CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Best Practices for Installation of Direct Current Fast Charging Corridors

South Coast Air Basin DC Fast Charging Network

Prepared for: California Energy Commission

Prepared by: South Coast Air Quality Management District

Gavin Newsom, Governor

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Patricia Kwon, South Coast Air Quality Management District
Jonah Eidus, EVgo
Enid Joffe, Clean Fuel Connection, Inc.
Jaime Nack, Three Squares, Inc.
J.R. DeShazo, University of California, Los Angeles Luskin Center for Innovation
Primary Authors

South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765
(909) 396-3065
SCAQMD website (www.aqmd.gov)

Agreement Number: ARV-12-053

Sharon Purewal
Commission Agreement Manager

Mark Wenzel
Office Manager
ADVANCED VEHICLE INFRASTRUCTURE

Hannon Rasool
Deputy Director
FUELS AND TRANSPORTATION

Drew Bohan
Executive Director

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Vahan Pezeshkian, Los Angeles Department of Transportation
Steven Weiss, Mel's Diner Santa Monica

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 develop best practices in the deployment of advanced vehicle infrastructure networks. 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 12, 2012 and the agreement was executed as ARV-12-053 on October 25, 2013.

ABSTRACT

For this project South Coast Air Quality Management District is partnering with EVgo, Clean Fuel Connection, Inc., University of California, Los Angeles Luskin Center for Innovation, and Three Squares, Inc. The South Coast Air Quality Management District team has completed a previous project to construct a robust Direct Current fast charger network along major highways.

This project of 10 Direct Current fast chargers in seven locations in Los Angeles and San Bernardino Counties, extends the growing Direct Current fast charging corridor, further connecting the metropolitan areas of Los Angeles, San Diego, Santa Barbara and Palm Springs.

The landscape for fast charging has evolved considerably since this project was initially funded in 2013 and a significant amount of learning and best practices have been developed. This report will discuss the overall deployment of these fast chargers to the existing fast charging network in the greater Los Angeles region and best practices in the areas of site selection, hardware, installation, networking software and services, and education outreach so that other jurisdictions and agencies implementing fast charging in their region may benefit.

Keywords: Direct Current fast charging, public charging, South Coast Air Quality Management District, EVgo, Clean Fuel Connection, Inc., Three Squares, Inc., charger network

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EXECUTIVE SUMMARY

The CEC funded the South Coast Air Quality Management District to install direct current fast chargers throughout the South Coast Air Basin under grant ARV-12-053 in 2013.

These efforts support the California Governor's Zero Emissions Vehicle Action Plan (https://www.gov.ca.gov/docs/2016_ZEV_Action_Plan.pdf) goal of 1.5 million zero emission vehicles on the road by 2025, support local climate and air quality goals, and lead to economic benefits for the region.

This project included several steps:

- Engage local staff and decision-makers, including stakeholders within the Cities and in the broader communities;
- Select target levels of plug-in electric vehicle charging infrastructure in new construction and model scenarios to demonstrate that local building codes are cost-effective compared to later retrofit costs or other soft-costs of development;
- Develop an innovative model code package for each city to increase the amount of plug-in electric vehicle charging electrical infrastructure included in new buildings, and to ensure that plug-in electric vehicle parking subject to the Title 24 Chapter 11B accessibility requirements is designed for compliance;
- Conduct outreach to stakeholders and address feedback before following a formal public process for adopting codes; and
- Examine the permitting and inspection process in Oakland and take additional steps to streamline these processes, including through staff training.

Each partnering local government adopted new building codes that require a higher level of plug-in electric vehicle charging infrastructure at a greater number of parking spaces than required by the California Green Building Standards Code. These efforts will generate significant benefits. The project team estimates that this project will create over 11,000 additional plug-in electric vehicle parking spaces with electric circuit infrastructure by 2025, facilitating adoption of at least 10,000 new plug-in electric vehicles. This will reduce at least 35,200 metric tons carbon dioxide equivalent of greenhouse gas emissions and avoid 3,520,000 million gallons of petroleum usage per year by 2025 along with significant improvements to air quality and public health.

The project team also identified potential future projects that can build on the successful adoption of these local codes. Implementing similar passenger vehicle local codes to additional jurisdictions is one opportunity. Others include electrical infrastructure solutions for curbside charging, accessibility guidelines, and guidelines for direct current Fast Charging. Building codes can also cover electric infrastructure for goods movement vehicles, such as forklifts at warehouses and stand-by emissions from transportation refrigeration units.

CHAPTER 1: Overview

This final project report is a compilation of best practices for the siting and use of direct current (DC) fast chargers, economic and vehicle range tradeoffs between availability of charging infrastructure and onboard battery capacity, changes in EV driver behavior, and necessary elements to include in community outreach and education programs.

As background information for the need for public DC fast charging infrastructure to support plug-in electric vehicles, California expects to be the largest United States market for Plug-In Electric Vehicles (PEVs), especially in the greater Los Angeles region with over 44 percent of the state's population and a historic and ingrained car-centric culture. The South Coast Air Quality Management District (SCAQMD), the California Air Resources Board and the Southern California Association of Governments recognize that in order to meet 2023 and 2032 federal $PM_{2.5}$ and ozone standards and achieve the statewide greenhouse gas (GHG) reduction targets, the use of zero-emission technologies such as PEVs will be required in the South Coast Air Basin. SCAQMD is currently demonstrating and implementing many zero-emission technology projects in the light-, medium- and heavy-duty transportation categories.

For this project, SCAQMD is partnering with EVgo, Clean Fuel Connection, Inc., University of California, Los Angeles (UCLA) Luskin Center for Innovation, and Three Squares, Inc. The project team completed a prior project to install seven DC fast charging stations in Los Angeles and Riverside counties in 2017. This project will extend the growing east-west DC fast charging corridor to a location in San Bernardino County, further connecting the metropolitan areas of Los Angeles, San Diego, Santa Barbara and Palm Springs. The landscape for fast charging has evolved considerably since this project was initially funded in 2013 and a significant amount of learning and best practices have been developed. This report will discuss the deployment of 10 DC fast chargers to the existing fast charging network in the greater Los Angeles region and best practices in the areas of siting and site selection, hardware, installation, networking software and services, and education outreach so that other jurisdictions and agencies implementing fast charging in their region may benefit.

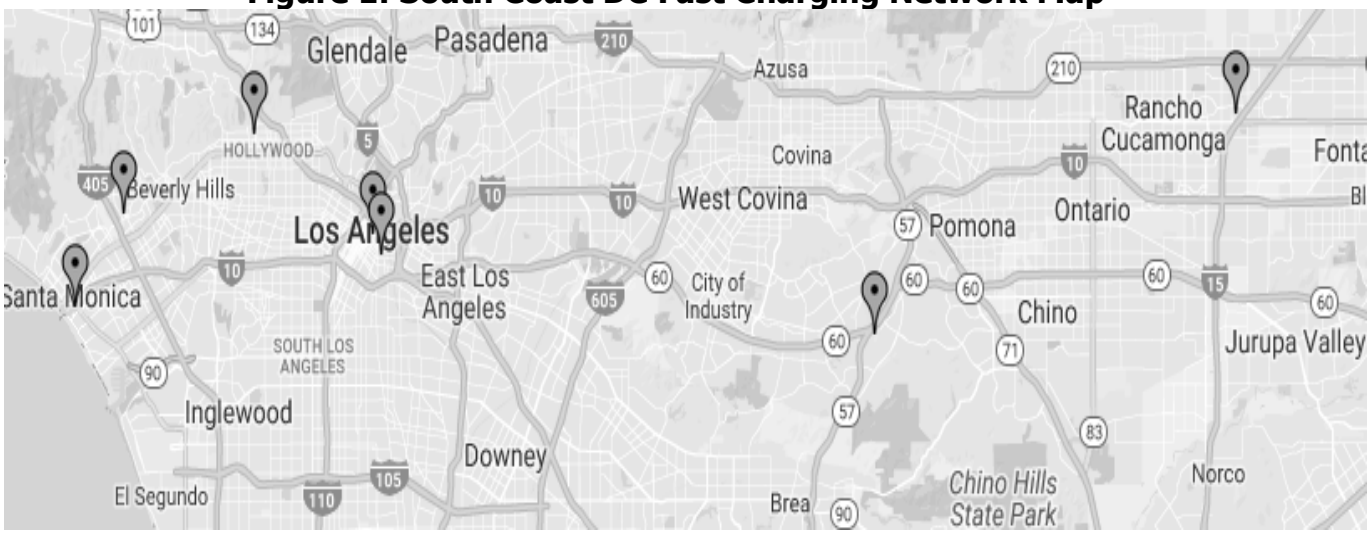
Each of the team members has expertise in an area key to the overall success of the project. EVgo will own, operate, and maintain the DC fast chargers. EVgo has been installing DC fast chargers in California, Texas and Washington, DC and currently has the nation's largest network of DC fast chargers in the nation. EVgo brings its national network of private retail partners to provide a cohesive network of charging stations along the major highway transportation corridors.

By partnering with EVgo, the nation's largest competitive power producer and investor/operator of solar power in the United States, and with Clean Fuel Connection, Inc., one of the most experienced installers of public electric vehicle supply equipment in Southern California, a fast charging infrastructure network necessary to transition to alternative, clean fuel sources is being created. In supporting mass market penetration of zero emission vehicles, SCAQMD is fulfilling its mission to protect public health from air pollution, with sensitivity to disproportionate impacts of air quality on local communities and businesses. This

project includes the installation of 10 DC fast chargers at the following seven locations, shown in Figure 1, located less than a mile from major highways:

1. Station 1—Mel's Drive In 1670 Lincoln Blvd, Santa Monica, CA 90404
2. Station 2—Victoria Gardens Mall 12505 N. Main Street, Rancho Cucamonga, CA 91739
3. Station 3—La Kretz Innovation Campus, 525 S. Hewitt Street, Los Angeles, CA 90013 (2 DC fast chargers)
4. Station 4— LADOT Westwood Broxton Avenue Parking Garage, 1036 Broxton Avenue, Los Angeles, CA 90025 (2 DC fast chargers)
5. Station 5— LADOT Little Tokyo/Arts District Gold Line Station, 200 N. Alameda Street, Los Angeles, CA 90012
6. Station 6— LADOT Hollywood & Highland Red Line Station, 6801 Hollywood Blvd, Los Angeles, CA 90028 (2 DC fast chargers)
7. Station 7—South Coast Air Quality Management District 21865 Copley Drive, Diamond Bar, CA 91765

Figure 1: South Coast DC Fast Charging Network Map



These stations are part of a regional plan developed by SCAQMD, with 10 DC fast chargers at seven sites along major transportation corridors in greater Los Angeles and within a mile to the nearest highway. These chargers were installed and operational on the EVgo network as shown in Table 1.

