Evaluating Multi-Unit Resident Charging Behavior at Direct Current Fast Chargers

Evidence From EVgo's High Power Charging Plaza Pilot

UCLA Luskin Center for Innovation

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Authorship

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Executive Summary

The *High Power Charging Plaza* (HPCP) program is a pilot project created by EVgo, the nation's largest public electric vehicle (EV) fast charging network, to develop direct current fast charger (DCFC) sites that can serve the EV charging needs of residents of multi-unit dwellings (MUD). DCFC provide charge much faster than typical home charging or slower level 2 charger (L2) public charging equipment and can deliver a meaningful charge in as little as 20 minutes. The program was developed under an agreement with the California Public Utilities Commission[1] and is meant to serve the public's interest in expanding charging access to residents of MUDs.

MUDs make up almost 30% of California's housing stock, but most MUDs do not have home EV charging options. Due to potentially high costs and other barriers, it is difficult (and in many cases impossible) to expand at-home charging at MUD properties. This problem could become a significant roadblock for California's ambitious transportation electrification goals, which include a target of zero new gasoline car sales by 2035. DCFC located in or near MUD-dense neighborhoods are one potential solution to bridge gaps in charging access for MUD residents.

Evaluating the HPCP program

In the 20 months between January 2019 and September 2020, during which we conducted this evaluation, EVgo developed 20 HPCP locations across California. These sites are located in public use microdata areas (PUMA) — census designated boundaries the size of a small city — with above-median numbers of MUD residents. The sites also have a minimum of three (and as many as 10) 50kW+ DCFC chargers.

We find that the HPCP program performs as designed, providing DCFC charging options that better serve MUD residents compared to non-HPCP locations. On average, HPCP program DCFC locations serve a modestly higher percentage of MUD resident users and host a higher percentage of MUD resident charging sessions than non-HPCP comparison DCFC. Relative to absolute customer and session count, the average HCPC stations served 29% more MUD resident customers and had 33% more MUD resident sessions than non-HPCP stations. Both differences between HPCP and non-HPCP stations are statistically significant, strongly suggesting that the HPCPs are, on average, attracting a greater share of MUD residents than non-HPCP locations. We also find substantial (and statistically significant) differences between the EVgo customers who have used an HPCP location and those who charge at non-HPCP comparison stations (Figure ES-1). Users of HPCP locations are more likely to: 1) be MUD residents, 2) lack access to home charging, and 3) report using DCFC as their primary charging mode. Not only are HPCP sites serving a higher percentage of MUD residents, but they also are proving to attract more customers who highly rely on DCFC to meet their charging needs.

We find that siting HPCP locations in MUD-dense areas is likely the primary driver of the success of the HPCP program. The number of MUD units in a PUMA is positively associated with both MUD resident user and session share. On the other hand, we find no association between the number of individual DCFC at a location and the share of MUD residents that location serves.

Lessons learned about MUD residents and DCFC

Surveyed users who report living in an MUD more frequently report having no home charging options but have about the same access to work charging as non-MUD respondents (Figure ES-2). A plurality of MUD resident EVgo users report using DCFC as their primary charging mode, and a majority report their primary charging mode is outside their home, compared to non-MUD users who mostly rely on home charging (Figure ES-3).

MUD residents both charge more frequently and demand more energy than non-MUD users. We find that this difference in charging behavior is primarily influenced by whether MUD residents have a home charging option. The DCFC use of MUD residents with home charging access does not differ significantly from non-MUD residents. Unsurprisingly, the strongest association with more DCFC use is whether a user reports that DCFC is their primary charging option. However, even those MUD residents who charge primarily at another non-home option obtain more charge at DCFC sites, suggesting that DCFC locations are often an important backup for other non-home charging modes.

We also find that MUD residents are more likely to state a preference for closer-to-home charging than non-MUD residents. This association holds regardless of whether the MUD residents have home charging or primarily charge

[1] The 2012 settlement agreement between the California Public Utilities Commission and certain NRG-affiliated entities required NRG to deploy EV charging infrastructure across the state. While NRG remains the obligated party, EVgo is executing the implementation of, and ongoing compliance with, the settlement as a service provider to NRG.

