



California Energy Commission Clean Transportation Program

FINAL PROJECT REPORT

Lemoore Union High School District

Natural Gas Fueling Infrastructure

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Mark Howard, Director of Business Services **Primary Authors**

Lemoore Union High School District 5 Powell Avenue Lemoore, CA 93245 Lemoore Union High School District web page (http://www.luhsd.k12.ca.us/)

Agreement Number: ARV-16-008

Sarah Williams Commission Agreement Manager

Elizabeth John Office Manager ADVANCED FUELS AND VEHICLE TECHNOLOGIES OFFICE

Hannon Rasool
Deputy Director
FUELS AND TRANSPORTATION

Drew Bohan Executive Director

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California Energy Commission:

• Sarah Williams | Project Manager

Lemoore Union High School District:

- Debbie Muro | Superintendent
- Mark Howard | Director of Business Services
- Michael Doria | Director of Facilities & Operations
- Alan Decker | Director of Transportation

City of Lemoore:

- Linda Beyersdorf | Finance Manager
- Amanda Champion | Management Analyst
- Frank Rivera | Construction Superintendent

AECOM:

- William Black | Principal Engineer
- Allen Randall | Principal Electrical Engineer

Fueling and Service Technologies, Inc:

• Jeff Latham | Project Manager

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation 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 GFO-16-602 to establish or expand infrastructure necessary to store, distribute and dispense compressed natural gas for use in natural gas vehicles. In response to GFO-16-602, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards December 20, 2016 and the agreement was executed as ARV-16-008 on February 22, 2017.

ABSTRACT

The Lemoore Union High School District refueling station project upgrades the existing compressed natural gas refueling station at 867 Iona Avenue in Lemoore (Kings County). A grant from the CEC allows the district to expand the existing compressed natural gas fueling station, which was originally built in 2012. The compressed natural gas station was upgraded to add one 200 standard cubic feet per minute compressed natural gas compressor, one fast-fill fueling dispenser, relocate the fueling island and install a canopy over the station. These improvements enhance the stations capabilities in support of the district's compressed natural gas fleet of student transportation vehicles, the City of Lemoore's service vehicles, as well as reliability and capacity to the public.

The compressed natural gas fleet has increased from nine buses in 2016 to 11 buses in 2017. The City of Lemoore has one compressed natural gas front loading refuse truck on order and expected to deliver in February of 2020. The new station increased compressed natural gas filling capacity to accommodate these needs and included electrical upgrades and spatial and infrastructure provisions for future expansion.

The project provided an upgraded electrical service, one 200 standard cubic feet per minute compressed natural gas compressor, one fast-fill fueling dispenser with two fueling houses and add a protective canopy. The fast-fill system is designed so two full-size buses can refuel simultaneously and deliver 30 gallons of gasoline equivalent per hose in a continuous five- to eight-minute period.

The fast-fill component will allow the district to enter refueling station access agreements with neighboring public agencies or to sell compressed natural gas at retail prices for personal vehicles. The district received verbal commitments for station usage from several other public entities in the area with a need for access to compressed natural gas fuel for their own fleets of transportation vehicles.

Keywords: Lemoore Union High School District, compressed natural gas, fueling station, natural gas infrastructure, natural gas bus fleet

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EXECUTIVE SUMMARY

This project sought to upgrade the existing compressed natural gas refueling station at Lemoore Union High School District's Transportation facility. The district upgraded the refueling station to add greater compression capabilities, fast-fill refueling capabilities and a canopy to cover the public fill stations.

The fleet has increased from nine compressed natural gas buses in 2016 to eleven compressed natural gas buses 2017. The compressed natural gas facility is shared with the City of Lemoore compressed natural gas fleet, and the City added two large Sewer Trucks and plans to add one Refuse vehicle.

With CEC funding, the district can construct the expanded compressed natural gas fueling station project. AECOM was contracted by the district to be the lead engineering agent for the station design and Fueling and Service Technologies, Inc. was contracted to complete the construction of the compressed natural gas fueling station expansion project.

Construction started on August 29, 2018 and was substantially completed in April of 2019.

The district installed one new 200 standard cubic feet per minute natural gas compressor, added one fast-fill refueling station, and added a canopy over the public fuel dispensers. The District has received a lot of positive feedback from internal and external stakeholders that frequent the station.

CHAPTER 1: Project Goals and Objectives

Introduction

The City of Lemoore is in the center of California, near the middle of the Central Valley. The Lemoore Union High School District serves approximately 2,200 students in one comprehensive high school, one continuation high school, two charter high schools and one adult school. The schools are widely known for their commitment to academic excellence for all students and the District has recently earned the designation as a "California Distinguished School District."