Table 1: Fast Charger Installation/Operational Dates

Agency	Site	Number of Chargers	Installation Date	Operational on EVgo Network
Mel's Drive In	Mel's Drive In Santa Monica	1	3/28/18	6/28/18
City of Rancho Cucamonga	Victoria Gardens Mall	1	6/12/18	6/27/18
LA Department of Water and Power	La Kretz Innovation Campus	2	7/24/18	8/28/18
LA Department of Transportation	Garage 680 – 1036 Broxton, Westwood	2	7/24/18	8/28/18
LA Department of Transportation	Little Tokyo Gold Line Metro Station – 101 Judge John Aiso Street	1	7/24/18	8/3/18
LA Department of Transportation	Hollywood & Highland Red Line Metro Station – 6801 Hollywood Blvd	2	7/14/18	11/4/18
SCAQMD	SCAQMD – 21865 Copley Drive, Diamond Bar	1	8/6/18	9/28/18

Source: SCAQMD

Project Eligibility

This project meets all of the minimum requirements for project eligibility as defined in PON-11-602 and does not contain any confidential information. Technology for DC fast chargers is changing rapidly. In 2010, Japanese original equipment manufacturers Toyota, Nissan and Mitsubishi partnered to develop DC fast chargers with the CHAdeMO quick charging connector standard with charging speeds of 40-60 kilowatt (kW) and speeds of up to 100 kW. The Nissan Leaf, Mitsubishi iMiEV, and Kia Soul use the CHAdeMO connector. In 2011, a Society of Automotive Engineers (SAE) Combined Charging System (CCS) connector standard for fast charging was adopted by United States and European original equipment manufacturers, with similar charging speeds and capable of charging up to 350 kW. The BMW i3, Chevy Bolt and Spark, Honda Clarity Hyundai Kona, and Volkswagen e-Golf use the CCS connector. Tesla has its own proprietary connector standard which can only be used by its vehicles.

There are multiple manufacturers of 50 kW DC fast chargers certified from a nationally recognized testing laboratory, with both CHAdeMO and CCS connectors. The ABB DC fast charger is Underwriters Laboratories listed while the Efacec DC fast charger is Edison Testing Laboratories approved. Edison Testing Laboratories is a commonly recognized certification that tests to the same standards as Underwriters Laboratories but typically on an expedited timeline. It is increasingly being accepted by local jurisdictions in the United States. The certification process is sufficiently expensive and time consuming that DC fast charger manufacturers will only choose one nationally recognized testing laboratory to pursue

certification of their fast charger. Other DC fast charger manufacturers include AeroVironment, BTC, and ChargePoint, among others.

In order to support the greatest number of PEVs and meet the requirements of the CEC grant, the project team installed dual DC fast chargers with CHAdeMO and SAE Combo connectors. EVgo issued a request for information to identify the current state of technology, including DC fast chargers, battery energy storage systems, and other options. Based on responses to the request for information, EVgo designed bid specifications and issued a request for proposal for the purchase of equipment to obtain the most competitive pricing and worked with the provider to integrate EVgo's networking software. In addition, EVgo meets the Open Charge Point Protocol, an application protocol for communication between electric vehicle supply equipment and a central management system for the charging station network. This would enable the operation of the DC fast chargers by any Open Charge Point Protocol compliant network provider and avoid a situation where the absence of a network provider such as EVgo would mean that installed hardware would no longer be operational and require replacement.

This project includes the following attributes:

- Charging provides both DC fast charging connector standards, CHAdeMO and CCS, and may include Level 2 charging with SAE J1772 connectors to meet Americans with Disabilities Act requirements imposed at certain sites
- Charging sites are located in public access parking lots. If fees are charged for parking, free or reduced parking charges are offered if a vehicle is only parking for the purpose of DC fast charging.
- Charging sites are located within a 1-mile driving distance of a major highway, in close proximity to populated areas or destinations
- Per the siting analysis performed by the UCLA Luskin Center for Innovation and plan for outreach to the surrounding communities, this project will add value to PEV drivers traveling along these major transportation corridors
- Charging sites chosen for their easy highway access and ability to provide safe, well-lit charging environments for PEV drivers in the region
- Project includes a five-year plan for ongoing operation, maintenance and reliable customer service at each location should there be any unforeseen equipment breakdowns
- Each station accepts credit cards as payment and is Open Charge Point Protocol compliant. Credit card support is available through the EVgo call center. Additionally, customers can put a credit card on file with their EVgo user account and receive a radio frequency identification card (Pay as You Go plan with no monthly fee on a pay per use basis or membership plan).
- EVgo equipment will not require a subscription fee or membership in any proprietary network as a condition of use
- DC fast chargers use an open source protocol such as Open Charge Point Protocol as a basic framework for network interoperability
- Installation will ensure that site locations have adequate power and transformer capacity available

CHAPTER 2:
Siting and Site Selection

Site selection methodologies implemented in this project were based largely on EVgo's historical experience, both in California and nationwide. The UCLA Luskin Center for Innovation also provided significant input into site selection, via its Innovation PEV Program.

Project Site Justification

Much of the input on site locations came from UCLA Luskin Center's sophisticated PEV adoption modeling software, identifying travel patterns between census tracts where PEV drivers reside, work and shop. The Luskin site selection model combines land use data on local densities of workplaces, MUDs and retail establishments with locations of existing charging stations. Finally, demographic data and the characteristics of the local transportation system are used as described in the *Southern California PEV Readiness Plan*[1] (written by the UCLA Luskin Center and winner of the 2013 Planning Excellence Award by the Los Angeles section of the American Planning Association). EVgo, Clean Fuel Connection, Nissan, and General Motors also provided input on the site selection and site substitution process. The UCLA Luskin Center analyzed the South Coast Air Basin and selected suitable locations at existing host location partners to maximize the effectiveness of the overall DC fast charging plan.

The 10 DC fast chargers at seven sites outlined in this project were selected because these sites are situated alongside major highways linking urban areas on heavily traveled routes and highly visible locations. These fast chargers serve to extend the network further east towards San Bernardino.

Based on these regional parameters, the original proposal targeted primarily grocery stores. Unfortunately, the grocery chain identified as an early partner unexpectedly backed out, and EVgo and Clean Fuel Connection needed to identify alternative site hosts in addition to the city government locations already selected. These stations are sited at EVgo retail partners such as coffee shops, convenience stores, drug stores, or shopping malls, filling infrastructure gaps in the South Coast Air Basin. Data shows that trips to these destinations are typically taken during off-peak hours. This project is being coordinated with a CEC funded project by the Southern California Public Power Authority in order to increase corridor charging opportunities within jurisdictions served by municipal owned utilities.

Lessons Learned

The past five years have seen significant changes in EV charging landscapes, and the lessons that EVgo has learned from this project and the data collected have been able to provide critical insight to key players across the industry, including utilities, regulators, original equipment manufacturers, host partners and other EV network providers and projects such as Volkswagen's Electrify America.

[1] Southern California PEV Readiness Plan https://scag.ca.gov/sites/main/files/file-attachments/scag-southern_ca_pev_readiness_plan_0.pdf?1605815051

In many cases, these experiences and data have refuted much of the conventional thinking and expert hypotheses that helped shape the early years of this industry. Driver usage patterns, capital and operational cost structures, site acquisition challenges and host site qualifications have led EVgo to change significant portions of their business strategy.

Specifically, EVgo has found that the type of host properties, as well as the specific regions and even sub-regions, can have an exponential impact on the amount of usage that the site receives. For example, EV drivers overwhelmingly prefer that DC fast charging stations be located adjacent to retail properties, so that they can run errands while they charge. Moreover, the type of retail property can make a significant difference. In general, grocery stores see significantly more usage than any other type of retail, followed by pharmacies/convenience stores, coffee shops and certain types of big box store chains (i.e. Walmart). Locations like municipal lots, specialty stores (i.e., a store that only certain market segment would shop at such as a pet store), colleges/ universities, restaurants or public parking available at workplace/multifamily residential sites tend to see significantly lower utilization than a regionally comparable grocery/convenience store/coffee shop. In many cases, this ratio can be as much as 4:1 or 5:1 in favor of relevant retail properties.

On a regional basis, charging locations that have seen the most utilization tend to be in high urban densities, with additional weight based on proximity to the highway. However, EVgo has seen that proximity to a highway alone is not nearly as valuable as EVgo and much of the EV industry had formerly suspected. For example, many locations on the east side of Los Angeles and into the Inland Empire, in close proximity to highways, are showing much lower utilization than locations on the more densely populated west side of Los Angeles, even those not in close proximity to highways. Moreover, there are high value location types (i.e. grocery stores) in the Inland Empire that show significantly lower usage than west side grocery store counterparts.

Other factors that are proving to be barriers to driver usage are parking fees and access barriers such as gated parking. Both factors are correlated with lower usage even in otherwise desirable locations.

The entire EV industry has always argued, and still maintains, that locations along highway corridors connecting dense urban zones are critical to the success of EV adoption. Even though these locations are still critical to industry success as a whole, there is a limit to how many loss leader locations that EVgo or any major network provider can support, and for any significant period of time. Both the utilization and growth rate at these types of locations are significantly below what much of the EV industry had originally assumed.

Another factor that slowed progress was the length of time required for site assessment and contract execution by potential site hosts. Once a site was identified and the site host expressed interest, a site assessment was performed to determine if the installation could be completed within the project budget. In several cases, contract negotiations were lengthy, and all contracts had to be approved by the City Councils of the respective local governments, leading to further delays in deploying fast charging infrastructure.

Metering and Demand Charges

Thinking about optimal DC fast charging locations has been shifting as more data is collected on actual driver usage and the economics of charging. Low utilization sites, especially those where EVgo pays utility demand charges to the site host, can be extremely expensive to

operate, and the cost to serve a single driver can well exceed what is considered reasonable to bill EV drivers for charging, not allowing for cost recovery at that site. While several of the sites in this program are performing adequately, most of the locations, specifically those located at city government properties in less densely populated areas, are performing well below what it costs EVgo to operate.