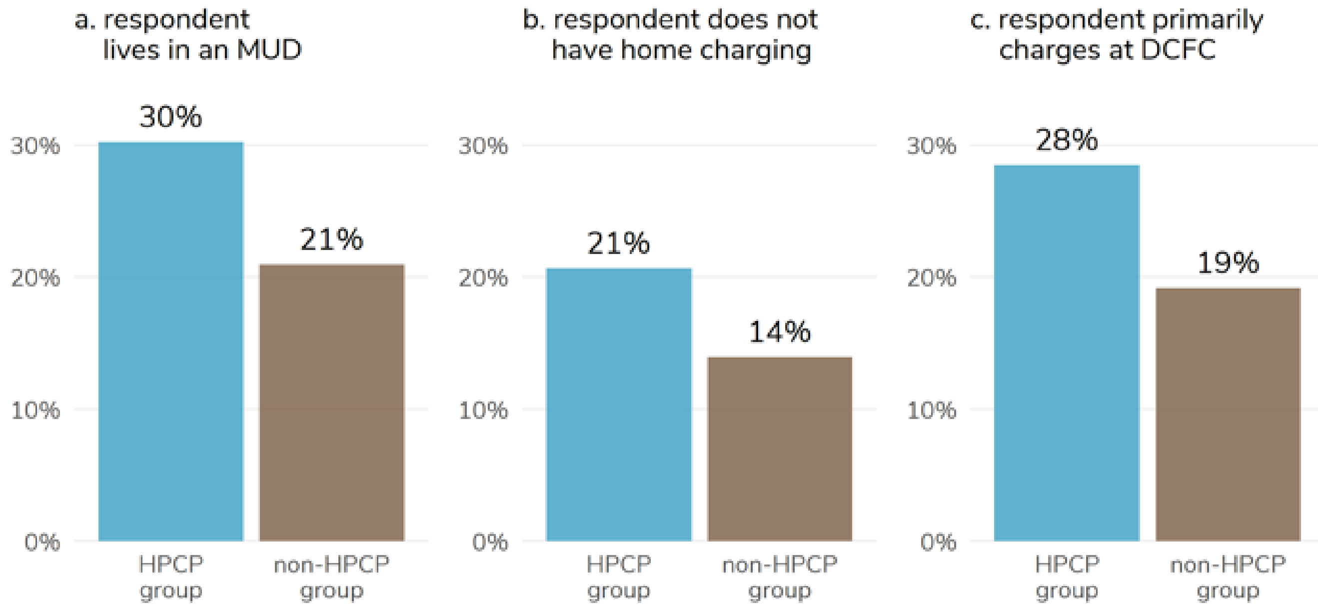


Figure ES-1. Percent of affirmative survey responses for HPCP and non-HPCP on three key user attributes

at a DCFC. This suggests that even those MUD residents with a reliable non-DCFC charging mode available to them more highly value the option of near home DCFC options.

We do not find that MUD residents have any stronger or weaker preferences for other important DCFC site attributes such as number of chargers, speed of chargers, proximity to workplaces or amenities, or siting near freeways and on travel routes.

Consistent with their preferences for closer to home charging, on average, MUD residents charge closer to home than non-MUD residents. As with other charging behaviors, that effect is primarily associated with those MUD residents who lack access to home charging.

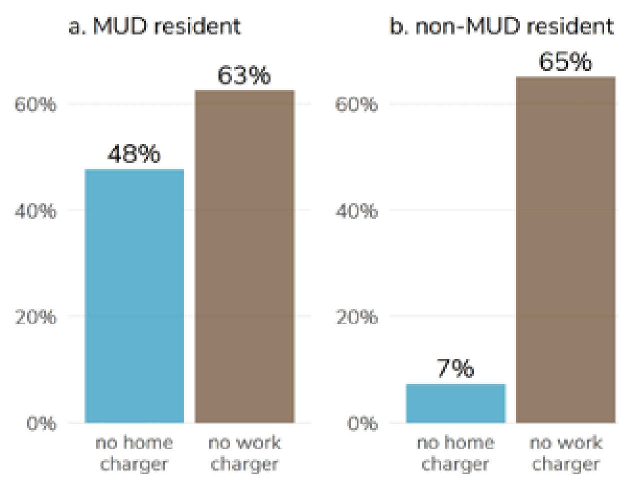


Figure ES-2: Responses for charging access for MUD and non-MUD residents

Recommendations and future research

While the PUMA-based siting criterion is sufficient to identify DCFC locations that better serve MUD residents, we find evidence that a narrower geographic targeting method might deliver better results. Specifically, we find that the number of MUD units within a five-minute travel shed (area that can be reached within five minutes' drive) is more predictive of MUD user and session share than the number of MUDs in that DCFC location's PUMA. Given this finding, we recommend that future MUD-focused DCFC installations be sited with more geographic specificity.

