$1,200,000	$2,250,000
Outreach and Technology Transfer		
Assessment and Technical Support of Advanced Technologies and Information Dissemination	400,000	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	**$16,500,000**	**$116,500,000**

Technical Summaries of Potential Projects

Infrastructure and Deployment

Proposed Project: Deploy Natural Gas Vehicles in Various Applications

Expected SCAQMD Cost: $750,000

Expected Total Cost: $5,000,000

Description of Technology and Application:

Natural gas vehicles 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: Upgrade Natural Gas Infrastructure

Expected SCAQMD Cost: $1,000,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

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 the public and school districts.

Potential Air Quality Benefits:

While having no direct impact on air emission reductions, new CNG stations will help facilitate the introduction of low-emission, NGVs initially in private and public fleets in the area. 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: Develop and Demonstrate Advanced Natural Gas Systems for Refueling Stations

Expected SCAQMD Cost: $200,000

Expected Total Cost: $4,000,000

Description of Technology and Application:

This program would support the development, demonstration and implementation of natural gas fueling station technologies to reduce private investment costs, increase the overall number of such fueling stations in strategic locations throughout the Basin, reduce the cost of natural gas equipment, standardize fueling station design and construction and provide outreach in two key market segments.

Small Refueling Stations. Small private and public fleets are currently constrained in their NGV refueling choices and do not possess in-house expertise or financial resources to design or install a fueling station. They are also unaware of governing codes or standards affecting such an installation. Providing outreach and financial incentives and reducing the cost and improving the safety, reliability and performance life of fueling station equipment could significantly increase the penetration of natural gas fueling stations.

Large Fast-Fill NGV Refueling Stations. Conventional gasoline refueling stations typically refuel between 100 to 300 vehicles per day. The perceived high costs of a fast-fill NGV refueling station that could refuel a similar number of vehicles has significantly curtailed the growth of a NGV refueling infrastructure. The project is intended to provide outreach and financial incentives, advance the technology of compressors, gas-dryers, dispensers, fuel meters and other major subsystems of a NGV fueling station system. The proposed improvements are expected to improve the performance and lower the capital cost and operating costs of fast-fill NGV refueling stations.

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 would significantly reduce the installation and operating costs of NGV refueling stations, besides improving the refueling time. This would lead to the expansion of the NGV fueling infrastructure and greater consumer acceptance, which in turn should support expedited commercial implementation of NGVs. The increased exposure and fleet and consumer acceptance of NGVs would lead to significant and direct reductions in NO_x, VOC, CO, PM and toxic compound emissions from mobile sources.

Proposed Project: Demonstrate 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;
- 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: $500,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

Hybrid electric, hybrid hydraulic, plug-in electric hybrid and pure EVs will likely 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

Expected SCAQMD Cost: $150,000

Expected Total Cost: $1,300,000

Description of Technology and Application:

Biofuels are potentially an important strategy to reduce petroleum dependence, air pollution and greenhouse gases. Biofuels are in fact receiving increased attention due to national support of and state activities resulting from AB 32, AB 1007 and the Low-Carbon Fuel Standard. These efforts are necessary to address the promulgation and deployment of low greenhouse gas emitting fuels and technologies if the state hopes to meet the 2020 target to reduce GHG emissions to 1990 levels as required by AB 32. However, to ensure that such fuels and technologies have low criteria pollutant emissions, specifically NO_x and PM, the emissions from lower carbon fuels, such as blends of biodiesel and ethanol, must be further analyzed.

In various diesel engine studies, replacement of petroleum diesel fuel with biodiesel fuel has demonstrated reduced PM, CO and air toxics emissions. Biodiesel is also promoted to reduce greenhouse gas emissions because it can be made from renewable feedstocks, such as soy and canola. Biodiesel can be formulated at varying percentages by blending with petroleum diesel fuel and is commonly used at 20 percent or B20 to avoid congealing at cold temperatures and possible engine seal and gasket damage which can occur with 100% biodiesel (B100). Biodiesel and biodiesel blends, however, have demonstrated a tendency to increase NO_x emissions, which exacerbates the ozone and $PM_{2.5}$ challenges faced in the Basin.

Ethanol is another biofuel that is gaining increased national media and state regulatory attention. The amount of ethanol in gasoline is currently 5.7% or E6 to replace the banned MTBE as an oxygenate to reduce CO emissions. There are efforts to further increase the ethanol content to 10% or E10 and higher as a means to increase the amount of renewable fuels in the state. Contemporary light-duty vehicles, however, are not equipped to manage increased levels of ethanol and could result in higher criteria pollutant emissions. As such, an investigation into the tailpipe emissions for commercial gasoline (E6), the certification fuel which is still based on MTBE gasoline and higher ethanol blends (e.g., E10) is warranted.

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 Reductions

Expected SCAQMD Cost: $250,000

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. Unfortunately, the in-use fleet--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 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); and
- electrical auxiliary power unit replacements.

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.

Proposed Project: Perform Study of Comparative Emissions of Alternative Fuel and Conventional Fuel Engines

Expected SCAQMD Cost: $250,000

Expected Total Cost: $1,000,000

Description of Technology and Application:

Various makes and models of heavy-duty engines using alternative fuels have been developed and deployed in the Basin. The certification procedure requires laboratory tests on the engine emissions performance as well as those of conventional heavy-duty diesel engines. It is important to assess the emissions performance of these engines in actual operation to determine if the engines are operating properly and the expected benefits of alternative fuels are being realized, including potential toxic emissions. It is also important to account for the well-to-tank emissions associated with the production and distribution of any of the proposed alternative fuels, in order to completely characterize their emissions impact.

The objective of this project is to assess the on-road emission performance of heavy-duty engines using alternative fuels, including natural gas, dual fuel and emerging liquid fuels such as Fischer-Tropsch liquids. The testing of equivalent heavy-duty engines using baseline fuels is needed to assess the relative emission performance. Diagnostic procedures will also be performed to help identify any mal-performing system.

Another emerging area of interest is the emissions from biofuels, especially low level blends of ethanol and high level blends of biodiesel. Low level blends of ethanol (E10) may have increased permeation and evaporative emissions from light duty vehicles. Also, a mixture of ethanol concentrations, e.g., between E10 and E85, has unknown tailpipe emissions, so a study to understand these effects is desired. Although there have been extensive studies conducted to quantify tailpipe emissions from biodiesel blends, an in-use emissions study would be useful to quantify the actual performance on a case-by-case basis.

The tailpipe emission measurements would be aggregated with the well-to-tank emissions to yield the full cycle emissions associated with the use of a particular test fuel. These well-to-tank emissions would be modeled using the GREET model developed by Argonne National Laboratory, or an equivalent full cycle emissions model.

Potential Air Quality Benefits:

This proposed program supports several 2003 AQMP On-Road Mobile Sources Control Measures, including M4, "Heavy-Duty Diesel Vehicles; Early Introduction of Low-NO_x Engines" and M5, "Heavy-Duty Diesel Vehicles; Additional NO_x Reductions in California." Certification of low-emission vehicles and engines and their integration into the Basin's transportation sector, is a high priority under the AQMP and the SIP. In addition, the identification of diesel exhaust particulate as a toxic air contaminant by CARB and the determination that diesel exhaust contributes over 70 percent of the increased cancer risk due to air pollution in the Basin suggest an urgency to expedite the implementation of clean alternatives to diesel engines to protect public health.

This program is intended to compare the full life-cycle emissions from alternative fueled and diesel fueled heavy-duty engines. This proposed project will also determine in-use emission performance and provide an indication of actual vs. certified performance.

Emission Control Technologies

Proposed Project: Develop and Demonstrate Advanced Aftertreatment Technologies

Expected SCAQMD Cost: $1,550,000

Expected Total Cost: $5,200,000

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.

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 non-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: $500,000

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 2007, which is an order of magnitude decrease in just three years. Off-road engines, however, have considerably higher emissions limits depending on the engine size. For example, Tier-3 standards, which took effect in 2006, 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: $1,500,000

Expected Total Cost: $10,000,000

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. 480V (Level 3) charging is under development.

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.

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; and 6) necessary infrastructure to demonstrate the potential clean air benefits of these types of vehicles.

Innovative approaches to electric drive systems are also under development that could improve performance, fuel efficiency and reduce emissions relative to the first HEVs commercially introduced. Innovations that may be considered for demonstration include: advancements in the auxiliary power unit, either ICE or other heat engine, especially using alternative fuels including natural gas and hydrogen; battery-dominant hybrid systems utilizing off-peak re-charging; and advanced battery technologies such as lithium-ion. Both new designs and retrofittable technologies will be considered.

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: $1,500,000

Expected Total Cost: $45,000,000

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 incredible 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; 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.

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: $250,000

Expected Total Cost: $2,600,000

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 lead acid and nickel-cadmium battery packs. Over the past few years, additional technology consisting of nickel sodium chloride and lithium-ion batteries has shown robust performance. Other technology manufacturers have also developed energy storage devices including flywheels, hydraulic systems and ultracapacitors. 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 the fuel consumption 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: Transfer and Demonstrate Hybrid and Electric Technologies to Conventional Applications

Expected SCAQMD Cost: $150,000

Expected Total Cost: $500,000

Description of Technology and Application:

Current battery electric technology may be applicable to a number of applications beyond conventional passenger cars. For example, studies conducted by a number of different parties suggest that a high percentage of consumer/commuter driving patterns total no more than 25 miles a day. From an air quality perspective, it may be particularly advantageous to identify and implement zero-emission vehicles in conditions where low mileage and heavy stop-and-go duty cycles are prevalent.

The objective of this program area is to identify and demonstrate applications that can best utilize zero- and near zero-emission technologies, such as neighborhood electric vehicles, electric scooters, passenger trams and low-speed cargo tugs. Applications to be included in this program include, but are not limited to, station cars, shared cars, fixed route fleets and other innovative applications, with potential linkages to transit through intelligent transportation systems.

The development of energy efficient systems reduces emissions associated with energy generation and is a criterion for projects funded under this category.

Potential Air Quality Benefits:

The 2007 AQMP identifies zero- and nearly zero-emitting ventures as a key attainment strategy. This project would demonstrate the viability of zero-emission technologies in innovative applications. Other benefits would include increased exposure and user acceptance of advanced technologies, direct emission reductions from in-basin demonstrations and the potential for increased use and resulting emission reductions of the demonstrated technologies through their expedited commercialization.

Proposed Project: Develop and Demonstrate Electric Container Transport Technologies

Expected SCAQMD Cost: $500,000

Expected Total Cost: $5,000,000

Description of Technology and Application:

Advanced transport systems can be used to transfer cargo containers from the ports to both local and "distant" intermodal facilities, thereby significantly reducing emissions from on-road trucks and locomotives and will also reduce traffic congestion in local transportation corridors. Such systems use magnetic levitation (maglev), linear synchronous motors or linear induction motors on dedicated guideways. 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. Container freight systems are not designed to carry any operators or passengers on the guideways. Current container transport concepts have been developed by General Atomics with California State University, Long Beach (GA-CSULB) and the Texas Transportation Institute (TTI). GA-CSULB has built a prototype system at GA's San Diego facility using maglev. This Electric Cargo Conveyor (ECCO) demonstration moves 20-foot containers. The elevated ECCO system costs about $100M per mile and $1.50 per container-mile for operation. TTI's concept for its "Freight Shuttle System" (FSS) uses linear induction propulsion in combination with steel wheels on a flat steel running surface, similar to conventional rail. The elevated FSS system costs about $20M per mile and $0.10 per mile in operating costs. Both systems utilize a lightweight carriage in which the containers are carried. Automatic cranes can be used to load and unload the containers.

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. These use electric propulsion for the containers on fixed guideways and 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 Technologies

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

Expected SCAQMD Cost: $1,500,000

Expected Total Cost: $3,000,000

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 PM emissions target is below 0.01 g/bhp-hr. 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 has 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: $250,000

Expected Total Cost: $700,000

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.

Proposed Project: Develop and Demonstrate Clean Container Transport Technologies

Expected SCAQMD Cost: $150,000

Expected Total Cost: $1,200,000

Description of Technology and Application:

At the ports of San Pedro Bay, cargo containers are moved from the docks either by railroad train or by truck. Generally speaking, railroad trains move containers long distances (greater than 500 miles) while trucks are used for shorter hauls (less than 400 miles). Because of limited rail capacity at the dock, many containers are also moved individually by truck to railroad intermodal yards 4 to 20 miles away (drayage) where the containers are then loaded on to trains for their long-distance trips. In order to reduce truck emissions and roadway congestion, various systems have been proposed to move containers over dedicated guideways using electrical propulsion. However, such systems cost from $20M to $100M per mile to construct. Two alternatives have been proposed: 1) short-haul shuttle trains using ultra-low-emission locomotives; 2) and drayage truck trains with multiple container trailers using ultra low-emission truck tractors. Ultra low-emission technologies such as LNG, CNG, SCR, particulate filters including DPFs, diesel oxidation catalysts (DOCs) and hybrid drive trains are available for locomotives and truck tractors.

It is proposed that a short-haul shuttle train with ultra low-emission locomotives be demonstrated in the South Coast Air Basin. This will involve developing and demonstrating the above stated emission technologies on freight locomotives. In addition, a system for building such trains will need to be developed for locally bound containers, likely at the railroad intermodal yards. While the economics of a shuttle train will be less attractive than a long-haul train, the cost effectiveness for emission reductions will be competitive with other emission strategies when considering the reductions from displaced trucks and eliminated traffic congestion.

The second proposal is to develop and demonstrate "truck container trains" to minimize drayage emissions. Such "trains" would use low-emission natural-gas truck tractors and travel at reduced speeds on either dedicated lanes on existing roadways, or on dedicated roadways. In order for such a system to be viable, the natural-gas truck tractors would need to be reconfigured to handle the excessive load of multiple trailers as well as to minimize emissions. Also, existing container trailer chassis would need to be revised in order to handle tandem trailers. (Three-trailer trucks are allowed on highways in certain states and four-trailer trucks are used in Australia). This project would develop the specifications for the natural-gas truck tractor, determine the optimum number of containers that could be trailored, determine a specification for the revised container trailer chassis and suggest regulatory and legislative changes that would be needed for operating such a system. Following this design effort, a demonstration project would be expected.

Potential Air Quality Benefits:

On-road heavy-duty diesel trucks are an integral part of operations at the ports by 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 is to use "advanced container transport systems" which cost from $20M to $100M per mile for about 5 miles. The proposed short-haul shuttle train with ultra-low-emission locomotives will cost much less and eliminate one to two hundred truck trips per train from the ports and the associated traffic congestion. Similarly, the truck container train will cost much less than the container transport system and have emission benefits greater than modernizing or retrofitting the fleet because fewer truck tractors will be needed. Nonetheless, new truck tractors and revised container trailer chassis will need to be developed and purchased with a net cost probably more than modernizing the fleet. However, the emission benefits will be greater and proportional to the number

of containers included in the container train since one truck trip will be eliminated for each extra container.

Proposed Project: Evaluate, Develop and Demonstrate Compressed Air Vehicle Technology

Expected SCAQMD Cost: $100,000

Expected Total Cost: $250,000

Description of Technology and Application:

Pneumatic engines derive their power from the expansion of high pressure air. These motors may be either a turbine or reciprocating type motor. The high pressure air used to drive the motor is stored on-board the vehicle in dedicated storage cylinders. The energy extracted from the air is solely attributable to its storage at high pressure, since air does not contain any intrinsic energy. The lack of intrinsic energy requires a relatively large volume of air to be stored at a pressure in the vicinity of 4500 psi to have any appreciable energy storage. The requirement for such high pressure air will necessitate either a centralized filling network of large compressors, or a distributed system of smaller home compressors, or a combination of the two. However, even the high pressure home filling compressors will be significantly more sophisticated than the low pressure compressors used for filling automobile tires.

The energy density of compressed air is significantly less than the liquid fuels currently used for transportation. The reduced energy density will limit the use of a vehicle solely powered compressed air. A vehicle solely powered by compressed air will be limited to applications comparable to a neighborhood electric vehicle, which has a limited driving range and operating speed. These vehicles must be small and extremely lightweight to offset the limited energy storage associated with compressed air.

