



California Energy Commission Clean Transportation Program

## FINAL PROJECT REPORT

# **Charge Fast!**

The Bay Area Corridor Charging Expansion Program

Prepared for: California Energy Commission Prepared by: Bay Area Air Quality Management District



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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 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-13-606 to fund electric vehicle charging infrastructure in several categories that will support growth of electric vehicles as a conventional method of transportation and adoption of plug-in electric vehicles over a wide range of California's population and socio-economic classes. In response to PON-13-606, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards April 4, 2014 and the agreement was executed as ARV-13-039 on July 8, 2014.

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## ABSTRACT

The Bay Area Corridor Charging Expansion program (later renamed to *Charge Fast!*) will deploy direct current fast chargers and co-locate Level 2 chargers at key destination sites in close proximity to the region's major transportation corridors. The Charge Fast! Program maximizes the geographical distribution of chargers around the Bay Area, thereby: 1) strengthening the region's limited fast charge network; 2) enabling plug-in electric vehicle drivers to have an extended range of travel and increase their use of plug-in electric vehicles; and 3) further supporting the adoption and growth of plug-in electric vehicles in the region. The project implements the strategies identified in the 2013 Bay Area Plug-in Electric Vehicle Readiness Plan and will assist California and the Bay Area region in achieving their air quality, greenhouse gas emissions, and energy independence goals.

**Keywords**: plug-in electric vehicles, charging stations, direct current fast chargers, Level 2 chargers, Bay Area Air Quality Management District, Charge Fast!

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## **EXECUTIVE SUMMARY**

The Charge Fast! Program seeks to expand access to charging, which is a potential barrier to EV adoption in the Bay Area. The Charge Fast! Program used California Energy Commission funding, along with Bay Area Air Quality Management District's Transportation Fund for Clean Air funding, to install 15 direct current fast chargers and 186 Level 2 charging stations. Two additional projects were solely funded through the Bay Area Air Quality Management District's Transportation Fund for Clean Air Program, which installed another 3 direct current fast chargers and 15 Level 2 charging stations. As of December 31, 2017, these stations dispensed a total of 241,883 kilowatt hours, which is equivalent to driving approximately 812,726 electric miles (instead of gasoline) and reducing approximately 0.17 tons of criteria pollutants (reactive organic gas, oxides of nitrogen, particulate matter) and 26,098 gallons of fuel per year. Key findings include:

- Working with the tenant or property owner to install the charging station resulted in fewer issues than partnering with contractors who do not own the installation site.
- Finding site hosts who were willing to install the necessary infrastructure for direct current fast chargers was a challenge.
- The number of days it took to place a project into service from contract execution varied from 86 days to 362 days.
- The direct current fast chargers installed through the Charge Fast! Program are generally used in the afternoon and dispense less than 18 kilowatt hours per charging session.

## CHAPTER 1: Charge Fast! Program

### **Overview**

The Bay Area Air Quality Management District (BAAQMD) developed the Bay Area Corridor Charging Expansion Program, later renamed to the Charge Fast! Program ("Program") to deploy charging infrastructure at key strategic sites to strengthen the existing but limited fast charge network, to extend the amount of zero emission miles driven by Bay Area plug-in electric vehicles (PEV), and to further support the adoption and growth of PEVs. The main objective of the Charge Fast! Program is to deploy ten direct current (DC) fast chargers and co-locate twelve level 2 chargers at six key destination sites in close proximity to the region's major transportation corridors. A secondary objective is to demonstrate the viability of providing PEV charging as a sustainable business.

The Charge Fast! Program seeks to expand access to charging, which is a potential barrier to PEV adoption in the Bay Area. As of the solicitation period (2014) for the Charge Fast! Program, there were only 49 publicly available fast chargers in the Bay Area, which translates into one publicly available fast charger for every 306 vehicles. According to the 2013 Bay Area PEV Readiness Plan, at a minimum, there should be one DC fast charger for every 235 vehicles.

