



**CALIFORNIA  
ENERGY COMMISSION**



**CALIFORNIA  
NATURAL  
RESOURCES  
AGENCY**

Clean Transportation Program

## **FINAL PROJECT REPORT**

# **City of San Diego Compressed Natural Gas Fueling Facility Final Report**

**Prepared for: California Energy Commission**

**Prepared by: City of San Diego**

The City of  
**SAN DIEGO** 

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# California Energy Commission

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# PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the 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-14-608 to fund projects that establish or expand infrastructure necessary to store, distribute and dispense compressed natural gas for use in natural gas vehicles, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards August 12, 2015 and the agreement was executed as ARV-15-013 on date of March 17, 2016.



# ABSTRACT

The City of San Diego's Environmental Services Department's compressed natural gas refueling station project installed new infrastructure at an existing operations yard located at the Collection Services Division at 8353 Miramar Place in San Diego. A grant from the CEC allowed the City of San Diego to purchase several key pieces of equipment necessary to complete the fueling station, the first phase of which was completed in spring 2017. The new facility serves the needs of both the Division as their current diesel collections fleet is in the process of being replaced with compressed natural gas-fueled collection vehicles. This facility also accomplishes a major goal of the City of San Diego to significantly reduce large amounts of greenhouse gases from its vehicle fleet. The facility allows vehicles to effectively utilize their entire fuel capacity via a slow fill fueling method, which further increases the efficiency of the fleet, as well as provides a significant cost savings by eliminating the need to rely on privately run fueling facilities.

Construction was accomplished through a contract with EFS West. The first phase of the project included the installation of natural gas compressors designed by Clean Energy Compression, 13 Fastech quad-hose time-fill assemblies, a dual hose fast-fill dispenser, and three storage tanks. This first phase allows the facility to fuel 52 vehicles simultaneously.

In 2018, the goal is to complete the final phases of the project which involve the installation of additional fueling hoses, as well as additional compressed natural gas storage tanks. When the final phase is complete, the facility will have the capability of fueling 140 compressed natural gas vehicles simultaneously.

**Keywords:** City of San Diego (The City), compressed natural gas (CNG), natural gas vehicles, greenhouse gas (GHG)

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## EXECUTIVE SUMMARY

As a municipality in the Twenty-First Century, it is impossible to ignore the effects of climate change on a City's residents and surrounding communities. San Diego, being on the west coast of the United States, has had a variety of challenges to endure unique to this region of the world. As a response to these concerns, the State of California implemented Assembly Bill 32 in 2006 and the California Air Resources Board established their own Climate Change Scoping Plan. In December of 2015 the City of San Diego developed a Climate Action Plan to reduce greenhouse gas emissions and decrease dependence on non-renewable resources. In order to effectively implement this plan, the City of San Diego identified five key strategies.

The second strategy within the Climate Action Plan focuses on clean and renewable energy. With this strategy in place, the City of San Diego aims to increase the number of zero-emission vehicles within the City of San Diego by converting the existing diesel-fueled refuse collection fleet to Compressed Natural Gas vehicles.

In order for this conversion to take place, the construction of a compressed natural gas fueling facility at the Environmental Services Department's Collection Services Division was required. The funding of this fueling facility, with the help from the CEC, will significantly reduce the amount of greenhouse gasses produced by the City of San Diego on a daily basis. This is due in part to the elimination of 140 diesel-fueled collection vehicles altogether, resulting in a reduction of approximately 1 million diesel gallons per year.

In 2013, the Environmental Services Department began developing a financial model to estimate the costs of installing the necessary infrastructure to fuel these new Compressed Natural Gas vehicles. The City of San Diego selected EFS West to serve as the design/build contractor and design work began in February 2016. The designs were completed later that year.

In an attempt to offset costs for the City, an application for this Grant (ARV-15-013) was submitted to finance the purchase of several key pieces of equipment necessary to operate the new Compressed Natural Gas fueling facility. This equipment included compressors, a time fill assembly, a gas dryer, electrical switchgear, and other associated parts. The cost of this equipment, totaling \$886,501.59, was significantly reduced as a result of the \$250,000 provided by this grant.

Following the construction of this facility, the first 20 Compressed Natural Gas vehicles began fueling in April 2017. At the time of this report creation, there are 36 refuse collection vehicles being fueled every night within the City's operations yard. An analysis of fuel usage among these vehicles shows that each new Compressed Natural Gas vehicle is displacing an average of 800 gallons of diesel fuel per month. This equates to a reduction in approximately 1.34 metric tons Carbon Dioxide equivalent per vehicle per month. The Division plans to replace approximately 20 diesel-powered vehicles each year until the entire fleet of 140 vehicles is operating solely on Compressed Natural Gas.

The project to date has been extremely successful. All Compressed Natural Gas vehicles that are currently in service in our division are successfully fueling up each night and our drivers are quickly adapting to the small operational differences of these trucks compared to their previous diesel models. There have been a few unexpected challenges, but they are minor compared to overall success of the project. For example, if a vehicle is filled with refuse and

unable to dump it at a landfill by the end of the day, they are unable to fuel up at night. This is a safety precaution in the unlikely chance that the vehicle picked up something combustible while on its route. This causes the driver to fuel up the next day at a nearby privately owned fueling facility, which causes a slight delay in our daily operations. Lastly, we have learned the importance of open communication between all involved parties, including Public Works. A slight miscommunication could result in a delay in the project timeline. However, these issues were minor compared to the overall success of the first phases of this process and we look forward to completing the final phases in the months to come.