A dual fuel version of the air motor could be developed to compensate for the limited energy density of compressed air. A combination of compressed air and the combustion of a fossil fuel could enable a vehicle to be operated for extended ranges at speeds greater than those attainable by a neighborhood vehicle. The use of an engine powered by compressed air and fossil fuels would be comparable in concept to a plug-in hybrid electric vehicle.

Potential Air Quality Benefits:

The program is intended to investigate the feasibility and potential applications of using compressed air as an energy storage medium for vehicular transportation. The use of stored energy in the form of compressed air will enable a more diverse and potentially cleaner, energy portfolio to be used for vehicular transportation. Current transportation fuels are predominantly liquid fossil fuels. Storing electrical energy in the form of compressed air could enable the use of renewable energy sources, such as wind, solar, hydroelectric and geothermal, in addition to traditional sources, such as nuclear and natural gas fueled power plants, to be used for transportation.

Hydrogen Technologies and Infrastructure

Proposed Project: Develop and Demonstrate Hydrogen Vehicles

Expected SCAQMD Cost: $150,000

Expected Total Cost: $2,000,000

Description of Technology and Application:

The SCAQMD has been involved in the development and demonstration of light-duty and heavy-duty vehicles operating on hydrogen as their primary fuel including a full-size transit bus. Hydrogen burning ICE vehicles provide a transition platform to advance hydrogen refueling technologies, gain valuable experience with hydrogen as a vehicle fuel and promote cleaner fuels to the public. The proposed project category is to continue developing and demonstrating additional platforms, including light-duty vehicles, which can be utilized in city fleets and medium-duty shuttles, which can be operated in city and airport fleets.

Potential Air Quality Benefits:

Certification of low-emission vehicles and engines and their integration into the Basin's transportation sector are 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 and toxic pollutants.

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, may be 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.

Mobile Fuel Cell Technologies

Proposed Project: Develop and Demonstrate Fuel Cells in Vehicle Applications

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)

Non-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: $300,000

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 than other fractions. Several technologies have been introduced and 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. To have a better understanding of changes in ultrafine particulate emissions from the application of these 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, engine or chassis dynamometer testing will 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 new aftertreatment technologies for alternative fuels and new engines. Additionally, epidemiologic and toxicological studies will be conducted as well as measurements of ambient levels to better understand the health effects and potential community exposures from ultrafine particles.

Potential Air Quality Benefits:

The 2007 AQMP relies on the significant penetration of low-emission vehicles in the South Coast Basin to attain federal clean air standards by 2010. Reduction of particulate emissions from the use of diesel fuel 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 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. The SCAQMD is currently monitoring particulate air quality at several Long Beach sites, Wilmington and Carson. 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 the 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 indirect 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.

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 Low-Cost Emission Monitoring Systems

Expected SCAQMD Cost: $200,000

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. 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: $500,000

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 Renewable-Based Energy Generation Alternatives

Expected SCAQMD Cost: $500,000

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, using 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, 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: $400,000

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	California Air Resources Board
Tim Carmichael	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
Pending Appointment	U.S. Department of Transportation
Dr. Sigmund Gronich.	U.S. Department of Energy
Pending Appointment	Port-Related
Charles Mitzutani	California Energy Commission
Dan Moran	Quality Body Works
Lee Wallace	Sempra Energy
Pending Appointment	Southern California Edison

SB 98 Clean Fuels Advisory Group

Tom Plenys	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
Jason Mark	Energy Foundation
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
Brian Runkel	California Environmental Business Council, Inc.
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

Appendix B

Open Clean Fuels Contracts as of January 1, 2010

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Incentive Programs-Alternative Fuels						
04167	Foothill Transit	Purchase 75 CNG Transit Buses under FY 2002-03 Carl Moyer Program	05/25/05	01/31/10	727,500	727,500
04169	City of Santa Monica	Purchase 57 New LNG Transit Buses under FY 2002-03 Carl Moyer Program	08/04/04	09/30/10	407,732	407,732
04171	City of Santa Clarita	Purchase 12 New CNG Transit Buses under FY 2002-03 Carl Moyer Program	07/28/04	07/31/10	126,000	4,203,432
Infrastructure and Deployment						
05109	Orange County Sanitation Districts	Upgrade CNG Fueling Station in Fountain Valley	02/04/05	02/28/10	24,000	80,000
05135	Sysco Food Services of Los Angeles, Inc.	Purchase & Install New LNG Fueling Station at City of Walnut Food Distribution Center	05/25/05	03/31/10	250,000	1,102,476
05250	Downs Commercial Fueling, Inc.	Purchase & Install New L/CNG Fueling System at Commercial Fueling Station in Temecula	11/04/05	12/31/10	$203,137	$833,333
06028	Consolidated Disposal Service, LLC	Purchase & Install CNG Fueling System at Long Beach Waste Transfer Station	11/23/05	12/31/11	222,038	740,127
06029	Clean Energy	Upgrade CNG Fueling Station at SoCalGas Santa Monica Facility	10/26/05	12/31/11	190,000	634,500
06030	Clean Energy	Purchase & Install CNG Fueling Station at Foothill Transit's Pomona Facility	04/13/06	12/31/11	92,506	250,000
06031	R.F. Dickson Company, Inc.	Upgrade CNG Station at Bellflower Facility	04/13/06	12/31/11	211,148	703,828
06042	UCLA Fleet & Transit Services	Upgrade Existing CNG Public Access Station with Dispenser & Card Reader	09/05/06	12/31/11	15,921	31,842
06043	County Sanitation Districts of Los Angeles	Purchase & Install CNG Fueling Station at Joint Water Pollution Control Plant in Carson City	03/10/06	12/31/11	250,000	850,000
06074	City of Sierra Madre	Purchase & Install New Public Access CNG Fueling Station at City Yard	03/16/06	12/31/11	73,776	368,880
06082	Clean Energy	Purchase & Install New 24-Hour Public Access CNG Fueling Station at SoCalGas's Canoga Park Facility	03/13/06	12/31/11	250,000	842,050
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	12/31/11	120,000	400,000
06091	City of Whittier	Purchase & Install New Public Access CNG Fueling Station at City Yard	03/18/06	12/31/11	150,000	450,000
06139	Lake Elsinore Unified School District	Purchase & Install New Public Access CNG Fueling Station at Maintenance Yard	06/29/06	12/31/11	128,000	367,000
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

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Infrastructure and Deployment (continued)						
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	486,000
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
07253	Colton Joint Unified School District	Local Match to Purchase & Install CNG Station	03/19/07	12/31/10	170,000	1,348,408
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
08033-1	California Air Resources Board	Demonstrate LPG Stop-Fill Unit	06/25/07	06/24/10	75,000	498,900
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
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
09348	AFV Fleet Services	Demonstrate Two Natural Gas Powered Police Vehicles	04/03/09	03/18/12	75,000	75,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Infrastructure and Deployment (continued)						
10051	BusWest	Lease Buses in Support of Mountain Area CNG Demonstration Program	10/09/09	12/31/10	80,000	161,928
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
10181	BAF Technologies	Demonstrate Natural Gas Powered Police Vehicle	12/31/09	08/31/10	34,500	34,500
Fuels/Emission Studies						
07054	West Virginia University	Conduct In-Use Emissions Testing of Refuse Trucks	12/13/06	03/31/10	740,000	740,000
07181	California Air Resources Board	Physical, Chemical & Toxilogical Assessment of the Semi-Volatile & Non-Volatile Fraction of PM	04/01/06	04/01/10	338,975	677,950
08033-2	California Air Resources Board	Test Particulate Measurement Device for In-Use Vehicles	06/25/07	06/24/10	125,000	504,514
08263	University of California Riverside/CE-CERT	Evaluate Emissions Impacts from Diesel Biofuel & Biofuel Blends	08/12/08	12/31/10	150,000	1,630,000
08304	Maschinenbau Haldenwang GmbH & Company KG	Pilot Program to Assess Feasibility of Enhancing Smog Check Tests in the South Coast Air Basin	07/16/08	03/31/10	99,423	373,847
08320	University of Denver	Remote Sensing Measurements of On-Road Emissions from Heavy-Duty Diesel Vehicles	02/06/09	01/31/12	161,041	322,092
09095	University of California Riverside/CE-CERT	Evaluate Emissions Impacts of Ethanol Blend Ratio for Light-Duty Vehicles	10/31/08	09/30/10	250,000	250,000
09290	University of California Riverside	Evaluate Emissions Impacts from Natural Gas Blends on Vehicle Emissions	01/30/09	08/31/10	50,000	450,000
10066	National Renewable Energy Laboratory	CRADA – Loan of 70 MPa Hydrogen Quality Sampling Apparatus to AQMD	11/02/09	12/31/10	0	0
Emission Control Technologies						
07236	National Renewable Energy Laboratory	Investigate the Role of Lubricating Oil on Particulate Matter Emissions from Vehicles	03/23/07	12/31/10	100,000	446,887
08033-3	California Air Resources Board	Demonstrate Retrofit SCR System for NO_x Emission Reduction Using Crystalline Matrix Storage for Ammonia	06/25/07	06/24/10	78,500	338,268
08068	Johnson Matthey Inc.	Develop & Demonstrate SCR Technology for NOx and PM Emissions	12/14/07	01/31/10	254,000	731,500
08161	Engine, Fuel & Emissions Engineering, Inc.	Demonstrate NOx & PM Emissions Control on Construction Equipment	01/04/08	10/31/10	135,830	330,850

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Emission Control Technologies (continued)						
08246	Griffith Company	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	05/14/08	08/24/11	191,000	297,000
08252	City of Culver City	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	07/08/08	9/30/11	38,900	138,475
08253	Tiger 4 Equipment Leasing	Demonstrate NO_x & PM Emissions Control Technologies on Diesel Powered Construction Equipment	01/13/09	08/24/11	17,600	17,600
08261	Community Recycling & Resource Recovery, Inc.	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	12/12/08	03/24/11	363,250	590,895
08272	ECCO Equipment Corporation	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	09/28/08	08/21/11	17,600	17,600
08318	ServoTech Engineering Inc.	Showcase: Demonstrate NO_x & PM Emissions Control Technology on Diesel-Powered Construction Equipment	07/08/08	12/15/11	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	03/24/11	38,900	38,900
09018	Placer County Air Pollution Control District	Develop & Demonstrate Stationary Emission Control System for Locomotives	09/24/08	05/31/10	50,000	1,132,000
10125	University of California Riverside	Demonstrate Projects for Renewable Feedstock to Energy and Fuel Technologies	12/11/09	01/10/11	101,369	211,883
Electric/Hybrid Technologies						
99109	Toyota Motor Credit Corporation	Three-Year Lease of Two RAV4 Electric Vehicles	04/04/99	02/01/10	100,880	100,880
04032	Electric Power Research Institute	Develop, Demonstrate & Evaluate Plug-In Hybrid-Electric Vans in Fleet Use	11/14/03	03/31/10	475,000	1,525,000
05260	Energy Control Systems Engineering, Inc.	Conversion of Light-Duty Vehicle to Plug-In Hybrid Vehicles	09/09/05	10/31/10	260,000	985,000
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	03/31/10	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
08294	Balqon Corporation	Purchase & Demonstrate an Electric Yard Hostler	05/15/08	05/31/10	300,000	300,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Electric/Hybrid Technologies (continued)						
08334	CALSTART	Demonstrate Heavy-Duty Hybrid Electric Vehicle for Parcel Delivery Application	10/16/08	09/30/10	325,000	595,000
09017	U.S. Environmental Protection Agency	Develop & Demonstrate Hydraulic-Hybrid Shuttle Bus	10/10/08	10/09/11	500,000	1,960,000
09023	ISE Corporation	Develop & Demonstrate a Battery Electric Transit Bus	08/07/09	05/31/11	290,000	2,285,000
09301	Electric Power Research Institute	Develop & Demonstrate Plug-In Hybrid Electric Vehicle Delivery Vehicle	06/30/09	03/31/11	964,320	2,164,320
09345	South Bay City Council of Governments	Demonstrate Medium-Speed Electric Vehicles	06/19/09	07/31/11	178,825	178,825
09360	BMW of North America LLC	Lease of Five Mini-E Cooper Electric Vehicles for One Year	05/05/09	05/04/10	600	600
09427	City of Santa Monica	Demonstrate Battery Electric Class 4 Utility Truck	12/15/09	06/14/11	87,205	210,910
Engine Technologies						
08192	Westport Power, Inc.	Develop & Demonstrate 2010 Compliant LNG Heavy-Duty Truck	01/25/08	05/31/10	2,250,000	9,894,027
10041	McNeilus Truck and Manufacturing	Develop Prototype Natural Gas-Powered Concrete Mixer Truck and Demonstrate its Performance and Emissions	11/06/09	11/05/10	100,000	380,000
Mobile Fuel Cell Technologies						
07356	ISE Research Corporation	Upgrade & Demonstrate Fuel Cell Bus	11/02/07	08/31/10	325,000	1,275,000
Hydrogen Technologies and Infrastructure						
04011	Air Products and Chemicals, Inc.	Install & Demonstrate an Industrial Pipeline-Supplied Hydrogen Fueling Station in Torrance	08/03/05	12/31/10	489,051	944,761
04185	Quantum Fuel Systems Technologies Worldwide	Develop & Demonstrate Hydrogen Internal Combustion Engine Vehicles	10/18/04	08/31/10	2,109,851	3,255,631
05165	Air Products and Chemicals Inc.	Install & Demonstrate Three Electrolyzers (in Burbank, Riverside & Santa Monica) and Two Mobile Fuelers (in Santa Ana & Ontario), with One Year of Hydrogen Fuel Supply	06/21/05	06/15/11	3,885,332	3,885,332
09410	California Hydrogen Business Council	Participate in California Hydrogen Business Council	06/01/09	05/30/10	20,000	405,500
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	10/29/11	88,000	88,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
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	06/25/07	06/24/10	374,988	749,976
08033-5	California Air Resources Board	Extended Analyses of Air Pollution & Cardiopulmonary Disease in the California Teachers Study Cohort	06/25/07	06/24/10	142,326	284,652
09307	California Air Resources Board	In-Vehicle Air Pollution Exposure Measurement & Modeling	09/01/08	04/30/11	250,000	500,000
Stationary Clean Fuels Technology						
99046	Engelhard Corporation	Field Evaluation of PremAir Ozone Catalyst Technology on AC Units	10/06/98	12/31/10	0	0
05207	SolSource Energy	Install an 80 kW Solar Panel System at SCAQMD Headquarters	06/06/05	06/05/11	360,000	693,000
06071	Gas Technology Institute	Field Demonstration of Advance Technology Boiler in South Coast District	03/15/06	03/31/10	135,000	612,146
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	02/28/10	35,000	35,000
02308	Sperry Capital, Inc.	Evaluate Financial Stability of Potential Contractors	06/25/02	12/31/11	35,000	35,000
02311	Cole, Jerald A.	Technical Assistance for Development, Outreach, & Commercialization of H2 Infrastructure & Reforming Technology	08/09/02	06/30/11	30,000	30,000
02333	University of California, Riverside	Technical Assistance on Clean Fuels, Hydrogen, Fuel Cell & Natural Gas Technologies	11/01/02	06/30/11	$30,000	$30,000
04049	Engine, Fuel & Emissions Engineering Inc.	Technical Assistance for Alternative Fuels Engine Technology	11/21/03	04/30/11	120,000	120,000
04146	Tom Gross	Technical Assistance for Hydrogen & Fuel Cell Technologies	06/23/04	05/31/11	25,000	25,000
05121	Sullivan, Cindy	Development, Analysis & Technology Implementation of Incentive Programs	03/14/05	03/31/11	75,000	75,000
05126	St. Croix Research	Development, Outreach & Commercialization of LNG, CNG and Hydrogen Fuels	03/15/05	03/31/11	25,000	25,000
05127	Protium Energy Technologies	Development, Outreach & Commercialization of Hydrogen and Fuel Cell Technologies	03/14/05	03/31/10	60,000	60,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Outreach and Technology Transfer (continued)						
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
05171	James Hazelton	Technical Assistance on AB 1222 Advisory Group	04/08/05	03/31/11	$45,000	$45,000
05198	Don Stedman	Technical Assistance for Remote Sensing Programs for Light-Duty Vehicles and Locomotives	05/30/05	11/30/10	25,000	25,000
07012	TIAX, LLC	Technical Assistance Related to the Air Quality Impact of Fuel Ethanol Usage	09/15/06	08/31/10	100,000	100,000
07027	Engine, Fuel & Emissions Engineering Inc.	Technical Assistance for Air Quality Impacts & Mitigation	09/29/06	08/31/10	25,000	25,000
07059	Dowling Associates, Inc.	Technical Assistance Related to Air Quality Impacts of Regional Goods	12/19/06	11/30/10	68,000	68,000
07060	Don Breazeale and Associates, Inc.	Technical Assistance Related to Air Quality Impacts of Regional Goods Movement	11/15/06	11/30/10	58,000	58,000
07062	The Tioga Group, Inc.	Technical Assistance Related to Air Quality Impacts of Regional Goods	12/19/06	11/30/10	58,000	58,000
07129	Breakthrough Technologies Institute, Inc.	Technical Assistance with Fuel Cell Technology	12/01/06	03/31/10	40,000	40,000
07130	Burnett & Burnette	Technical Assistance with CNG Technology	01/17/07	12/31/10	40,000	40,000
07165	Clean Fuel Connection Inc.	Technical Assistance with Compliance of Carl Moyer Program Guidelines	02/07/07	12/31/10	50,000	50,000
07167	Tech Compass	Technical Assistance with Hydrogen and Fuel Cell Technologies	03/31/08	12/31/10	75,000	75,000
07177	TIAX LLC	Technical Assistance with Evaluation of Project Proposals for Carl Moyer Program	01/27/07	12/31/10	50,000	350,000
07185	Joseph C. Calhoun, P.E., Inc.	Technical Assistance for Development, Outreach & Commercialization of Advanced Low-Emission Vehicle Technologies	01/29/07	01/31/10	50,000	50,000
07247	TIAX LLC	Technical Assistance with Low-Emission and Alternative Fuels Technologies	03/19/07	12/31/10	125,000	125,000
07314	Engine, Fuel and Emissions Engineering, Inc.	Technical Assistance with Advanced Heavy-Duty and Off-Road Technologies	06/25/07	12/31/11	60,000	60,000
08210	Sawyer Associates	Technical Assistance on Mobile Source Control Measures and Future Consultation on TAO Activities	02/22/08	02/28/10	25,000	25,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Outreach and Technology Transfer (continued)						
08251	Gladstein, Neandross & Associates Inc.	Technical Assistance, Outreach and Implementation of the SOON and the Goods Movement Program	06/06/08	05/30/10	50,000	250,000
08254	Maria Robles, R.N.	Administrative Assistance in Organizing Two Air Quality & Health-Related Conferences	05/02/08	07/31/10	149,760	149,760
08311	CALSTART	Technical Assistance with Development, Outreach, and Commercialization of Advanced Technology to Transit, Port & Other Activities	07/11/08	05/31/10	75,000	75,000
09004	EDV Commercialization	Technical Assistance on Plug-In Hybrid Electric Vehicles & Associated Technologies	08/20/08	08/31/10	15,000	15,000
09183	Gary Full	Technical Assistance on Remote Sensing Measurement Technologies as Applied to Auto, Heavy-Duty Diesel and Other Mobile Sources	02/20/09	06/30/10	20,000	20,000
09184	University of California Riverside	Technical Assistance on Advanced, Low- and Zero-Emission Technologies and Implementation Activities	01/23/09	08/30/11	60,000	60,000
09185	Clean Fuel Connection Inc.	Technical Expertise on the CARB EMFAC Mobile Emissions Model and Other Related Mobile Source Issues	05/08/09	06/30/10	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	06/30/10	30,000	30,000
09253	Nexant, Inc.	Technical Assistance on Alternative Fuels Life-Cycle Analyses	01/02/09	06/30/10	20,000	20,000
09255	Stan Lisiewicz	Technical Assistance with Caltrans	01/29/09	12/31/10	10,000	10,000
09292	Clean Air Now	Provide Funding Support to the Clean Air Challenge Curriculum Project	01/30/09	04/30/10	60,000	150,000
09371	CALSTART	Technical Assistance for Chairman's Initiative Green Tech Connect Forum	04/19/09	10/31/09	20,000	20,000
09337	Mark Weekly, CPA	Follow-Up Assessment of AQMD's Compliance with Special Revenue Funds	03/03/09	01/31/11	15,000	15,000
09372	Three Squares Inc.	Outreach Assistance for Chairman's Initiative Green Tech Connect Forum	05/29/09	12/31/09	41,000	41,000

