CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Workplace Electric Vehicle Charging at The Los Angeles Department of Water and Power

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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 PON-11-602 to provide funding opportunities under the ARFVT Program for alternative fuels infrastructure. In response to PON-11-602, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards August 16, 2012 and the agreement was executed as ARV-12-051 on July 24, 2013.

ABSTRACT

The Los Angeles Department of Water and Power expanded its network of electric vehicle supply equipment with the Energy Commission's award of $75,000 in grant funding and The Los Angeles Department of Water and Power's $182,000 in match share funding. Twenty-eight charging stations were included in the expansion, twelve of which are shared by the general public and employees. Sixteen chargers are exclusively for employee use.

Installation of 28 chargers was completed in early 2015 and data gathered over six months indicate 9279 hours of charging over 2598 charging sessions. This amounts to 8,052 kilowatt hours supplied which displaces approximately 712 gallons of gasoline and prevents approximately 6.34 tons of carbon dioxide from being released into the atmosphere over the six months of data collection.

Together these installations work to support Governor Brown's Executive Order B-16-12 which directs state government to adopt zero-emission vehicles as well as Executive Order B-18-12 which calls for reduced greenhouse gas emissions. Additionally, it demonstrates how electric vehicle supply equipment can be jointly used by employees and the general public. Moreover, the project facilitates the widespread adoption of electric vehicles.

Keywords: Electric Vehicle, Workplace Vehicle Charger, Emission Reduction

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EXECUTIVE SUMMARY

This report details the Los Angeles Department of Water and Power's installation and analysis of utilization of 28 level 2 electric vehicle charging stations at its main office building in Los Angeles. This building is known as the John Ferraro Building and is located at 111 N. Hope St., Los Angeles, CA 90012.

The Los Angeles Department of Water and Power's Facilities Design Group coordinated with Los Angeles Department of Water and Power construction crews to complete charger installations. Although 32 charger stations were originally commissioned in the grant, only 28 chargers were ultimately installed during the contract term. An additional 74 chargers are operational at this location for employee use, but these units were not installed during the contract term. Smart meters enabled the Los Angeles Department of Water and Power to track and record usage for six months. Twelve of the 28 chargers are open for public and employee use while the remaining sixteen are only accessible to employees.

Overall the new installations met most of the program goals. Despite not reaching the target number of 32 new chargers, the project still provided useful data on the charging patterns of 76 employee-owned plug in vehicles. Additionally, the lessons learned will serve as a valuable resource for future projects aimed at expanding electric vehicle supply equipment infrastructure for employee use. Employee adoption and use of plug-in electric vehicles at the John Ferraro Building increased during the contract terms and continues to expand as a result of this project

CHAPTER 1:
Objectives and Approach

1.1 Goals and Objectives

The $75,000 grant from the CEC has a goal of installing 32 electric vehicle chargers at the Los Angeles Department of Water and Power (LADWP) main office building seen in Figure 1 below. Utilization will be tracked and operations data namely, fossil fuel displaced, air emissions reductions, and jobs and other economic benefits, will be analyzed. This goal is consistent with broader objectives pursued by the Energy Commission and the LADWP:

- Promote the widespread adoption of electric vehicles
- Decrease reliance on fossil fuels
- Reduce greenhouse gas emissions

The charger installation project continues a well-established practice of clean technology adoption at LADWP. Not only does this project supplement the existing 137 electric vehicle chargers already installed on site for fleet and employee use, but it also leads by example. LADWP recently implemented a commercial rebate program to subsidize charger installations at businesses across the City of Los Angeles. With workplace charging, employees will have access to charging stations during their workday and will thus be more eager to switch to electric vehicles and promote the technology to customers and other employees.

Figure 1: LADWP's main office building and employee lot on 111 N Hope Street.

1.2 Approach

The Facilities Design Group of LADWP oversaw the project and coordinated with the electric vehicle supply equipment supplier as well as LADWP's construction crew on the procurement and installation of the chargers.