EVgo's original business model called for each fast charger to be on a separate utility meter so that electricity costs could be easily tracked. Unfortunately, based on the current utility rate structure, a portion of the electricity costs is fixed, regardless of actual usage. This portion of the monthly electricity bill is the demand charge and is based on the highest single use during the month. Given the 50-kW requirement of the BTC DC fast charger, EVgo is billed for 50 kW of demand, regardless of whether one driver uses the charger or 1,000 drivers. Usage of each of the installed DC fast chargers started low and ramped up over time. As a result, revenue from driver fees in the early months does not cover the cost of electricity. Even after many months of operation, the monthly cost of electricity exceeds the revenue stream at some locations. Unfortunately, this is not a sustainable business model.

Midway through the project, EVgo adjusted their business model to select locations where the DC fast charger could be added to an existing utility meter. This had the result of spreading the monthly demand chargers over more kilowatt hour usage, reducing the negative impact of demand chargers. EVgo negotiated a reimbursement rate for each site host based on a blend of expected demand charges and kilowatt hour costs. This approach proved to be a more cost-effective way for handling low utilization sites and providing greater geographical coverage for the EVgo DC fast charging network.

CHAPTER 3:
Hardware

EVgo and Clean Fuel Connection, Inc. selected BTC Power as the hardware manufacturer for this program through a request for quote to identify the best performing and most cost effective 50 kW DC fast charger for this project.

With over 600 DC fast charger units deployed, BTC Power is the largest United States based manufacturer of DC fast chargers, which have been commercially available since 2013. BTC Power DC fast chargers are built for a lifespan of 15 years, with minimal maintenance requirements other than bi-annual product maintenance. BTC Power has also integrated their hardware with multiple network software providers, making their DC fast charger capable of being operated on multiple networks including EVgo, Greenlots, Electrify America, and Southern California Edison's Charge Ready program.

The BTC EVFC-50-5 DC fast charger, shown in Figure 2, can be installed on either 208-volt service or 480-volt service (Model EVFC-50-5-208 or EVFC-50-5-480, respectively). These voltage options allow for additional installation flexibility at the site level.

BTC Power's 50 kW DC fast charger can be configured as a single charger, with either a CHAdeMo or SAE connector, or a dual charger with both a CHAdeMo and SAE connector integrated into a single unit, capable of charging a wide variety of EV's. The dual connector configuration was selected for this program.

Figure 2: BTC Power DC Fast Charger

DC Fast Charger: EVFC-50-5

BTCPOWER
www.btcpower.com

Model	EVFC-50-5-208	EVFC-50-5-480
Power Rating	50 kW	50 kW
Input Power	208 VAC, 3-Phase	480 VAC, 3-Phase
Input Power Breaker	200 A	100 A
Input Current	160 A	70 A
Required Power Capacity	58 kVA	58 kVA
Max. Output DC Current	50 A	50 A
Max. Output DC Voltage	50-500 V	50-500 V
Frequency	50 Hz / 60 Hz	
Efficiency Rating	>90%	
Connectors	CHAdeMO, SAE Combo	
Network	EVP, Credit Card, OCPP	
Storage Temperature	-20°C to +55°C	
Operating Temperature	-30°C to +55°C	
Relative Humidity	90%	
Safety Compliance	ETL Listed for USA and Canada; Complies with UL 2594, UL 2231-1, UL 2231-2, NEC Article 625, FCC Part 15, Class A, ADA Compliant	

Product Dimensions:
43"[w], 73.5"[h], 32.19"[d]

Source: BTC

CHAPTER 4: Installation

Overview

All installations were completed on time and within budget by Clean Fuel Connection using in-house electrical crews. The amount of time required for each installation ranged from two weeks to several months, depending on timeframes for material deliveries, City permitting, and utility work/approvals. Installation work included the following scope of work:

- Site design and engineering
- Permitting with the local authority having jurisdiction
- Trenching, installation of conduit and wire
- New meter pedestal and electrical panel where required
- Transformers where required
- New utility service where required
- Pouring concrete bases for DC fast chargers and any pedestals or transformers
- All final connections to DC fast chargers
- Striping, safety bollards and EV charging stenciling and signage
- Utility interconnection where required
- Final inspections by local authority having jurisdiction and/or utility where required
- Network connection to EVgo

Some sites had 480-volt power, but other sites only had 208-volt power available. Fortunately, BTC hardware can be configured to work with either type of power. Installation costs varied by site, ranging from $26,000 to $56,000 per charger.

Lessons Learned

There were a number of issues that slowed progress on the project. While most of the installations were not particularly complicated, there were significant challenges and barriers to installation that needed to be overcome at each site.

Disabled Access for EV Charging

Compliance with the California Americans for Disability Act Guidelines for disabled access for EV charging as defined by the California Division of the State Architect was a significant challenge during this project. During the period of construction under this contract, disabled access for EV charging was governed by the "Interim Disabled Access Guidelines for Electric Vehicle Charging Stations 97-03" dated June 5, 1997. These guidelines were subject to varying interpretations by local authorities having jurisdiction, and in several cases, the project design went through several iterations in order to comply with local interpretations of California accessibility requirements. Some of the ambiguity of the 1997 Guidelines has been resolved with the issuance of the 2016 California Building Code, Chapter 11B, effective January 2017, but compliance with disabled access remains challenging for EV charging installations. In many cases, it can significantly increase the cost of installing Level 2 or DC fast charging infrastructure by triggering requirements for accessible charging spaces, even with the

installation of the first charger at a site. These additional accessibility requirements include limitations on slope (no greater than 2 percent), standards for an accessible path of travel from the charging space to the nearest entrance of the facility, and wider space requirements for regular vehicle and van accessible charging spaces.

Power Availability

The BTC 50kW DC fast chargers require a substantial amount of 208-volt or 480-volt power. Many locations were eliminated because they did not have adequate electrical capacity and the required upgrades would have exceeded the project budget. In other locations, the power that had been available during the initial assessment was no longer available at the time of construction. After load testing, multiple load calculations and consulting an electrical engineer, Clean Fuel Connection was able to find a workable solution for each location. However, the process was laborious and time consuming.

CHAPTER 5:
Networking Software & Services

EVgo provides comprehensive networking, service and maintenance for all DC fast charging stations in this program. As the largest public DC fast charging service provider in North America, EVgo has extensive experience managing and operating DC fast charging stations.

Networking

EVgo's attention to customer needs led to the implementation of a new network system operating platform in June 2017. This platform is based on the software service from Driivz. Founded in 2012, the Driivz platform is currently used to manage the largest public EV charging networks in Europe with over 9,000 charging connectors on more than 60 different types of charging stations used by over 140,000 EV drivers.

Importantly, with the EVgo and Driivz operating experience, its systems are built from real customer requirements. EVgo and Driivz have worked with many different EV related stakeholders throughout the world including automaker partners, utilities, EV drivers, site hosts, service providers, mobility providers, and government agencies. Each stakeholder has their own set of requirements for their needs and those of their customers. EVgo chose Driivz as the network developer based on their success, and together with Driivz have developed a multifaceted platform that serves all of these stakeholder needs.

The EVgo/Driivz platform offers a multitude of functionalities, including real-time remote diagnostics, remote service and maintenance (when possible), driver billing, metering and monitoring, reporting, facilitation of host reimbursement, as well as a comprehensive driver portal and mobile app complete with mobile application charger authentication.

The first six months of operation under the new EVgo/Driivz have proven to be an upgrade in networking functionality, improving EVgo's service level and customer satisfaction.

Acceptable Forms of Payment

EVgo offers a number of ways to pay for each charge.

- Credit Card – All EVgo charging stations offer payment via credit card. All stations deployed under this program have a credit card reader capable of accepting all major credit cards.
- EZ-Charge – All new Nissan LEAF drivers receive an EZ-Charge card, which entitles drivers to two years of free charging on the EVgo network (as well as other selected networks). EVgo developed EZ-Charge in conjunction with Nissan. The program provides drivers with a radio frequency identification card that can be registered on multiple networks. This process is facilitated by a jointly managed website that allows EV drivers to register their card and the networks of their choosing. All major networks participate in this program (Aerovironment, ChargePoint, Greenlots, JNSH, and EVgo).
- BMW ChargeNow – Purchasers of new BMW i3 vehicles who enrolled by December 31, 2018, receive a ChargeNow card to access all EVgo stations. To implement this project, EVgo works with the ChargeNow administrator (ChargePoint) to authenticate each transaction.

- EVgo Mobile App – Customers are able to pay through EVgo's mobile app

Customer Service/Support

EVgo chargers are fully networked, enabling real-time status updates for EV drivers and EVgo technical staff to ensure maximum uptime, and our best-in-class Call Center (help desk) is available 24/7/365. If the chargers experience any error, Network Operations is notified instantly. Once an error is flagged, trained staff diagnose the error appropriately and dispatch a technician for repair if needed. Through the Call Center, chargers can also be quickly started and reset remotely. Performance of the Call Center is show in Table 2.

EVgo's comprehensive approach to customer service comes originally from the company's origin with NRG Energy. As the retail electricity provider for over 3 million customers, NRG and its retail companies (Reliant, Cirro, and Green Mountain Energy) built systems and processes to handle approximately 6.5 million calls per year.

Table 2: Customer Call Center Performance

Call Center Performance	
	Simply Smart Solutions
Call Offered (NCO)	9764
Calls Handled (NCH)	9562
Calls Abandoned (NCA)	202
Service Level (SL)	97.0%
Average Speed of Answer (ASA) (in seconds)	9
Average Handle Time (AHT) (in seconds)	344
Max Delay (in seconds)	1016

Source: EVgo

EVgo's Call Center representatives are dedicated to the needs of EV drivers and currently handle approximately 8,000 calls per month, with average waiting times of less than twenty seconds per call.

EVgo regularly monitors customer satisfaction through a variety of channels, including detailed operational metrics, as well as phone and internet surveys to ensure customers are satisfied with the service EVgo delivers. All customer issues are monitored through an internal tracking system. This system tracks customer issues by multiple variables, including EV model, location, charger type and issue, so that trends can be easily detected, resolved quickly and proactively addressed. This system allows EVgo to evaluate practices and policies to avoid the recurrence of preventable issues.

EVgo's Call Center regularly ranks in the top service category compared to our peers. Specific metrics include average speed of answer, calls abandoned rate, issue resolution time and customer satisfaction in order to constantly improve the customer experience.

Although many routine customer questions and concerns can be resolved on the phone, our operations team also continuously monitors all of our charging equipment so that action can be taken before issues arise. Our Network Operations Center can remotely reset chargers via

the Open Charge Point Protocol network, and our network is programed to avoid outages or offline chargers with the inclusion of a default setting to "free vend" in the event of a communication error or loss of status, enabling customers to charge their vehicle despite a loss of communication.

