



California Energy Commission Clean Transportation Program

FINAL PROJECT REPORT

Los Angeles Department of Water and Power: Compressed Natural Gas Fueling Station at Western District Yard

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James Talavera Joseph Benyon Primary Authors

Los Angeles Department of Water and Power PO Box 51111 Los Angeles, CA 90051-0100

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Miki Crowell Project Manager

John P. Butler II Acting Office Manager ADVANCED VEHICLE INFRASTUCTURE OFFICE

Kevin Barker Deputy Director FUELS AND TRANSPORTATION

Drew Bohan Executive Director

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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 opportunities for projects to support installation of new natural gas fueling infrastructure and upgrades to existing natural gas fueling infrastructure. In response to PON-12-605, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards August 2, 2013 and the agreement was executed as ARV-13-014 on May 23, 2014.

ABSTRACT

The Los Angeles Department of Water and Power (LADWP) services nearly four million residents in the City of Los Angeles. LADWP provides the residents with essential water and power services. LADWP has a fleet of about 8,000 vehicles to maintain its infrastructure and facilities. Within its fleet, LADWP has alternative-fueled vehicles to support its mission to foster environmental sustainability while providing reliable utility services. One of the alternative fuels vital to LADWP's operation is compressed natural gas. Prior to the construction of the compressed natural gas fueling station at Western District Yard, LADWP did not have an adequate number of fueling locations to fuel the natural gas powered vehicles within its fleet. The installation of the fueling station at Western District Yard enabled LADWP to provide fuel to its natural gas fleet and reduce the time and mileage traveled by its vehicles. By reducing the miles traveled to fuel vehicles, LADWP reduced the amount of greenhouse gas emissions emitted from these vehicles.

Keywords: Compressed Natural Gas, fueling station, fleet

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EXECUTIVE SUMMARY

The LADWP is the nation's largest municipal-owned utility. LADWP provides essential and reliable water and power services to almost four million residents in the City of Los Angeles. It also maintains transmission facilities, aqueducts, reservoirs, hydroelectric generation plants, wind and solar energy generation facilities, and various other assets.

LADWP has an operating fleet of about 8,000 vehicles that travel all over the City of Los Angeles' 460 square miles service territory. The vehicles are used to perform work at LADWP facilities and on its infrastructure located throughout the service territory.

While accomplishing the needs of LADWP and its customers, LADWP is also committed to being a leader in environmental sustainability. LADWP has alternative-fueled vehicles and thus requires different fuel sources other than gasoline. One of these fuels is compressed natural gas. LADWP had three public compressed natural gas fueling stations at Temple Street Yard in Downtown Los Angeles, Truesdale Yard in Sun Valley, and Valley Center in Van Nuys.

The installation of a new compressed natural gas fueling station at Western District Yard enabled LADWP to expand its fueling infrastructure to its existing fleet and transportation corridors in West Los Angeles. Having a fueling station at Western District Yard reduced the trip distance of LADWP's natural gas vehicles to refuel, therefore, extending the life of LADWP's fleet as well as avoiding potential emissions from traveling to further compressed natural gas fueling stations.

Project Site: Western District Yard

Before the construction of the compressed natural gas (CNG) station at Western District Yard, Los Angeles Department of Water and Power's fleet station at Western District Yard performed routine fleet maintenance only. To refuel, fleet vehicles had to travel to any of the three CNG fueling stations at Temple Street in Downtown Los Angeles (10.8 miles away), Truesdale Yard in Sun Valley (16.6 miles away), and Valley Center in Van Nuys (19.3 miles away).

LADWP chose to build a CNG station at Western District Yard because it allows its thirty five CNG vehicles to refuel without having to travel to refuel, which reduces the amount of vehicle miles traveled by these vehicles and increases productivity.

Project Process

The goal of the project was to build a CNG station for LADWP fleet vehicles to use to reduce mileage and travel time. After five years, LADWP completed construction of the CNG fueling station in November 2018.