Contract	Contractor	Project Title	Start Term	End Term	AQMD $	Project Total $
Outreach and Technology Transfer (continued)						
10062	TIAX, LLC	Technical Assistance for Implementation of Proposition 1B Program	11/13/09	12/31/10	150,000	150,000

Appendix C

Final Reports for 2009

SCAQMD Contract #06017 **December 2009**

Incentive Buydown Program for CNG Home Refueling Appliance

Contractor
FuelMaker Corporation

Cosponsor
MSRC

Project Officer
Phil Barroca

Background

Light- and medium-duty natural gas fueled vehicles in the South Coast Air Basin are primarily owned and operated by centralized municipal fleets. Expansion of light- and medium-duty natural gas vehicles to the general consumer market will significantly contribute to reducing air pollution in the Basin and help promote general awareness and acceptance of these cleaner vehicles. FuelMaker Corporation of Toronto, Canada with sponsorship from CARB, the U.S. Department of Energy (DOE), Technology Partners Canada and the AQMD set out in 2001 and 2002 to develop a safe, cost-effective, standardized CNG home refueling appliance (HRA). In February 2005, the FuelMaker "*Phill*" HRA received Canadian Standards Association (CSA) certification as an outdoors or in-garage vehicle refueling appliance which was followed immediately with commercial availability. In 2005, the AQMD and the MSRC provided match funding of $400,000 each to sponsor a buydown incentive program for consumers interested in either purchasing or leasing a *Phill* HRA. Both the AQMD and MSRC programs allocated $100,000 each toward a purchase program under contract with FuelMaker Corporation, and $300,000 each towards a lease program under separate contract with American Honda. Both programs provided a combined total incentive to the consumer of $2,000.

Project Objective

The objective of this project is to provide the general consumer with a $2,000 buydown incentive to assist in purchase of a natural gas vehicle home refueling appliance and indirectly promote expansion of natural gas vehicles in the general consumer market. Market research during the research and development phase of the home refueling appliance (HRA) found consumer's reluctance to invest in alternative fuel vehicles was due in large part to lack of fueling infrastructure. To qualify for the incentive program the consumer must own, or demonstrate that they operate or have a purchase order for a CNG-fueled vehicle, and show evidence that the unit is installed at an address within the jurisdictional boundaries of the AQMD.

Technology Description

The *Phill* HRA is a small, compact 4-stage gas compressor capable of delivering 3000 or 3600 psig natural gas at a rate of 0.3 ft^3 per hour, making it suitable for overnight fueling of light-duty NGVs. The unit is compact enough and certified for indoor installation and use. The HRA uses residential pipeline natural gas and can deliver 4 gasoline gallons equivalent (GGE) of CNG over 10 hours. The slow fill process also reduces heat losses associated with fast fills and ensures a more complete filling of the fuel tank.

Status

The incentive buydown program for the purchase of the CNG home refueling appliance was approved by the AQMD Board in May 2005, and made retroactive to April 2005 to synchronize with the MSRC's start of funding. The original funding amount provided assistance to 100 purchasers and 300 leasors of the HRA. The purchase and lease programs were conducted concurrently under separate contracts. Popularity of the purchase program outweighed the interest in the lease program; full subscription to the purchase incentives was achieved by the end of the second quarter of 2006. Due to the success of the purchase program, the AQMD Board de-obligated $250,000 from the lease incentive program and re-apportioned this amount to the purchase program. MSRC did not match this action and elected to maintain the lease program and not replenish the purchase program. To maintain the purchase buydown incentive at $2,000, and with no additional co-funding, the AQMD increased its contribution from $1,000 to $2,000 per HRA purchased and installed. The three month period following the funding reapportionment (March through May 2007) saw the largest subscription to the program with 39 units purchased.

In July 2008, the Board approved an additional $146,000 for the HRA purchase buydown

incentive program bringing the AQMD contribution for this program to $496,000 and overall program total funding to $596,000, translating into 298 units at $2,000 each. In April 2009 FuelMaker unexpectedly filed Chapter 11 ceasing production and sales of the HRA. The number of HRAs purchased and installed through this program totaled 268 units or 90% of total program goals.

Results

The total number of HRAs for which purchase incentive funding was provided totaled 298 units. Prior to the abrupt filing of Chapter 11 by FuelMaker in April 2009, the buydown incentive program realized the purchase and installation of 268 HRAs and achieved 90% of the program's total objective of 298 units. A review of the quarterly purchasing patterns in Fig. 1 shows consumer's interest in the *Phill* HRA reached a peak in the second quarter of 2007, a full year prior to retail gasoline prices rising above and sustaining a $3.50 per gallon or more for five continuous months. However, it is worth noting that the sustained high gasoline prices presumably stimulated interest in the program during the latter half of 2008.

Benefits

How many consumers purchased or decided to purchase a NGV because of the availability of a HRA and more specifically the buydown incentive program was not incorporated into program. A correlation between Honda Civic GX sales data and *Phill* purchase data could be performed to evaluate the number of new GXs introduced into the region and the owner's which participated in the buydown incentive program; concurrently these vehicles would represent an equal number of gasoline –fueled vehicles displaced with possibly lower fuel economy and most probably higher emissions than the GX.

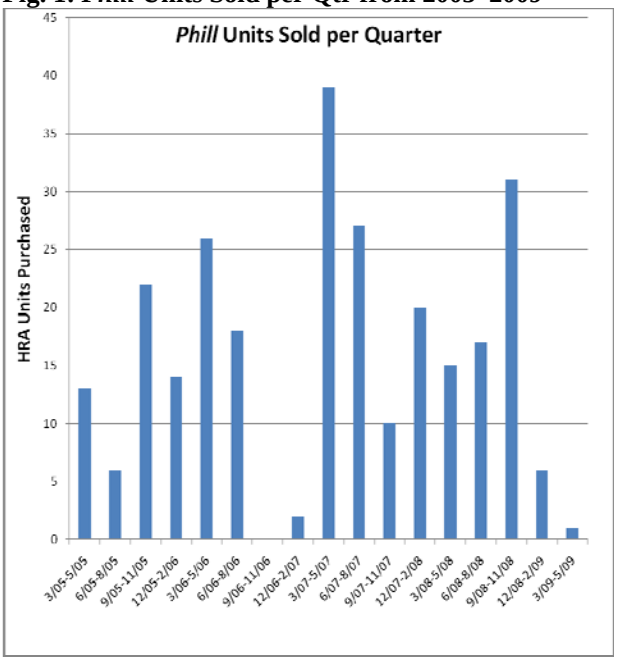
Project Costs

The buydown incentive program for purchasing or leasing the CNG home refueling appliance commenced in April 2005 with the MSRC and AQMD each providing $400,000 to assist 400 consumers with acquiring and installing a *Phill* HRA. Each program allocated $100,000 for purchase of 100 HRAs and $300,000 for lease of 300 HRAs. The purchase programs were contracted with FuelMaker and the lease programs were contracted with American Honda. The purchase program was fully subscribed by September 2006, and in February 2007 the AQMD Board approved to de-obligate $250,000 from the lease buydown incentive program and reapportion this amount to the purchase buydown incentive program. In July 2008, the Board approved an amendment to the HRA purchase program to add $146,000 bringing the AQMD total for purchase incentives to $496,000 and the purchase incentive program total to $596,000. The total incentive monies for the purchase of an HRA would equate to 298 HRAs purchased and installed in the Basin @$2,000 per unit.

Commercialization and Applications

FuelMaker Corporation with sponsorship from CARB, the U.S. Department of Energy (DOE), Technology Partners Canada and the AQMD set out in 2001 and 2002 to develop a safe, cost-effective, standardized CNG home refueling appliance. In February 2005, the FuelMaker "*Phill*" HRA received Canadian Standards Association (CSA) certification as an outdoors or in-garage vehicle refueling appliance. Commercial production of the *Phill* commenced with the CSA certification in 2005. The unexpected Chapter 11 filing by FuelMaker Corporation in April 2009 resulted in the discontinuation of the *Phill*. However, the rights to manufacture and market the *Phill* have been obtained by a third party and reintroduction of the *Phill* is expected sometime in the second quarter of 2010.

Fig. 1: *Phill* Units Sold per Qtr from 2005–2009



SCAQMD Contract #03098 **July 2009**

Develop LNG-L/CNG Refueling Station

Contractor
Taormina Industries

Cosponsors
Priority Reserve R1309.1 Fund
Clean Fuels Fund
AES Settlement Fund
MSRC/AB 2766 Discretionary Fund
CEC's Alternative Fuel Infrastructure Program

Project Officer
Larry Watkins

Background
LNG and L/CNG refueling infrastructure supports the following goals, which are recognized by the SCAQMD in support of the Rule 1190 Series Fleet Rules:

- Enabled increased acquisition and utilization of natural gas vehicles by developing fueling infrastructure;
- Fulfills the need for additional L/CNG infrastructure to support the new requirements on fleets which cannot afford to build their own infrastructure. Fleets such as taxis and airport shuttles are not able to build their own infrastructure because they do not have enough concentrated load.

Completed Station – Taken 07/22/03

Project Objective
The project objective accomplished under this grant was to cost-share the purchase of equipment and facilitate the construction of a permanent L/CNG refueling station to be installed at Taormina's Anaheim Truck Depot in Anaheim, CA. This fueling station provides refueling for light-, medium- and heavy-duty vehicles at a rate of 6,000 to 12,000 gallons of LNG per day (maximum station capacity equals 15,000 gallons). CNG demand is anticipated to initially reach about 20 percent of total LNG capacity.

Technology Description
Use of Liquefied Natural Gas and Liquefied-to-Compressed Natural Gas improves air quality in the SCAQMD region by reducing emissions from mobile sources – specifically hydrocarbons, oxides of nitrogen and greenhouse gases. It also promotes fuel efficiency through the advancement of alternative fuels and advanced technology.

Status
The project was completed in late July/early August 2003. The final report is on file with complete technical details of the project. Infrastructure contracts require five years of annual reporting after station commissioning and retention of one percent of funding until the five years of annual reporting are complete; thus, the term of infrastructure contracts are typically 6-7 years. The project term for this project was extended slightly to address issues detailed in the following section.

<u>Workplan Milestones</u>

Task 1: Finalize Design and Specifications for Fueling Station - Due Date: June – September 2002
Task 2: Release Invitation of Bids for Site Construction and Equipment Installation and Select Contractor -
Due Date: September – November 2002
Task 3: LNG Fueling Site Preparation (Permit approvals, concrete work, electrical, plumbing

and other work as needed) - Due Date: Dec. 2002 – March 2003
Task 4: Purchase LNG Fueling Equipment
Due Date: March 2003
Task 5: Install LNG Fueling Equipment
Due Date: April 2003
Task 6: Facility Start-up - Due Date: June 2003
Task 7: Site Evaluation and Training Personnel on Fueling Procedures - Due Date: May - June 2003

Problems Encountered

Several issues arose during the development and actual implementation of the project:

1. The cost of materials and labor had risen since the project was originally formatted. As a result, the scope had to be altered to produce a cost-effective project that still met the original equipment and operational requirements of the grant contract(s).

2. The contractor had to do a separate submittal for Fire Department approval for the Fire Safety Control System (due to the Fire Eye sensor).

3. During construction, the contractor was required by Building and Safety to get a PE sign-off because one of the containment wall's vertical uprights was off-center and leading into an adjacent cell.

4. The high-pressure CNG transmission line had to be installed subgrade in a trench which leads across the property from South to North, to be connected to the CNG dispensing island on Blue Gum Street. The Building and Safety inspector wanted to see every part of the exposed conduit, which did not allow planned back-filling all trenched sections except the inspection holes.

5. Building and Safety appointments did not occur at agreed times and/or dates. All of these developments contributed to the project time-frame being longer than the original plan.