EVgo and other charging network providers should note that MUD resident users are likely to demand their services more than residents of other housing types. Therefore, there is a strong business case for those companies to do their best to unlock EV adoption in the MUD resident segment. Furthermore, because MUD resident users both prefer, and more frequently charge at, locations nearer their homes, EV infrastructure planners should include MUD-focused DCFC alongside other conventional priority locations such as along travel corridors and at regional attractors.

This analysis provides evidence that MUD-focused locations can better serve existing MUD resident EV drivers. Although that suggests that DCFC access can help enable MUD resident EV adoption, it is not evidence that expanded access will necessarily *cause* more MUD resident adoption. Future research should focus on better understanding the motivations of EV ownership among MUD residents without home charging and developing an experimental program design with which to test whether MUD-focused DCFC can have a causal effect on expanded MUD resident EV ownership.

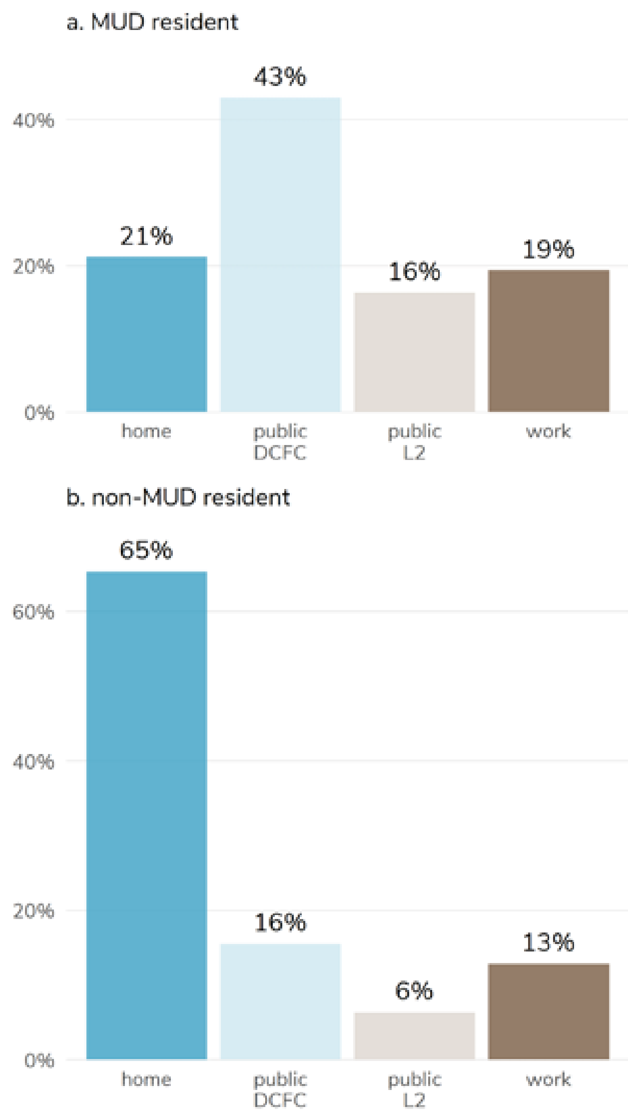


Figure ES-3: Responses for primary charging location for MUD and non-MUD residents

Chapter 1. Introduction

California is a leader in the transition to electric vehicle (EV) passenger travel. However, while the state pursues its ambitious passenger vehicle electrification goals, residents who live in multi-unit dwellings[2] (MUDs) and have no home charging access are at risk of being left behind. Nearly three in 10 California homes are located in MUD properties, meaning that friction among MUD residents caused by charging barriers could cause significant drag on EV adoption in California.

Expanding access to charging for those residents will become a critical component of transforming the passenger vehicle market in California. This report focuses on the expansion of direct current fast charging (DCFC) infrastructure[3] in areas near MUD properties as a potential strategy to help bridge the gap in charging access for those who live in apartments, condos and other multifamily housing where it might be difficult to obtain a charge at home.

The report was commissioned by EVgo Services LLC[4] to evaluate its *High Power Charging Plaza* (HPCP) pilot program[5] and investigate the fast charging behaviors of its MUD resident users. The HPCP pilot is meant to serve the EV charging needs of MUD residents by installing DCFC charging locations in areas with high concentrations of MUDs. This program offers the chance to develop a better understanding of how MUD residents use fast chargers and to evaluate whether MUD-focused DCFC locations like those developed through the HPCP program can provide better charging access for the MUD customer segment.