In April 2013, LADWP contracted Architecture, Engineering, Consulting, Operations, and Maintenance (AECOM) to produce the design of the fueling station. LADWP managed the progress of the design and met with AECOM regularly. As the design of fueling station continued, a safety issue was brought up due to the layout of the fueling site and equipment. The layout forced LADWP's heavy duty vehicles to travel around the facility to fuel them. The facility yard consisted of replacement equipment, fleet vehicles, and department buildings. The design at the time caused tight spacing for heavy duty vehicles, making it difficult and unsafe to maneuver around the facility. After several discussions and other considerations of project changes were explored, the yard layout and location of incoming power changed from the initial design to provide better traffic flow and safer access to fueling islands. On September 2015, AECOM's contract with LADWP expired before the design could be completed.

Instead of contracting out the remaining design work to another consultant, LADWP determined that it would complete the design in-house for better progress flow and to prevent any delays in hiring a new contractor. Once LADWP took over the design of the project, LADWP discovered that some of the equipment specified by the previous consultant would not meet LADWP's design requirements for the site. This discovery resulted in another redesign of the CNG fueling station. Once the design satisfied LADWP's requirements in March 2016, it went through Los Angeles Department of Building and Safety (LADBS) for approval and issuance of construction permits. LADBS reviewed the designs and required changes to be made to the site's design prior to issuing construction permits; therefore, designs had to change yet again before receiving final approval from LADBS. While LADBS reviewed the design, LADWP prepared bid specifications to hire a contractor to construct the station. LADWP advertised the bid in early 2017 and awarded to General Physics Strategies (GPS) in October 2017.

Construction of the CNG fueling station at Western District Yard started in early 2018. More than a decade before the start of this project agreement, a hazardous waste spill occurred on this site and soil and groundwater contamination remediation activities were performed. Prior to the start of construction, GPS tested the soil at the sites for contaminants from the hazardous waste spill to determine how it could store and dispose of soil that would be excavated. Once GPS determined that the soil was not contaminated, LADWP authorized GPS to begin constructing the station. Below is the finalized CNG fueling station equipment area before construction began (Figure 1).



Figure 1: CNG Fueling Station Equipment Area (Before Construction)

Source: LADWP

During the excavation period, several large weather events occurred around late February 2018 and early March 2018 that caused some of the trench walls to fail and rainwater flooded the excavated areas. GPS crews stabilized the trench walls and pumped the water out of the construction site. These failures and flooding delayed the station construction by two months. Figures 2 and 3 shows the impacts of heavy rain that filled the ongoing construction sites with water.



Figure 2: GPS Crew Pumping out Water From a Trench

Source: LADWP





After the excavation areas were fixed, GPS continued with construction and began testing and commissioning the site in November 2018. The total capacity of the CNG station is at 108,000 standard cubic foot of natural gas and has a maximum compression equipment output of 1,040 standard cubic foot per minute. The CNG is supplied by the Southern California Gas Company (SoCal Gas). The fueling station is also operating at 934 amps at 480 volts 3-phase. LADWP started collecting six months of CNG fuel usage and mileage data starting in November 2018 and completed in April 2019. Figures 4 through 8 show the finished fueling area as well as inspection of the new equipment by the LADWP crew.



Figure 4: CNG Fueling Equipment Area (After Construction)

Figure 5: LADWP Crew Inspecting and Testing CNG Equipment



Source: LADWP

Figure 6: CNG Dryer (Left Side) and CNG Compressors (Right Side)





Figure 7: CNG Fueling Station Islands (After Construction)



Figure 8: CNG Fueling Pump With Fast-Fill Hose Dispenser

Source: LADWP

Data Collection Method

At this CNG fuel station, LADWP uses a fuel management system (Figure 9) to collect data from vehicle drivers during the fuel transaction. Drivers must record the LADWP vehicle's number being fueled and current odometer reading. Once the fueling finished, the fuel management system records the number of gasoline gallons equivalent (GGE) refueled and sends the information to LADWP's fleet database.

When the fuel management system is not operating correctly, the drivers are instructed to log the vehicle number, odometer reading, and gasoline gallon equivalent dispensed manually in a fuel log book. The equipment supervisor inputs the data from the log book to the fleet database at a later time.