For the Charge Fast! Program, charging stations sites are placed in areas of strategic importance, as identified in the Siting Element of the Bay Area PEV Readiness Plan. Each of the DC fast charge stations includes two dual connectors: one CHAdeMO port and one Society of Automotive Engineers Combo port. The Charge Fast! Program reinforces the existing quick charging station network by providing range assurance to current and future PEV drivers. For the Charge Fast! Program, CEC funding, along with BAAQMD's Transportation Fund for Clean Air funding, was used to install 15 DC fast chargers and 186 Level 2 charging stations. Two additional projects were solely funded through the BAAQMD's Transportation Fund for Clean Air Program, which installed another 3 DC fast chargers and 15 Level 2 charging stations. This deployment exceeded the original objective of 10 DC fast chargers and 12 level 2 chargers; however, delays in getting the projects implemented resulted in not all projects being able to report six months of usage data. The stations installed through the Charge Fast! Program provide PEV drivers a place to charge away from home and work. For the purpose of this report, only projects that have incurred six months of data, which are highlighted in blue below, are discussed herein.

#### Table 1: Charge Fast! Projects

Project Number	Project Sponsor	Project Components	CEC \$ Awarded	TFCA \$ Awarded	Total \$ Awarded	No. of Facilities	No. of Charging Stations
15DCFC01	Federated Indians of Graton Rancheria	3 dual-connector DC fast & 2 dual- port level 2 charging stations*	\$62,275	\$47,200	\$109,475	1	5
15DCFC03	Alameda Municipal Power	2 dual-connector DC fast charging stations in Alameda	\$48,912	\$36,000	\$84,912	1	2
16DCFC01	City of Saratoga	1 dual-connector DC fast charging station in Saratoga	\$29,750	\$5,250	\$35,000	1	1
16DCFC03	City of Brisbane	1 dual-connector DC fast charging station in Brisbane	\$38,000	\$2,000	\$40,000	1	1
16EV056	Bay Area HQ Authority	2 dual-port level 2 charging stations in San Francisco	\$17,128	\$-	\$17,128	1	2
17EV018‡	Los Altos School District	182 single-port Level 2 and 8 dual- connector DC Fast charging stations in Mountain View and Los Altos	\$99,900	\$1,280,100	\$1,380,000	9	190
16EV021 <del>I</del>	Ford Point LLC	1 DC Fast and 8 dual-port Level 2 charging stations in Richmond	\$-	\$73,000	\$73,000	1	9
16EV006 <del>I</del> , ‡	Sonoma Mountain Village, LLC	Install 7 dual-port level 2 and 2 dual- connector DC fast charging stations in Rohnert Park	\$-	\$184,000	\$184,000	1	9
		Total	\$295,964	\$1,627,550	\$1,923,514	16	219

\* Project includes one DC charger that did not receive CEC funding.

<sup>1</sup> Project did not receive CEC funding, but is provided as match for this program.

<sup>+</sup> Project has a solar component to offset energy dispensed from the charging stations.

Through the Charge Fast! Program, BAAQMD and its partners will provide at least 66 percent of the match funds. This minimizes the match from the Energy Commission to 34 percent of the total project cost, allowing the Energy Commission funds for PEV deployment to be allocated to a larger number of participants. Since these sites will aide in expanding California's network of charging stations, the Charge Fast! Program will reduce California's costs of implementing a network of charging stations in the future. BAAQMD and the site hosts are providing a significant share of the cost.

Additionally, to remove the expensive upfront cost of owning/purchasing property prior to the installation of the DC fast charger, a portion of the DC fast chargers will be installed on land that is leased to the project Sub-Contractor. This leasing model will serve as a template that can be adopted for other DC fast charge installations.

BAAQMD entered into a contract with each of the charging station owners/operators. These Sub-Contractors conducted planning/engineering, purchased equipment, installed and placed the chargers into service, inspected and tested the chargers, and provided a minimum of six months of data. All of the work required to have the equipment placed into service was expected to be completed within twelve months. Once the equipment was placed into service, each of the Sub-Contractors is expected to own, maintain, and operate the equipment for a minimum of three years. For a period of six or more months, BAAQMD will collect, compile and report usage data for each of the charging stations funded through this grant award. The data will supplement the limited data BAAQMD is currently collecting through its previous PEV deployment programs, to help provide a more comprehensive picture of charging use in the Bay Area region. Figure 1 shows a map of the five facilities analyzed in this paper.