Maintenance

Good maintenance practices are critical to a quality customer experience. Having operated the nation's largest DC fast charging network at high levels of availability (currently exceeding 98 percent uptime), EVgo understands how to implement a robust maintenance operation. A number of EVgo operational employees come from power plant or utility backgrounds and bring that expertise to our high-speed EV charging network.

EVgo is committed to providing the most reliable charging network in America and maximizing the uptime of the charging network by ensuring all equipment and systems undergo regular, timely, and high-quality maintenance. EVgo has multiple partners to perform service, preventative maintenance, and corrective maintenance for EVgo's nationwide infrastructure. All maintenance on electric vehicle supply equipment, electrical supply equipment, network infrastructure, and non-core equipment is performed in conformance with local, state, and federal fire and electrical regulations, and in accordance with all original equipment manufacturer recommendations and requirements. All sites undergo regular preventative maintenance including visual inspection, performance testing, cleaning, and functional validation. All maintenance is fully documented, and summary reports will be available on request.

Demonstrated Results

PlugScores from PlugShare are an objective measure of customer satisfaction levels and are developed via direct user feedback based on station uptime, customer service, and overall quality of the site location. Table 3 shows the national PlugScores for EVgo's DC fast charging network and industry partners' charging networks, and two of the cities in the United States with the largest networks. EVgo's operating standards and customer-centric service model produce the highest customer satisfaction scores in the industry.

Table 3: Customer Satisfaction Scores for Fast Charging

	EVgo	ChargePoint	Blink	Greenlots	Other
National Average DC Network PlugScore	9.0	7.7	5.5	6.8	7.0
# DC Charging Sites - Los Angeles	64	24	6	17	28
Average DC PlugScore - Los Angeles	9.3	8.2	5.6	7.7	7.9
# DC Charging Sites - San Francisco	52	19	30	8	10
Average DC PlugScore - San Francisco	8.5	8.3	5.6	6.3	7.4

Source: EVgo

CHAPTER 6:
Education Outreach

Involving local stakeholders in PEV readiness is crucial to the successful deployment of DC fast charging stations. Drivers and charging site hosts need help understanding the benefits of driving PEVs and having public fast charging in their communities, the economic value proposition that PEV driving and/or charging holds for them, and correct procedures for using DC fast charging stations.

An education and outreach campaign has been developed to facilitate PEV readiness in DC fast charging station communities by engaging the following stakeholder groups:

- Site hosts (owners/employees/students);
- Local businesses (owners/employees);
- Local homeowners and commuters;
- Local governments, associations, and media; and,
- PEV advocacy groups

Three Squares Inc. has served as the Project Community Outreach and Education Lead. In this role, they have designed a comprehensive outreach strategy to raise awareness about the new DC fast charging stations throughout their surrounding communities.

Three Squares, Inc. is a Santa Monica-based environmental consulting firm that has been directly involved in the development of California's PEV infrastructure as a contractor to the SCAQMD and to several PEV manufacturers. From organizing alternative fuel vehicle tradeshows, expos, and ride and drive events, to working directly with PEV manufacturers on their marketing and communications plans, Three Squares, Inc. has extensive experience engaging the public's interest in PEVs. Three Squares, Inc. has also developed community outreach and education campaigns for SCAQMD to increase awareness about PEVs and created the CleanCarChoices.org online calculator to showcase the benefits of switching from a gasoline-powered vehicle to a PEV.

Outreach Events

Three Squares, Inc. has developed a series of DC fast charging station launch events to raise awareness about new station locations. This ranged from traditional press events to awareness events held in conjunction with another scheduled event or site host promotional opportunity.

Outreach at Local Farmers Markets

As an alternative to traditional ribbon cutting and press events that were conducted for DC fast chargers installed under CEC grant ARV-13-026, Three Squares worked with Coachella music festival organizers in 2018 to get an 'Electric Vehicles' button added to the official festival website. This helped raise awareness about the SoCalFast network, directed traffic to the SoCalFast website and encouraged EV drivers to 'charge up' at the new DC fast charging stations on their way to and from the concert. This marked the first time Coachella included a section for EV drivers on their 'Getting There' page. ChargeUp postcards were designed and distributed to the Palm Desert City Hall, the Palm Springs Visitors Center, and other

community outlets. #ChargeUp graphics and promotional language were also distributed via the online channels of Plug In America, SoCal EV, BMW i3 SoCal, and the Desert Tesla Club.[2] The two DC fast chargers at Palm Desert and Palm Springs in the Coachella Valley were installed as part of CEC grant ARV-13-026.

As a continuation of the previous awareness campaign, Three Squares designed a fast charging awareness campaign in conjunction with local farmers markets in close proximity to the fast chargers. The awareness events focused on local residents and workers who frequented the neighborhoods where the DC fast chargers were sited. A '#ChargeUp' campaign was developed to announce the launch of the DC fast charging stations, which included:

- Thursday Westwood Farmers' Market on May 17, 2018
- Sunday Hollywood Farmers' Market on May 27, 2018
- Sunday Historic Downtown LA Farmers' Market on June 10, 2018 (shown in Figure 3)

Figure 3: Downtown LA Farmers Market Awareness Event

Source: Three Squares, Inc.

[2] #ChargeUp graphics and promotional language can be viewed online: https://www.facebook.com/threesquaresinc/photos/a.445646143431.238444.90452633431/10156605916203432 and https://www.facebook.com/threesquaresinc/photos/a.445646143431.238444.90452633431/10156605916228432

The launch for these stations was held in conjunction with local neighborhood farmers' markets. The Westwood Farmers' Market is in close proximity to the fast charger in Westwood village; the Hollywood Farmers' Market is in close proximity to the fast charger installed at the Hollywood and Highland red line metro station; and the Historic Downtown LA Farmers' Market is in close proximity to the Little Tokyo gold line metro station and the La Kretz Technology Center.

Social Media

Social media coverage at the three #ChargeUp events are shown in Figures 4, 5 and 6.

Figure 4: Social Media Coverage for Westwood Event

During the #ChargeUp Westwood event, onsite staff received feedback about the SoCalFast network and DC fast charging in general from several EV drivers. Highlights of this feedback are below:

Driver #1:	This driver had previously exclusively used chargers in the ChargePoint network. However, having recently gotten locked out of her ChargePoint account, she was happy to learn about the EVgo DCFC in her neighborhood. Furthermore, she was excited to learn about the fast charge capabilities of this charger.
Driver #2	This driver is a student at UCLA and had her vehicle charging at an on-campus station while she was at the farmers' market. She expressed frustration about the on-campus chargers being occupied the majority of the time. Therefore, she was ecstatic to learn about the additional DCFC coming online in Westwood.
Driver #3:	This driver and his wife recently purchased an electric vehicle. Because they are still in the process of familiarizing themselves with the EV infrastructure in the area, he was excited to learn about the SoCalFast network of chargers in Greater Los Angeles and appreciated having the map to see the DCFC locations.

Source: Three Squares, Inc.

Figure 5: Social Media Coverage for Hollywood Event

During the #ChargeUp Hollywood event, onsite staff received feedback about the SoCalFast network and DC fast charging in general from several EV drivers. Highlights of this feedback are below:

Driver #1	This BMW i3 driver was thrilled to learn about the new DCFC stations in the region. He lives close to UCLA, and was disappointed that the campus had removed several charging stations. Therefore, he was very happy to know that new stations are coming online in the area.
Driver #2	This Chevy Bolt driver was enthusiastic about the new charging stations because she is moving to a new apartment and will no longer have access to a charger she can use to re-charge her vehicle overnight. Since she will now have to charge her vehicle during the day, she was excited to learn of these chargers that will provide a faster, more efficient option for her vehicle.
Driver #3:	This driver is actively looking to purchase an electric vehicle. He currently owns an electric scooter and would like to transition from this to an electric vehicle. He was excited to learn about the affordable fast chargers throughout Los Angeles and said he would look into buying a car that is DCFC compatible.

Source: Three Squares, Inc.

Figure 6: Social Media Coverage for Downtown Los Angeles Event

During the #ChargeUp DTLA event, onsite staff received feedback about the SoCalFast network and DC fast charging in general from several EV drivers. Highlights of this feedback are below:

Driver #1	This was an older driver who has been waiting for decades to see the electric vehicle movement take off. He was thrilled to see a rise in electric vehicle usage due to the new DCFC stations in the region.
Driver #2	This market-goer is looking to buy an EV. Because she is just beginning to familiarize herself with EV infrastructure, she was very interested in learning about the differences between DC fast charging and Level 2 charging. She was also happy to know that DCFC stations are being built across the region, as she felt more secure in her decision to buy an EV knowing there are fast charge options throughout the area.
Driver #3:	This driver's brother lives in Downtown LA and he is always looking for charging stations in the area. He was excited to share information about the SoCalFast network with his brother. Moreover, after learning that there are many DCFC stations in region, he expressed interested in buying an EV for himself.

Source: Three Squares, Inc.

Feedback

Three Squares gathered feedback on the outreach events. Based on the results from these past outreach events, Three Squares worked on designing a future outreach awareness events to increase the number of members of the general public who learned about the benefits of fast charging and other performance metrics. Based on feedback from the traditional press event and charging events for CEC grant ARV-13-026, Three Squares identified the following challenges with hosting outreach events for fast charging, where free fast charging was offered to EV drivers:

1. **Charging Time** – Since a single charger is only capable of charging one vehicle at a time, only one to two vehicles per hour can be accommodated at an outreach event. For a 5-hour event, this means only six to 10 vehicles can be charged at the station. For instance, one vehicle (a Chevy Bolt) charged for almost an hour at the Mel's Diner event. Hence, the audience size for each event is limited because of the charging time to at most 10 vehicles per event.
2. **Site Host Limitations** – The owner of Mel's Diner was supportive of the event as long as we held it during their slowest times (Monday or Tuesday during lunch hour) as their parking lot is full at all other times. Although this time slot was not ideal, there was no other option. The owner also expressed concern that he did not want too many vehicles waiting in line to charge since we could only charge one vehicle at a time.
3. **Audience Target** – For the #chargeup events, our on-site audience is limited to only those drivers who have fast charge capable vehicles that live in the area or find it convenient to pass by the station. This is a limited number of people. However, since the event cannot accommodate more than 10 vehicles, it is almost a match.
4. **Outreach Target** – Since many vehicles cannot be accommodated on site at each event, the goal is to reach a large audience online via partnership promotions and outreach efforts. Three Squares was successful in increasing views of both

SoCalFast.com and in raising awareness that this new network of fast chargers exists in the South Coast Air Basin. For example, getting the "Electric Vehicle" button on the Coachella concert website which linked back to the SoCalFast.com site and promoted the two charging stations, was a big outreach win. For the Mel's Diner event, outreach efforts were magnified by several social media accounts linked to West Hollywood accounts. If the goal of these events is to raise awareness about these new DC fast charging stations to encourage the adoption and purchase of EVs, this type of online outreach allows hundreds of thousands of viewers to be informed about these stations.