Figure 9: Fuel Management Terminal on CNG Fueling Island

Source: LADWP

Data Analysis Method

LADWP compared the current fueling data of Western District Yard CNG vehicles with the fueling data from when the vehicles used to fuel at the fueling station on Temple Street. The Temple Street CNG fueling station is used to compare fueling data, as opposed to Truesdale and Valley Center, because it is the closest CNG fueling station from Western District Yard. The CNG vehicles would not travel a farther distance to refuel unless their vehicles had been assigned to a job site close to the other two stations. Metrics used for comparison are difference in mileage traveled, fuel usage, and potential of greenhouse gas (GHG) emissions reductions. In the data analysis, LADWP focuses on the following GHG emissions: carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). LADWP analyzed these emissions using

the vehicle mileage traveled and emissions factors from The Climate Registry Default Emission Factor Document¹.

The total amount of fuel dispensed from the Western District Yard CNG station contains data from LADWP vehicles stationed at Western District Yard and other LADWP vehicles. Based on the operation of the new fuel management system, fueling records may not be available if the system is not functioning properly or if it is under maintenance. Total fuel dispensed for Western District Yard vehicles may not be exact because some drivers may not record the data properly or may forget to log the data. The total fuel can, in the alternative, be estimated based on the mileage traveled during the period of data collection and the average fuel usage based on the 2017 and 2018 data from LADWP's database. The individual mileage traveled would be calculated using the first and last odometer reading of the six-month data period.

For comparison, LADWP used the approximate amount of GGEs of Western District Yard vehicles to calculate simulated diesel emissions². LADWP used the emissions from the CNG vehicles and the simulated diesel emissions to estimate the amount of emissions reduced from using CNG vehicles instead of diesel vehicles.

¹ The Climate Registry Default Emission Factor Document has a list of up-to-date emission factors from publicly available data sources. Every year, The Climate Registry updates their emission factors as different components

² For this report, the emission factors for CO₂, CH₄, and N₂O will be used. Link:

⁽https://www.theclimateregistry.org/wp-content/uploads/2018/06/The-Climate-Registry-2018-Default-Emission-Factor-Document.pdf)

CHAPTER 2: Analysis and Discussion of Data Results

Data Collection

During the period of November 2018 through April 2019, a total of nearly 10,200 GGE of CNG was dispensed to over 50 different vehicles. Thirty-five of these vehicles are heavy-duty vehicles stationed at Western District Yard. The vehicles consisted of stake trucks, dump trucks, cement finisher trucks, and maintenance and construction trucks. During the data collection period, some fuel quantity data was not recorded properly for each vehicle due to a faulty fuel management system; therefore, the fuel quantity for some transactions is missing. LADWP had to estimate the missing quantity from the mileage traveled during the six-month period and the average fuel usage of the fleet. Collectively, the Western District Yard vehicles fueled at least 7,200 GGEs of CNG while they traveled 35,500 miles.

The same heavy-duty vehicles at Western District Yard fueled an average of 10,300 GGEs of CNG while they traveled an average of 50,800 miles over a six-month period from 2017 and 2018 data³. Based on the records of Western District Yard vehicles fueling at Temple Street over a six-month period from 2017 and 2018 data, the vehicles traveled 5,560 miles just to fuel at the Temple Street CNG fueling station and returning to their parking location at Western District Yard, assuming 20 miles per round trip for each transaction. This number does not include the mileage traveled to different job sites.

The average fuel efficiency for the LADWP's fleet based on the 2017 and 2018 data, is 4.91 miles per GGE. This is assumed in table 1 where data was given for GGEs of CNG dispensed and miles traveled based on extrapolation from current data.

³ A 6 month average was taken from the dispensed GGEs of CNG and mileage traveled for 2017-2018 data to stay consistent with the 6 month data collection.

Table 1: Current and 2017-18 Data GGEs of CNG Dispensed and Miles Traveled			
	Six-Month Data from	Average Six-Month Data	
	November 2018 to April	from January 2017 –	
	2019	December 2018 ⁴	
GGEs of CNG Dispensed	7,200	10,300	
Miles Traveled	35,500	50,800	
Round Trip Mileage			
from Western District	0	5,560	
Yard to Temple Street			

Source: LADWP

Data Results and Impacts

The Climate Registry Default Emission Factor Document states CNG and diesel emission factors for CO₂, CH₄ and N₂O. These are reflected in the values in table 2.