Broadband TeleCom Inc. fabricated the electric vehicle chargers rated for 30 Amps and 7.2 kilowatts. The decision to buy Broadband TeleCom Inc. chargers was made through a competitive bidding system in which Broadband TeleCom Inc. emerged as the lowest cost electric vehicle supply equipment manufacturer while maintaining a high standard of product quality.

Installation was performed by LADWP's Electrical Construction and Maintenance crews with minimal interruptions to traffic and minor reductions in parking availability. In the dedicated employee parking area (located on lower B level), eight dual pedestal chargers were put in place with each pedestal serving two parking spots. This accounts for 16 of the chargers in the grant.

The customer and employee parking lot (located on upper A level) contains the remaining 12 chargers, which each have their own pedestal. The chargers were placed along the wall of the parking lot to make them clearly visible and distinct from regular parking spaces.

Once the chargers were installed in both parking lots, smart meters were added a few months later to register and record usage data. Unfortunately, two of the 28 chargers did not have their smart meters installed in time for the report as a result of internal billing problems. Still the remaining 26 chargers that are metered captured the vast majority of overall usage. Figures 2 and 3 shows charging stations located in the employee parking garage and customer lot.

Figure 2: Twelve public and employee chargers in the customer lot

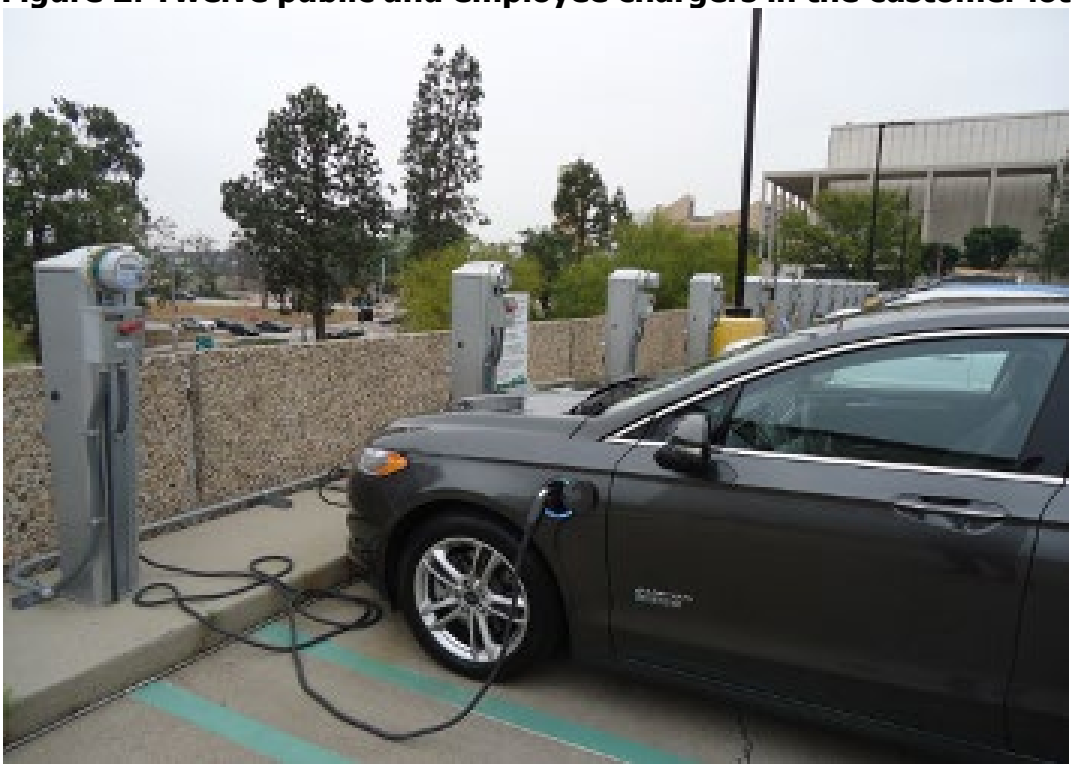
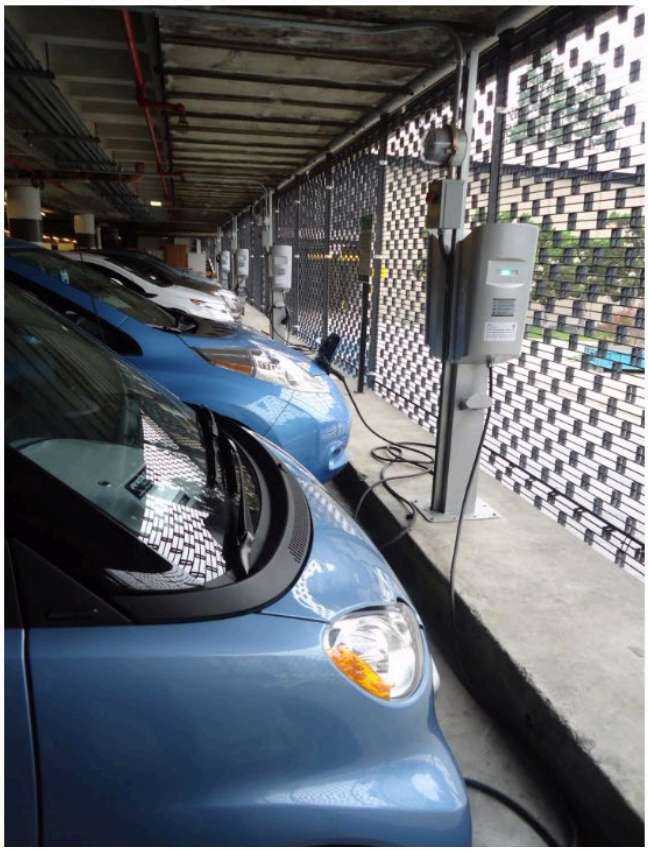