Results

Successful installation of key infrastructure, extending a technology that is already proven and established as commercially viable, supports the growth of alternative fuel vehicles.

Benefits

This refueling infrastructure allows fleet operators within the vicinity of the station to feel comfortable in purchasing LNG and CNG vehicles, knowing that a fuel source is available. There are no known adverse environmental impacts as a result of this project.

The L/CNG refueling infrastructure also supports the following goals:

- Improves air quality in the SCAQMD region by reducing emissions from mobile sources;
- Promotes fuel efficiency through the advancement of alternative fuels and advanced technology.

Project Costs

Increased costs of equipment and design/permitting /construction changes increased the total cost of the project from $1,021,850 to $1,066,799. All of the additional costs were absorbed by Taormina Industries, LLC. Co-funding from public funds is as follows:

SCAQMD's Priority Reserve Fund 1309.1/ Clean Fuels Fund	$213,000
SCAQMD's AES Settlement Fund	$200,000
MSRC/AB 2766 Discretionary Fund	$100,000
CEC's Alternative Fuel Infrastructure Program	$241,000

Commercialization and Applications

This project demonstrates successful commercial installation at a significant truck refueling facility, which can be duplicated at similar facilities.

SCAQMD Contract #04085 **August 2009**

Construct Natural Gas Fueling Station in Banning

Contractor
City of Banning

Cosponsors
Banning Unified School District
City of Banning
MSRC/AB 2766 Discretionary Fund
Riverside County Transportation Department
Riverside County Transportation Commission
SCAQMD

Project Officer
Larry Watkins

Background
With the support of the South Coast AQMD, the City of Banning has completed a publicly accessible, fast-fill compressed natural gas (CNG) fueling station. The CNG station is located at 176 East Lincoln Street, just east of San Gorgonio Avenue, in Banning. There was previously a slow-fill station at that location which was replaced with 2 fast-fill CNG hoses, dispensing at either 3000 or 3600 psi.

Project Objective
The SCAQMD provided the City of Banning $140,000 to help offset construction costs for the natural gas station. The City of Banning shall operate the station for at least five years after the first commencing to dispense fuel to fleets.

Figure 1: Completed CNG Station

The facility fills an important gap in natural gas infrastructure in the region; provides more reliable service to Banning's existing CNG bus fleet; and allows for the cities of Banning, Beaumont and other local fleets to utilize clean burning CNG powered vehicles to meet their respective growing transportation demands.

Technology Description
The City of Banning was an early pioneer in the deployment of compressed natural gas (CNG) vehicles and developed a slow-fill CNG pump for the Banning transit and school system in 1995. Due to expanding demands on the station and significant improvements in both the station and vehicle technology, the City of Banning decided to expand the local CNG infrastructure with the development of a new, state-of-the-art CNG fueling station.

Initially, Banning was planning to develop a public access fast-fill CNG refueling station on a parcel of City-owned land on 22nd Street. However, because some of the grants for this project originated from federal CMAQ funds, the projected development timeline was too long to meet the needs of the City. To meet Banning's and Beaumont's immediate CNG fueling demands, the City contracted for an analysis of the City's existing infrastructure and determined that it was more efficient to upgrade Banning's *existing slow*-fill CNG refueling infrastructure to provide the additional fueling capacity needed.

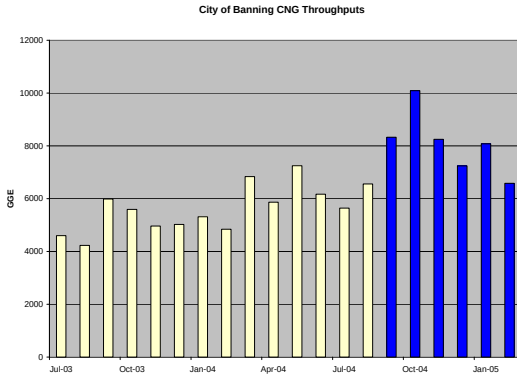
The City of Banning released a competitive bid for the project, which was awarded to Allsup Corporation. The upgraded public-access CNG fueling station includes 36,000-scfm storage and twin 75 HP compressors. There is a single dual-hose dispenser capable of dispensing CNG at 3,000 psi. and 3,600 psi.

Status
On September 28, 2004, the City of Banning inaugurated a publicly accessible CNG fueling station located at the City's Fleet Maintenance Yard at 176 East Lincoln Street. This replaced an older slow-fill CNG station that required daily maintenance during each 24-hour period and was not publicly accessible.

Figure 2: Grand Opening

Results

Station throughput since September 2004 has increased 42% over the prior 12-month period. Furthermore, now that the local fleets are assured that a reliable source of fast-fill CNG is available, it is anticipated that they will expand their existing CNG fleets. The facility is currently serving CNG



vehicles operated by the Banning Unified School District, Southern California Gas Company and the U.S. Army Corps of Engineers.

Benefits

The City of Banning anticipates that the operation of this CNG fueling station will now allow for other local fleets to begin deploying CNG vehicles, thus even further reducing diesel consumption and harmful emissions within Eastern Riverside County.

The City of Banning is located near the intersection of Interstate 10 and California 60 freeways in Riverside County, which comprises eastern approach to the Los Angeles metropolitan area. Prior to the opening of this station, the nearest publicly accessible CNG stations were located 27 miles away in either direction, with a gap in public access, fast-fill CNG fueling of more than 55 miles. This significant gap made travel into and through the area by CNG-fueled refuse trucks, transit buses, utility trucks and other vehicles types very difficult and therefore unlikely. This refueling station closes an existing gap and will serve as an important facility in our region's efforts to reduce our pollution.

Project Costs

The final cost of the station was $690,000, slightly more than the projected cost, with co-funding as follows:

SCAQMD	$140,000
MSRC/AB 2766 Discretionary Fund	$120,000
City of Banning	$130,000
Riverside County	$100,000
Riverside County Transportation Commission	$50,000
Banning Unified School District	150,000

Commercialization and Applications

The CNG station described herein is a fully operational and commercial alternative fueling station that has been built to accommodate future expansion for additional CNG fuel customers. The City of Banning will continue ongoing outreach with other users' fleets, such as private fleets, refuse haulers and other governmental agencies complying with the SCAQMD's fleet rules.

Both the pricing (which includes no profit, since this site is operated by a governmental agency) and location (easily accessible via the nearby freeway systems and the industrially zoned area) should incentivize additional fleets to use the station.

SCAQMD Contract # 06157 **June 2009**

Develop & Demonstrate Biodiesel Fuel with Selective Catalytic Reduction

Contractor
City of Santa Monica

Cosponsors
California Energy Commission
City of Santa Monica
Extengine Transport Systems
National Renewable Energy Laboratory
Tellurian Biodiesel
SCAQMD

Project Officer
Mike Bogdanoff

Background

The SCAQMD contracted to demonstrate biodiesel used with selective catalytic reduction (SCR). This project demonstrated the feasibility for a retrofit SCR system to approach the 2010 U.S. EPA NO_x standards for heavy-duty engines of 0.2 g/bhp-h, while also identifying strategies for addressing the issues associated with greater use of biodiesel.

Project Objective

The objective of this project was to conduct a biodiesel fuel demonstration and field testing without and with SCR. The emission effects of this technology were then to be validated by emission testing conducted at the CARB laboratory in Los Angeles.

Technology Description

A 2005 International 9200i tractor owned by the City of Santa Monica was retrofitted with a titania-vanadia-tungsten catalyst and a urea dosing system supplied by Extengine Systems, Inc. This tractor was operated under normal service conditions within the City of Santa Monica refuse collection and transportation fleet. An on-board emissions measurement system supplied by Engine, Fuel, and Emissions Engineering, Inc. was installed on the vehicle; the system measured the emissions and fuel use of the vehicle while it operated on ultra-low-sulfur diesel (ULSD), 20% biodiesel (B20), and 99% biodiesel (B99) on consecutive days. The vehicle, with a similar aftertreatment system, was then tested at the California Air Resources Board (CARB) Los Angeles Heavy-Duty Emissions Lab and tested on the Urban Dynamometer Driving Schedule (UDDS) to again assess the effects of ULSD, B20, and B99 on the performance of the urea-SCR aftertreatment system.

Figure 1: Truck with Portable Emission Measurement Equipment Installed

Status

This project was completed in early spring of 2009. A final report including complete technical details of the project is on file.

Results

The SCR system reduced NO_x emissions by 64%-87% and its performance was not affected by the use of biodiesel. For the 2004 engine used in this program a 90% NO_x reduction is needed to reach 2010 US EPA NOx levels.

Results from this testing showed that oxides of nitrogen (NO_x) emissions increased by 6%-12% when the blend was increased from ULSD to B20, by 16%-35% when the blend was increased from ULSD to B99, and by 26%-27% when it was increased from B20 to B99. Particulate matter (PM) emissions decreased by 37%-50% when the blend was increased from ULSD to B20, by 71%-79% when it was increased from ULSD to B99, and by 60%-63% when it was increased from B20 to B99.

Benefits

PM emission differences due to variable blends of biodiesel: All results that showed statistical significance at the 95% confidence level showed a reduction in PM for the addition of biodiesel vs. ULSD. The PM measurements for the truck yielded the following statistically significant results:

- ULSD vs. B99: 71-78% PM decrease (4 results, on-road) to a 79% PM decrease (1 results, in-lab)
- ULSD vs. B20: 37-50% PM decrease (2 results, on-road) to a 49% PM decrease (in-lab)

NO_x reduction due to SCR: All results having statistical significance between the means show that the NO_x reduction efficiency of the SCR system was not negatively affected by the addition of biodiesel.

On-road testing:

- The reduction in NO_x due to SCR during the fully **loaded** truck testing was 69% for ULSD, 68% for B20, and 64% for B99. These differences in reduction were not statistically significant.
- The reduction in NO_x due to SCR during the **unloaded** truck testing was 61% for ULSD, 64% for B20, and 64% for B99.

In-lab testing:

CARB in-lab test results for NO_x reduction due to the Extengine SCR system indicate that all tests were statistically significant and showed no negative effects on SCR NOx reduction efficiency due to fuel type. The NO_x reduction was shown to be 87% for all fuels. It should also be noted again that a different dosing pump was installed in the truck for the CARB in-lab testing; this may have resulted in higher SCR efficiencies than those observed in the on-road data.

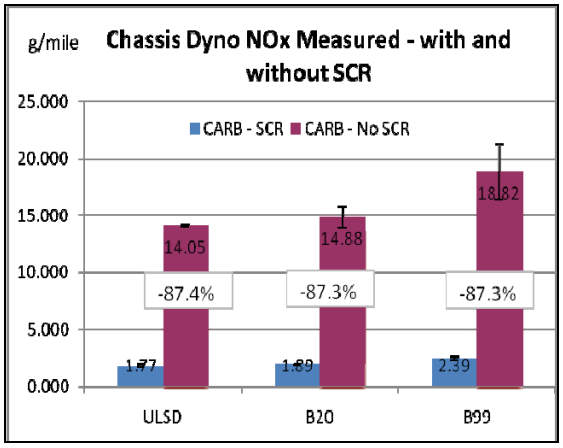


Figure 2: Laboratory NO_x Reduction Due to SCR System on All Fuels

Project Costs

The final project costs were $241,693. This represents a 50/50 cost-share between SCAQMD and other participants, which included City of Santa Monica, NREL, EF&EE, Extengine, CARB, CEC and Tellurian Biodiesel. The SCAQMD contributed $119,193 and the combined participants contributed $122,500 over the course of the project.

Conclusions

- Overall trends observed during the on-road and in-laboratory testing of the retrofitted Extengine SCR system as installed on the test vehicle indicated that there was not a significant decrease in the performance or efficiency of the SCR system when increased levels of biofuels were introduced.
- The use of biodiesel did result in higher NO_x emissions than the use of ULSD (in tests with statistical significance). However, the SCR system substantially reduced NO_x and more than mitigated the increased NO_x due to the use of the biodiesel blends.
- The use of biodiesel did result in lower PM emissions than the use of ULSD (in tests with statistical significance).

SCAQMD Contract #09150 **February 2009**

Develop & Demonstrate Stationary Emission Control System for Marine Vessels (AMECS)

Contractor

Advanced Cleanup Technologies, Inc.

Cosponsors

Advanced Cleanup Technologies, Inc.
Port of Long Beach
Port of Los Angeles

Project Officer

Mike Bogdanoff

Background

In August 2006, the Advanced Locomotive Emissions Control System (ALECS) was successfully demonstrated at Union Pacific Railroad's rail yard in Roseville, CA. This proof-of-concept demonstration was sponsored by the U.S. Environmental Protection Agency, CARB, and others. The ALECS consists of an overhead moveable "bonnet" arrangement to collect emissions from locomotives being serviced and a ground-mounted Emission Treatment System (ETS). The ALECS demonstration reduced locomotive emissions by more than 90 percent and reduced noise by 5-7 decibels. The ground-mounted ETS was then engineered to treat emissions from at-berth ships in a system called the Advanced Maritime Emissions Control System (AMECS).

Project Objective

The objective of this project was to further develop and demonstrate Advanced Cleanup Technologies Inc.'s (ACTI) AMECS and determine its capacity to remove emissions from at-berth ocean-going ships.

Technology Description

AMECS captures and treats the exhaust gas from ship's auxiliary engines, generators and boilers during hotelling operations. A large bonnet is lifted over and remotely secured to the exhaust stack of the ship, which encloses several exhaust outlets.

The exhaust gases are drawn from the bonnet through ducting into the dock-mounted

ETS where the pollutants are removed (see Figure 1).

The ETS utilizes a Preconditioning Chamber where metered sodium hydroxide is injected to remove SO_x emissions; three Cloud Chamber Scrubbers (Tri-Mer Corp.) to remove PM emissions; and a Selective Catalytic Reduction (SCR) Reactor (Argillon Corp.) to remove NOx emissions. It is designed to remove 95 percent or more of the SO_x, PM and NOx from the berthed ship exhaust. A substantial percentage of VOC is incidentally removed, also.

Figure 1: AMECS during Testing on the Queen Lily

Status

In May 2008, the AMECS was installed on the dock at Metropolitan Stevedore at the Port of Long Beach, Pier G, Berth 214. The bonnet capture system required significant design modifications to better accommodate the variety of ship stacks and to properly capture all the emissions. The testing of two ships, the Queen Lily and the Angela, was conducted in May and July 2008, respectively. Professional Environmental Services performed the emission tests in parallel with the Continuous Emission Monitoring System of the AMECS.

Results

The emission testing of the Queen Lily and the

Angela yielded average reductions of 99 percent SOx, 95 percent PM, 99 percent NOx and 96 percent VOC.

Benefits

The potential impact of implementing the AMECS technology in the Southeast Basin of the Port of Long Beach is illustrated below. This would mean coverage of Berths G212, G214, F208, F211, F204/205, and F206/207, for which two ETS's and six to eight emission capture systems would be required (see Figure 2).

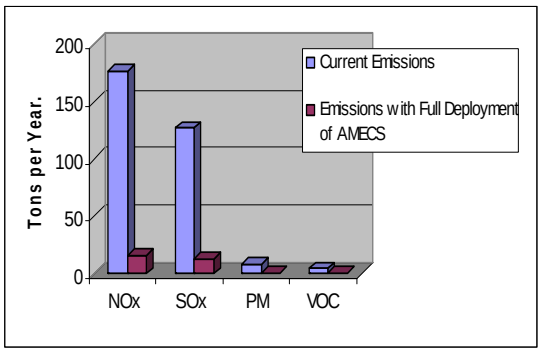


Figure 2: Hotelling Emissions in the POLB Southeast Basin with AMECS

Another benefit of AMECS is the ability to treat ship exhaust emissions without any modification to the ship. There is also no interference with normal ship or ship loading or unloading operations. Finally, AMECS reduces emissions from the auxiliary boilers, which shore power solutions do not address. The waste water generated by the AMECS will be suitable for disposal in an industrial sewer. The generated solid waste has been tested and found to be non-hazardous and suitable for disposal in a landfill, or it can be recycled or incinerated.