### Figure 1: Map of Facilities



Source: Bay Area Air Quality Management District

## CHAPTER 2: Summary of Benefits

### **Environmental Benefits**

The Charge Fast! Program will reduce greenhouse gas emissions and improve air quality. By expanding public access to DC fast chargers and level 2 chargers and extending the trip range of electric vehicles, the Charge Fast! Program will displace conventional vehicle miles and encourage the adoption of PEVs. To meet the anticipated PEV charging needs, all installations will be implemented along heavy traffic corridors that are likely to experience the highest demand for DC fast charging as identified in the 2013 Bay Area PEV Readiness Plan. The strategic locations of these chargers will provide high visibility of PEVs and PEV infrastructure to the public. Visibility may help to educate and inform prospective consumers and may even encourage prospective consumers to purchase a PEV.

As of December 31, 2017, a total of 241,883 kilowatt-hours (kWh) has been dispensed from the charging stations. This is equivalent to driving approximately 812,726 electric miles (instead of gasoline) and reducing approximately 0.17 tons of criteria pollutants (ROG, NOx, and PM) and 26,098 gallons of fuel per year. Projecting out to three years, the facilities are expected to dispense 1,451,298 kWh, which is equivalent to driving approximately 4.9 million electric miles. This is equivalent to reducing approximately 1.02 tons of criteria pollutants and 156,588 gallons of fuel per year.

### **Economic Benefits**

Through the Charge Fast! Program, new jobs will be created and sustained. The investment in electric infrastructure benefits California-based firms and improves their capacity for market leadership and job creation. Additional local construction and electrical jobs will be created from the installation and construction phases of the project.

In addition to reducing greenhouse gas emissions and improving air quality by reducing petroleum consumption and dependence, the Charge Fast! Program will result in a greater benefit-cost number as defined by the expected amount of greenhouse gas reductions per dollar of Energy Commission funding requested. The amount of Energy Commission award requested was \$500,000, and the expected greenhouse gas emissions reduced is 508 tons per year. Based on our analysis the cost-effectiveness for this project is \$982.58 per tons of emission reduced per year, for a total five years, this equates to \$196.52.

Indirect economic benefits include increased PEV sales and tax revenue for cities, as well as supporting local PEV suppliers.

### **Progress Report**

For the purposes of this report, only projects that have incurred at least six months of data, shown in Table 1, are discussed. The cumulative amount of energy dispensed by all charging stations is shown in Figure 2.



Figure 2: Cumulative Energy Dispensed, as of December 31, 2017

Figure 3 shows the total energy dispensed by facility, and Figure 4 shows the average monthly energy dispensed per port.

# Figure 3: Total Energy Dispensed Between Start of Operation and December 31, 2017



#### Source: Bay Area Air Quality Management District



#### Figure 4: Average Monthly Energy Dispensed Per Port

## Chapter 3: Case Studies

### Alameda Municipal Power (15DCFC03)

Alameda Municipal Power, located at 2000 Grand Street in Alameda, is the City of Alameda's nonprofit electric municipal utility serving over 34,000 customers. This project installed twodual port DC Fast Chargers, which provides corridor charging, shown in Figure 5, since it is situated 0.6 miles from State Route 61 and 1.4 miles from Interstate 880. These chargers also provide workplace charging since Alameda Municipal Power employs approximately 90 people at this location. This fills a major gap in the fast charging network.



Figure 5: Alameda Municipal Power Charging Stations

Source: Bay Area Air Quality Management District

Between the start of operation on October 21, 2015 and December 31, 2017, this facility has dispensed 15,775 kWh, which is equivalent to driving approximately 53,003 electric miles. Figure 6 shows a histogram of the energy dispensed per charging session. On average, approximately 8.4 kWh was dispensed per charging session. Figure 7 shows a histogram of the duration of charging sessions, which was approximately 24 minutes on average. Figure 8 shows a histogram of the distribution of charging start times, which has the highest frequency during mid-day.



Figure 6: Histogram of Energy Dispensed per Charging Session



Figure 7: Histogram of Charging Time



Figure 8: Histogram of Charging Start Times

### Federated Indians of Graton Rancheria (15DCFC01)

The Federated Indians of Graton Rancheria owns and operates the Graton Resort & Casino. This casino was built in 2013 and is considered a major destination with approximately 6,000 visitors each day. Located adjacent to US-101 at 288 Golf Course Drive West in Rohnert Park, this facility serves as a corridor, destination, and workplace. The Graton Casino is considered a major destination in the Bay Area.