Figure 3: Sixteen chargers in the employee lot installed in two separate banks.



Chapter 2: Results

2.1 Implementation

After installation was completed in January 2015, the chargers were immediately utilized. Spaces for these charging stations filled up in both lots as soon as employees came in to work each morning and remained occupied throughout the working day. In fact, the popularity of the chargers became a problem as the general public wasn't getting the chance to charge since all the parking spaces were occupied by employees. Thus, to encourage sharing and public access, four-hour limits were placed on spaces adjacent to the charging stations. The new restriction on parking has allowed ample opportunities for both employees and the public to charge. Signs displaying these restrictions can be seen in Figure 4 below.

Circuit breakers were also causing issues in the first few weeks of use. When old chargers were removed to make room for the new installations, the circuit breakers were not changed to reflect the larger current flow. This resulted in several service calls to reset the circuit breakers. Ultimately, the problem was solved by replacing the circuit breakers to accommodate the new chargers.

With circuit breaker issues resolved, some challenges still remain in ensuring equal charging access. As space in the customer parking lot is always limited, gasoline- fueled cars sometimes take the open charging station parking spots out of necessity. A partial solution is already in place with parking spaces restricted to electric vehicles only. However, placing restrictions on all charging stations may not be feasible due to the limited number of total spaces in the parking lot. Other options are currently being reviewed at this time to accommodate both electric and non-electric cars.

Figure 4: Restrictions on electric vehicle parking enforced to ensure public access

2.2 Number of Charge Events

The meters were installed on December 19, 2015. Six months after installation, the data extracted from the smart meters provided valuable usage information. One of the highlights from the compilation and analysis was the total number of charging events. Altogether, there were 2598 charge events over the 127 working days in which data was collected. The average usage was determined to be 19.9 or 20 charges each day across the 26 metered chargers, a 77 percent usage. Comparing the 2598 total charge events with the 9279 charging hours, the average charging event duration was calculated to be 3.57 hours, or 3 hours and 35 minutes. Figures 5 and 6 illustrate the usage broken down by month.

