CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Waste Management Moreno Valley CNG Station Upgrade Project

Public-Access Fueling in California

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Ronald Pope (Gladstein, Neandross & Associates.)
Niki Beigi (Gladstein, Neandross & Associates)
Primary Authors

Waste Management Collection and Recycling, Inc.
17700 Indian Street
Moreno Valley, CA 92551
Waste Management Website (www.wm.com)

Agreement Number: ARV-12-050

Elyse Cheung-Sutton
Commission Agreement Manager

Elizabeth John
Office Manager
ADVANCED FUELS AND VEHICLE TECHNOLOGIES OFFICE

John P. Butler II
Acting Deputy Director
FUELS AND TRANSPORTATION

Drew Bohan
Executive Director

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-12-605 to provide funding for projects that develop infrastructure necessary to store, distribute, and dispense electricity, E-85, propane, diesel substitutes, and natural gas. In response to PON-12-605, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards March 18, 2013 and the agreement was executed as ARV-12-050 on June 30, 2013.

ABSTRACT

The primary barrier to natural gas vehicle deployment is the lack of supporting infrastructure. There is limited access to natural gas infrastructure in Moreno Valley near the heavily traveled intersection between Interstate 215 and State Route 60. This enormous barrier deters the adoption or expansion of natural gas advanced technologies by the many goods movement fleets that haul cargo through Riverside County. Additionally, the high costs of upgrading and constructing natural gas infrastructure is a significant prohibitive factor preventing many fleets from deploying such necessary infrastructure.

Under grant agreement ARV-12-050, Waste Management Collection and Recycling, Inc. sought to upgrade the company's public access compressed natural gas fueling station at its Moreno Valley location, to support its existing and rapidly expanding fleet of compressed natural gas powered solid waste collection vehicles, as well as the numerous local and regional goods movement fleets in the Inland Empire of California.

This critical infrastructure project provides solutions to overcome the significant refueling barrier that has hindered the development and widespread use of natural gas as a transportation fuel in Riverside County.

The project site, located at Waste Management Collection and Recycling, Inc.'s existing facility at 17700 Indian Street in the city of Moreno Valley, provides a convenient and affordable source of compressed natural gas fuel for Waste Management Collection and Recycling, Inc's fleet of heavy-duty refuse trucks that operate daily from this facility.

The goal of upgrading Waste Management Collection and Recycling, Inc.'s compressed natural gas fueling station in Riverside County was to support the growth of its substantial compressed natural gas fleet, as well as to continue to support rapidly expanding public compressed natural gas fleets. The upgraded compression capacity will further encourage the replacement of heavy-duty diesel trucks with clean burning, ultra-low-emission natural gas trucks in the Southern California region. A final goal of this project was to infuse the Southern California regional natural gas refueling infrastructure with locally produced, ultra-low carbon compressed natural gas fuel.

Keywords: Energy Commission, compressed natural gas, Waste Management, natural gas fueling station

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Under grant agreement ARV-12-050, Waste Management Collection and Recycling, Inc. upgraded their compressed natural gas fueling station in Moreno Valley to support its existing and rapidly expanding private fleet of compressed natural gas-powered solid waste collection vehicles. The station was upgraded with higher power compressors and additional nozzles which increased the total flow rate from 1,200 standard cubic feet per minute to 3,000 standard cubic feet per minute. Located along several important local and regional transportation corridors, including I-215 and State Route 60, this station was also equipped for retail sale and supports many other goods movement fleets such as Riverside Transit Agency and the City of Moreno Valley.

For this project, the CEC awarded Waste Management Collection and Recycling, Inc. a grant totaling $300,000, which Waste Management matched with $398,564 of private funds. The project began in May 2013 and closed in March 2016. The upgraded station became operational in July 2015 and distributed on average 159,729 diesel gallon equivalent of natural gas per month during the six-month data collection period. In comparison, before the upgrade the station distributed on average 110,204 diesel gallon equivalent of natural gas per month in 2012.

The fuel usage at the upgraded station will lead to an estimated annual throughput of 1,916,747 diesel gallon equivalent per year. Of the 1,916,747 diesel gallon equivalent, Waste Management Collection and Recycling, Inc. consumed 1,558,309 diesel gallon equivalent (not including retail sales); compared to equivalent diesel usage, this consumption corresponds to emissions reductions of more than 121.19 tons per year of oxides of nitrogen, 2.46 tons per year of particulate matter and 6,355 metric tons of carbon dioxide equivalent.

CHAPTER 1:
Project Background and Objectives

There is limited access to natural gas infrastructure in Moreno Valley near the heavily traveled intersection between Interstate 215 and State Route 60 which deters the adoption and expansion of natural gas technologies. Additionally, prohibitive is the high costs of upgrading and constructing natural gas infrastructure.