# **CHAPTER 1:**

## **Project Purpose and Approach**

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### **Introduction**

In January 2013, the City's Environmental Services Department began evaluating the financial and environmental benefits of converting its fleet of refuse and recycling collection vehicles from low-sulfur diesel to CNG. A financial model was developed that considered fuel prices, required fueling infrastructure necessary to support a large fleet of heavy-duty vehicles, additional operational and maintenance costs, and increased vehicle costs compared to projected costs of continuing to utilize diesel. The results of the study were compelling from a financial perspective as well as environmentally. The evaluation team prepared a report that was presented to the City management for consideration and in Fiscal Year 2015 \$1.2 million was allocated to the project to begin the contractor selection process. In Fiscal Year 2016 the Department requested an additional \$900,000 for the project budget with the plan to add another \$900,000 in Fiscal Year 2018 for a total budget of \$3.0 million.

In September of 2014, the City issued a Request for Qualifications to pre-qualify contractors interested in designing and constructing a time fill fueling facility at the City's Environmental Services Operations Station. Four contractors responded and three met the minimum qualifications and were allowed to submit Requests for Proposal in April 2015. However, after selecting the contractor with the lowest bid, a funding issue arose. The project bid came in at \$4.6 million, and when coupled with other project related costs the total estimate rose to \$5.3 million. Therefore, the Environmental Services Department looked for additional funding, \$250,000, from a solicitation of CNG infrastructure projects issued by the CEC helped to complete the project.

### **Background**

This project was put in place to accomplish several city-wide goals. The first was to deploy alternative/renewable fuels and advanced transportation technologies to help attain the state's climate change, clean air, and alternative energy policies. The second goal was to ensure a supply of stably priced fuel using technologies that were proven in the waste collection industry. The construction of the Collection Services Division's CNG fueling infrastructure was required in order to support the planned conversion of the refuse and recycling collection vehicles to natural gas. Concurrently, these goals helped the Department reach critical City-wide benchmarks of reducing greenhouse gas emissions in the San Diego area and reduce dependence on foreign oil.

The existing operations facility located at 8353 Miramar Place is the fueling and storage location for the entire fleet of diesel collection vehicles for the City's Collection Services Division. It currently has four fast-fill diesel pumps for the vehicle fleet, as well as any other City vehicle that requires fueling. As the fleet is transitioned to CNG, they will begin utilizing the new facility, and the existing diesel pumps will be primarily used by other City Divisions and smaller diesel vehicles still in operation in the Collection Services Division.

## **Project Objective**

The objective of this project was to design and construct a new CNG fueling facility to serve the City's Refuse Collection Fleet. The project has been implemented in four phases, consisting of an initial design/permitting phase followed by three phases of construction, sequenced to coincide with multi-year procurement cycle of new CNG-powered refuse trucks. The project also includes CNG-related upgrades to the adjacent vehicle repair facility to comply with requirements of the California Fire Code. The project will reap environmental benefits from the utilization of cleaner-burning natural gas (vs. diesel) as well as financial benefits resulting from the significantly lower cost of natural gas vs. diesel as a fuel source. The following equipment as shown in Table 1 was purchased for the fueling facility, funded in part by the \$250,000 provided by the California Energy Commission's grant.

**Table 1: Equipment Purchase Breakdown**

<b>Equipment Parts</b>	<b>Vendor</b>	<b>Invoice #</b>	<b>Detail</b>	<b>Qty</b>	<b>Vendor's Total Price</b>	<b>Tax</b>	<b>Freight / Misc.</b>	<b>Total</b>	<b>CEC Funds</b>	<b>Match Share</b>
Compressor	Clean Energy Compression	OP12493-PF	IMW50-7250DA-300-4500-5AC Right	1	\$216,021			\$216,021	\$60,920	\$86,396
Compressor	Clean Energy Compression	OP12493-PF	IMW50-7250DA-300-4500-5AC Left	1	\$216,021			\$216,021	\$60,920	\$86,396
Compressor	Clean Energy Compression	OP12493-PF	3" 300# inlet kit flex hose, manual ball valve	2	\$3,040			\$3,040	\$857.30	\$1,216
Compressor	Clean Energy Compression	OP12493-PF	Master Control Hybrid Panel (MCH)	1	\$25,251			\$25,251	\$7,121	\$10,099
Compressor	Clean Energy Compression	OP12493-PF	Motor Control Center	1	\$19,198			\$19,198	\$5,414	\$7,678
Compressor	Clean Energy Compression	OP12493-PF	3-line Priority Panel, 5000 psi	1	\$34,910			\$34,910	\$9,845	\$13,961
Compressor	Clean Energy Compression	OP12493-PF	Upgrade priority panel cabinet from N12 to N4X	1	\$7,259			\$7,259	\$2,047	\$2,903
Compressor	Clean Energy Compression	OP12493-PF	Upgrade of 1" external manual ball valve	1	\$768			\$768	\$217	\$307
Compressor	Clean Energy Compression	OP12493-PF	Flowmeter adder on time fill line	1	\$8,951			\$8,951	\$2,524	\$3,580
Compressor	Clean Energy Compression	OP12493-PF	Commissioning	1	\$16,667			\$16,667	\$4,700	\$6,666
Time Fill Assembly	Fastech	INV045213	Quad-Hose Time Fill Posts	13	\$91,741	\$7,339	\$400	\$99,480	\$28,054	\$39,786