5. **Other Outreach Activities** – Outreach activities near the station to reach the desired audience vs. focusing on the 10 vehicles charging during the event, with booth at the farmer's market to promote SoCalFast and fast charging station.

Results

DC fast charging station launch events were held to promote the grand opening of the stations. Additionally, Three Squares, Inc. executed digital outreach campaigns to promote the opening of those stations. Three Squares, Inc. partnered with community organizations and EV advocacy groups to spread the word about DC fast charging stations to their networks through social media, online calendar, and e-newsletter promotions. These outreach campaigns were successful in getting information about DC fast charging stations and the SoCalFast network to millions of people. Table 4 illustrates the digital reach of each campaign.

Table 4: Customer Satisfaction Scores for Fast Charging

Station/Campaign	Digital Reach
Palm Desert City Hall & Palm Springs Visitors Center	137,500 people
Mel's Drive-In on Sunset	489,900 people
LADOT Westwood	803,700 people
LADOT Hollywood & Highland	704,600 people
La Kretz Innovation Center & LADOT Little Tokyo	821,900 people
Total	2,957,600 people

Source: Three Squares, Inc.

Given the stated purpose of this project to disseminate information about SoCalFast DC fast charging stations, this project can be considered successful. Information about these stations was distributed to nearly 3 million people who live in and around the communities in which the stations are located.

Benefits

Through the outreach and education campaign, PEV educational information was distributed to members of the communities where SoCalFast DC fast charging stations are located. Educational materials included information about the benefits of driving PEVs and having public fast charging, the economic value proposition that PEV driving and/or charging holds, and correct procedures for using DC fast charging stations.

CHAPTER 7: Conclusions

There have been significant changes in technology and awareness of what is needed to successfully install EV infrastructure since this CEC grant was first awarded in 2013, in response to a PON-11-602 issued in 2012. Hardware manufacturers and network providers have become dominant players in the EV charging landscape but also several prominent companies have declared bankruptcy and withdrawn as a result of not being able to make a successful financial and business case for continued operation in the charging sphere. These included Blink, which was later replaced by CarCharging, 350Green, Better Place, and other companies. Those companies that continue to provide EV charging services have done so by evolving, adapting, and improving their technology, installation, software, and networking platforms to accommodate the changing needs of EV drivers, original equipment manufacturers, and electric vehicle supply equipment manufacturers.

EV charging has become an amenity for early adopters who were the first to purchase and drive limited range EVs with an 80 – 100-mile electric range starting with the advent of the Nissan Leaf in 2011 to the first plug-in EV with the Chevy Volt, later in 2011. This was followed by the release of the Tesla Model S in 2012, which was the first long range EV of 160 – 265 miles. Since that time, there are many 200 mile+ range EVs including the Tesla Model X and 3, Chevy Bolt, Hyundai Kona Electric, Audi e-tron, Nissan Leaf e+, and Jaguar I-Pace.

Along with evolutionary jumps in vehicle technology to incorporate larger size batteries and EVs with greater range comparable to a conventionally fueled gasoline vehicle, these were accompanied by corresponding technology gains in EV charging infrastructure. Level 1 (120 volt) charging was replaced by Level 2 (240 volt) charging and then DC fast charging (480 volt). DC fast charging has continued to become higher powered as battery pack sizes have increased in EVs. Initial DC fast chargers were 50 kW and only had CHAdeMO connectors for Asian fast charging vehicles. SAE adopted its own connector standard, CCS, in 2011 and 50-kW fast chargers with CHAdeMO and CCS connectors became commercially available starting in 2013 with the Efacec and ABB 50 kW fast chargers.

Due to the ability of the CCS connector standard to charge vehicles at up to 350 kW, more original equipment manufacturers are adopting the CCS connector as its DC fast charging connector standard. As part of the Volkswagen settlement, the Electrify America program installed its first public 350 kW DC fast charger in Livermore, California in early December 2018, while EVgo opened its first public 350 kW DC fast charger in Baker, California in mid-December 2018. Ionity, a charging network in Europe supported by BMW, Daimler, Ford, and Volkswagen with Audi and Porsche, installed several 350 kW DC fast chargers in Germany in October 2018. As part of the FastCharge research project initiated in July 2016 which has received almost $9 million in funding from the German Federal Ministry of Transport and Digital Infrastructure, the FastCharge research consortium, in partnership with BMW and Porsche, installed a prototype 450 kW DC fast charger in Germany in December 2018.

On an independent track, Tesla started deploying its own 90 kW fast charging network using its proprietary connector in 2012, and then 120 kW and 145kW fast chargers were later

installed within the Tesla network. In June 2019, Tesla installed eight 250 kW fast charger at its Fremont, California factory.

All of these indicators show that there will be continued growth in technology and increased specialization of providers offering services to site hosts and EV drivers. Network providers will continue to expand their respective networks and at the same time collaborate on common standards and protocols such as open roaming and interoperability protocols that allow EV drivers to use a single network's radio frequency identification card across multiple networks in the same way that consumers can use ATM cards at multiple banks or use their cell phones internationally across multiple service providers. This builds upon the open standards protocols for software platforms controlling EV chargers to allow hardware to be operated by multiple network providers and software platforms. There is also continued progress on open demand response protocols for energy management of EV chargers at a host site such as Open Automated Demand Response Protocol, Open Smart Charging Protocol, and Open Charge Point Interface. The development of these open standards will also help ensure that there continues to be technology that avoids proprietary technology and standards that cannot be flexible and adapt to changing EV charging needs.

One unexpected outcome of installing the DC fast chargers with the CCS connector is that due to the relative scarcity of public fast chargers with this type of connector, these fast chargers drew a large number of EV drivers to these sites. There has also been significant growth in the number and types of 200+ mile battery EVs that have become commercially available and that have been purchased. When these longer range EVs require charging, it typically takes about one hour to get to an 80 percent state of charge, meaning much longer dwell time on a limited number of fast chargers. Availability and queuing have become serious issues. In addition, there has been an exponential rise in the number of rideshare drivers such as Uber, Lyft and Maven, companies who have actively promoted the use of EVs for their drivers (some companies offer discounts on the lease of EVs). This led to long lines for the DC fast charger at the Mel's Diner Santa Monica site, to the extent that the line of rideshare drivers queuing for fast charging interfered with the availability of parking for Mel's Diner patrons. After a month of long lines by rideshare drivers blocking access to the parking lot/spaces but not patronizing the restaurant, the owner of Mel's Diner demanded that EVgo turn off the fast charger. EVgo negotiated with the owner of Mel's Diner for a year to come to an agreement regarding the operation of the fast charger, including offering rent or subsidy to make up for lost business, but were unable to come to mutually agreed upon terms. EVgo was then forced to remove the fast charger at this location and is in the process of installing this fast charger at a retail shopping mall in Calabasas at an already approved site location for CEC grant ARV-13-026. It is clear that siting of future public fast charging infrastructure will need to meet the needs of rideshare drivers with larger parking lots to deal with queuing and not interfere with access to nearby businesses.

This paper serves to encapsulate the learning of installing EV infrastructure from multiple perspectives: a regional government agency attempting to direct public investments towards early deployment of fast charging corridors in communities underserved by chargers, a network provider utilizing a combination of public and private funding to strategically expand key charging corridors within their established and growing networks, an installer who has extensive field and local experience in installing infrastructure in commercial, government, and residential settings, a university economic research group with experience on PEV readiness issues and the ability to use its site modeling software to optimize site host locations, and an

outreach organization with significant experience in designing and hosting effective education outreach events for environmental technologies targeted to the general public and residents in Environmental Justice or Disadvantaged Communities. This paper also serves as a historical footnote to record the learning over the past five years on the installation of DC fast charging infrastructure.

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.

COMBINED CHARGING SYSTEM (CCS)–EV charger designed by the Society of Automotive Engineers that combines the J1772 charger with a Direct Current charger into one charging plug.

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

ELECTRIC VEHICLE (EV)—A broad category that includes all vehicles that are fully powered by electricity or an electric motor.

GREENHOUSE GAS (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (NOx), halogenated fluorocarbons (HCFCs), ozone (O3), per fluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

KILOWATT (kW)—One thousand watts. A unit of measure of the amount of electricity needed to operate given equipment. On a hot summer afternoon, a typical home—with central air conditioning and other equipment in use—might have a demand of 4 kW each hour.

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.

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)—A global association of more than 128,000 engineers and related technical experts in the aerospace, automotive, and commercial-vehicle

industries. The leader in connecting and educating mobility professionals to enable safe, clean, and accessible mobility solutions.[3]

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)—The air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties. This area of 10,740 square miles is home to over 17 million people—about half the population of the whole state of California. It is the second most populated urban area in the United States and one of the smoggiest. Its mission is to clean the air and protect the health of all residents in the South Coast Air District through practical and innovative strategies.

UNIVERSITY OF CALIFORNIA, LOS ANGELES (UCLA)—A public research university located in Los Angeles, California. It is one of the 10 campuses in the University of California (UC) system.

[3] Society of Automotive Engineers is available at https://www.sae.org/about/

APPENDIX A: Utilization

Table A-1 shows the utilization rate of the South Coast DC charging network.