Waste Management Collection and Recycling, Inc. (WM) sought to upgrade its slow fill and public access fueling station in Moreno Valley to support its existing and rapidly expanding fleet of compressed natural gas (CNG) powered solid waste collection vehicles (108 at the time that the project was proposed) that operate in Riverside County. The upgraded CNG station is located at 17700 Indian Street in Moreno Valley, providing a convenient and affordable source of natural gas fuel for WM's expanding fleet of trash hauling trucks that operate from the facility daily. There was a critical gap in fueling infrastructure and not enough convenient fueling to support WM's planned deployment of CNG vehicles. WM calculated that even without the considerable number of local and regional vehicles that will use the station, WM would have enough private fueling volume to justify a full station.

For this project, the CEC awarded WM a grant totaling $300,000 which WM matched with $398,564 of private funds.

Project Objectives

The objectives of upgrading the Moreno Valley CNG station were to support fuel requirements of the existing and planned expansion of WM's CNG refuse collection and transfer trucks, in addition to other fleets in the region. Another objective of the project was to reduce greenhouse gas emissions from transportation activities in California.

Currently, WM's Moreno Valley site maintains a large fleet of 133 natural gas trash-hauling trucks. WM's plan is to convert the remaining diesel units at its Moreno Valley location such that 100 percent of the fleet operates on natural gas. The originally projected goals for this project included:

- Providing for the total cumulative station throughput and corresponding displacement of more than 9,455,400 gallons of diesel fuel with domestically produced, low-carbon natural gas over the six-year project life by 2020;
- Providing for the total cumulative reduction of more than 33,961 metric tons of greenhouse gas emissions over the six-year project life by 2020;
- Completing these goals at a total cost effectiveness as low as $0.0317 per gallon of diesel fuel displaced and $8.83 per metric ton of greenhouse gases reduced over the project life through 2020; and
- Serving as a model for other large-scale refuse collection and station operators to how to successfully implement advanced technology infrastructure programs in collaboration with state agencies.

CHAPTER 2:
Scope of Work

Scope of Work

WM's Scope of Work under grant agreement ARV-12-050 included the completion of the proposed upgrades and reporting of the CNG fueling station. WM was responsible for upgrading the CNG fueling station with the following new equipment:

- Three ANGI JGQ/2 Compressors (250-horsepower per Compressor)
- Twin Hose Retail Dispenser
- Three Light-Duty Nozzles
- Three Bank Cascade System
- 142 Time Fill Fueling Positions

Each compressor has an output of 1,000 standard cubic feet per minute (scfm) (for an overall station capacity of 3,000 scfm or 30,995 diesel gallon equivalent (DGE) per day) and at peak output, the station can provide 21.43 DGE per minute from direct fill off the compressors without taking into account the benefits of the cascade storage system. The system has an average demand of 390 kilowatts and has averaged 2,456 kilowatt hours per day to operate the fueling station.

All equipment meets American Petroleum Institute, American Society of Mechanical Engineers, International Society of Automation, American Gas Association, National Electric Code, and National Fire Protection Association requirements. The station also included the installation of utility tie ins, start up, debugging, stabilizing the refueling station, along with design, engineering, permitting, project management, and purchasing. WM's work included fire protection, fire detection, methane detection, and all necessary safety elements identified with hazardous operations process safety.

Technical Tasks

WM completed several technical tasks in order to complete the CNG station upgrade in an orderly and efficient manner. In particular, WM completed the below technical tasks under this project:

Site Preparations

WM prepared the project for installation of equipment for the dispensing at the natural gas fueling facility. WM provided design management and preconstruction planning services and submitted the Site Preparation Report to the Commission Agreement Manager.

Equipment Installation

WM installed all necessary equipment and supplies at the site. Installation of the natural gas fueling infrastructure equipment was completed in accordance with the system design specifications.

Commission and Operate Natural Gas Fueling Infrastructure

WM performed start-up of the system and equipment on-site and commissioned the system into operation.

Data Collection and Analysis

WM collected, and continues to collect, operational data from the station. WM analyzes this data for the economic and environmental benefits of the project, such as station throughput and associated project emission benefits.

The site is located at 17700 Indian Street, Moreno Valley, CA 92551, as shown in Figure 1.

Figure 1: CNG Station Location

Source: Gladstein, Neandross & Associates.

Photographs

Figures 2-4 capture various views of the project.

Figure 2: Gas and Compression Equipment

Source: Chip Wertz, Waste Management

Figure 3: Customers Fueling at the Retail Station

Source: Chip Wertz, Waste Management

Figure 4: New Transformer

Source: Chip Wertz, Waste Management

Annual Fuel Throughput

The upgraded station has been operational since July 2015, and approximately 133 WM vehicles currently utilize the Moreno Valley CNG station. The estimated fuel usage over the six-month data collection period, July 1, 2015 to January 1, 2016, was approximately 958,373 DGE. On average, monthly throughput is approximately 159,729 DGE. This translates into an estimated annual throughput of approximately 1,916,747 DGE per year.