<b>Equipment Parts</b>	<b>Vendor</b>	<b>Invoice #</b>	<b>Detail</b>	<b>Qty</b>	<b>Vendor's Total Price</b>	<b>Tax</b>	<b>Freight / Misc.</b>	<b>Total</b>	<b>CEC Funds</b>	<b>Match Share</b>
Storage	FIBA Technologies	38440	HG-03-1304-23-00-CNG-EFS-01, 23' LG ASME 5500 psi...	1	\$70,050	\$5,604		\$75,654	\$21,335	\$30,257
Gas Dryer	PSB Industries	53400	NG-SR 21-6DDP, Dryer 460V	1	\$19,752			\$19,752	\$5,570	\$7,900
Gas Dryer	PSB Industries	53600	NG-SR 21-6DDP, Dryer 460V	1	\$19,752			\$19,752	\$5,570	\$7,900
Gas Dryer	PSB Industries	54151	NG-SR 21-6DDP, Dryer 460V	1	\$39,505			\$39,505	\$11,141	\$15,800
Fast Fill Dispenser	Kraus Global	55136	Dual hose fast fill Kraus dispenser	1	\$9,900		\$1,207	\$41,107	\$11,592	\$16,440
Switchgear	CED	2106-418716	Switchboard MS w/ Quick Connect	1	\$40,060	\$3,105		\$43,165	\$12,173	\$17,263

Source: The City

# CHAPTER 2:

## Project Activities and Results

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### Project Approach:

The entire CNG fueling facility project encompasses design, planning, permitting, equipment procurement, construction, start up, and training for a CNG time-filled fueling station to be owned and operated by the City and located at the Environmental Services Operations Station at 8353 Miramar Place, San Diego, CA 92121. The Design Build Contractor has coordinated with the City staff, San Diego Gas and Electric staff, and other oversight/permitting agencies while preparing and submitting detailed plan drawings to the City’s Development Services Department for permit approval and any related reports or studies to ensure a timely, well-coordinated, and properly designed project and build out.

The project is being constructed in three (3) phases and will include at completion the ability to fuel 140 refuse trucks over an eight (8) hour fueling window. The major components of the project include the combination of compressors and enclosures (skids), compressor control panels, gas dryers with onboard regeneration systems, programmable logic controllers based electronic station control system, pressure vessel storage assemblies, time-fill hoses, and the connection to the San Diego Gas and Electric gas pipeline at the property line. These items can be seen in Figure’s 1 through 3. All related equipment and appurtenances for proper and safe operation of a CNG facility meet site constraints, as well as local, State, and federal standards.

**Figure 1: Clean Energy Compressors**



Source: The City

Phase 1 included site preparation and the majority of the fueling infrastructure to accommodate up to 35 percent of the existing refuse and recycling collection fleet, which were converted to CNG by the completion of the project (Phase 1). The tasks attached to Phase 1 and their start and finished dates can be seen in Table 2 below. Phases 2 and 3 are dependent on the remaining 65 percent of the CNG vehicle acquisition to occur over a five (5) year procurement period. This procurement period has remained on track, as approximately 20 vehicles per year are being replaced with new CNG models until the entire fleet is converted. For the purposes of this report, the City’s agreement with the CEC encompasses the pre-construction tasks, as well as the first phase of construction.

**Table 2: Pre-Construction / Phase 1 Project Timeline**

<b>Task #</b>	<b>Task</b>	<b>Start</b>	<b>Finish</b>
1	Pre-Construction Notice to Proceed	2/11/16	2/11/16
2	Pre-Construction Design/Permitting	2/11/16	9/14/16
3	Phase 1 Notice to Proceed	8/29/16	8/29/16
4	Phase 1 Submittals/Equipment Procurement	8/29/16	12/30/16
5	Phase 1 Construction (Overall)	9/15/16	2/24/17
6	Phase 1 Construction (Mobilization/Layout)	9/15/16	2/24/17
7	Phase 1 Construction (Civil/Structural)	9/29/16	12/5/16
8	Phase 1 Construction (Electrical)	10/19/16	2/3/17
9	Phase 1 Construction (Mechanical)	10/11/16	2/3/17
10	Phase 1 Construction (System Startup/Testing/Final Inspection)	2/6/17	2/24/17
11	the City Acceptance/Turnover	2/24/17	2/24/17

Source: The City

**Figure 2: Quad-Fill Hoses**



Source: The City

The project includes allocations to maintain the equipment (compressors, dryers, hoses, storage tanks, etc.) at a level that will allow the facility to run effectively indefinitely. Proper equipment maintenance will afford the City a reliable, efficient station that is cost effective and dependable.

**Figure 3: 5500 PSI Storage Tanks**



Source: The City

The Department will utilize the Program Manager and other internal City staff to manage the work of the selected contractor to ensure that the project remains on time and on budget. The proposed project schedule outlines how the project will be executed in a timely manner.