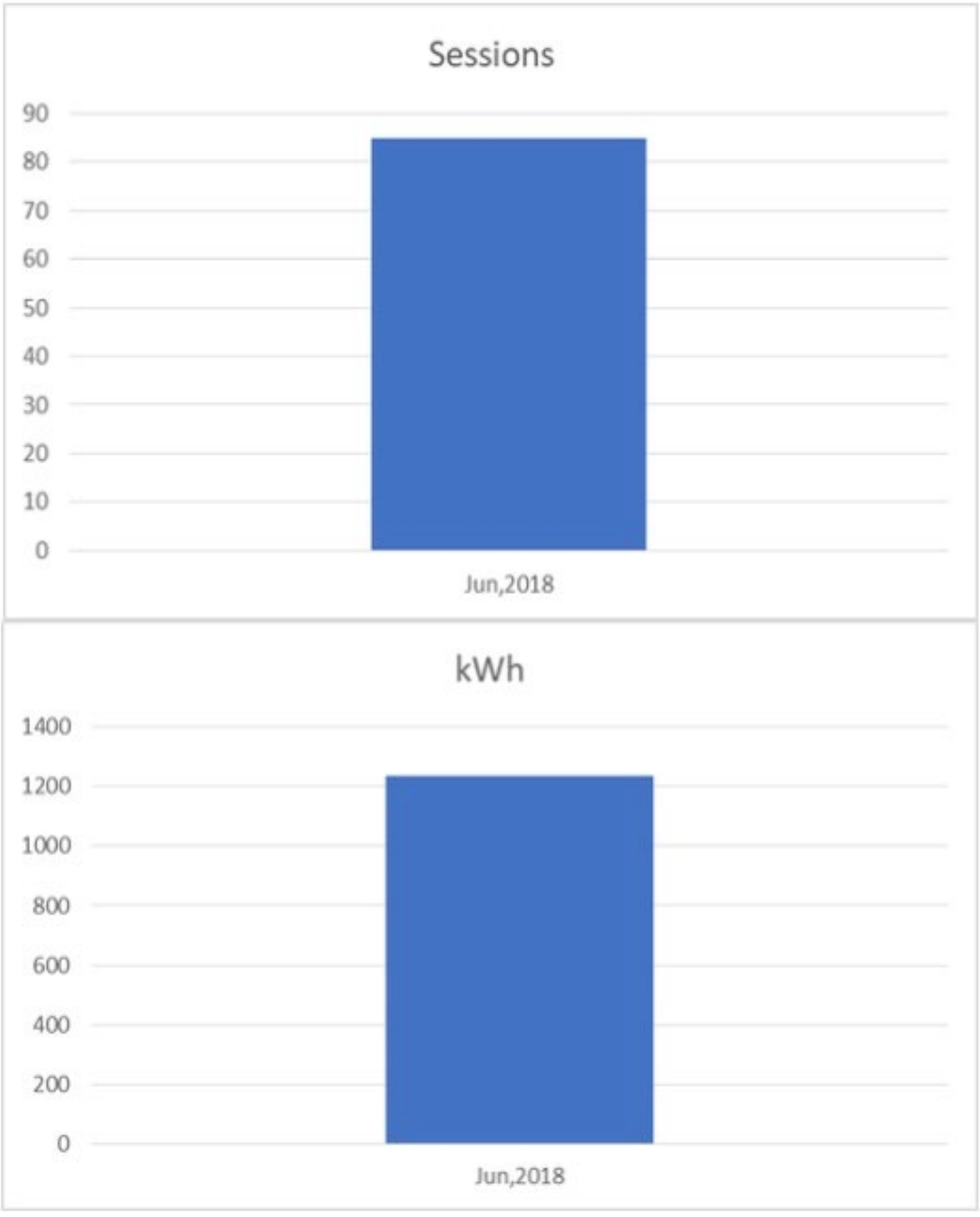
Table A-1: South Coast DC Charging Network Usage Rate

Site	# of Chargers	Operational Date	Kilowatt hour (kWh) (DC1)	Sessions (DC1)	kWh (DC2)	Sessions (DC2)	TOTAL kWh	TOTAL Sessions
Mel's Drive In Santa Monica	1	6/28/18	1235	85	-	-	1,235	85
Victoria Gardens / Rancho Cucamonga	1	6/27/18	41802	3,360	-	-	41,802	3,360
La Kretz Innovation Campus	2	8/28/18	27960	1,533	33,433	1,811	61,393	3,344
Garage 680 – Westwood	2	8/28/18	38803	2,405	44,760	2,444	83,563	4,849
Little Tokyo Gold Line Metro Station	1	8/3/18	59439	2,796	-	-	59,439	2,796
Hollywood & Highland Red Line Metro Station	2	11/4/18	14713	697	6,967	400	21,680	1,097
SCAQMD – Diamond Bar	1	9/28/18	28004	2,011	-	-	28,004	2,011

Source: EVgo

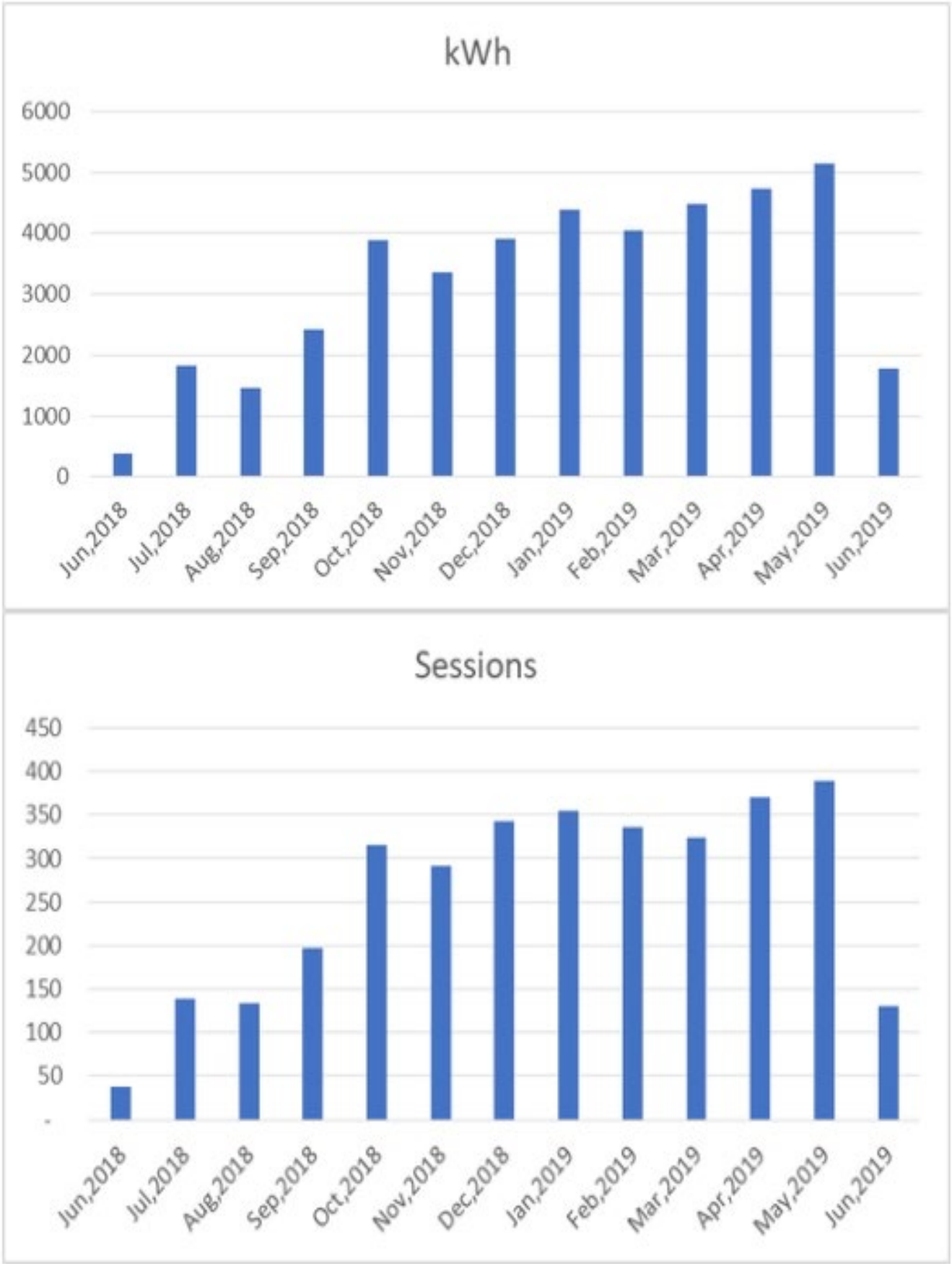
Figures A-1 through A-7 show kWh usage and total charging sessions for all seven locations in the South Coast DC charging network.

Figure A-1: Station 1—City of Santa Monica—kWh Usage and Total Charging Sessions, June 2018



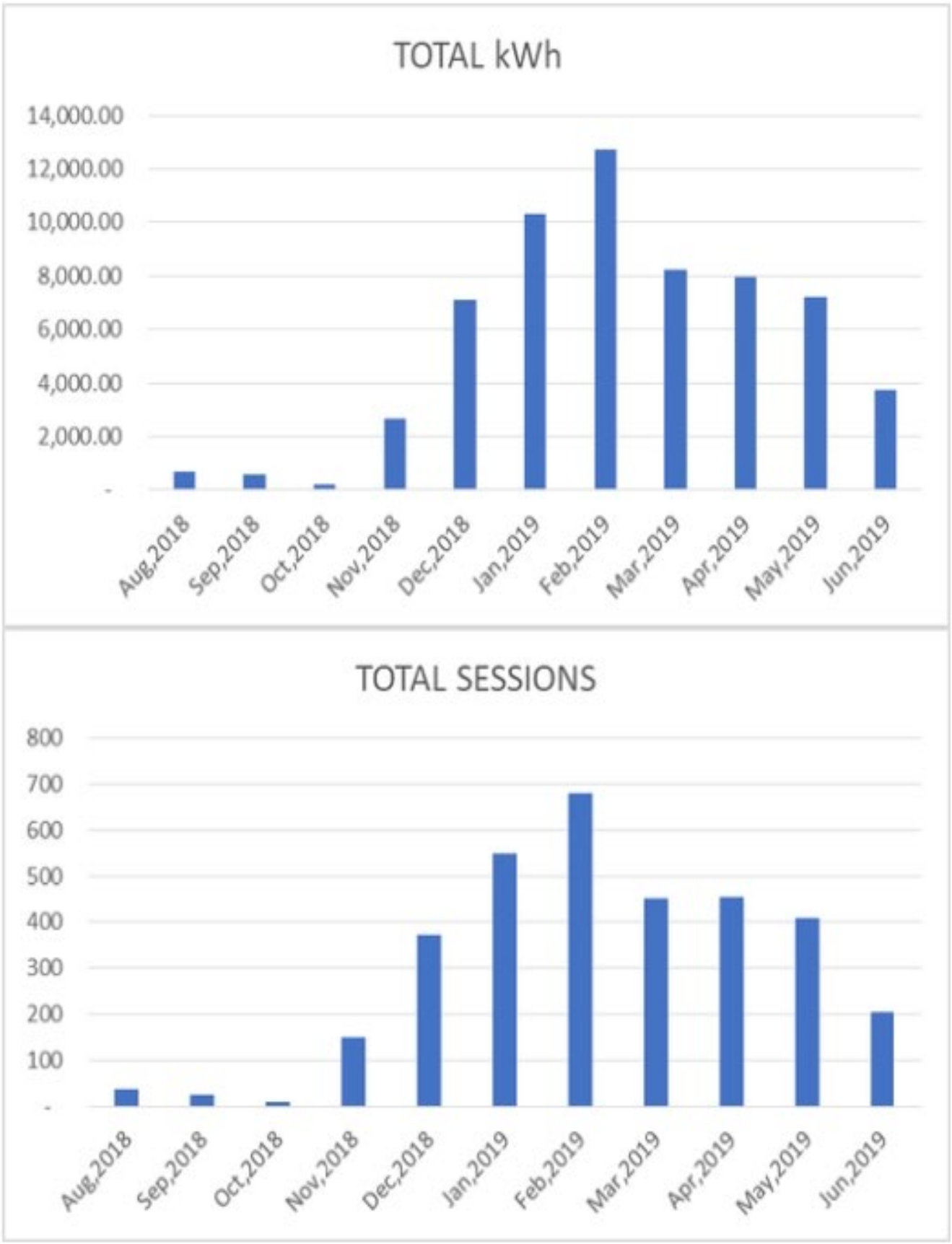
Source: EVgo

Figure A-2: Station 2—City of Rancho Cucamonga—kWh Usage and Total Charging Sessions Per Month, June 2018 through June 2019