Figure 5: Charge Events Over 127 Working Days

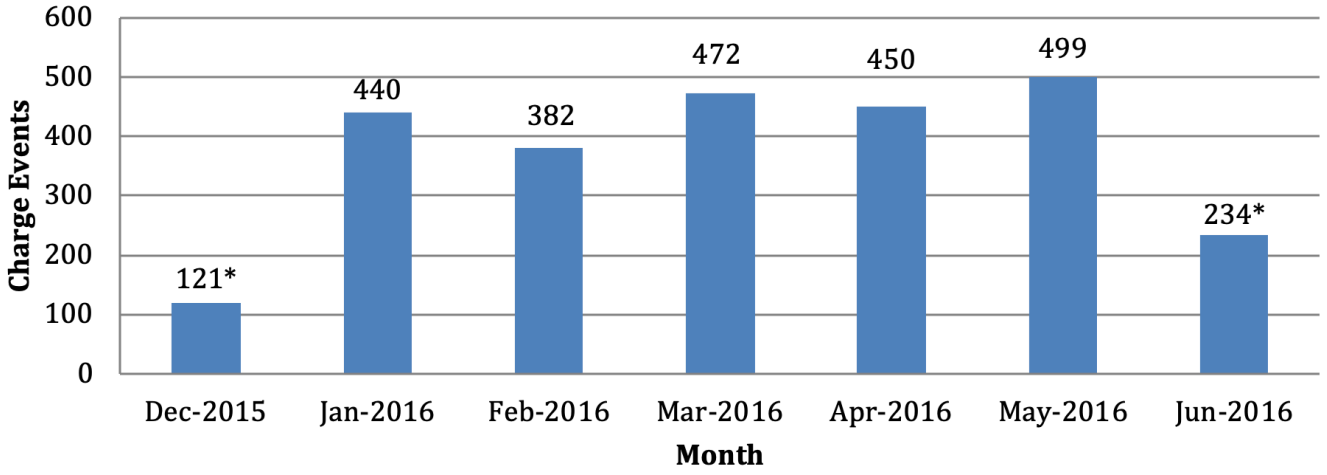
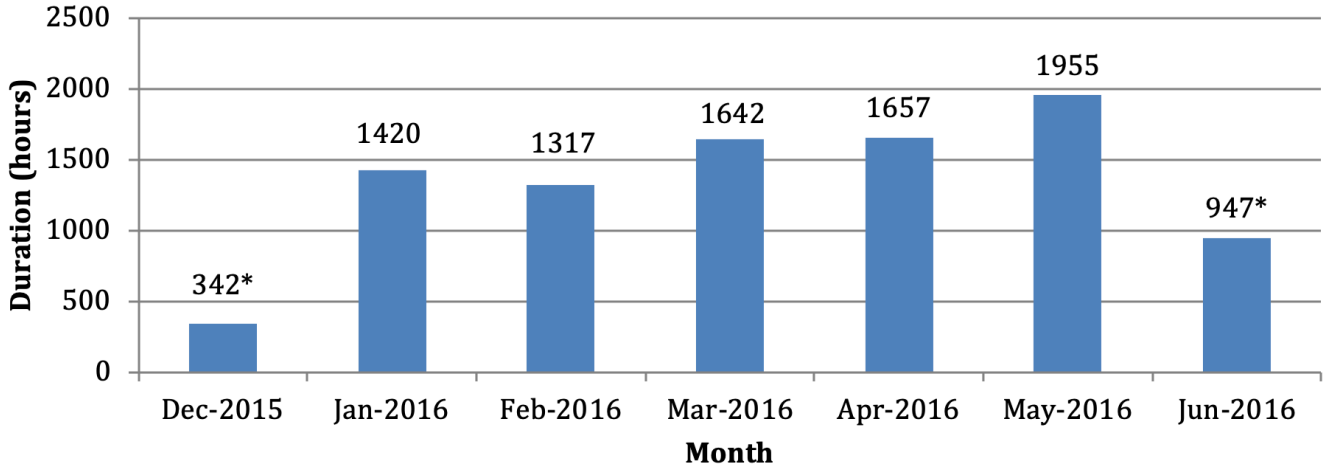


Figure 6: Charge Duration Over 9279 Charging Hours



Source: LADWP

2.3 Number of Days of Usage

Further breaking the usage down, the number of days with a charging session is shown in Table 1.