Project Costs

The projected costs for this project were $598,211 for developing the AMECS and emission testing two ships. These costs were to be funded by:

ACTI	$244,157
Port of Long Beach	149,527
Port of Los Angeles	149,527
SCAQMD	55,000
	$598,211

The actual final costs incurred were $777,881 with ACTI paying the additional costs.

Commercialization and Applications

The cost of an AMECS system is $12.3 million for a two-tower dock-based unit and $9.5 million for a barge based unit. The average annual operating cost is $1.0 million with an expected 20-year life. Based upon the emission reductions determined under this project, the cost-effectiveness of the AMECS has been calculated for various types of ships berthing at the Ports of Long Beach and Los Angeles. The average cost effectiveness of AMECS is about $13,000/ton.

The AMECS technology used in this project appears ready for commercialization. It is expected that the AMECS demonstration unit will be operated for another year at Pier G214 in order to further refine the system and procedures, to enhance its reliability and maintainability, and to verify its operating costs.

SCAQMD Contract # 09374 **October 2009**

Develop & Assess Humid Air System for Diesel NO_x Reduction

Contractor

California State University Long Beach Foundation

Cosponsor

SCAQMD

Project Officer

Alfonso Baez

Background

According to CARB, in 2010 on-road heavy duty diesel trucks are estimated to account for up to 28% or 559 tons per day of NO_x and up to 12 % of PM emissions inventory statewide. Truck idling contributes significantly to these emissions. Idling emissions are significant at the port terminals and distribution centers where long waiting periods are required for loading and unloading operations, and at rest areas and traffic stops, among others. CARB (2006) has proposed regulation to reduce idling emissions from new trucks starting with the 2008 model year. The regulation would require manufacturers to either meet an emissions standard or have a timer system that automatically shuts off the engine after five minutes of continuous idling.

On the average, diesel-fueled vehicles are about 20-40% more fuel efficient and their greenhouse gases about 15% less than comparable gasoline-fueled engines. However, the major adverse effects of diesel engines are their NO_x and PM emissions. The U.S. standards for tailpipe emissions of NO_x have been tightened over the years and effective with the 2009 model year, California and Federal Tier 2 vehicle emission standards for NO_x emissions for new vehicles operating in the U.S. are now set at an average of 0.07 grams/mile. This regulation for diesel NO_x emissions requires diesel engine manufacturers to incorporate various advanced technologies such as exhaust gas recirculation and selective catalytic reduction (SCR) for reducing diesel NOx emissions. In low-speed diesel engines, a water emulsion system has been effective in reducing NO_x. The optimum NO_x reduction for this method is limited to 20-30 percent. Another approach for reducing diesel NO_x emissions is fumigation or humid air motors. In this method, water vapor is injected into the intake air supplied to the engine cylinders. The process reduces the local temperature in the cylinder and raises the specific heat of the air-fuel mixture which also contributes to the elimination of the hot spots in the engine cylinder. With decreased temperature, NO_x reduction is achieved. With an optimized system, fumigation can reduce NO_x emissions without significant increases in hydrocarbon emissions. Other benefits of the process include longer life of the engine components due to reduced cycle temperature and reductions in carbon deposits.

Project Objective

The present investigation was focused on adding humidity to the intake air of a high-speed diesel engine for reducing its NO_x emissions with both low-sulfur diesel fuel and a bio-diesel fuel. The addition of the humidity is performed with distilled water. For diesel trucks, distilled water can be supplied in the form of a tank and with slight modifications to the engine intake air system, NO_x reduction can be achieved.

Technology Description

A Vanguard three-cylinder liquid-cooled aspired diesel engine with a maximum output power of 20 BHP at 3600 rpm was used in the experiments. The experiments were performed at an average engine RPM of 1350 and an output load of 15 lbs, using low-sulfur diesel fuel and 20% biodiesel (B20 from Soy). Initially an air-assisted water atomizer was designed, and the engine was tested with addition of the distilled water droplets to the air intake. With the addition of the water droplets, there was immediate and substantial decrease in the exhaust NO_x and increases in CO with negligible effect on the brake specific fuel consumption (BSFC). However, since with this design the amount of the water droplets added to the air intake could not be controlled, instead a

Honeywell model HE120 air-humidifier was used for humidifying the intake air.

Figure 1: Diesel engine with the water atomizer unit (left) and humidifier (right)

Status

The project has been completed and the final report was submitted on October 30, 2009.

Results

Figure 2 shows variation of the exhaust NO_x with % relative humidity for the air-assisted water atomization system. The output NO_x has been normalized by the corresponding % relative humidity. As indicated before, with this system, it was hard to control the amount of water in the intake air which resulted in fluctuation in the exhaust NO_x. Before the water atomization was turned on, the ambient relative humidity was approximately 50%. Then the water atomization system was turned on and NO_x and % relative humidity were measured at 10 sec. interval until 100% relative humidity was reached. At this stage, addition of water resulted in accumulation of water in the cylinders and large drop in the engine output and eventually choking condition.

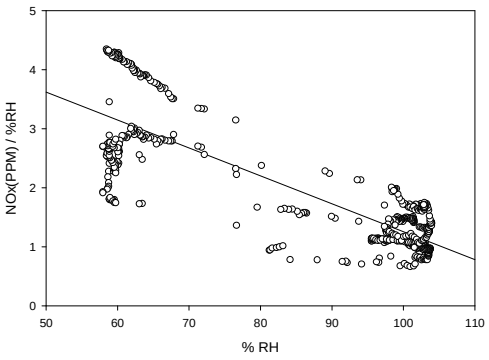


Figure 2: Variation of the normalize NOx with % relative humidity for the air-assisted water atomization system

Assuming a linear fit to the data, the output NO_x decreases with increasing the % relative humidity and at 100% relative humidity, it is nearly one-third of the corresponding value without the added droplet.

Figure 3 shows variation of NO_x emissions with increases in relative humidity, normalized by their initial values. For the diesel fuel the average decrease in NO_x emissions at saturation is approximately 25% while the decrease for the bio-diesel is about 40%. These results indicate that with an efficient humidifier which can maintain the relative humidity in the intake air at saturation condition, significant reductions in diesel NO_x emissions can be obtained.

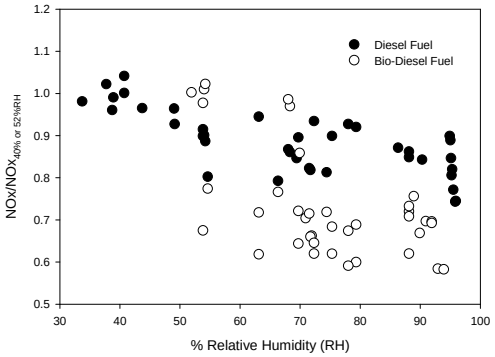


Figure 3: Variation of the normalized NO_x emissions with % relative humidity

Benefits

The current investigation provides preliminary results on a low-cost method for reducing NO_x emissions of diesel trucks. Further investigations are underway to develop a continuous system to maintain the level of humidity of the intake air according to the engine load. Reduction of NO_x emissions can significantly improve air quality in the LA/LB ports area and in the Southern California region.

Project Costs

The project was completed with funding from the SCAQMD in the amount of $17,500 and cost-share contributions 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 # 07265 **January 2009**

Demonstrate a Battery Electric Tram

Contractor
Descanso Gardens

Cosponsors
SCAQMD
Los Angeles County

Project Officer
Lisa Mirisola

Background

Current battery technology is applicable to a number of specific applications beyond conventional passenger cars. From an air quality perspective, it is particularly advantageous to identify and implement zero emission vehicles in conditions where low mileage and heavy stop-and-go duty cycles are prevalent, such as short-distance delivery vehicles, shuttle buses, and tourist trams.

Descanso Gardens in La Cañada Flintridge covers 160 acres encompassing varied plant collections, native wildlife, a native chaparral area, a lake and bird observatory, as well as historic structures in Los Angeles County. Descanso Gardens has offered "live" narrated tram tours to guests since 1958. The Gardens serve approximately 290,000 visitors per year, including extensive educational programs for local schools.

The long-term vision of the Gardens is to become a self-sustaining natural environment with regard to water and energy, and where possible, waste disposal and recycling. Self-sustaining alternative energy strategies include highlighting the use of solar energy to make the connection between the process of photosynthesis in plants and the production of electricity for human use.

Project Objective

As a first step in implementing their vision, Descanso Gardens proposed to replace their aging propane-fueled tram with a zero emission tram, which they plan to recharge with solar photovoltaic electricity in a future phase.

Their existing 45-passenger tram consisted of three trailers that were purchased in 1958 and a propane tug from the 1970s. It travels 10 miles per day, with a top speed of 10 mph, and operates seven days per week. The low-mileage, stop-and-go, predictable route fits well with the attributes of battery-electric vehicles.

Technology Description

The proposed electric tram consists of a battery - powered electric tug plus three trailers.

Tug Technologies manufactured the tug; the electric tow is equipped to pull three loaded trailers with its 3,000 lbs draw bar pull capacity. The narrow body style tram houses a Deka 80Volt 625 AMP HR battery. The tram also has a Hobart charger and an overhead guard for drivers. It plugs in for charging overnight, just like the electric utility carts currently used by Descanso Gardens for groundskeepers. Additional features include: power steering, four-wheel suspension, multiple function dash display with battery discharge indicator, an hour meter and fault display.

The three Executive Trailers from Specialty Vehicles feature beach seats, aluminum roof, surge braking, all-wheel steering, tail and brake lights, a narrow body style, upgrade to four-wheel brakes and 12" deck height. One trailer is wheelchair accessible.

Status

With the new tug, Descanso Gardens can serve the needs of approximately 15,000 guests who annually take advantage of the tram tour and it is now performing according to expectations.

When first delivered, the tug needed a number of adjustments: the power steering pump had a high pitched noise, the starting sequence was difficult for drivers to start, the braking system needed

modifications and a sound system had to be installed.

Tug Technologies addressed all items which were completed by the end of May 2008. Since then, the electric tram has been fully operational.

Battery-Electric Tram in Operation

Results

The new electric tram conducts tours six days a week and is able to accommodate one wheelchair passenger. Because it produces zero emissions, the tram has lower maintenance needs, making it very cost efficient. The charge holds throughout the day and even has extra to spare. The trailers are comfortable and the overhead cover shades guests on hot days. It performs well on hills and is quiet and comfortable. The tight turning radius and narrow profile fit the Garden landscapes.

Benefits

The tram offers a great tour experience to riders, but it also gives all Descanso Gardens' guests cleaner air. The electric tram offers wheelchair access. The seats are comfortable and the ride is very quiet. This new tram is a model for other botanical gardens that wish to offer tram rides and lower their overall emissions.

Project Costs

This project was completed according to the original budget. Total funding was $121,000, of which the SCAQMD's cost-share was $96,000.

Commercialization and Applications

Descanso Gardens is demonstrating how electric technology can be used to pull a 42-passenger tram in a botanical garden or park setting. It also has the potential of operating on solar energy, which is the ultimate goal of the Gardens.

pSCAQMD Contract #07293 June 2009

Develop & Demonstrate Electric Tow Truck for Transporting Containers from Shipping Terminal

Contractor
Balqon Corporation

Cosponsor
Port of Los Angeles

Project Officer
Mike Bogdanoff

Background

The SCAQMD in cooperation with CARB, U.S. EPA and San Pedro Bay Ports in 2006 committed to cut diesel-related PM by more than 47% and smog-forming NO_x emissions by more than 45% within five years. Integral part of the plan supports projects to increase utilization of electric and hybrid vehicles in applications in and around the San Pedro Bay area ports.

Project Objective

Project objective was to develop and demonstrate the world's first all-electric Class 8 truck with the ability to transport containers and cargo of up to 60,000 lbs with a range of 50 miles. This project objective involved incorporation of a Balqon drive system into an existing Class 8 truck chassis to determine the feasibility of using electric vehicles in yard tractor and drayage applications. In January 2008, Balqon successfully demonstrated a running prototype of an electric truck in port applications.

Technology Description

The project was planned to develop and demonstrate a completed electric-powered Class 8 truck incorporating current control, battery and charger technology. The project also required demonstration of the vehicle in port application towing 30 tons of load at a minimum speed of 25 mph with a range of 50 miles on a single charge and the ability to be charged between shifts.

The project was divided into two main tasks:

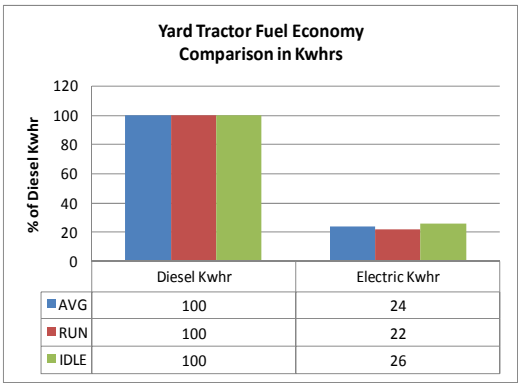
Figure 1: Heavy-Duty Class 8 Electric Truck in Demonstration

Task 1: Running Chassis and Cabin Assembly

This task consisted of development of three main components, namely the flux vector inverter development, integration of electric motor and automatic transmission into chassis, and development of battery module and charging system. In order to achieve load towing requirements of the project, Balqon developed a high-capacity flux vector inverter which is used to control the speed of the vehicle by varying the input frequency and battery voltage to the motor. In addition, a microprocessor controlled data acquisition system was incorporated to allow real-time data acquisition of key metrics of the vehicle during dynamic testing. A high-capacity fast charger was developed to fully charge the vehicle in less than four hours and give a partial 60 percent charge in 90 minutes. The charge system is also designed to concurrently charging up to four vehicles at a time.

Task 2: Design Verification Testing

In January 2008, the completed electric truck was delivered to the Port of Los Angeles for design verification and field testing for a period of sixty days. Following are tests conducted at test facility.



The vehicle was tested with a 68,000 pound trailer load and max speed of 35mph was recorded. Curb-Idle tests concluded idling energy in kWhr consumed by electric tractor was 74 percent lower than a diesel yard tractor. Fuel consumption testing was conducted with average speed of 15 mph. Fuel consumption of electric tractor calculated in terms of kWhr/mile was determined to be 78 percent lower against published mpg of diesel tractors during continuous range test. On-road test was conducted with 100% load. Test results concluded vehicle range to be 27 miles under full load in on-road applications with 10% grade.

Status

This electric tractor development project was undertaken to validate the feasibility of use of zero-emission technology in off-highway applications and in addition to determine technological barriers related to addressing short-haul applications at the Port of Los Angeles. The initial product equipped with lead acid batteries verified that the propulsion technology was adequate to address off-highway applications but required additional development of higher-capacity controller technology in production units to address on-highway short-haul applications. In addition, the duty cycle in certain marine terminal applications required vehicle to be charged during break times to meet range requirements. In future designs, new battery technology needs to be investigated for large marine terminal applications to increase energy capacity by approximately 30 percent.

Results

Energy consumption of the electric truck measured in Kwhr was 78 percent more efficient than the diesel-powered tractor. During idle operation, the electric yard tractor is 74 percent more efficient than the diesel tractor. The average usage of a yard tractor in marine applications at the San Pedro Bay Ports is estimated to be 2,500 hrs/year. Average fuels consumption of electric tractor was measured to be 13.3mpg in yard tractor application compared to average 3.2mpg of diesel tractor.

Benefits

The emissions benefits of using electric trucks for yard tractor applications in California, based on diesel fuel usage by 2,277 diesel-powered yard tractors in use in California, are estimated to be 12.78 tons/day of NOx, 8.98 tons/day of CO and 0.42 tons/day of PM. Electric vehicles generate less than 2 percent PM and less than 0.4 percent NO_x based on emissions generated by power plants in California. It is estimated that in the South Coast Air Basin area, replacement of all diesel-powered yard tractors with electric yard tractors can potentially reduce 4,000 tons of emissions every year.

Project Costs

The total project cost incurred was $527,000 of which $250,000 was the cost of running-chassis development and $267,000 was the cost of vehicle assembly and testing. An additional cost of $9,500 was incurred to prepare the final report.