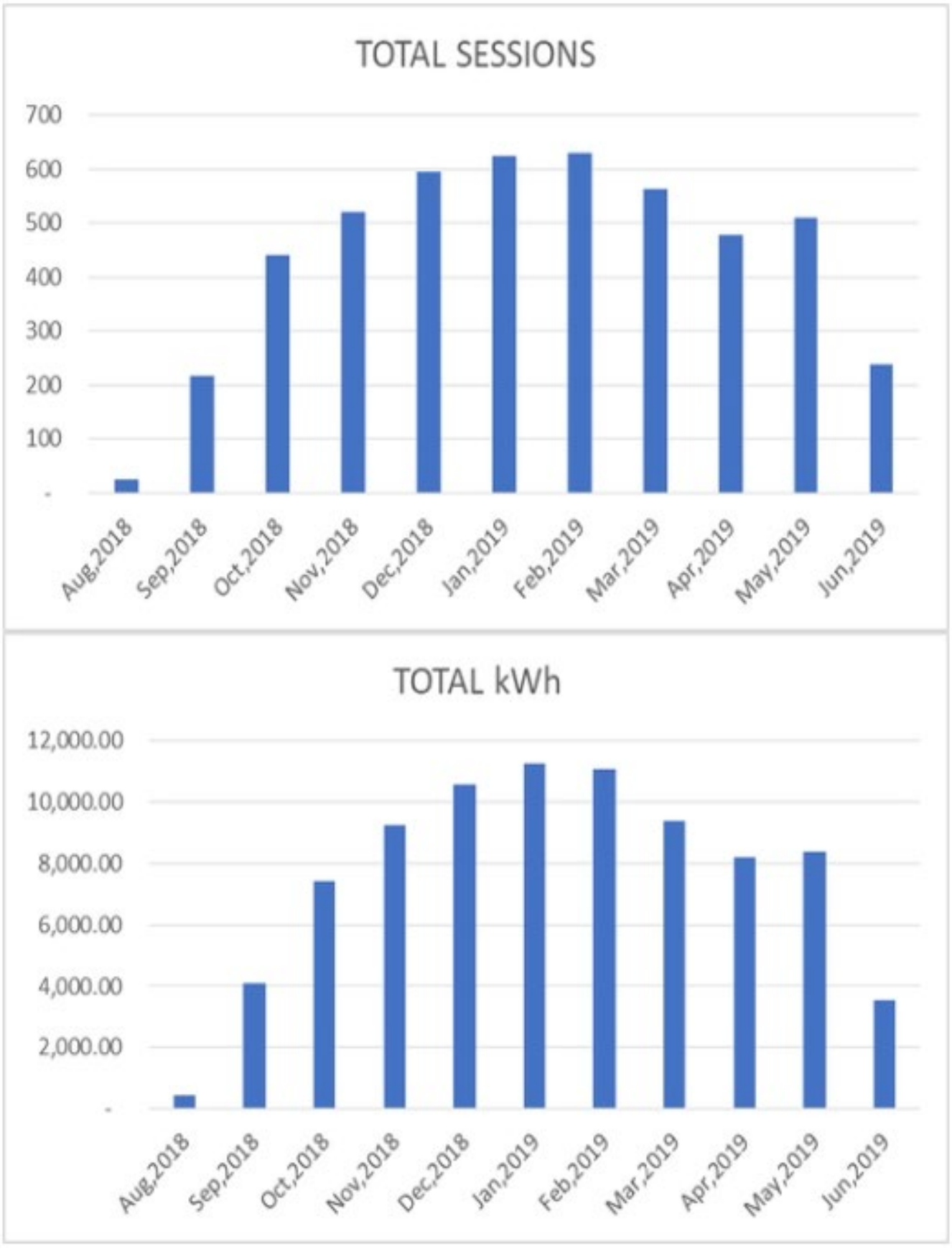
Source: EVgo

Figure A-3: Station 3—City of Los Angeles—kWh Usage and Total Charging Sessions Per Month, August 2018 through June 2019 (2 DC Fast Chargers)



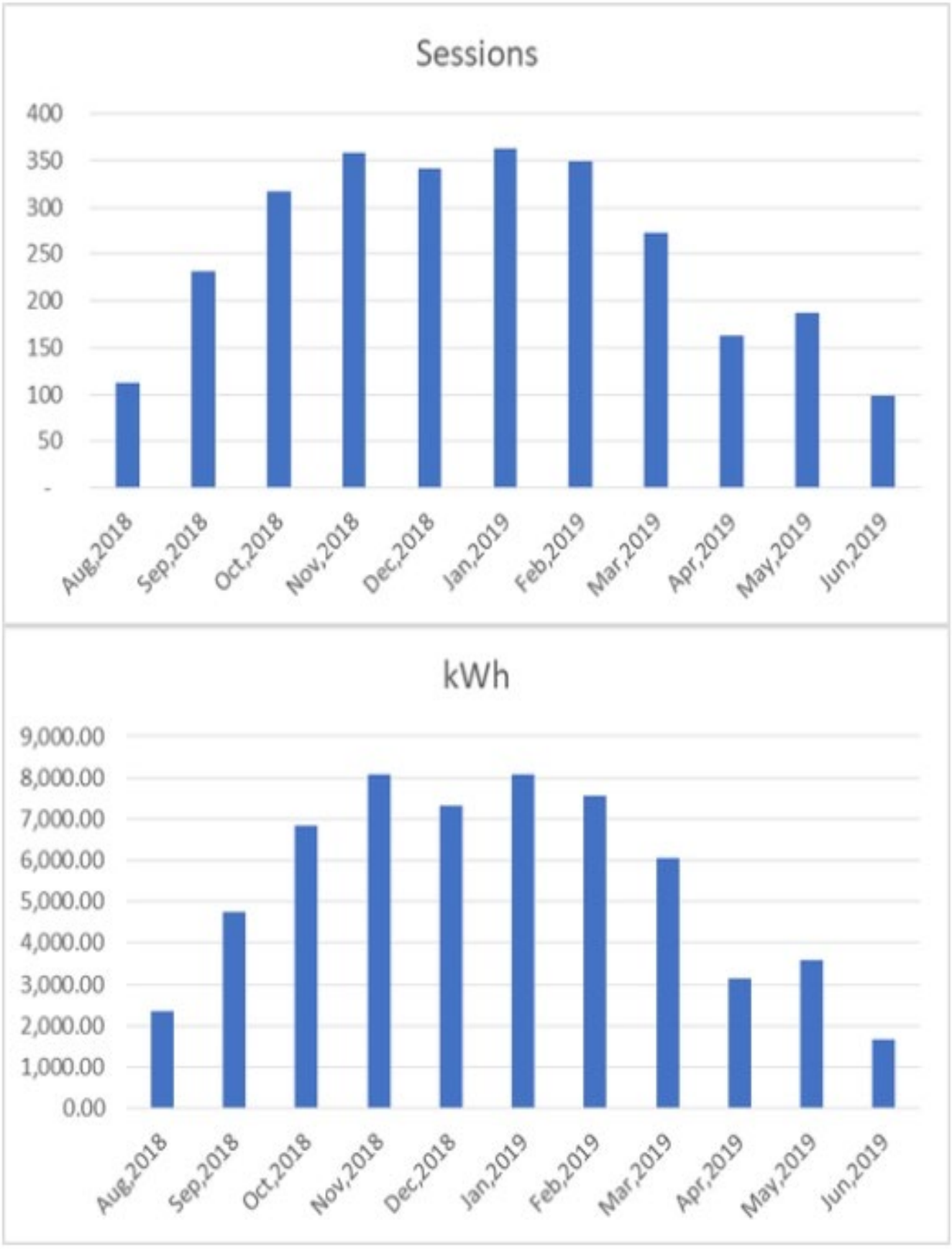
Source: EVgo

Figure A-4: Station 4— City of Los Angeles—kWh Usage and Total Charging Sessions Per Month, August 2018 through June 2019 (2 DC Fast Chargers)