The project installed two dual-port DC Fast Chargers and two dual-port Level 2 chargers, shown in Figure 9, which serves Graton Resort & Casino employees, visitors, and PEV drivers travelling to/from San Francisco, southern Bay Area counties, Napa and Marin to/from Sonoma County. A third DC charger was also installed by the project sponsor, but no CEC funding was provided for this charger.

#### Figure 9: Federated Indians of Graton Rancheria Charging Stations



Source: Bay Area Air Quality Management District

Between the start of operation on March 3, 2016 and December 31, 2017, this facility has dispensed 100,120 kWh, which is equivalent to driving approximately 336,404 electric miles. Figures 10 and 11 show a histogram of the energy dispensed per charging session for DC Fast and Level 2 chargers, respectively. On average, approximately 10.4 kWh was dispensed per DC Fast charging session and 8.2 kWh was dispensed per Level 2 charging session. Figures 12 and 13 show histograms of the duration of active charging sessions, which was approximately 42 minutes on average for DC Fast chargers and 123 minutes for Level 2 chargers. Figures 14 and 15 show histograms of the distribution of charging start times, which has the highest frequency between 11 AM and 12 PM and 5 PM and 6 PM for DC Fast chargers and between 4 PM and 5 PM for Level 2 chargers.



Figure 10: Histogram of Energy Dispensed per Charging Session – DC Fast Chargers



Figure 11: Histogram of Energy Dispensed per Charging Session – Level 2 Chargers



#### Figure 12: Histogram of Active Charging Time – DC Fast Chargers

Source: Bay Area Air Quality Management District







Figure 14: Histogram of Charging Start Times – DC Fast Chargers

Source: Bay Area Air Quality Management District



Figure 15: Histogram of Charging Start Times – Level 2 Chargers

### City of Saratoga (16DCFC01)

The City of Saratoga installed one dual-port DC Fast Charger at the Saratoga Public Library parking lot located at 13650 Saratoga Avenue, shown in Figure 16. This parking lot is visible from the street and close to the library entrance. The library is centrally located on an arterial in a commuter corridor and is easily accessible and located approximately one-half mile from on- and off-ramps of Highway 85, the only link to the highway system in the city. In addition, there are several schools and churches near the library, which is used frequently by students and adult residents.

Approximately 480,000 visitors walk through the library doors per year. This does not include people who drop off/pick up passengers, park to make book returns and donations without coming in, and people who may be using the lot for other purposes. The library is open seven days a week, except for 14 holidays a year. The parking lot is open and available at all times. Reducing the known visitors down to a very conservative factor of 25 percent to account for drivers who bring passengers, and for the nearby children who may walk to the library after school and wait for pickup, it estimated that at least 120,000 vehicles visit the library on an annual basis.



#### Figure 16: City of Saratoga Charging Station

Source: Bay Area Air Quality Management District

Between the start of operation on June 13, 2017 and December 31, 2017, this facility has dispensed 7,893 kWh, which is equivalent to driving approximately 26,519 electric miles. The city charges \$9.95 per hour for usage, charged on a per-minute basis. Figure 17 shows a histogram of the energy dispensed per charging session. On average, approximately 11.8 kWh was dispensed per charging session. Figure 18 shows a histogram of the distribution of charging start times, which has the highest frequency during the mid-afternoon hours. No active charging duration data was provided.



Figure 17: Histogram of Energy Dispensed per Charging Session



Figure 18: Histogram of Charging Start Times

## Chapter 4: Lessons Learned

### **Project Delays**

Three of the original sites were unable to proceed with their projects. This resulted in a second solicitation being conducted by BAAQMD to replace these projects. An additional three projects from the second solicitation were also unable to complete their projects. The time needed to find new sites to replace the ones that fell out meant that not all projects were able to report six months of operation data by the end of the Charge Fast! Program. Finding site hosts who were willing to install the necessary infrastructure for DC fast chargers was a challenge. BAAQMD found that working with the tenant or property owner to install the charging station result in fewer issues than partnering with contractors who do not own the site.

### **Project Timeline**

Table 2 summarizes the project timeline and provides the number of days between contract execution and the date all stations were placed into service. The number of days it took to place a project into service from contract execution varied from 86 days to 362 days. These timelines align with the timelines of charging station deployment projects at BAAQMD. The engineering and construction for 16EV021 took longer than anticipated.