Commercialization

The technology developed under this project provided the first heavy-duty electric truck in the world with the capacity to carry or tow cargo loads over 30 tons. This technology can be incorporated into diverse products such as yard tractors, on-road drayage vehicles, reach stackers, industrial forklifts, trash hauling vehicles and airport tractors. In June 2008 POLA ordered twenty (20) electric yard tractors equipped with the electric drive system developed during this projects; in addition, POLA ordered five (5) trucks for on-road drayage applications.

SCAQMD Contract # 07306 August 2009

Develop, Demonstrate & Certify Heavy-Duty Natural Gas Engine Meeting 2010 Emission Standards

Contractor

Emission Solutions, Inc.

Cosponsors

Emission Solutions, Inc.
Clean Energy
SCAQMD
Southern California Gas Company

Project Officer

David Coel

Background

Emission Solutions, Inc. (ESI) received CARB approval in 2006 for its diesel-to-CNG engine conversion technology that allowed it to become the cleanest-burning heavy-duty engine in the market place at that time. This engine technology was dedicated to on-road, intra-city vehicle applications serving school districts, food/beverage distribution and municipal sectors among others.

Project Objective

The contractor proposed to develop and certify a natural gas heavy-duty engine model to assist in the implementation of SCAQMD fleet rules and help address potential shortages in natural gas heavy-duty engine model availability. The engine to be made available to the market place was the ESI Phoenix NG 7.6L meeting 2010 model year emission standards.

Technology Description

The ESI goals going into the project, which proved overall to be realistic and achievable, were to perfect previously adopted stoichiometric combustion technology and to meet 2010 model year emission standards. The project achieved these goals with a dedicated, spark-ignited natural gas engine without the use of cooled exhaust gas recirculation (EGR), setting it apart from any other natural gas or diesel engine technology in the market place today. Only one other engine manufacturer meets 2010 emission standards, and that manufacturer uses natural gas but requires cooled EGR to achieve its 2010 certification. The disadvantage of cooled EGR is the amount of heat it dissipates under the hood, not so with this engine; and there is no diesel engine meeting 2010 emission standards today.

Engine on Dyno Testing CCT Equipment

Status

The project, consisting of engine development, testing and certification, was successfully completed with the receipt of a CARB Executive Order for MY 2010 dated July 7, 2009. This project was able to achieve its goals, involving the manufacture of a dedicated heavy-duty natural gas engine using the core of the Navistar DT 466E heavy-duty diesel engine as the core of the engine. The project team was able to utilize the block and other major components of the diesel engine and did not have to change any important engine settings or functions such as valve clearances, air-to-air charger, water cooling and with only minor changes to the turbocharger and were required to lower only slightly the amount of boost to the engine and to control that boost for emission purposes.

Engine development, while taking longer than expected, progressed generally as anticipated. One reasons for the delay involved the team's inability to get into the test cell at Electronic MicroSystems as planned after engine development was completed in ESI's R&D facility in McKinney, TX. Engine development goals were focused from day one on the design and development of a heavy-duty natural gas engine without the use of EGR, thereby eliminating the problems of excessive heat buildup under the hood with the use of EGR, which required cooling. This would also lower the operating temperature of the engine, extending the life expectancy of the engine and

all of its major components. The goal was to evaluate all available Combustion Cooling Techniques (CCT) with associated emission control hardware, including a three-way catalytic convertor. Applying a new Electronic Control Unit and newly developed firmware/software, R&D efforts were initiated. A goal also was to perfect our previously successful stoichiometric, turbocharged, closed-loop adaptive learn combustion technology with new electronics.

The team lowered the compression ratio of the engine from 17:1 to 10.5:1. All diesel fueling system components on the Navistar diesel engine were removed, reducing weight. The engine was tested with and without EGR, and with newly developed electronic and improved combustion technology without EGR, and with newly developed electronic and improved combustion technology; objectives were achieved without EGR. Other means of cooling were tested, including high pressure fans to cool intake air to the combustion chamber, but the engine met criteria without the use of this additional external cooling. The team identified, purchased and installed various EGR and CCT systems, and tested these systems with new software. A new heavy-duty dynamometer and a new water system were installed to test these different systems. New software was written to accommodate cam shaft and crank shaft pickup sensors and wiring harnesses had to be upgraded. Turbo design was altered for initial testing in a certified lab to verify whether EGR would be required to achieve 2010 emissions. This testing was required to eliminate the requirements for new software for a variable geometry turbocharger as well as for EGR.

Prior to shipping test engines to EMS, all internal combustion parts were cryogenically treated for heat rejection. The engines were shipped to EMS for transient emission testing over the federal FTP cycle using a fuel blend conforming to CARB certification fuel specifications. Testing was completed October 16, 2008 and data submitted to CARB, with initial CARB Executive Order received on May 12, 2009, followed by CARB Executive Order dated July 7, 2009 combining both the 12-valve and 24-valve engines.

Results

The project successfully obtained both CARB and U.S. EPA certification for MY 2010 for both engines that will allow ESI to not only re-power existing International diesel engines dating back to MY 1995 with 12-valve engine, but also to install a 24-valve engine in current model year International vehicles, including trucks and buses. This dedicated natural gas engine does not require extensive training; the International dealers throughout Southern California and around the country embrace this concept because it offers their customer base an alternative to their diesel engines manufactured by Navistar/International. ESI intends to develop a larger dedicated natural gas engine platform, using the International MaxxForce 10 diesel engine as the base platform, in the 9.3L range generating some 350 HP and 1200 lb-ft torque.

Benefits

The benefits of this project can be summarized as reduced emissions (easily meeting MY 2010 CARB standards), improved economics using domestically abundant natural gas resource base that is less costly than imported crude oil from which diesel is refined, and reduced greenhouse gases. The natural gas engine developed is more efficient than the diesel engine it is replacing. There are greatly reduced particulate and toxic emissions related to this engine, and there are obvious benefits from eliminating leaks associated with underground diesel storage tanks through the use of above-ground storage of natural gas in high pressure DOT and ASME approved storage vessels.

Project Costs

The in-house R&D phase of the project exceeded estimated costs, but ESI handled these costs internally.

Commercialization and Applications

The commercial applications of this technology are immediate and real. Two projects in the SCAQMD area involve a two-truck demonstration project with Westrux International, the largest International dealer west of the Mississippi, for food/beverage distribution and municipal applications; and a school bus crash test project to allow ESI to begin the conversion of California diesel-powered school buses to natural gas. The larger 9.3L engine will also allow ESI to begin to penetrate the ports with those trucks entering and leaving the ports with goods and services.

SCAQMD Contract #08037 **March 2009**

Integrate & Demonstrate Cummins Westport ISL G Natural Gas Engine in School Bus

Contractor
Thomas Built Buses

Cosponsors
SCAQMD

Project Officer
Ranji George

Background

Pursuant to the SCAQMD's Lower Emission School Bus program, there have been 535 CNG buses purchased to replace older, diesel engine school buses. Over 80% of these buses have been equipped with the John Deere 6081H 8.1L CNG engine. John Deere exited the CNG on-highway engine business effective December, 2007. As a result of this action, a void was created in alternative fuel offerings in the marketplace for school buses. The development of the Cummins Westport ISL G engine in the Thomas rear engine school bus offering fills this void and provides the cleanest commercial heavy-duty engine available today to the school bus market.

Project Objective

The objective is to develop, test, and bring to market the Cummins Westport ISL G engine. This will enable school districts to continue to procure and operate school buses utilizing CNG engine technology. The Cummins Westport ISL G will replace the discontinued John Deere 6081H engine. ISL G equipped buses will meet very clean NOx and PM standards and will be available on a timely schedule.

Technology Description

The Cummins Westport ISL G engine is an 8.9L, turbocharged engine available in horsepower (hp)/torque (lb-ft) ratings ranging from 250 hp/730 lb-ft to 320 hp/1,000 lb-ft. Thomas will

offer this engine in ratings of 250 hp and 280 hp. The ISL G utilizes Stoichiometric Cooled Exhaust Gas Recirculation (EGR) in the combustion process in place of excess air (Lean Burn). Cummins Cooled EGR lowers in-cylinder temperature and reduces oxygen concentration. The engine incorporates a new electronic control module that provides full monitoring and control of engine sensors, the fuel system and the ignition system. The ISL G creates an oxygen-free exhaust allowing for the use of a 3-way catalyst. The 3-way catalyst is a simple passive device utilized to control hydrocarbon, CO, and NOx output. Additionally, the engine has a comparatively low installed weight which gives it a highest power to weight ratio in its class. The ISL G meets U.S. EPA and CARB 2010 emissions standards and EEV.

Status

This project is complete as of October 9, 2008 and units are now being offered in the marketplace equipped with the ISL G. The final report is complete with the required technical details of the project. The major project events are as follows:

June 2007 – Contract executed between Thomas Built Buses and the SCAQMD inaugurating the Cummins Westport ISL G project.

February 2008 – Tasks 1 and 2 as described in the SOW were completed and reported to the SCAQMD. Prototype bus constructed and testing conducted to assure proper operation and function as per the vehicle DTP&R.

April–May 2008 – Cooling system tests performed to the parameters specified by the engine manufacturer and transmission manufacturer. Five pre-production series buses constructed to refine production techniques, ensure proper operator training, and test all systems in the production environment.

June 2008 – Production units started.

July – August, 2008 – Initial customer deliveries of school buses equipped with the ISL G engine.

ISL G Natural Gas Engine

Results

Emissions results related to this project are tied directly to the emissions certifications of the ISL G. Pursuant to that, the ISL G was certified on June 4, 2008 by CARB Executive Order #A-021-0479 for use as an on-highway engine in vehicles with a GVWR over 14,000 lbs with the following NOx and PM emissions levels:

in g/bhp-hr	NOx		PM	
	FTP	EURO	FTP	EURO
STD	0.20	0.20	0.01	0.01
FEL	*	*	*	*
CERT	0.11	0.01	0.01	0.001
NTE	0.30		0.02	

Benefits

The benefits of utilizing the compressed natural gas engine are well documented. The use of CNG will reduce NOx and PM emissions as well as reduce the emission of greenhouse gases. In addition, the introduction of new low-emission vehicles takes older high-emitting diesel vehicles off the road.

Project Costs

Engineering hours required to convert and document the design work on the installation were underestimated in the initial proposal. These were partially offset by lower than expected costs associated with prototyping and testing a completed Saf-T-Liner HDX. Overall, no additional funding was requested or required from the SCAQMD and the additional work done in the design phase paid dividends in the performance of the finished product.

Table I

Activity	Budgeted Amount	Actual Amount
Task 1 – 1,992 hours	$149,400	$260,400
Task 2 – 1,618 hours	$121,350	$180,000
Task 3 – 60 hours + prototype parts	$14,500	$12,000
Task 4 – Cooling Test	$23,000	$15,000
Discounted Value of Test Vehicle	$35,000	TBD
Final Report & 2-Pg. Synopsis	$0	$0
TOTAL PROJECT COST	$343,250	$467,400

Commercialization and Applications

The ISL G is applicable for school bus and transit bus use and is currently in service in both. Additional development of the ISL G in combination with transmissions equipped with a retarder would further adapt this engine offering to the California market.

The market for school buses in the SCAQMD exceeds 8,500 units. The ISL G is a potential option for all of these units.

AQMD Contract #08146 *March 2009*

Integrate & Demonstrate Cummins Westport ISL G Natural Gas Engine in School Bus

Contractor
Blue Bird Corporation

Cosponsors
Blue Bird Corporation
SCAQMD

Project Officer
Mr. Ranji George

Background
Local communities have access to financial grants to purchase school buses powered with clean-air technology. Cummins-Westport's new ISL G CNG engine is capable of achieving much lower emission levels than its diesel counterparts with NO_x at 0.2 g/bhp-hr.

Blue Bird Corporation has extensive experience with integrating alternate fuel systems successfully in buses. Blue Bird has been building vehicles powered by alternate fuels since 1992 and has built about 2000 buses. Based on design & performance guidelines outlined in industry standards and Federal Motor Vehicle Safety Standards (FMVSS) including but not limited to 303, NFPA 52 and CA Title 13.

Project Objective
The primary objective of this project is the integration of the Cummins ISL G engine fueled by CNG in the Blue Bird rear engine school bus application that meets 2010 EPA requirements for NO_x and PM emissions.

Technology Description
The emissions control technology including the emissions control device is designed by Cummins-Westport. Blue Bird is responsible only for the integration of the engine and supporting components as per Cummins-Westport guidelines for optimal and acceptable performance on school buses. The test vehicle had a 280 hp / 900 ft-lbs engine installed in it.

Status
At the present time, both 280 hp/900 ft-lbs and 250 hp/730 ft-lbs ratings are available for purchase through Blue Bird's ordering system for any customer to configure and purchase on the A3RE product. These ratings have been certified to meet all system performance and installation requirements as outlined by Cummins Westport. Cummins approval for this installation is dated May 12, 2008.

Figure: Cummins Westport ISL G Engine

The demonstration vehicle pictured above has been taken to industry trade shows and to various school districts including but not limited to Temecula Valley Unified, Lake Elsinore Unified, Murrieta Valley Unified, Menifee Union, Chaffey Unified, Chino Valley, etc. Several vehicles built with this new engine have been delivered to customers in California already.

Results
A glider unit was built at Blue Bird, Fort Valley, GA manufacturing location during the month of December 2007. The longest lead time items in completing the glider unit for development purposes was availability of the TWC (three-way catalyst) and the engine. Upon receipt of these components, vehicle installation was completed.

During the design phase, Blue Bird teamed up with Cummins-Westport and cooling system supplier AKG. The intent was to use the system that would best meet the cooling system (air and jacketed water, de-aeration system) requirements. Exchange of key technical data including but not limited to heat rejection numbers, vehicle envelope dimensions etc. was done as part of the routine development process. As a result the size of fan, fan system parameters including pressure, speeds etc. were finalized such that the system could meet all requirements. Driveline, transmission, alternator and starter systems were chosen to meet optimal performance requirements.

A first round of installation evaluation tests was conducted at a Cummins facility in Fort Myers, FL during mid-March 2008. Subsequent tests were completed at Fort Valley to ensure installation requirements were met, as outlined by Cummins-Westport. As summarized in the table shown below, all requirements for installation were met and this installation received Cummins approval on May 12, 2008.

	Rated Power		Peak Torque	
Engine	ISL G	Spec	ISL G	Spec
Config.	A3RE		A3RE	
Rad TTTD	101.2	119	104.8	128
CACoTD	35.3	38	28.5	
Fan RPM	2223		1479	

Table 1: Completed Installation Evaluation Requirements

Benefits

The CNG ISL G engine on Blue Bird's rear engine school bus program will support and contribute to emissions reduction strategies in the South Coast Air Basin. CNG powered buses are proven to operate reliably. Blue Bird has a long-established presence in offering this technology.

Project Costs

The SCAQMD's cost-share was $250,000. Overall project costs are listed below:

Description of Task	Details	Amount
Engine Spec/Requirement	Purchase of Engine	$22,700
Test Vehicle Production	California Bus Build	$110,425
Engine Installation Design	1299.5 Hrs @ $90/hr	$116,955
Test Vehicle Part	Procurement estimates	$47,000
Test Vehicle Build	420 Hrs @ $35/hr	$14,700
Vehicle Testing	465 Hrs @ $35/hr	$16,275
Travel to Fort Myers for testing (2 engg pers.)	($247 air/$950 hotel + misc)	$2,927
Contractor Design assist.	30 Hrs @ $90/hr	$2,700
	Total	$333,682

Commercialization and Applications

This product is now commercially available for purchase. Blue Bird is in the process of developing a next-generation rear engine school bus product. In 2007, optional 20 year certification was offered composite fuel containers along with the prior offering for 15 year certification containers thus making this product more attractive; in addition, a cruise control feature is now available with this engine.

A tail pipe venture-type heat diffuser device is provided with this product. This is to improve and mitigate any heat that may be discharged due to exhaust emanating from the TWC. Optional dual front or dual rear fuel fill locations are available with this product.