Background

The Lemoore compressed natural gas (CNG) station is jointly operated by the Lemoore Union High School District, Lemoore Union Elementary School District, Central Union School District, Island Union School District, and the City of Lemoore. The four school districts formed the group, Lemoore Area Schools Transportation, to provide a central transportation facility to support each of the districts. Lemoore Area Schools Transportation provides daily transportation for 1,111 students in the greater Lemoore area and throughout Kings County and serve as many as 7,600 students annually in the four school districts providing transportation for field trips and after-school sports. Lemoore Area Schools Transportation currently operates eleven CNG school buses and two CNG Honda Civics. The City of Lemoore, population 25,000, recently converted its fleet of refuse vehicles to CNG. Presently, they have five CNG refuse vehicle, two large Sewer Trucks, one CNG street sweeper, two CNG Honda Civics, three CNG Ford Focus and two CNG Ford Transit vans. The City of Lemoore's CNG fleet has grown significantly, with plans to add one refuse vehicle in the near future.

Original Station

When the station first opened in September 2012, the public usage was unknown. We are now seeing up to 10,000 gas gallon equivalents (GGEs) per month being dispensed to the public and local fleets, including CalVans and Kings County Area Public Transit Agency. The original station consisted of two 75 standard cubic feet per minute (scfm) compressors (Figure 1), one gas dryer, 20 time-fill hoses, two fast-fill hoses, and nine 12,000 standard cubic foot American Society of Mechanical Engineers storage vessels. The school districts and the City of Lemoore fill their vehicles overnight at the time-fill hoses and the public and other area fleets are able to use a credit card or Lemoore CNG Gas Card to fill at the fast fill pumps. The fast-fill pumps are served by the nine storage vessels.



Figure 1: Original 75 SCFM Compressors

Source: Lemoore Union High School District

Due to the growth in the Lemoore Union High School District bus fleet and City of Lemoore's CNG fleet, we have collectively added enough CNG busses and city vehicles to the time fill station that we often do not receive a full fill during the week. In addition to the City's plans to add vehicles, Lemoore Union High School District has also added two CNG busses, which have only increased the demand on the plant. This project was designed to at least double the compression capacity of the plant and ensure a complete fill of our vehicles on the time fill as well as enhance the redundancy and reliability of the plant in the event a compressor is down for maintenance. Furthermore, with the increased demand from the public fast fill stations, the additional compressors will be able to more quickly refill the fast fill tanks and allow for increased service capabilities at the pump.

Project Approach

To meet our objective of increasing the throughput of CNG from our station and accommodate large 18-wheeler trucks to fill at the public dispenser, the station was upgraded with the following components:

- one 200 scfm compressor
- one transit-fill dispenser
- relocation of the dispenser fueling island to allow large vehicles adequate clearance on both sides of the dispensers
- one shade canopy over the dispenser fueling island

The new 200 scfm compressor is shown in Figure 2.



Figure 2: New 200 SCFM Compressor

Source: Lemoore Union High School District

The scope of work approved in the grant included the following technical tasks related to the design, engineering and the construction of the CNG fueling station expansion project:

Engineering and Design

The goal of this task is to complete all required design and engineering work, to enable successful construction of the natural gas fueling facility.

- Inspect facility location and determine necessary design and planning work.
- Complete engineering, design and construction plans for facility.
- Develop list of equipment to be procured.

Construction and Operation

The goal of this task is to construct the natural gas fueling facility and operate the facility for six months.

- Prepare site for equipment installation.
- Purchase equipment.
- Install natural gas fueling facility equipment at site.
- Inspect and verify equipment complies with all applicable safety regulations.

- Prepare and submit documentation of results of the inspection which will include photographs, observations about the equipment, and declaration that the equipment complies with all applicable safety regulations.
- Fuel natural gas vehicles at facility for six months.

Data Collection and Analysis

The goal of this task is to collect operational data from the project, to analyze that data for economic and environmental impacts, and to include the data and analysis in the Final Report.

- Collect 6 months of throughput, usage, and operations data from the project.
- Identify any current and planned use of renewable natural gas at the facility.
- Compare any project performance and expectations provided in the proposal to Energy Commission with actual project performance and accomplishments.

CHAPTER 2: Project Results

The district opened the new dispensers to the public in February of 2019 and completed the project in April of 2019. The completed CNG station is shown in Figure 3.



Figure 3: Completed CNG Station Expansion Project

Source: Lemoore Union High School District

Table 1 below captures the monthly fuel consumption reported by the district from February 2019 through July 2019.