The Environmental Services Operation Station is an 11.14-acre facility located at 8353 Miramar Place, San Diego, CA that is the home to the City's fleet of refuse and recycling collection vehicles. The site has parking for the fleet (140 vehicles), an 18-bay vehicle maintenance facility (repair shop), administrative offices, locker rooms, truck wash, refuse and recycling container storage, and various other buildings. Space for the necessary equipment and the fueling lines exists on our current site and no additional land acquisitions were necessary. Since the site can accommodate the necessary infrastructure without overall expansion, the Environmental Services Operations Station was an ideal location for this project. Mayor Kevin Faulconer utilized this project as an opportunity to visit the site himself and give a press conference on the benefits of the fueling facility at this location. This site visit by Mayor Kevin Faulconer can be seen in Figure 4 below.

**Figure 4: Mayor Kevin Faulconer and Division staff with a brand new CNG vehicle**



Source: The City

# CHAPTER 3:

## Project Assessment

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The goals of this project were as follows: Purchase equipment necessary to support the installation of the Environmental Services Department's CNG fueling station and to operate the station for a minimum of 6 months. Both goals have been accomplished, as the fueling facility began operating in April 2017. The equipment listed in Table 1 is the comprehensive list of all equipment funded in part by the CEC's grant, while Table 2 breaks down the operational data gathered from April 2017 to November 2017. The next phases of the fueling facility construction will be underway in a matter of weeks, however for the purposes of this report, we can only speculate that those phases will be as successful and problem-free as phase 1. Once the final phases are complete, the facility will be able to fuel a maximum of 140 vehicles simultaneously over an 8-hour period.

See below for a comprehensive analysis of the data gathered both on the fueling facility's utility usage and the CNG vehicle operations. Note that the mileage of the vehicles is much higher than expected when compared to the amount of CNG dispensed by the facility. This is due to several factors, including the fact that while the facility was still under construction, the vehicles were already in operation and were fueling at various private stations throughout the city. As a safety precaution, they are also unable to fuel at night if the vehicle is still full of refuse, recycling, or greenery waste. This forces the driver to fuel at a private fueling station located nearby.

The analysis was done between March 2017 and November 2017, which encompassed the first round of vehicles that were purchased for the CNG transition. These vehicles were all automated side-loading refuse and recycling collection vehicles purchased for \$300,000 each. These vehicles are 2016 Peterbilt 320 models and were manufactured by AMREP. After November, an additional 5 rear-loading refuse, and recycling collection vehicles were purchased for \$305,000 each. These vehicles are 2017 Crane Carrier Company ISL G 320 manufactured by Pak-Mor. During the creation of this report, there are an additional 11 side-loading vehicles being delivered and will be placed into service in February 2018. These additional vehicles will not be included on any analysis within this report besides their inclusion in Table 3, as they have not been in use long enough to examine their data. Table 3 displays information on the two vehicle types in use as of January 2018.

Vehicle information, diesel displacement, life cycle GHG reduction, criteria emissions reduction and comparison, diesel displacement, monthly mileage, and statewide economic impacts are also analyzed in the following pages in Tables 3-9, and Figures 5-7. Diesel displacement is calculated by converting CNG usage to diesel gallon equivalent (DGE) with Energy Economy Ratio provided by California Air Resource Board. The life cycle GHG emission reduction from displacing diesel fuel with CNG for the fleet is estimated using the carbon intensity of fuel pathways in Low Carbon Fuel Standards. Comparison of criteria emissions between diesel (previous) and CNG (current) fleet is done by applying the AFLEET tool from Argonne National Laboratory<sup>1</sup>. Statewide economic impacts on total outputs, earnings of households, employment, and added-value are estimated using RIMS II final-demand multipliers, an

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<sup>1</sup> [Argonne National Laboratory Website](https://www.anl.gov/) <https://www.anl.gov/>

economic analysis tool for a regional project recommended by the Bureau of Economic Analysis, US Department of Commerce. The results show significant reductions in GHG emission and criteria pollution. Positive changes on total outputs, earnings of households, employment, and added value of statewide industries are also observed, although a decrease for the petroleum industry occurs due to diesel displacement.

**Table 3: Vehicle Information (as of January 2018)**

Model	Year	Manufacturer	Engine	Quantity	Cost per vehicle
Peterbilt 320	2016	AMREP	Spark-Ignition	31	\$300,000
Crane Carrier Company ISL G 320	2017	Pak-Mor	Spark-Ignition	5	\$305,000

Source: The City

**Table 4: Life-Cycle Carbon Intensity and Energy Economy Ratio Information for Fuel Replacement**

Fuel	Low Carbon Fuel Standards pathway	Carbon Intensity Carbon Dioxide equivalent / Mega Joule	Energy Economy Ratio *
Diesel	ULSD001	102.01	1
CNG	CNGF204	80.59	0.9*