Table 2: Emission Factors for CO₂, CH₄ and N₂O in Kilograms per GGE

	CO ₂	CH ₄	N ₂ O
CNG	6.90	0.0097	0.000860
Diesel ⁵	10.21	0	0

Source: Climate Registry 2018 Default Emission Factor Document

Using these emission factors in Table 2, LADWP staff calculated the CNG and simulated diesel vehicle emissions with the amount of GGEs dispensed from the current six month data period. LADWP staff also calculated avoided emissions by simulating emissions from the round trip mileage to the Temple Street CNG fueling station using the amount of transactions Western District Yard has from its vehicles. The round trip mileage (20 miles) multiplied by the amount of transactions provides the simulated total miles traveled. LADWP staff calculated the avoided emissions by dividing the simulated total miles traveled by the average fuel efficiency. The results are in metric tons of CO₂ emissions equivalent (CO_{2e}). These values are calculated in Table 3 and 4.

⁴ The average 6 month data from January 2017 through December 2018 was calculated by summing up the total amounts of GGEs of CNG dispensed, miles traveled, and round trip miles for Western District Yard vehicles; then, the sum is divided by 4 since there are four 6-month periods within two years.

	CO2 Emissions (metric tons)	CH4 Emissions (metric tons CO2e)	N ₂ O Emissions (metric tons CO ₂ e)	Grand Total (metric tons CO2e)
CNG Emissions	49.65	1.74	1.84	53.23
Simulated Diesel Emissions ³	64.69	0	0	64.69
Total Reductions	15.04	0	0	11.46

Table 3: Calculated Six-Month Emissions Reductions in Metric Tons of CO2e

Source: LADWP

Table 4: Calculated Avoided Six-Month Emissions in Metric Tons of CO2e

	CO2 Emissions (metric tons)	CH₄ Emissions (metric tons CO₂e)	N ₂ O Emissions (metric tons CO ₂ e)	Grand Total (metric tons CO2e)
Avoided CNG Emissions	6.00	0.21	0.22	6.43

Source: LADWP

About 7,200 gasoline gallons, or 6,300 diesel gallons⁶, was displaced by CNG based on the November 2018 through April 2019 GGE data from Table 1. From Table 3, there is a decrease of 18 percent in CO_2 , CH_4 , and N_2O based on six months of CNG usage data versus diesel usage. Since the heavy-duty vehicles do not have to travel to Temple Street anymore, the vehicles avoided at least 6 metric tons of CO_2e emissions as seen in Table 4.

From the information above, the estimated carbon intensity value of this project for simulated diesel emissions is 20 pounds⁷ of CO_2 per GGE, or 23 pounds of CO_2 per diesel gallons equivalent (DGE). The estimated carbon intensity of CNG usage is 16 pounds of CO_2 per GGE, or 19 pounds of CO_2 per DGE. By using CNG vehicles, LADWP avoids approximately 3 pounds of CO_2 per GGE.

The mileage traveled difference can be calculated from Table 1. From an average of six months, the heavy-duty vehicles decreased mileage travel by at least 15,000 miles every six months or 30,000 annually. From this decrease, the current duty cycle of the fleet saves at least 30,000 miles per year. If the facility seeks to acquire future or replacement CNG vehicles,

⁵ Diesel emissions for methane and nitrous oxides are negligible.

^{6 1} gasoline gallons equivalent = 0.877 diesel gallon equivalent

^{7 1} metric ton = 2204.6 pounds

the expected duty cycle can account for tasks done within its service territory without having to refuel at Temple Street. New fleet vehicles would be expected to perform more jobs than the current fleet in overall lifetime.

Troubleshooting

The software of the new fuel management system had some incompatibilities with LADWP's database during the six-month data collection period and it was not possible to instantly record data.

A majority of the recorded data was manually written down by drivers. Some employees forgot to record their fueling data and since some data not included in this analysis, LADWP used an alternative estimation method.

CHAPTER 3: Conclusions

The Western District Yard CNG fueling station is in operation. LADWP CNG vehicles and its employees working within the western side of its service territory are refueling at the Western District Yard CNG fueling station. Fifty LADWP vehicles have refueled at the new CNG fueling station based on current data, with 35 of them stationed at Western District Yard.

Operational and Environmental Benefits

The current layout of the yard allows the heavy-duty vehicles to move through without difficulty or safety issues. This prevents unnecessary idling and easy maneuvering, which allows the vehicle to refuel seamlessly.