Table 1: Moreno Valley CNG Station Fuel Throughput

Time Period	Retail DGE	Total Site Throughput DGE[1] (including retail)
July 2015	30,195	138,419
August 2015	30,195	179,222
September 2015	29,221	155,042
October 2015	30,195	149,334
November 2015	29,221	186,472
December 2015	30,195	149,884
Total Throughput for Reporting Period	179,219	958,373
Monthly Average (July 2015 - Jan. 2016)	29,870	159,729
Estimated Annual Throughput	358,438	1,916,747

Source: Gladstein, Neandross & Associates

On average, the retail station serviced 38.5 customers per day.

Emission Reductions

By displacing diesel fuel with natural gas, WM is responsible for the following pollutant emissions reductions. Using the Carl Moyer Program Guidelines methodology for calculating criteria pollutant emission reductions and using a baseline model year 2006 diesel refuse collection vehicle, WM can expect to achieve the following criteria pollutant reduction benefits by using natural gas vehicles instead of diesel.[2]

[1] Calculated at 1,089 BTU/ft3, 138,490 BTU per DGE. Retail DGE calculated based on reported gasoline gallon equivalent where a gasoline gallon equivalent contains 120,439 BTU (all HHV).

[2] California Environmental Protection Agency, Air Resources Board, "Carl Moyer Program Guidelines" June 2011 https://ww3.arb.ca.gov/msprog/moyer/guidelines/current.htm. See Formula C-8 on page C-5.

Table 2: Annual Criteria Pollutant Reduction Calculations

Criteria Pollutant Emission Reduction Calculation	Oxides of Nitrogen	Particle Matter
Baseline Emission Factor (g/mi) 2006 Diesel	11.64	0.254
Baseline Emission Factor (g/mi) 2006 Diesel, w/o Particle Matter Retrofit	11.64	0.254
Reduced Emission Factor (g/bhp-hr)	.20	0.01
Conversion Factor (bhp-hr/mi)	2.90	2.90
Energy Consumption Factor (bhp-hr/gal)	18.50	18.50
Annual Estimated Fuel Consumption in DGE (*)	1,558,309	1,558,309
% in Operation in CA	100%	100%
Projected Baseline Emissions (tons/year)	127.19	2.783
Projected Emissions (tons/year)	6.36	0.318
Annual Emission Reductions (tons/year)	121.19	2.466
Emission Weighting for Cost Effectiveness Calculations	1.00	1.00
Annual Weighted Emission Reductions (tons/year) (*)	**121.19**	**2.466**

Source: Gladstein, Neandross & Associates based on data from California Air Resources Board.

The calculations shown above correlate to the emission benefits based upon the station's estimated annual throughput. As a result of the Moreno Valley CNG Upgrade Project, WM is able to achieve the reduction of more than 121.19 tons per year of oxides of nitrogen, and 2.46 tons per year of particle matter. Additionally, the project will contribute to the reduction of 6,355 metric tons of carbon dioxide (CO2) equivalent per year. Greenhouse gas (GHG) reductions were calculated using carbon intensities from the Low Carbon Fuel Standard Table 6 Carbon Intensity Lookup Table for Gasoline and Fuels that Substitute for Gasoline[3]. The reference fuel is diesel which has a carbon intensity of 98.03 g carbon dioxide equivalent (CO2e) (ULSD001) and natural gas has a carbon intensity of 67.7 g CO2e (CNG001).

The annual emissions reductions calculated in Figure 5 are based on WM's share of the annual fuel usage from the upgraded CNG station. This project however, consisted of the upgrade of an existing CNG station to increase the capacity and throughput of the station. Thus, the emissions calculations above do not reflect additional reductions achieved by this project, but rather the upgraded station as a whole. This was because the consultant was unable to obtain fuel usage data for the original CNG station.

Figure 5: Annual Carbon Displacement

$$\left(\frac{98.03\ gCO_2e}{MJ}_{(r)} - \frac{67.7\ gCO_2e}{MJ}_{(p)}\right) x \frac{134.47\ MJ}{DGE} x \frac{1{,}558{,}309\ DGE}{yr}\ x 1\ x \frac{MT}{1{,}000{,}000g} = \frac{6{,}355\ MTCO_2e}{yr}$$

r = reference fuel, p = project fuel

Source: Gladstein, Neandross & Associates

[3] California Environmental Protection Agency, Air Resources Board, "Carbon Intensity Lookup Table for Gasoline and Fuels that Substitute for Gasoline" December 2012. https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities

CHAPTER 3:
Results

Results

WM has completed the proposed upgrades of the CNG fueling station at its existing fueling station in the City of Moreno Valley. The station is open and currently operational, fueling WM's fleet of regional CNG waste collection vehicles. The station development was completed according to plan and with no major issues. There were no additional jobs created by the project.