**\*: For spark-ignition engines**

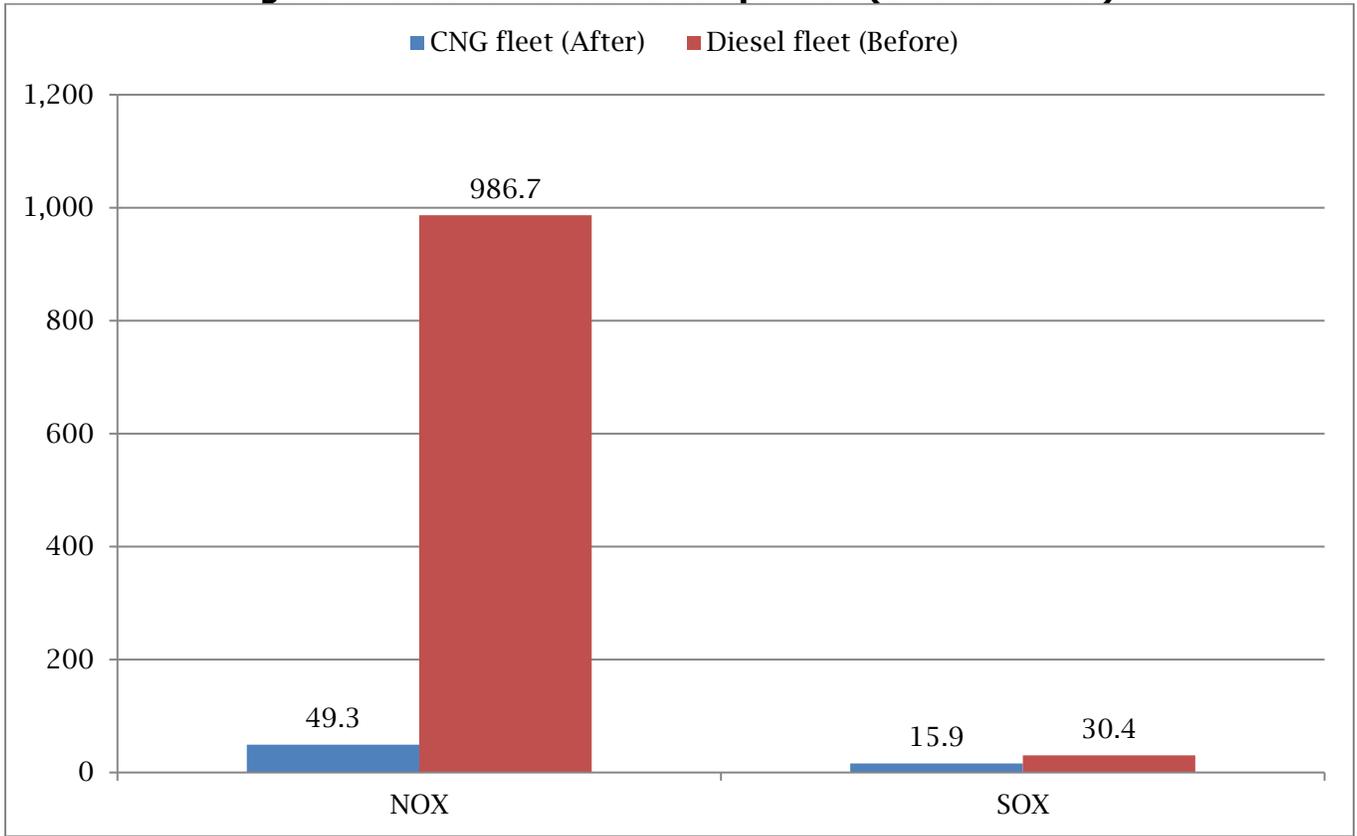
Source: The City

**Table 5: Criteria Emissions Analysis**

	Annual Mileage	Fuel (CNG: Gasoline gallon equivalent; Diesel: gallon)	nitrogen dioxide pounds	PM10 pounds	PM2.5 pounds	VOC pounds	Sox pounds
CNG	405,413	239,969	49.3	179.7	41.1	92.1	15.9
Diesel	405,413	195,516	986.7	179.7	41.1	92.1	30.4

Source: The City

**Figure 5: Criteria Pollutant Comparison (CNG vs Diesel)**



Source: The City

**Table 6: Fuel Consumption and Displacement**

<b>Month (2017)</b>	<b>Electrical Costs</b>	<b>Electric Usage Kilowatts Per Hour</b>	<b>Natural Gas Costs</b>	<b>NG Usage (one million British thermal units)</b>	<b># of Vehicles Fueled</b>	<b>Number of Days Per Month Vehicles Were Fueled</b>	<b>Diesel Gallons Displaced*</b>	<b>GHG Emissions Avoided (metric tons carbon dioxide equivalent) **</b>
MAR	\$200	71	\$1,012	193	NA	NA	1,363	2.28
APR	\$8,212	11,129	\$10,324	1,993.2	20	20	14,075	23.59
MAY	\$6,998	13,343	\$10,010	1,864.2	20	23	13,164	22.07
JUN	\$8,684	13,836	\$12,446	2,244.8	20	22	15,852	26.57
JUL	\$7,353	15,739	\$13,304	2,553.2	20	21	18,029	30.22
AUG	\$8,015	13,893	\$11,651	2,247.9	20	23	15,873	26.61
SEP	\$7,222	14,095	\$11,689	2,317.9	20	21	16,368	27.44
OCT	\$6,980	14,100	\$11,326	2,329	20	22	16,446	27.57
NOV	\$7,397	15,261	\$12,406	2,567.5	20	22	18,130	30.39
Total:	\$61,063	111,467	\$94,167	18,310.7	20	174	129,300	216.74
Monthly Average	\$7,608	13,924.5	\$11,644	2,264.7	20	22	15,992	26.81