Table 1: Charging Days (Single Meter With Either One or Two Chargers)

Station No.	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2016	May-2016	Jun-2016	Total Charging Days	Working Days	Percent of Days in Use
1	5	9	19	17	14	15	10	89	127	70 percent
2	2	11	16	20	16	20	10	95	127	75 percent
3	0	3	14	17	17	15	5	71	127	56 percent
4	0	4	11	18	14	11	6	64	127	50 percent
5	5	18	9	13	18	15	7	85	127	67 percent
6	4	16	7	13	7	16	5	68	127	54 percent
7	6	21	14	17	18	19	10	105	127	83 percent
8	6	22	18	20	18	18	11	113	127	89 percent
9	4	16	13	17	20	21	11	102	127	80 percent
10	8	10	7	22	21	21	11	100	127	79 percent
11	5	19	19	18	20	20	10	111	127	87 percent
12	5	17	20	17	18	21	10	108	127	85 percent
13	3	19	20	14	12	16	8	92	127	72 percent
14	7	19	19	16	13	13	8	95	127	75 percent
15	8	19	20	23	22	21	12	125	127	98 percent
16	7	19	20	23	21	21	11	122	127	96 percent
17	5	20	20	23	21	21	11	121	127	95 percent
18	7	19	8	9	18	21	11	93	127	73 percent
Total	**87**	**281**	**274**	**317**	**308**	**325**	**167**	**1759**	**2286**	**77 percent**

Source: LADWP

As shown in Table 1, chargers were being utilized on a total of 1759 days. Comparing this to the total of 2286 working days, the average charger is expected to be plugged in 77 out of every 100 working days.

2.4 Maximum Capacity of the New Fueling System

With each of the chargers outputting 7.2 kilowatt hours (kWh), a later generation Nissan Leaf or similar equipped battery electric vehicle could go from no charge to full charge in about four hours. A Plug-In Hybrid Electric Vehicle, such as a Volt, can also typically fully charge in about four hours If fully utilized, each of these chargers can accommodate between two and three charge cycles or vehicles during work shift hours. Extrapolating this to account for all 28

installed chargers, the maximum capacity of the fueling system is between 56 and 84 fully charged cars per day.

The maximum capacity of these charging stations alone matches the total demand in the building. A recent survey of cars indicated 75 plugin employee-owned vehicles are parking in John Ferraro Building, which is well within capacity of the new chargers and more than enough considering the 74 existing chargers. The electric vehicles may be assigned to different parking levels, but all employees have access to the chargers funded by this grant when they park in the publicly accessible customer lot. A more detailed breakdown of the electric vehicles owned by employees is presented in Table 2 below:

Table 2: Survey of Employee owned Electric Vehicles

Parking Level	**Plug-In Hybrid Electric and All Electric**
Upper A	31
Lower A	29
B	15
Total	**75**

2.5 Displaced Gasoline

The total mileage on electric vehicle fleets is commonly used to determine the gasoline displaced. Given that the cars being refueled are privately owned by employees and customers, such a calculation was not feasible. Instead a different method was used. Using data gathered from the first four months of usage, it was determined that 8,052 kWh were supplied by the chargers. Government statistics from fueleconomy.gov indicate that the average electric vehicle efficiency is 61 percent and the average gas fueled car is 19 percent efficient.[1] The kWh supplied by a gallon of gasoline is 36.3 kWh. Dividing the energy supplied from the chargers by the energy in a gallon of gasoline while adjusting for the efficiency of each type of car results in a net displacement of 712 gallons of gas. This calculation is repeated below for reference in Figure 7:

Figure 7: Formula used to calculate displaced gasoline

$$\frac{Energy\ Supplied\ by\ Chargers}{Energy\ in\ a\ Gallon\ of\ Gas} * \frac{Electric\ Vehicle\ Efficiency}{Conventional\ Vehicle\ Efficiency} =$$

$$\frac{8052\ kWh}{36.3\ kWh\ /gallon} * \frac{61\%}{19\%} = 712\ gallons$$

Source: LADWP

[1] U.S. Department of Energy (www.fueleconomy.gov)

2.6 Emissions Reduction

Based on data from fueleconomy.gov the emissions from a Toyota RAV4 electric vehicle charging in downtown Los Angeles is 180 grams of gasoline per mile. By comparison, 500 grams are released per mile for conventional gas-fueled cars.