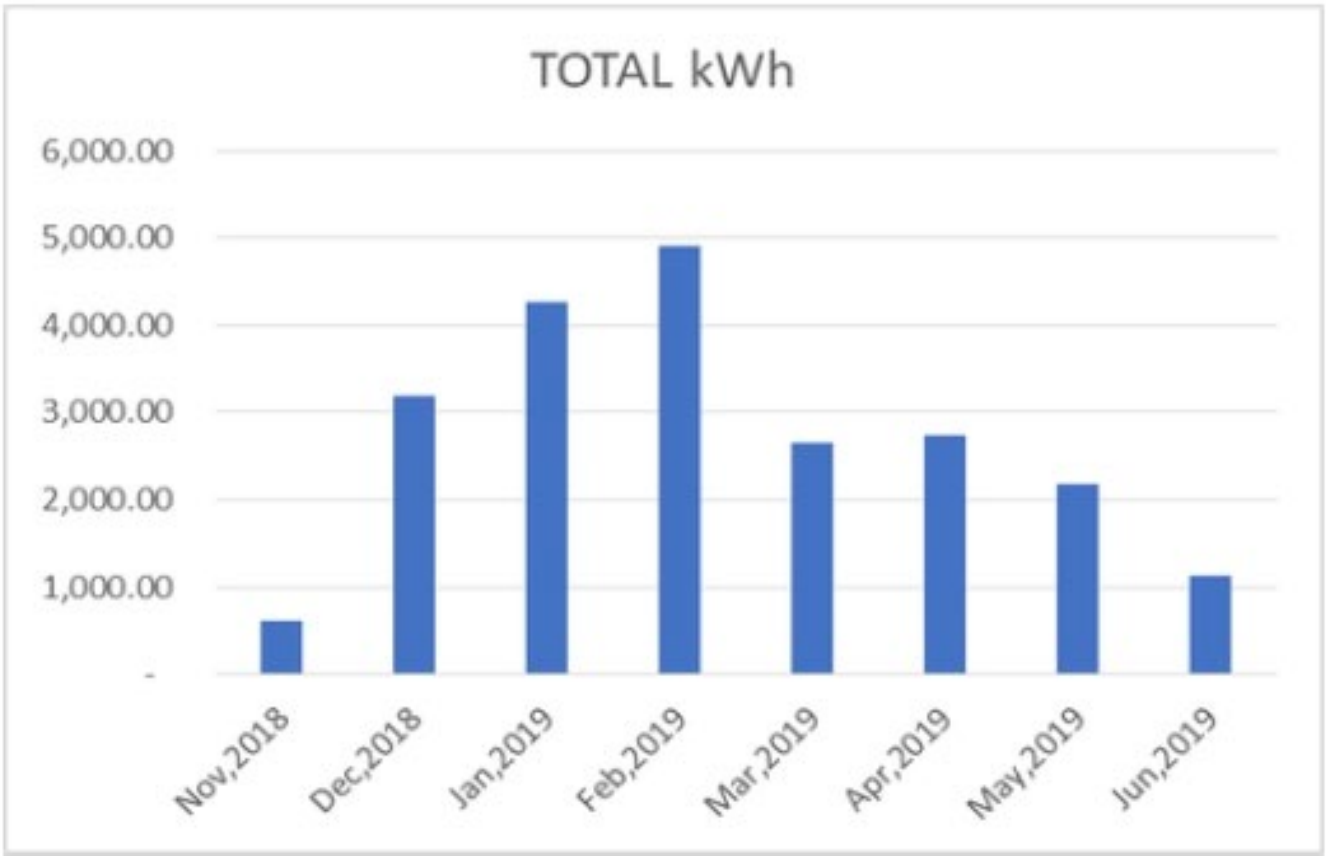
Source: EVgo

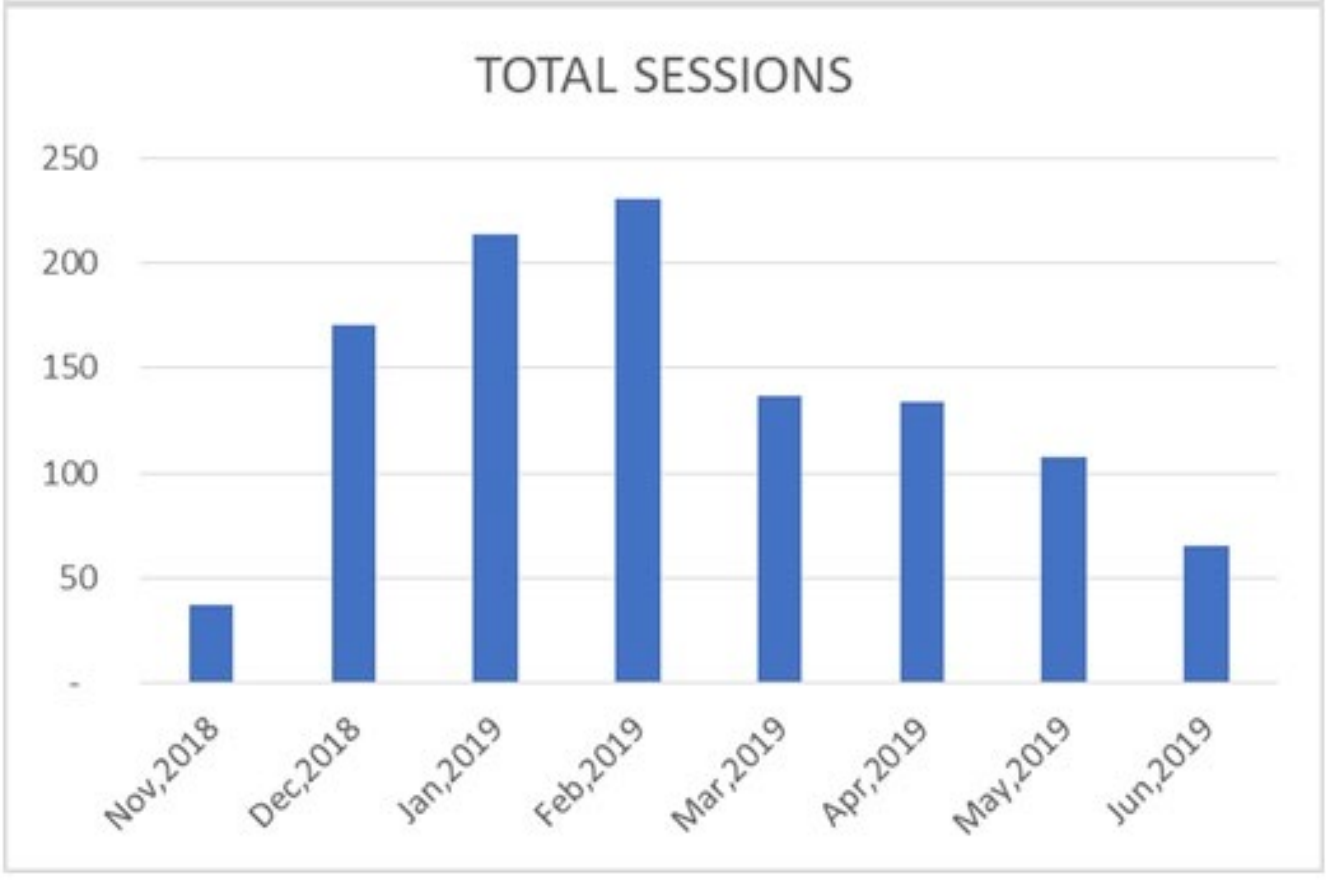
Figure A-5: Station 5— City of Los Angeles—kWh Usage and Total Charging Sessions Per Month, August 2018 through June 2019



Source: EVgo

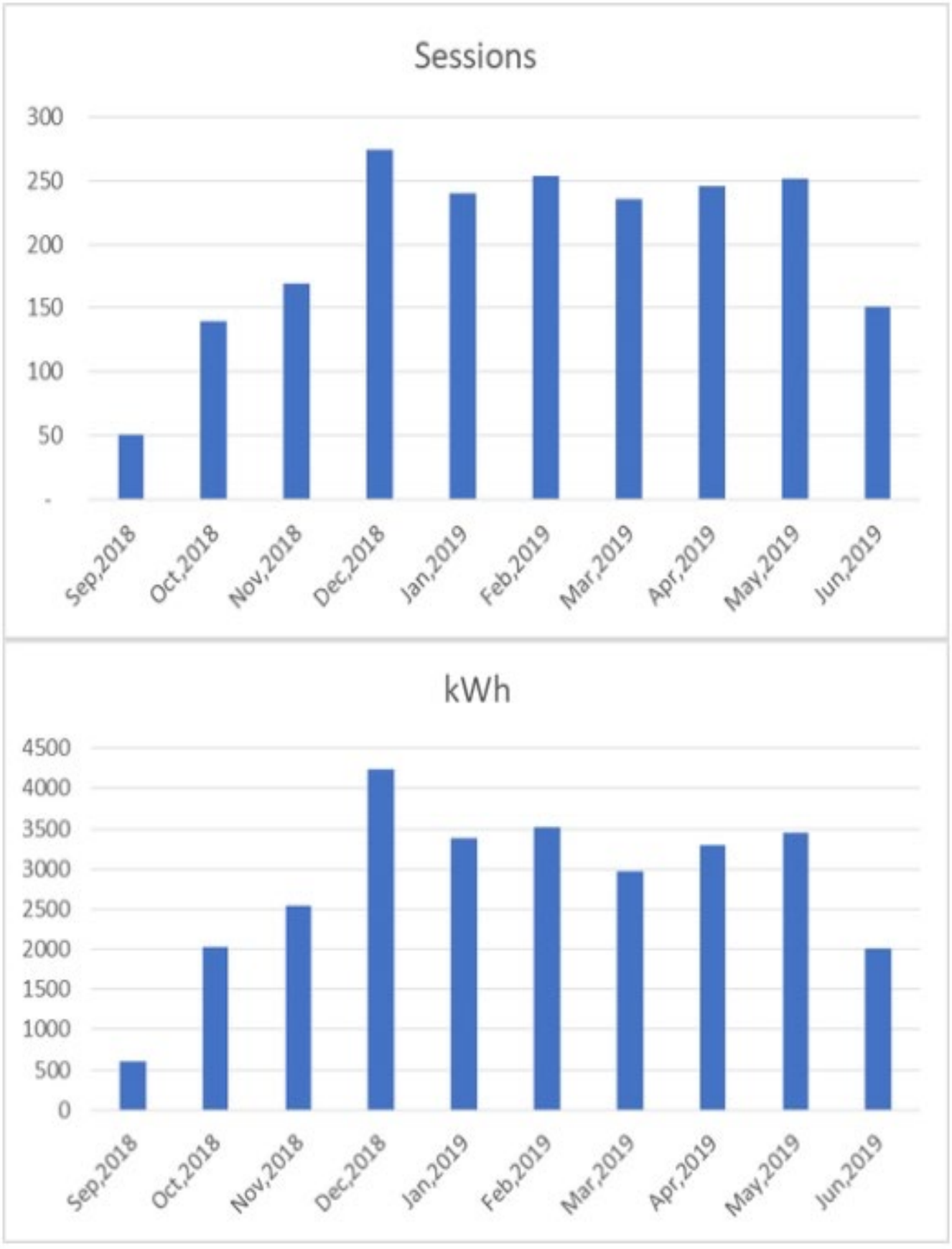
Figure A-6: Station 6— City of Los Angeles—kWh Usage and Total Charging Sessions Per Month, November 2018 through June 2019 (2 DC Fast Chargers)





Source: EVgo

Figure A-7: Station 7—City of Diamond Bar—kWh Usage and Total Charging Sessions Per Month, September 2018 through June 2019



Source: EVgo