\*: Diesel gallon displaced (DGE) = CNG consumption (Mega Joule) × Energy Economy Ratio × Unit conversion (DGE/134.47Mega Joule)

\*\* : GHG emission avoided (metric tons Carbon dioxide equivalents) = [Displaced Diesel (Mega Joule) × Carbon Intensity of Diesel] – [CNG consumption (Mega Joule) × Carbon Intensity of CNG]

Source: The City

**Table 7: Monthly Vehicle Record (Recorded on Last Day of Each Month)**

<b>Vehicle #</b>	<b>MAR '17</b>	<b>APR '17</b>	<b>MAY '17</b>	<b>JUN '17</b>	<b>JUL '17</b>	<b>AUG '17</b>	<b>SEP '17</b>	<b>OCT '17</b>	<b>NOV '17</b>
815-327	8,333	9,380	11,094	12,902	14,535	15,927	16,844	17,838	18,987
815-328	7,960	8,596	9,111	11,336	12,789	14,971	16,989	18,836	20,778
815-329	3,971	6,811	7,120	9082	11,043	13,435	15,150	17,652	18,343
815-330	3,171	4,750	6,600	8,492	10,445	12,040	13,953	15,758	17,452
815-331	5,316	5,478	6,910	8,994	10,692	12,147	13,905	15,132	16,958
815-332	10,177	11,828	13,396	15,226	17056	18,885	20,275	21,608	23,482
815-333	5,093	5,464	6441	7,418	8,997	10,575	11,706	13,515	15,201
815-334	12,084	14,091	14,091	14,930	16,178	17,613	19,582	21,644	23,331
815-335	5,166	6,754	8,233	10,033	11,792	13,633	15,317	17,154	18,935
815-336	4,875	6,854	10,552	11,912	14,131	16,836	17,000	19,163	21,027
815-337	5,998	7,786	10,028	12,156	14,160	16,373	18,511	20,004	21,862
815-338	4,353	6,217	8,259	10,406	12,395	14,479	16,379	17,472	18,867
815-339	6,740	8,480	10,201	12,221	14,099	15,726	17,302	19,143	21,071
815-340	0	498	2,159	4,259	6,235	8,169	10,099	11,958	13,799
815-341	3,273	5,105	7,518	9,494	11,170	13,111	14,922	16,694	18,500
815-342	3,272	5,015	6,983	9,334	11,314	12,128	14,153	15,892	17,797
815-343	7,963	9,974	11,931	14,295	16,415	17,367	18,244	20,127	22,098
815-344	6,908	9,485	10,328	11,925	13,239	15,122	15,721	16,341	17,715
815-345	4,101	5,813	7,976	10,051	11,140	13,014	14,752	16,524	18,289
815-346	5,421	6,102	8,129	10,075	12,033	12,753	14,746	16,890	18,594

Source: The City

**Table 8: Monthly Vehicle Mileage Range**

<b>Vehicle #</b>	<b>APR '17</b>	<b>MAY '17</b>	<b>JUN '17</b>	<b>JUL '17</b>	<b>AUG '17</b>	<b>SEP '17</b>	<b>OCT '17</b>	<b>NOV '17</b>	<b>Total</b>
815-327	1,047	1,714	1,808	1,633	1,392	917	994	1,149	10,654
815-328	636	515	2,225	1,453	2,182	2,018	1,847	1,942	14,182
815-329	2,840	309	1,962	1,961	2,392	1,715	2,502	691	14,372
815-330	1,579	1,850	1,892	1,953	1,595	1,913	1,805	1,694	14,281
815-331	162	1,432	2,084	1,698	1,455	1,758	1,227	1,826	11,642
815-332	1,651	1,568	1,830	1,830	1,829	1,390	1,333	1,874	13,305
815-333	371	977	977	1,579	1,578	1,131	1,809	1,686	10,108
815-334	2,007	0	839	1,248	1,435	1,969	2,062	1,687	11,247
815-335	1,588	1,479	1,800	1,759	1,841	1,684	1,837	1,781	13,769
815-336	1,979	3,698	1,360	2,219	2,705	164	2,163	1,864	16,152
815-337	1,788	2,242	2,128	2,004	2,213	2,138	1,493	1,858	15,864
815-338	1,864	2,042	2,147	1,989	2,084	1,900	1,093	1,395	14,514
815-339	1,740	1,721	2,020	1,878	1,627	1,576	1,841	1,928	14,331
815-340	498	1,661	2,100	1,976	1,934	1,930	1,859	1,841	13,799
815-341	1,832	2,413	1,976	1,676	1,941	1,811	1,772	1,806	15,227
815-342	1,743	1,968	2,351	1,980	814	2,025	1,739	1,905	14,525
815-343	2,011	1,957	2,364	2,120	952	877	1,883	1,971	14,135
815-344	2,577	843	1,597	1,314	1,883	599	620	1,374	10,807
815-345	1,712	2,163	2,075	1,089	1,874	1,738	1,772	1,765	14,188
815-346	681	2,027	1,946	1,958	720	1,993	2,144	1,704	13,173
<b>Total</b>	<b>29,456</b>	<b>34,793</b>	<b>37,481</b>	<b>35,317</b>	<b>34,446</b>	<b>31,246</b>	<b>33,795</b>	<b>33,741</b>	<b>270,275</b>