Also, roughly 112.2 gallons of gasoline produce 1 metric ton of CO_2.[2] By displacing 712 gallons of gasoline, a total of 6.34 metric tons of CO_2 were not released.

2.7 Jobs and Economic Development

Money spent on the chargers provided thousands of dollars in revenue to Broadband TeleCom Inc., the charging station manufacturer and a California company. Supporting this company helps to fund additional progress and development in clean energy transportation. Local LADWP electricians and engineers were utilized for the construction portion of the project. This supports job creation and local economic development.

The savings for electric vehicle drivers has a significant impact on the local economy as well. Data compiled from a California Electric Transportation Coalition and University of California, Berkeley assessment indicate the following:

- Money saved on gas and spent on household goods or services generates 16 times as many jobs.
- The savings and new jobs stay in the local economy while fossil fuel revenues leave.
- Electric vehicle adoption increases wages and employment in the service and entertainment industry—jobs that are not directly tied to electric vehicles.
- Low-income groups see benefits faster than high-income groups due to the jobs created in service industries.

Many of the benefits are passed on to people who do not own electric vehicles.[3]

2.8 Renewable Energy at the Facility

Being a leader in renewable energy generation, LADWP has made clean energy in its office buildings a priority as well. Across the customer parking lot in which 12 of the chargers were installed, an employee parking lot contains an array of solar panels providing clean energy throughout the year.

2.9 Source of the Alternative Fuel

LADWP, the nation's largest municipal utility, provides its own power to supply charging stations in John Ferraro Building. The current renewable energy portfolio makes up 23 percent of total generating capacity. For a detailed illustration see the pie chart in Figure 8 below:

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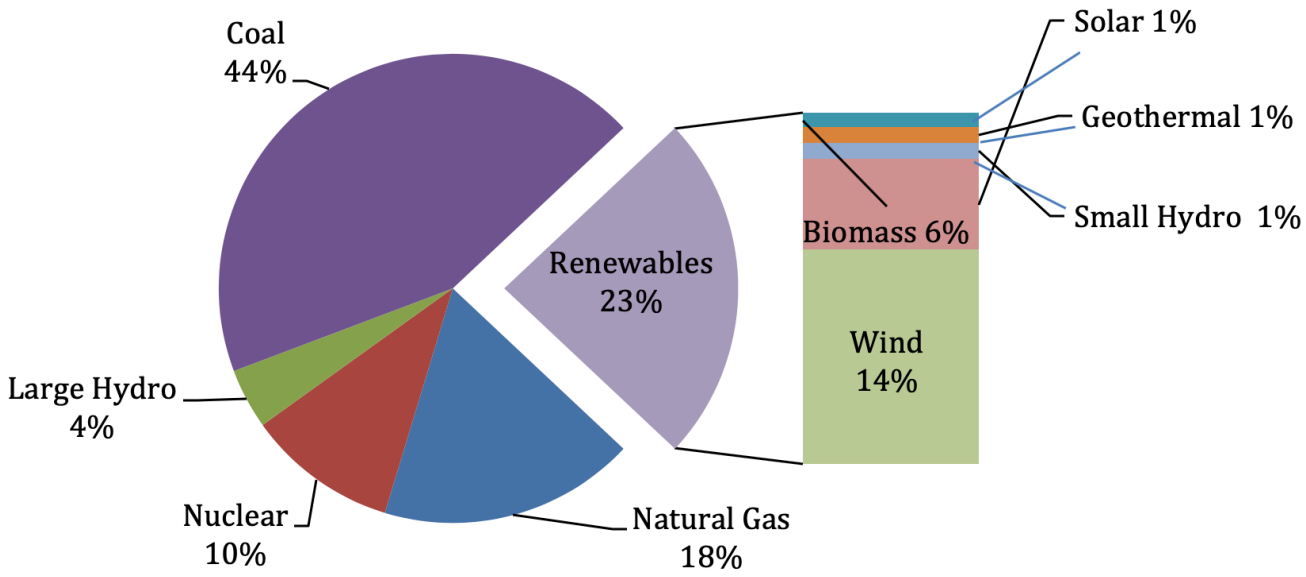
[2] U.S. Energy Information Administration (https://www.eia.gov/)