SCAQMD Contract # 08224 **January 2009**

Develop & Certify Natural Gas-Powered Pickup Trucks

Contractor
BAF Technologies

Cosponsors
SCAQMD
Clean Energy

Project Officer
Adewale Oshinuga

Background

In light of increases in populations and vehicle-miles-driven, air quality continues to suffer. At the same time, the availability of on-road alternative fuelled options from OEMs has actually decreased. These issues set the stage for a project that would bring to market retrofit alt-fuel vehicles targeted towards high-mileage fleet operators. By increasing the availability and use of CNG vehicles, this project benefits from the many advantages of natural gas: CNG is a proven engine fuel technology; previous investments made to expand the infrastructure of CNG fuel stations; lower tailpipe emissions; and, increased usage of natural gas increases U.S. energy diversity. Additionally, recent increases in the retail price of gasoline and diesel fuel have negatively impacted all drivers, fleet operators in particular, and the domestic economy as a whole.

Project Objective

The primary objective of this project was to bring to the marketplace additional certified CNG vehicles in light of Ford's 2004 decision to terminate production and sale of natural gas vehicles in the U.S. This was to be accomplished by the introduction of a dedicated CNG CARB-certified SULEV 5.4L F-150 and a dedicated CNG CARB certified SULEV 5.4L F-250/350 for MY 2008. Additionally, BAF committed to hold the incremental sale price of the base (standard) model F-150 to $14,500 throughout the 2008 model year, and actually lower the cost to $13,500.00 for MY 2009 and MY 2010.

Technology Description

The MY 2008 SULEV CNG F-Series Pickup continues the expansion of the BAF CalComp product line. The CalComp system is unique in its ability to provide a simple, safe, and reliable method of retrofitting Ford products to operate on CNG. Unlike other systems the CalComp does not require a separate control module. Instead, control of the CNG system is handled entirely through the OEM Powertrain Control Module (PCM), which BAF reprograms for CNG operation. By maintaining system control through the PCM rather than adding another control module, CNG diagnostics and service procedures are the same as for gasoline vehicles. The CalComp system also meets all the requirements of current California OBD-II regulations, with full access to the on-board diagnostics using the original OEM Diagnostic Connector Link (DCL).

Installation of the CalComp is fairly straightforward. Gasoline hardware components are removed (tank, hoses/plumbing, fuel rails, injectors, etc) and their CNG counterparts are installed. The CalComp system does however require installation of an Injector Driver Module (IDM) between the PCM and the CNG injectors to amplify the current flow.

Status

The project was completed in whole and copies of CARB Executive Orders for both the SULEV CNG F-150 and SULEV CNG F-250/350 were attached to the AQMD Final Report submitted September 25, 2008.

A 2008 Ford 5.4L F-150 was used to design prototypes of the CNG tank system and other high-pressure hardware items. Additionally, a MY 2008 5.4L F-250 was used to design a similar but slightly different CNG tank storage system. Underhood components for both models are the same with only slight differences in their location based on available space under the hood.

Performance calibration and emission testing of both demonstration vehicles was conducted at the Prodrive test lab in Wixom, MI. Upon completion certification applications were filed with CARB and U.S. EPA.

CARB approval of both applications was delayed for a period of months due to several issues; ranging from CARB personnel changes to a request for additional OBD-II data that required BAF return to the test facility to conduct more testing. A signed OBD-II Letter of Compliance was received from CARB for both the F-150 and F-250/350.

Results

Tables 1 and 2 provide emission test results for both the SULEV CNG F-150 and the SULEV CNG F-250/350. Due to the broad range of weight classes for the F-series Pickup the testing was split into a Light-duty F-150 application and a separate Heavy-duty F-250/350 application. In both cases the test data clearly shows the certified emissions meet the targeted SULEV standard set for this project.

TABLE 1. F-150 EMISSION TEST RESULTS

Emission Component	Test Results	CARB SULEV Standard
NMOG	0.007 g/mile	0.010 g/mile
CO	0.3 g/mile	1.0 g/mile
NOx	0.01 g/mile	0.02 g/mile
HCHO	1.6 mg/mile	4.0 mg/mile
Hwy NOx	0.003 g/mile	0.03 g/mile

TABLE 2. F-250/350 EMISSION TEST RESULTS

Emission Component	Test Results	CARB SULEV Standard
NMOG	0.014 g/mile	0.100 g/mile
CO	1.9 g/mile	3.2 g/mile
NOx	0.1 g/mile	0.1 g/mile
HCHO	1.8 mg/mile	8.0 mg/mile
Hwy NOx	0.03 g/mile	0.2 g/mile

Benefits

Benefits of this project are primarily tied to lower tailpipe emissions. By comparison the SULEV CNG F-150 is certified to a 52% lower CO standard and a 50% lower NOx standard than the original ULEV gasoline vehicle. (Note – the actual test numbers are even cleaner.) Additionally, CNG SULEV vehicles produce far less CO2 than gasoline vehicles, which lowers their impact upon global warming.

Beyond direct emission reductions this project has successfully brought to the marketplace two new options for fleet operators and retail customers to purchase safe, reliable natural gas vehicles, at a time of increasing demand on the world's diminishing supply of crude oil and escalating prices at the pump.

Project Costs

Cost-share partners for t his project were as follows:

BAF Technologies:	$250,600
SCAQMD:	$250,000
Clean Energy:	$175,000

Commercialization and Applications

This project funded two new applications for the BAF CalComp fuel system: the MY 2008 CNG SULEV F-150 and the MY 2008 CNG SULEV F-250/350. These new applications mark the continued expansion of the CalComp product line and demonstrate the capabilities of both BAF and CalComp to provide solutions for air quality improvement.

BAF's total sales of the CalComp system, including the F-150 and F-250/350, were expected to reach 500 in MY 2008..

Additional applications of the CalComp technology are being examined; in particular, the MY 2009 Lincoln Town Car Limo and the Lincoln MKS.

SCAQMD Contract #04004 **June 2009**

Demonstrate Two Fuel Cell Vehicles at SCAQMD HQs in Diamond Bar

Contractor
Mercedez-Benz USA, LLC

Cosponsors
SCAQMD

Project Officer
Lisa Mirisola

Background
The implementation of zero-emission vehicles is a key component in the effort to achieve air quality attainment in the South Coast Air Basin. Fuel cell vehicle technology is emerging at an accelerated pace and may play a crucial role in this effort. By combining the operating range of conventional internal combustion engines with high efficiency, zero tailpipe emissions and fast refueling, fuel cell vehicles have the best chance of becoming the drive system of the future. Mercedes-Benz has been developing this technology since 1994. The Mercedes-Benz A-Class "F-Cell" which has been deployed around the globe is the world's first pre-production series vehicle. 60 F-Cell passenger vehicles are being operated by customers in Japan, Singapore, Europe and the United States. The largest number of vehicles having been operated in the United States. The SCAQMD is one of the partners collaborating with Mercedes-Benz in this demonstration. The aims of this world-wide field trial are to further develop the technology to a volume production level by seeing how the vehicles perform under real-world conditions, and to establish what the infrastructure requirements will be.

Project Objective
The project objective was to demonstrate two fuel cell vehicles at SCAQMD in Diamond Bar for use in general and high-profile applications to test the performance of the vehicles in the context of SCAQMD fleet activities.

Technology Description
In the "F-Cell," the entire fuel cell system is accommodated in the sandwich floor of the long-wheelbase Mercedes-Benz A-Class. The fuel cell utilizes hydrogen and oxygen. In a controlled, electrochemical reaction in the fuel cell, these two gases generate energy in the form of electricity and heat, with water being released as a by-product. This energy is used to drive the vehicle via an electric motor.

Figure 1: Demonstration Vehicle

The high-torque electric motor which receives current from the fuel cell has an output of 65 kW. A high-voltage battery can store the energy generated during braking (recuperation) and provide it for acceleration and start of the vehicle. The vehicle accelerates from 0 to 60 miles in about 16 seconds and gets a top speed of around 87 miles/h. Its tanks supply compressed hydrogen (350 bar) to the fuel cell system, giving the "F-Cell" a cruising range of more than 100 miles. Due to the high efficiency of fuel cell technology, the hydrogen consumption is equivalent to fuel mileage of 56 miles per gallon.

Status
Vehicle operation commenced in March 2005. Two vehicles were operated for a period of two years; one vehicle was operated during the final 2+ years of deployment. Project work was completed June 4, 2009. The vehicles were incorporated into the SCAQMD fleet and driven

for work-related purposes. They were also used for a variety of outreach activities for display and

ride-n-drives at events and conferences throughout the South Coast Air Basin.

Results

Mercedes-Benz deployed over 30 vehicles in the United States to validate fuel cell technologies for infrastructure and transportation as well as assess technology/commercial readiness for the market. Within the context of a project with the Department of Energy, 25 vehicles were deployed. All vehicles, including those deployed at South Coast, were equipped with a fleet data acquisition system. As at other customer locations, a server was placed on SCAQMD property where vehicle data was initially downloaded and then transferred to a central file server. Although SCAQMD F-Cell vehicles were operated outside the DOE project, data from these vehicles has also been provided to the DOE which uses the data to monitor the progress of fuel cell vehicles against DOE technology validation milestones.

The lack of an adequate hydrogen infrastructure network in the region prevented vehicle operators from using the car outside the immediate surrounding area. Constraints on mobility were compounded by the approximate 100 mile range of the F- Cell. Scenarios such as this were not uncommon for other F-Cell customers. A Customer Acceptance and Perception Study undertaken by Mercedes-Benz Research and Development North America revealed that range affected driver behavior. The next generation F-Cell will have achieved one of the DOE technology milestones of a 250 mile range without infringing on trunk space. In addition to an increase in range due to even better efficiency and higher hydrogen storage pressure, next-generation vehicles should have access to a greater number of hydrogen fueling stations.

The primary contribution to the overall demonstration project has been the accumulation of mileage and the data acquired thereby. Analyzing this data enables Daimler's engineers to learn about the feasibility of the technology in everyday operation and to develop future vehicle generations based on the experience gathered in projects like this. Altogether four vehicles were in use during this time.

Benefits

Fuel cell vehicles produce zero emissions in operation and reduce greenhouse gas emissions by 50% or more compared to gasoline vehicles, even when the hydrogen is produced through the less favorable process of reforming natural gas. Over the course of this demonstration with SCAQMD alone, 5.5 tons of $C0_2$ emissions have been avoided. This technology has great potential to meet greenhouse gas reduction targets, improve fuel efficiency, reduce dependence on imported petroleum and develop domestic resources. Demonstration projects such as this one with SCAQMD are crucial to the further development of this technology.

Project Costs

The SCAQMD contributed $240,000 for the lease of two vehicles for the period of one year. Thereafter, vehicle lease fees were waived. Vehicle service and maintenance costs for the two vehicles operated at SCAQMD were provided within the context of service performed for the additional F-Cell vehicles deployed throughout the State.

Commercialization and Application

The A-Class F-Cell was deployed around the globe for technology demonstration purposes. Lessons learned from this demonstration phase have flowed into the development of the next generation B-Class. Introduction of this next generation vehicle is anticipated in 2010. The purpose behind this deployment is to gain further customer acceptance of the technology and to support the build-up of a hydrogen infrastructure.

The challenge with the following generation will be to reduce component costs as the number of vehicles deployed continues to rise. Assuming that infrastructure build-up keeps pace with the ever rising number of fuel cell vehicles on the road, limited commercialization can occur as of 2015. The final step envisioned is mass production of fuel cell vehicles from 2020 onwards at which time the required infrastructure should be in place.

SCAQMD Contract #08335 & 09436 **July & December 2009**

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

Contractor

Bevilacqua-Knight, Inc.

Cosponsors

Steering team members through 2009 are auto manufacturers (Chrysler, Daimler, General Motors, Honda, Hyundai, Nissan, Toyota and Volkswagen), energy providers (Chevron, and Shell Hydrogen), technology companies (Automotive Fuel Cell Corporation and UTC Fuel Cells), and government agencies (the California Air Resources Board, the California Energy Commission, the California Department of Food and Agriculture, the South Coast Air Quality Management District, the U.S. Department of Defense National Automotive Center, U.S. Department of Energy, the U.S. Department of Transportation, the U.S. Environmental Protection Agency and NREL). Associate partners are hydrogen gas suppliers (Air Products and Chemicals, Inc., Linde North America, and Praxair); hydrogen fueling station infrastructure providers (Proton Energy Systems, Inc., Powertech Labs) Universities (UC Davis—ITS and UC Irvine – NFCRC) and bus transit agencies (AC Transit in the Alameda-Contra Costa area, Santa Clara Valley Transportation Authority in the Bay Area, and SunLine Transit Agency in the Palm Springs area).

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 has grown to include over 30 organizations interested in demonstrating fuel cell vehicle and fueling infrastructure technology.

Project Objective

There were several goals for 2008-2009:

- 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 combined final report covers the SCAQMD contracts 08335 for 2008 and 09436 for 2009 membership. Both contracts were completed on schedule in 2009.

Figure 1: Hydrogen Road Tour Event

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 Santa Fe , Kia's Sportage and Borrego, Nissan's XTrail, Toyota's FCHV-ADV, and Volkswagen's HyMotion. The fuel cell transit buses include four Van Hool buses with UTC fuel cells integrated by ISE (three placed at AC Transit and one at Sunline Transit) and one bus from Proterra (battery dominant with a Hydrogenics FC range extender—to be placed at the City of Burbank in early 2010). CaFCP is also planning for additional buses at AC Transit, Sunline Transit, and SFMTA.

Results

Specific accomplishments include:

- Automotive members placed just under 300 fuel cell passenger vehicles on California roads from 1999 through 2009, including the first retail customers starting in 2005;
- Transit agency members have demonstrated nine fuel cell buses since 1999, with 5 still currently in operation (see technology description)
- There are now 5 open access hydrogen fueling stations in operation in California. There are also close to 21 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 led 'Hydrogen Road Tour' technology demonstration showcased 12 fuel cell vehicles in a 10 day/28 city/1700 mile rally from the San Diego border with Mexico north to Vancouver, BC, Canada. The event provided thousands of people with a first-hand experience of FCV's including an opportunity to drive each vehicle, so that they can compare them to their current everyday vehicles. It also provided many examples of the road readiness of current FCV's, including climbing the major mountain passes between California and Oregon.
- The CaFCP continues to upgrade its comprehensive up-to-date website focusing on efforts in California, holds monthly public open houses in West Sacramento, participates in technical and educational conferences, and plans annual outreach events.

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 vehicle 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 member efforts, 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 Partnership 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 provide fuel and fueling infrastructure. The Partnership's annual operating budget is over $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 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 #: 03201 **November 2009**

Install & Demonstrate Two Bulk Delivery-Type Hydrogen Fueling Stations in Orange County

Contractor

University of California Irvine, Advanced Power & Energy Program

Cosponsors

U.S. Department of Energy
SCAQMD

Project Officer

Larry Watkins

Background

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 as a principal ZEV candidate. The SCAQMD has allocated a total of $2.065 million toward the installation of a network of hydrogen fueling stations throughout the Basin to support the operation of FCVs in the Basin. The University of California Irvine (UCI)'s Advanced Power and Energy Program (APEP) assisted with the development and deployment of two hydrogen fueling stations in Orange County.

Project Objective

APEP is responsible for the development and deployment of permanent and a mobile hydrogen fueling station in Orange County. The site for the permanent station is the University of California Irvine's North Campus facility. The objective of the mobile fueler is to provide flexibility in meeting specific needs that arise in Orange County.

APEP is responsible for equipment selection, design, and permitting; site development, construction and installation; commissioning; operation and maintenance; and data analysis. Air Products & Chemicals Inc. (APCI) is a principal subcontractor for the permanent station and a candidate supplier for the mobile station.

Technology Description

Designed by APCI in collaboration with APEP, the permanent station consists of a series 200 compressor skid, 52.5kg gaseous hydrogen storage vessel 3-pack, 35MPa and 70MPa hydrogen dispenser, control panel, booster compressor, vaporizer, cooling block, and 1500 gallon cryogenic liquid hydrogen storage. The station is designed to dispense 25kg or fill 7-10 vehicles a day. Fill times are approximately 3-7 minutes for both fueling pressures depending on the tank level of the vehicle. The mobile station is projected to include a high-pressure compressed hydrogen supply tank, compressor, and fueling hardware.

Status

The permanent station design was approved on January 24, 2006. Site preparation began June 20, 2006, with the removal of the first-generation fueling dispenser installed in 2002. Electrical work began in early July and all equipment specified was delivered to the fueling station site on July 24, 2006. The development, construction and installation process was overseen by personnel from APEP and APCI.