Project Number	Project Sponsor	Contract Execution	Date Placed into Service		
15DCFC01	Federated Indians of Graton Rancheria	12/14/2015	3/9/2016		
15DCFC03	Alameda Municipal Power	3/13/2015	10/26/2015		
16DCFC01	City of Saratoga	3/13/2017	6/13/2017		
16EV006	Sonoma Mountain Village, LLC	5/2/2016	9/6/2016		
16EV021	Ford Point LLC	3/10/2016	3/7/2017		

#### **Table 2: Project Timeline**

Source: Bay Area Air Quality Management District

### **Availability of Chargers**

The chargers are available 24 hours a day, 7 days a week for each facility. However, Sonoma Mountain Village (16EV006) adjusts the availability of chargers during concerts and events.

### **Pricing Structure**

15DCFC01: Free charging

15DCFC03: \$7/hour initially, then \$0.45/kWh

16DCFC01: \$9.95 per hour for usage, charged on a per-minute basis.

16EV006: Free charging was reported; however, ChargePoint specifies that all nine of these chargers have a fee of \$0.20 per kWh, with a minimum charge of \$1.00.

16EV021: Free charging

### **Utilization of Charging Assets**

Some of the DC fast chargers deployed by the Charge Fast! Program will use an innovative process to manage peak electricity demand. These stations will have the ability to adjust pricing to manage the demand on the charger. The result of the pricing strategy will reduce the potential strain a DC fast charger can have on California's electrical grid during times that the demand for electricity is at its highest.

## GLOSSARY

BAY AREA AIR QUALITY MANAGEMENT DISTRICT (BAAQMD)—Tasked with regulating stationary sources of air pollution in the nine counties that surround San Francisco Bay: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, southwestern Solano, and southern Sonoma counties. It is governed by a 24-member Board of Directors composed of locally elected officials from each of the nine Bay Area counties, with the number of board members from each county being proportionate to its population.

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.

DIRECT CURRENT (DC)—A charge of electricity that flows in one direction and is the type of power that comes from a battery.

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.

PLUG-IN ELECTRIC VEHICLE (PEV)—A general term for any car that runs at least partially on battery power and is recharged from the electricity grid. There are two different types of PEVs to choose from—pure battery electric and plug-in hybrid vehicles.

## APPENDIX A: Monthly Energy Dispensed (kWh)

Figure 19: Monthly Energy Dispensed					
	15DCFC01	15DCFC03	16DCFC01	16EV006	16EV021
Oct-15		151.45			
Nov-15		293.42			
Dec-15		126.50			
Jan-16		351.72			
Feb-16		244.39			
Mar-16	732.36	593.50			
Apr-16	1,541.23	246.59			
May-16	2,052.13	241.29			
Jun-16	2,240.80	438.75			
Jul-16	2,837.13	548.41			
Aug-16	2,668.32	557.52			
Sep-16	2,956.47	613.32			
Oct-16	3,530.05	644.68			
Nov-16	2,948.77	704.89			
Dec-16	3,563.95	755.84			
Jan-17	4,911.20	782.38		5,140.14	
Feb-17	4,346.99	569.89		2,634.79	
Mar-17	4,851.70	739.20		3,777.72	3,800.94
Apr-17	5,462.77	585.38		2,252.52	5,950.63
May-17	5,661.65	863.89		2,226.81	6,483.25
Jun-17	5,129.28	931.19	641.01	2,648.95	6,547.21
Jul-17	6,507.45	580.12	1,116.42	1,945.65	6,936.85
Aug-17	6,437.63	952.64	1,355.38	2,182.83	7,946.56
Sep-17	7,970.38	1,019.11	1,626.04	2,432.91	8,549.52
Oct-17	7,640.93	850.73	1,432.97	3,986.54	9,306.09
Nov-17	7,871.83	705.17	1,255.28	6,610.37	8,892.65
Dec-17	8,257.23	682.81	465.59	9,599.39	8,242.59
<b>Total Energy</b>	100,120.25	15,774.78	7,892.69	45,438.62	72,656.28

Figure 19 shows the monthly energy dispensed at five Fast Charge! locations.