[3] California Electric Transportation Coalition (https://caletc.com/)

Figure 8: Power Sources for LADWP Chargers



Source: LADWP

As an industry leader, LADWP is committed to satisfying renewable energy mandates such as SB350, which requires 50 percent renewable energy by the year 2030. At the same time, the utility will divest from coal with an upcoming sale of its coal powered Navajo Generating Station. With this sale and other aggressive green energy projects planned in the future, LADWP is on track to meet the goals set in SB350 ahead of the deadline.

2.10 Energy Efficiency Measures

Since the 1990's the LADWP's main office building has undergone energy efficiency retrofits. This includes variable frequency driven chillers which adjust energy consumption to meet air conditioning demand and ramps down afterward to conserve energy. Additionally, lighting fixtures have been replaced with more energy efficient units, and as mentioned in Chapter 2.8, a bank of solar panels was installed in the parking lot to produce and harness renewable energy. This long history of energy efficiency culminated in the building's Leadership in Energy and Environmental Design certification in 2015.

2.11 Future Expansion

LADWP is in the process of purchasing 43 new Nissan Leaf and over 100 new Chevy Volt vehicles, a sizeable addition to the existing electric vehicle fleet. To accommodate this expansion, a new bank of charging stations is in the planning stages, and installation is on track to finish before final shipment of the new cars.

In addition, LADWP is in the process of planning for the expansion of additional workplace chargers at its main office building and supporting facilities throughout Los Angeles.

2.12 Lessons Learned

The new chargers detailed in this report provided useful experience with installing and managing charging stations. Due to unexpected difficulties with charger and meter installation, only 28 of the planned 32 chargers were ultimately commissioned. The internal issues affecting the project are currently being resolved. Still despite not meeting the target, the completed chargers provided plenty of insight in to charging patterns and a record of

environmental benefits. Other problems included public access in parking lots shared by employees and the public. This issue was resolved with four-hour charging limits on electric vehicle parking spaces which allow customers to use the charging stations later in the day. Similarly, issues with non-electric cars taking up charging station spots were addressed with parking restrictions near charging stations. Finally, many old circuit breakers were tripping as they were configured for the old and less powerful chargers. Adding higher capacity circuit breakers resolved the issue.

2.13 Accomplishments

As mentioned earlier, the goal of 32 charger installations was not met, however, the 28 installed chargers still had a significant impact. These charging stations increased public access to charging in the heart of downtown Los Angeles and expanded the network of chargers available to LADWP employees. In the first four months alone, 317 gallons of gasoline were displaced preventing 6.34 metric tons of CO_2 from being released into the atmosphere. Charging patterns also revealed themselves with an average charge duration of 3 hours and 35 minutes per session. Demand for chargers was also analyzed with each charger being used 77 out of every 100 working days.

The project and its end results are consistent with broader goals pursued by the Energy Commission and the LADWP. The increased availability of charging encourages rapid adoption of electric vehicles among employees, as well as the general public. The project will ultimately further the development of green transportation technology. Meanwhile, smart meters on the chargers allow for the continued tracking of environmental benefits. Recognizing these achievements, the project has succeeded on multiple fronts in advancing electric vehicle infrastructure and adoption of electric vehicles.

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).

KILOWATT-HOUR (kWh)—The most commonly used unit of measure telling the amount of electricity consumed over time, means one kilowatt of electricity supplied for one hour. In 1989, a typical California household consumed 534 kWh in an average month.

LOS ANGELES DEPARTMENT OF WATER AND POWER (LADWP)—An electric municipal utility serving the greater Los Angeles, California, region.