6-Month Throughput	19-Feb	19-Mar	19-Apr	19-May	19-Jun	19-Jul			
Fast Fill Dispensers (GGE)	3,958.88	6,761.30	2,489.42	2,443.10	2,272.85	2,092.91			
Time Fill Dispensers (DGE X 1.136 = GGE)	4,629.17	5,541.75	5,157.39	5,926.61	4,289.25	3,421.95			
TOTAL GGE:	8,588.05	12,303.05	7,646.81	8,369.71	6,562.10	5,514.86			

Table 1: Monthly Fuel Consumption

Source: Lemoore Union High School District

The total GGE consumed in the 6 months prior to the new station coming online was 44,221 GGE, as compared to the total GGE consumed in the 6 months after the new station was 48,985 GGE (Figure 4). We anticipate this to continue to increase, once Waste Management brings its new CNG trucks online to serve our area. This is an increase of almost 4,800 GGE over 6 months, which is about 5,700 therms. This is a direct reduction of about 85 greenhouse gas pounds. This is in addition to the 44,221 GGE (653 greenhouse gas pounds) of maintaining the station in operations. As the fleet increases these reductions will increase.



Figure 4: Total GGE Consumed

Source: Lemoore Union High School District

Assumptions and Conversion Factors

The district used the following conversion factors in calculating the environmental impacts noted above (greenhouse gas emissions avoided):

- The project team estimated of natural gas dispensed (therms or standard cubic feet) and converted therms or standard cubic feet into British thermal units (one therm = 100,000 British thermal units).
- Using standard cubic feet, district staff used the U.S. Energy Information Administration's estimate that California's natural gas has: 1,036 British thermal units /standard cubic feet.
- CNG dispensed was converted into megajoules (MJ) by using 1 MJ = 947.8 British thermal units.
- DGE dispensed was calculated by dividing MJ of CNG fuel dispensed by MJ per gallon of diesel (146.3 MJ/diesel gal).

For greenhouse gas emissions avoided:

- The project team multiplied the megajoules of CNG dispensed by differential between CNG and diesel carbon intensity: 15.74 grams carbon dioxide equivalent/MJ.
- The team then converted the grams figure into pounds of carbon dioxide equivalent.

CHAPTER 3: Project Assessment

The project sought to expand the existing CNG fueling station to support the districts and the City's growing CNG fleet, which addresses the goals of the Clean Transportation Program by reducing dependence on fossil fuels and expanding alternative fuel infrastructure in California. The completed CNG refueling station expansion project succeeded in helping the district achieve these goals and the goals of the CEC.

Project Success

The project effectively more than doubled the potential CNG output capabilities of the station and increased the fueling capacity available to the public. District and City vehicles now receive full fills each night on the time-fill posts. Large 18-wheeler trucks can now fill at the transit dispenser in under 5 minutes. The shade canopy has attracted more attention from commuters traveling on the 198 and 41 freeways. Waste Management has recently contacted the District to setup gas card accounts as they intend to add 5 new CNG dump trucks to their fleet in our area. All stakeholders have been very pleased with the results of the new CNG station expansion.

Project Conclusions

Numerous conclusions and lessons learned have been identified because of this project. The first lesson learned throughout this project was the importance of coordinating with all public and private utilities, which may affect the project. Utility companies have very long lead times to schedule any site upgrades and is best to contact them as early as possible to schedule the project. Additionally, we experienced delays in the procurement process shortly after the grant award due to minor scope of work concerns had by the City of Lemoore. In hindsight, it would have benefited the project schedule to have all engineering plans complete and reviewed by the City prior to submitting the grant so that the project was "shovel ready" after award.

The project was also slow to start due to procurement challenges. The low bidder was disqualified due to non-compliance with the bid documents and subsequently, we needed to secure additional funding before proceeding with award to the winning bid. We were able to secure additional match funding with the City of Lemoore and proceed with the project. With a little luck and help from the construction team and the CEC, we managed to execute a successful project once we broke ground. Despite the high degree of administration burden associated with not only the District's procurement and construction policies, but the grant requirements as well, we are all very happy with the end result and are grateful for the opportunity to work with the staff at the CEC.

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.

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 fuel.

GASOLINE GALLON EQUIVALENT (GGE)—The amount of alternative fuelit takes to equal the energy content of one liquid gallon of gasoline. GGE allows consumers to compare the energy content of competing fuels against a commonly known fuel—gasoline. GGE also compares gasoline to fuels sold as a gas (natural gas, propane, and hydrogen) and electricity.

MEGAJOULE (MJ)—A joule is a unit of work or energy equal to the amount of work done when the point of application of force of one newton is displaced one meter in the direction of the force. It takes 1,055 joules to equal a British thermal unit. It takes about one million joules to make a pot of coffee. A megajoule itself totals one million joules.

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.