In terms of operational data and results, WM currently has 133 CNG trucks in their fleet that operate out of the Moreno Valley facility. Of these, on average, 115 CNG trucks are fueled per day based on a 5-day week (or 87 per day based on a 7-day week). WM's fleet is refueled on a slow fill basis.

In addition to WM's usage, there are approximately 38.5 retail transactions per day based on a 7-day week. On average, each retail transaction equals approximately 25.2 DGEs.

The original application contemplated annual throughput in the first year of operation equal to 1,406,200 DGE including both WM fleet use plus retail, with a six-year total of 9,455,400 DGE (2015 through 2020 inclusive). Based on the first six months of operation (July 1, 2015 through January 1, 2016), the total estimated annual station throughput is 1,916,747 DGE, and the six-year total is estimated to be 11,500,482 DGE. This is approximately 15 percent higher throughput than originally planned.

Over a six-year period, the originally estimated cost effectiveness (measured in dollars of grant funding per DGE) was $0.0317 per gallon of diesel reduced; the actual is now projected to be $0.0261. Over the same six-year span, the estimated cost effectiveness of GHG reduction (measured in dollars of grant funding per metric ton of CO2e reduced) was originally estimated at $8.83 per metric ton; the actual is now projected to be $7.87.

Issues

WM received an extension to the contract timeline due to a delay in the completion of the permit drawings that delayed the ordering of equipment by about five (5) months. In addition, Moreno Valley Electric has some very specific transformer requirements that resulted in the need to customer order from one vendor, and more than doubled the lead time for more standard equipment. The installation of the equipment upgrades related to the retail improvements required that the retail operations were shut down for approximately 25 days.

CHAPTER 4: Conclusions

Led by a prepared and seasoned team with a vast understanding of the technology, this project supports the state's goals to displace petroleum and reduce GHG emissions from WM's existing fleet. The successful installation of this CNG station provides much needed fueling infrastructure to supply WM's fleet and other local fleets with natural gas. Natural gas is a clean, safe, abundant, and domestically produced fuel. Natural gas contains less carbon than any other fossil fuel and thus produces lower CO2 and GHG emissions per year. In fact, natural gas vehicles produce 20-30 percent less than greenhouse gas emissions than comparable diesel vehicles. WM is quite familiar with the many benefits of natural gas, with the largest fleet of heavy-duty natural gas trucks in California and throughout North America. WM is dedicated to doing business in the most sustainable way possible, as well as offering its customers more ways to live green via the air quality benefits of CNG.

WM has successfully completed over 120 CNG station implementation projects with another 70 stations in various stages of planning and/or construction, and as a result has a high level of expertise and experience in the successful planning, construction, commissioning and operation of CNG stations in both the US and Canada that we believe is now well known within the refuse industry.

Commercialization

This project will provide the additional necessary infrastructure needed to make alternative fuels like, natural gas, a commercially available and preferable fueling option. WM remains committed to reducing emissions and creating cleaner solutions, such as the construction of alternative fuel natural gas fueling stations for its fleet and others within the neighborhoods that WM's employees work and live.

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

CARBON DIOXIDE (CO2)—A colorless, odorless, nonpoisonous gas that is a normal part of the air. Carbon dioxide is exhaled by humans and animals and is absorbed by green growing things and by the sea. CO2 is the greenhouse gas whose concentration is being most affected directly by human activities. CO2 also serves as the reference to compare all other greenhouse gases (see carbon dioxide equivalent).

CARBON DIOXIDE EQUIVALENT (CO2e)—A metric used to compare emissions of various greenhouse gases. It is the mass of carbon dioxide that would produce the same estimated radiative forcing as a given mass of another greenhouse gas. Carbon dioxide equivalents are computed by multiplying the mass of the gas emitted by its global warming potential.

COMPRESSED NATURAL GAS (CNG)—Natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

DIESEL GALLON EQUIVALENT (DGE)—The amount of alternative fuel it takes to equal the energy content of one liquid gallon of diesel gasoline.

GREENHOUSE GAS (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (NOx), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

STANDARD CUBIC FEET PER MINUTE (SCFM)—The molar flow rate of a gas corrected to standardized conditions of temperature and pressure, thus representing a fixed number of moles of gas regardless of composition and actual flow conditions.

WASTE MANAGEMENT (WM)— Waste Management is a North American environmental services provider headquartered in Houston, Texas. Waste management is the activities and actions required to manage waste from its inception to its disposal. This includes the

collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process.[4]

[4] About Waste Management (https://support.wm.com/hc/en-us/articles/360034758892-What-is-Waste-Management)