The Western District Yard vehicles do not need to travel longer distances to Temple Street for refueling since the construction of the fueling station, resulting in an 18 percent reduction of GHG emissions and 30,000 avoided miles traveled annually. This exceeds the agreement goal of reducing 20,000 miles annually. This also benefits LADWP as the fueling station significantly reduces wear and tear on the heavy-duty vehicles, which can be expensive to maintain.

Economic and Job Development

The CNG fueling station does not give the public access to their pump stations and remains exclusive to LADWP vehicles. Therefore, there is little potential for LADWP to increase its revenue or develop jobs as a result of this project.

However, the design and construction of the fueling station allowed LADWP to hire contractors. During the project, LADWP hired two contractors: AECOM and GPS. GPS also had subcontractors to supply and fabricate the equipment to complete construction.

Moving Forward

The construction of the fueling station furthers LADWP's progress in decreasing GHG emissions. The project was a success and exceeded the goals of the agreement. However, LADWP experienced some obstacles that it could have avoided if there had been less personnel turnover throughout the design and construction of the CNG fueling station. This project changed design groups within LADWP midway through the design that caused significant schedule delays while the new team was getting up to speed. In addition, there were several staff changes throughout the project that caused delays while personnel were on-boarded to the project. LADWP will continue to track the CO₂, CH₄ and N₂O emission reductions as a result of the installation of the CNG station.

GLOSSARY

ALTERNATIVE AND RENEWABLE FUEL AND VEHICLE TECHNOLOGY PROGRAM (ARFVTP)-Created by Assembly Bill 118 (Nunez, Chapter 750, Statutes of 2007), the program with an annual budget of about \$100 million supports projects that develop and improve alternative and renewable low-carbon fuels, improve alternative and renewable fuels for existing and developing engine technologies, expand transit and transportation infrastructures, and establishing workforce training programs, conduct public education and promotion, and create technology centers, among other tasks.

ARCHITECTURE, ENGINEERING, CONSULTING, OPERATIONS, AND MAINTENANCE (AECOM)-A multi-national engineering consulting firm contracted by LADWP to design the CNG fueling station. The contract ended prior to the design completion.

CARBON DIOXIDE (CO2)-A greenhouse gas produced from a variety of sectors, including the usage of compressed natural gas. It is a colorless and odorless gas produced from burning carbon. Greenhouse gases are often compared to CO2 as CO2 equivalents due to its longevity in the atmosphere and production from human activities.

COMPRESSED NATURAL GAS (CNG)-A renewable alternative fuel that is stored at high pressure and produces less air pollution than gasoline.

DIESEL GALLON EQUIVALENT (DGE)-The amount of compressed natural gas equivalent to one liquid gallon of diesel. (1 DGE = 1.14 GGE)

GASOLINE GALLON EQUIVALENT (GGE) -The amount of compressed natural gas equivalent to one liquid gallon of gasoline. (1 GGE = 126.67 cubic feet)

GENERAL PHYSICS STRATEGIES (GPS)-A multi-national engineering and construction services company contracted by LADWP to construction the CNG fueling station. GPS was the general contractor on the project.

GREENHOUSE GAS (GHG)-A gas that absorbs infrared radiation, which causes a "greenhouse effect" in the atmosphere. The excessive release of these gases is a main contributor to global warming. Different gases have different global warming potentials, or the ability to trap heat in the atmosphere.

LOS ANGELES DEPARTMENT OF BUILDING AND SAFETY (LADBS)-A department within the City of Los Angeles that advises, guides, and assists customers to comply with various building and utility codes.

LOS ANGELES DEPARTMENT OF WATER AND POWER (LADWP)-The largest municipal water and power utility in the nation that provides water to more than 600,000 customers and electricity to 1.4 million customers. The owner and operator of the CNG Fueling Station.

METHANE (CH4)-A greenhouse gas produced from a variety of sectors, including the usage of compressed natural gas. It has a global warming potential of 25 times that of carbon dioxide.

NITROUS OXIDE (N2O) -A greenhouse gas produced from a variety of sectors, including the usage of compressed natural gas. It has a global warming potential of 298 times that of carbon dioxide.