Source: The City

**Table 9: Project Investments on Industries and Associated RIMS II Final-Demand Multiplier**

<b>Activity</b>	<b>Equipment /Fuel</b>	<b>Impacted industry with final-demand changes</b>	<b>RIM II Final Demand Multipliers for California Output (1)</b>	<b>Earnings (2)</b>	<b>Employment (3)</b>	<b>Value-added (4)</b>
Government purchase (in-state)	Quad-Hose Time Fill Posts	3332A0 Industrial machinery manufacturing	1.5231	0.4087	6.3918	0.6561
Government purchase (in-state)	Switchgear	335313 Switchgear and switchboard apparatus manufacturing	1.425	0.2902	4.8918	0.6329
Fuel purchase	CNG	221200 Natural gas distribution	1.4085	0.2619	3.0215	0.6748
Fuel replacement	Diesel	324110 Petroleum refineries	1.2454	0.2068	1.8126	0.3966
Government purchase (out-state)	Imports of other equipment (e.g. compressor, dryer)	4A0000 Other retail	1.4456	0.4772	14.4344	0.9067

Source: The City

Each entry in column 1 represents the total dollar change in output that occurs in all industries for each additional dollar of output delivered to final demand by the industry corresponding to the entry.

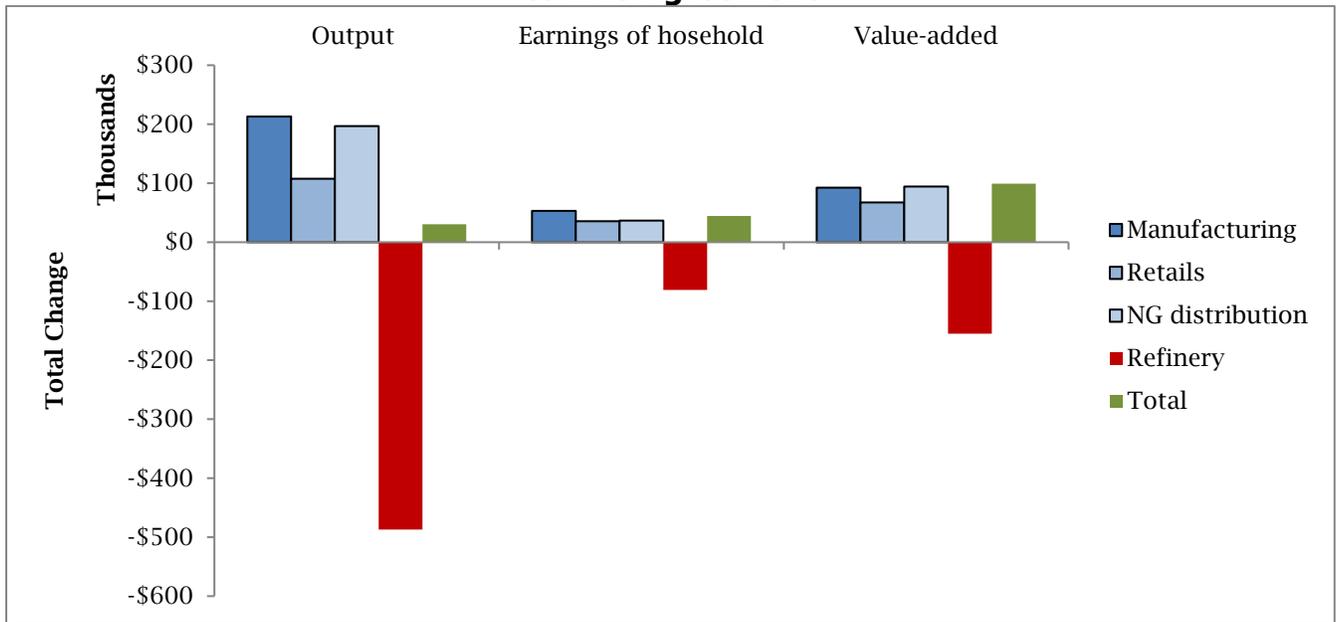
Each entry in column 2 represents the total dollar change in earnings of households employed by all industries for each additional dollar of output delivered to final demand by the industry corresponding to the entry.

Each entry in column 3 represents the total change in number of jobs that occurs in all industries for each additional 1 million dollars of output delivered to final demand by the

industry corresponding to the entry. Because the employment multipliers are based on 2015 data, the output delivered to final demand should be in 2015 dollars.