The first fill at the station occurred on September 12, 2006 after a month of testing; the UC Irvine Fire Marshal granted final approval of the completed system on October 9, 2006. The official grand opening of the station for public access was held on February 27, 2007. The station remains operational with the exception of scheduled downtime for routine maintenance since its opening and serves vehicle fueling for six automobile manufacturers and their customers.

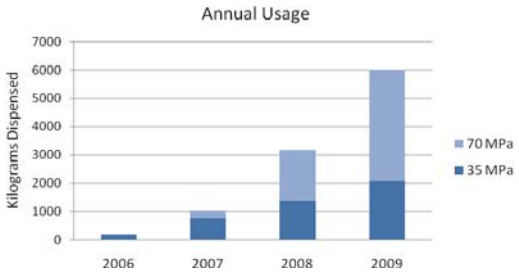
Hydrogen Station

The mobile station is designed to reflect dramatic technology development and changing demands in performance, and positioned for procurement.

Results

The performance of the permanent station has far exceeded expectations. Designed to dispense 25kg a day, the station averages 30kg a day, often reaching 46kg a day during peak periods.

The graph below depicts the annual usage of the station, showing kilograms dispensed and type of fill:



Original projections for station usage were based on fewer number of fuel cell vehicles located in the area. Since 2006, the number of users accessing the station has increased from 5 to over 120 trained users and local FCV drivers. Auto manufactures with hydrogen powered vehicles in the area include, General Motors, Honda, Hyundai, Mercedes, Mazda and Toyota.

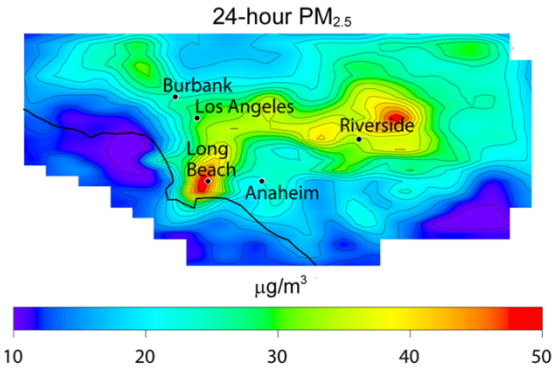
The high station demand requires an aggressive maintenance schedule for the compressor skid and cooling block.

The lessons learned from the design, operation, and customer use of the permanent station have informed the design requirements for the mobile station. The mobile station is now positioned for procurement.

Benefits

Based on the performance evaluations of the UCI station, APEP is able to assess how drivers use the station and the requirements for future hydrogen infrastructure scenarios. Using the APEP STREET (Spatially and Temporally Resolved Energy and Environment Tool) methodology developed in collaboration with the AQMD, the following image represents the potential emissions impact of a hydrogen infrastructure for an anticipated 2060 market penetration of zero-emission fuel cell vehicles as applied in the South Coast Air Basin.

Using data acquired from our existing station and other data sources, STREET enables accurate assessment of a broad array of hydrogen generation, distribution, and dispensation pathways in combination with varying future fuel cell vehicle penetration levels in terms of greenhouse gas, resource consumption, energy, and air quality impacts.



Project Costs

The SCAQMD contribution for the permanent UCI station was $573,666. The funds allocated for the mobile station are $289,734.

Project Costs

Permanent Station	
Task 1 - Design and Permitting	$3,422
Task 2 - Construction and Installation	$290,236
Task 3 – Commissioning	$35,440
Task 4 - Operation and Maintenance	$66,568
Task 5 - Data Acquisition/Analysis	$63,267
Task 6 – Program Reporting	$114,733
Mobile Station	
Tasks 7-12 (allocated)	$289,734
SCAQMD Total:	$863,400
Cost Share	$429,700
Project Total	$1,293,100

Commercialization and Applications

Since 2006, additional hydrogen stations have been established within the state. The UCI station remains one of the most technologically advanced, publically accessible, and popular stations in California. The station technology has proven to be reliable and user friendly. Due to this success, auto-manufacturers look to Irvine as an early market adopter for hydrogen fueling stations and hydrogen powered vehicles. As a result, the UCI station is a remarkable success and already exceeds the design daily utilization by nearly a factor of two in support of the emerging hydrogen economy.

SCAQMD Contract # 07359 **August 2009**

Study on Combustion Exhaust & Respiratory Health of Port Community Children

Contractor
University of Southern California

Cosponsors
NIEHS Grant #P30 ES07048
SCAQMD

Project Officer
Jean Ospital

Background
The use of on-road heavy-duty diesel trucks for local and regional movement of cargo from the ports of Los Angeles (POLA) and Long Beach (POLB) results in disproportionate localized exposure of airborne pollutants which may adversely affect children's health.

Project Objective
The objective of this study was to assess the local impact of on-road traffic flow through communities near POLA and POLB by measuring the health burden on community school children. The study was designed to address whether children living close to or attending school near busy roadways had more asthma or respiratory symptoms, and whether children with higher exposure had higher rates of asthma and symptoms

Technology Description
2687 schoolchildren (1539 kindergarten and 1148 fifth grade students, nominal ages 5.7 and 10.8 years, respectively) were recruited through public school classrooms in communities adjacent to the Ports of Los Angeles and Long Beach. Parent-completed residential and medical history questionnaires provided information about historical and current subject health status. A separate study provided estimates for several markers of combustion exhaust (elemental carbon, ultrafine particle number, and nitrogen dioxide). Dispersion model estimates of contributions from local traffic emissions, based on neighborhood streets and community roadways, were used to investigate the influence of proximal roadway traffic on reported symptoms and airway disease.

Status
Field operations ended in June 2008. The final study report has been filed with the AQMD Project Officer. Enrollment of study participants was more challenging than expected, and required additional effort.

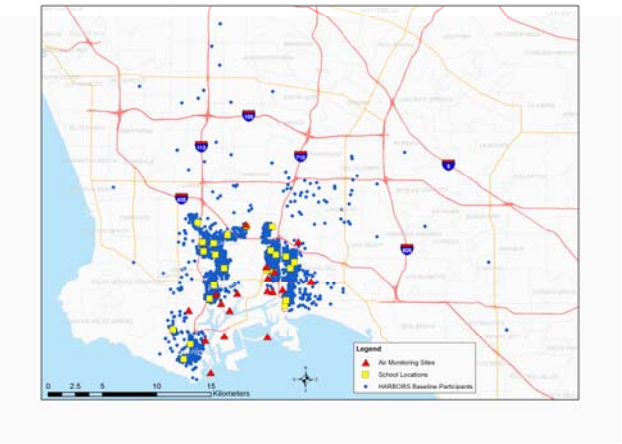


Figure 1 from report, showing study area, participating subjects' residences (circles), study schools (rectangles), and air monitoring sites (triangles).

Results
The prevalent asthma rate among all port community study subjects as a group (~17%) was elevated but not dramatically higher than those reported in previous Children's Health Study (CHS) communities. Compared to previous CHS cohorts, port community kindergartners had slightly higher asthma rates.

Exposure to 24-hr average levels of elemental carbon (EC) was associated with increased respiratory symptoms (bronchitis, cough, and

phlegm); these effects were more apparent in fifth-graders. Health effects were associated with exposures at homes and schools.

No consistent response was observed with respect to road type or road proximity. Children living close to or attending schools near busy roadways did not report higher rates of asthma or more respiratory symptoms.

Respiratory symptoms were associated with higher community levels of EC, a combustion exhaust component associated with on-road vehicles as well as ship engines, industrial boilers, refinery processes, rail, harbor craft, and off-road activities.

The study concluded that combustion exhaust (from a wider range of combustion processes than on-road traffic alone) is measurably affecting the respiratory health of young children who live and go to school in the port communities.

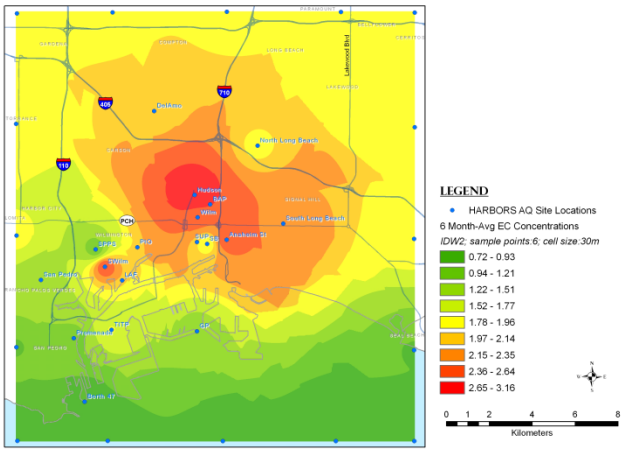


Figure 5 from report, showing elemental carbon area concentrations.

Benefits

Objective assessment of health effects should provide motivation for continued efforts to reduce emissions of combustion exhaust in the port area, which will improve the respiratory health of local school children.

Project Costs

The SCAQMD project award was for $489,300. Additional resources (~$50,000) were provided by NIEHS Grant #P30 ES07048 to offset study-related efforts of the USC co-investigators and allow limited project dollars to be used to cover additional field operations costs.

Commercialization and Applications

The collected information will be useful in the justification for continued emission reduction efforts to improve public health.

Additional analyses should be undertaken to help identify susceptible sub-populations within the larger cohort (by incorporating lifetime exposure assessment, characterizing allergic status of the study population, and analyzing archived information about genetic inheritability) and to perform improved exposure analyses (when additional exposure data becomes available). Preservation and continued health monitoring of this unique cohort is also recommended to obtain directly relevant and focused insights regarding children's respiratory health.

SCAQMD Contract #08337 **January 2009**

Southern California Clean Vehicle Technology Expo

Contractor
Gladstein, Neandross and Associates, Inc.

Cosponsors
13 Sponsors and 29 exhibitors

Project Officer
Connie Day

Background

The Clean Vehicle Technology Expo is part of the South Coast AQMD's overall program to reduce emissions from mobile sources, the source of over 75% of Southern California's air pollution. The Ontario Expo provides the suppliers of clean vehicles and equipment exposure to the single largest concentration of fleet managers and procurement officers in the United States. This group attends Expo in order to receive the latest clean vehicle technology and funding information to help them more expeditiously and economically convert their fleets over to cleaner, alternative fueled vehicles (AFVs).

Project Objectives

- Educate fleet operators about SCAQMD and CARB fleet rules while showcasing available funding opportunities, tax credits and incentives.
- Provide public and private fleet operators with an opportunity to learn about: light-, medium- and heavy-duty clean and alternative fuel vehicle technologies; the commercial availability and future availability of these clean technologies; the potential benefits of deploying these alternative fuel vehicles/equipment; and the financial and technical resources available from government agencies and other third parties to assist in the transition to these technologies.
- Educate engine, chassis, battery and vehicle manufacturers, energy providers, and infrastructure developers about the needs and concerns of fleet operators.
- Address issues impacting fleet operators' ability to purchase and deploy light-, medium-, and heavy-duty clean fuel vehicles, and provide public agencies with the knowledge and tools to craft better programs to reduce vehicle emissions and petroleum use.
- Facilitate the formation of project teams (fleet operators, fuel providers, engine/chassis manufacturers, infrastructure developers, public agencies, funding providers and other AFV project experts) to develop proposals for cost-effective economically sustainable light- medium-, and heavy-duty alternative fuel projects that will contribute to the achievement of ambient air quality standards and reduce dependence on foreign energy sources.
- Coordinate a new agenda component focused on funding and discussions concerning billions of dollars in incentives now available to fleet operators and equipment and technology providers. Money Monday featured workshops, including one-on-one counseling sessions provided by agency staff, on how to secure Prop 1B funding, SOON funding for off-road emission reductions, and other high-priority funding opportunities.

Technology Description

The Clean Vehicle Technology Expo showcased a variety of vehicle technologies including electric, natural gas, propane, hybrid, diesel, and hydrogen fuel cell.

Status

The SCAQMD Southern California Clean Vehicle Expo took place on October 13-15, 2008. This project is complete.

Results

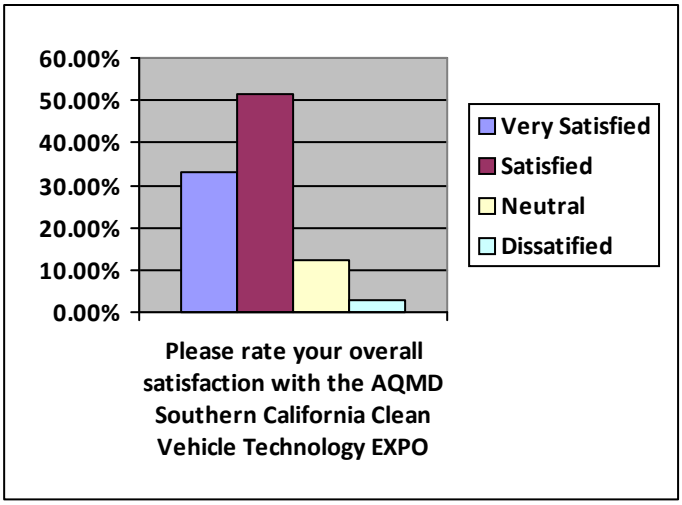
The 2008 Expo agenda was extended to three days to allow for a full day focused on funding. This new format allowed for in-depth discussions on various topics and featured highlights such as keynote addresses by Jim Hebe, Senior Vice President, Sales & Operations of Navistar; Michael Jackson, Senior Vice President of Waste Management; and Cristin Lindsay, Senior Director of XPRIZE. Panel presentations featured experts discussing the latest technologies and vehicles available for light-duty, heavy-duty, and off-road applications. The Expo Hall featured an array of the latest and most advanced vehicle products, including several "world's firsts" such as a dedicated electric heavy-duty truck, a CNG plug-in hybrid electric hybrid solid waste collection truck, an LNG powered Caterpillar wheeled loader,

and a variety of state-of-the-art other AFVs including propane, electric, and alternative and clean fuel vehicles. Vehicles represented in the Ride and Drive and NGV pavilion ranged from light duty to heavy duty and included school and municipal buses, refuse trucks, fuel cell vehicles and many more.

The fourth annual Expo provided a unique opportunity for fleet operators to learn and exchange information with technology providers, public agencies and peers about regulatory and policy updates, operational strategies, available incentives, and much more. Expo's first "Money Monday" was a success and generated lively discussions concerning how exactly to apply for funding, make the right buying decisions, and develop proper compliance plans. The morning sessions were followed by a series of workshops that allowed attendees to sit down with agency officials to have specific questions answered and compliance plans reviewed.

Included among the 700 attendees were fleet representatives from 50 cities, Counties of Orange, Los Angeles, Riverside, Sacramento, San Bernardino, Alameda, Ventura, and Santa Barbara, many private fleets such as Athens Services, Waste Management, Federal Express, and Granite Construction, school bus fleets including Los Angeles Unified School District, public agencies such as the Los Angeles Fire Department, fleet departments from universities such as UCLA, a number of transit authorities, and several ports and marine terminal operators.

Participants were provided with information on how to build effective relationships with providers of state-of-the-art electric, fuel cell, natural gas, hybrid, propane and other alternative clean fuel technologies, as well as acquire information about available grant funding for these projects. They were also provided with information on the SCAQMD and CARB fleet and off-road rules, cleaner engine and vehicle availability in 2008 and beyond, tax credits and incentives for fleets.



Benefits

Several events in the Expo Hall created the opportunity for networking and discussions about possible partnerships, projects, and collaborative ideas. Sponsors & Exhibitors also received information about the budgets, performance needs, and operating concerns of these fleet managers to assist with future product development.

Speakers presented new technologies and discussed their company's contributions, opportunities, and challenges in alternative vehicle technologies. Breakout sessions allowed for in-depth exploration of topics and expanded Q&A sessions in specific sectors.

Project Costs

Expenses		
Labor Total	$200,500.00	$199,983.75
Expenses	$132,972.34	$131,883.80
Conference Total	$333,472.34	$331,867.55
Income		
Funding Secured	$261,150.00	$261,150.00
Registration Income	$34,115.00	$32,710.00
Total Funding	$295,265.00	$293,860.00
NET INCOME		-$38,007.55

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
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