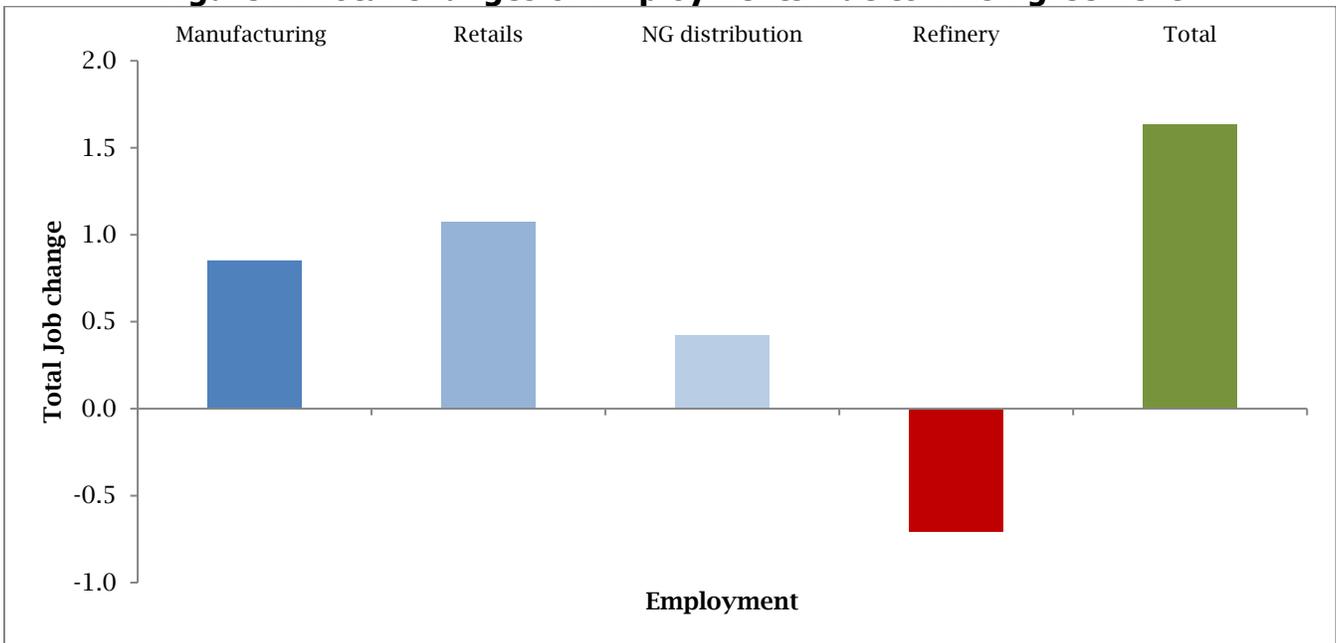
Each entry in column 4 represents the total dollar change in value added that occurs in all industries for each additional dollar of output delivered to final demand by the industry corresponding to the entry. Figure 6 below, represents a chart showing the total changes in output according to the information contained in Table 9 on the previous page. Figure 7 below represents the new jobs that have been created by this project.

**Figure 6: Total Changes of Outputs, Earnings of Households, and Valued-Added Due to This Agreement**



Source: The City

**Figure 7: Total Changes of Employments Due to This Agreement**



Source: The City

# CHAPTER 4:

## Project Conclusions

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Although we have finished the portions of the project laid out in the City's grant agreement with the CEC (Pre-construction and phase 1 construction), the entire CNG fueling project is not yet complete. As we prepare for construction phases 2 and 3, we will use what we have learned so far to better accomplish the rest of our goals. We have also learned a great deal about the operation of a CNG fueling station. This type of station was foreign to our division and a lot of the equipment now being used was not needed in our past infrastructure. The City is now proud to be a resource for other governmental entities and private organizations that would like to build their own CNG fueling facilities.

There have been a variety of challenges that we have had to face as we began fueling our first round of refuse collection vehicles. The fact that a vehicle cannot be parked next to a pump overnight if it has not been dumped at a landfill has provided an unexpected challenge to our operations. This is due to the low probability that a vehicle might have collected combustible materials the day before which may react dangerously while inside the truck and compromise the fueling station. For now, the workaround has been to have the trucks parked away from the pumps and to provide a select few drivers with the city purchasing cards for the sole purpose of purchasing fuel at private enterprises the next day.

Another lesson we learned is that it is critically important to maintain open communications not only with the staff working on the construction of the facility, but the Public Works administrative staff as well. There have been times where a lack of speedy response to a question caused intermittent delays in the project's progress, however this is minor in terms of the overall project.

Throughout this next year, our division analysts will be hard at work determining if there are any other funding sources available that could lessen the overall costs similar to the way that this grant through the CEC has done. The Collection Services Division currently has the budgeted funds necessary to complete the project, however the City is always looking for ways to reduce its costs for the benefit of the taxpayers.

Lastly, we have found it incredibly important to keep a log of all decisions and progress made over the course of the project's duration. Due to the departure of some of our administrative staff in the middle of this process, we have had to bring new eyes to an existing project which can be a hurdle in the progression of a project if a new team needs to be brought up to speed before anything can continue.

These encompass most challenges that our division has faced during this project, however they are minor compared to the enormous success that the fueling station has had overall. We are greatly looking forward to completing the last of the construction within the next year, as well as the transition to a fleet fully fueled by CNG. The city will always strive to be an innovator in Environmental progress, and we are happy to share our successes with anyone who might be considering building a fueling facility of their own.

## 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 gasoline.

GREENHOUSE GAS (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (NO<sub>x</sub>), halogenated fluorocarbons (HCFCs), ozone (O<sub>3</sub>), per fluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

THE CITY OF SAN DIEGO (THE CITY)— The Environmental Services Department ensures that City of San Diego residents are provided with a clean and safe environment. The Department pursues waste management strategies that emphasize waste reduction and recycling, composting, and environmentally sound landfill management. The department is also responsible for the collection and disposal of refuse, recyclables, household hazardous waste and green waste.<sup>2</sup>

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<sup>2</sup> [The City of San Diego](https://www.sandiego.gov/) <https://www.sandiego.gov/>