The HPCP pilot program rests on underlying assumptions about MUD residents and their fast charging preferences and behaviors, specifically that they will use DCFC that are close to their homes and that they are able to rely on those sites as a replacement for, or supplement to, other charging modes. For that reason, we focus the first part of this evaluation on an analysis of MUD residents' attitudes toward DCFC station attributes and the charging behaviors that they exhibit. Key questions include: Do MUD residents value charging station attributes (such as proximity to home) differently than non-MUD residents? How are current MUD resident DCFC users, especially those without home charging access, using DCFC stations? Does MUD residents' DCFC use differ from that of non-MUD residents?

The report then focuses on an evaluation of the HPCP pilot program to determine the extent to which HPCPs are serving the MUD customer segment. We shift focus from comparing MUD users to non-MUD users to comparing HPCP locations and users to non-HPCP locations and users. We assess HPCP performance at serving MUD residents compared to EVgo locations not developed under the HPCP program. We also compare survey responses of users who use HPCP locations to those who have not used HPCP locations to identify whether there are systematic differences between the users of HPCP and non-HPCP sites.

Background

California has set ambitious goals to achieve carbon neutrality by 2045.[6] More than one-quarter of California's carbon emissions result from passenger vehicles.[7] Therefore, to meet carbon reduction goals, passenger vehicle travel must rapidly decarbonize. To do so means transitioning the passenger vehicle fleet to zero emission vehicles (ZEV), of which most are likely to be EVs[8] and thus will require charging infrastructure.[9] State goals for ZEV sales include 1.5 million ZEVs in 2025 and 5 million by 2030.[10] Most recently, Gov. Gavin Newsom has signed an

[2] Multi-unit dwellings are housing where more than one housing unit is located on a single property. Common examples are apartments and condos.

[3] DCFC are public EV chargers that can deliver a faster charge than residential chargers and are capable of refueling most EV models to at least 80% charge in under an hour.

[4] EVgo is the largest charging network provider of DCFC in the United States.

[5] The HPCP pilot is part of EVgo's program activities pursuant to a settlement agreement between NRG (EVgo's former parent company) and the California Public Utilities Commission.

[6] Calif. Exec. Order B-55-18, 2 (2018). https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf

[7] California Air Resources Board. (2020). California Greenhouse Gas Emissions for 2000 to 2018 Trends of Emissions and Other Indicators. Retrieved from https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2018/ghg_inventory_trends_00-18.pdf

[8] EVs are the market leader for zero emission vehicles in the passenger vehicle sector and are likely to be the most common ZEV on California roads.

[9] Infrastructure is specifically critical for battery electric vehicles (BEV) as opposed to plug-in hybrids (PHEV), because they rely solely on electricity. Moreover, BEVs usually can use DCFC, whereas few PHEVs can.

[10] Office of Gov. Edmund G. Brown Jr. (2018). *Governor Brown Takes Action to Increase Zero-Emission Vehicles, Fund New Climate Investments*. ca.gov. https://www.ca.gov/archive/gov39/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/index.html

executive order aimed at prohibiting the sales of new non-ZEVs after 2035.[11]

Meeting ambitious ZEV targets requires the mass market adoption of EVs in less than two decades. To reach that, the market needs to rapidly expand beyond early adopter consumers and into customer segments (like MUD residents) where EV uptake has not made significant inroads.

EV adoption among MUD residents

MUD residents (particularly those who live in an apartment or condo) are underrepresented among EV drivers in California. In a survey of Clean Vehicle Rebate Program recipients conducted between 2013 and 2015, just 7.6% of EV purchasing respondents reported living in an apartment or condo.[12] A 2017 California Air Resources Board-funded survey of plug-in electric vehicle drivers found that only 6.8% of EV-owning respondents reported living in an apartment.[13] However, according to American Community Survey estimates, approximately 28.8% of homes in California are in buildings with three or more units.[14]

A number of factors may contribute to this phenomenon, including that MUD residents tend to be lower income and therefore are less likely to purchase an EV. However, chief among concerns over what might cause low uptake of EVs is that MUD residents often lack access to charging, either at home or in another convenient location.

Access to charging at home is commonly found to be the most consequential infrastructure factor that influences consumer EV purchase decisions.[15] This is unsurprising given that charging at home — where electricity costs are low and vehicles sit in garages or driveways for many hours — is particularly advantageous.

Unfortunately, lack of home charging is an obstacle for many MUD residents. Although comprehensive data on the availability of home charging at MUDs is unavailable, there is general agreement that few MUDs have home charging access. For example, a 2012 study found that fewer than 5% of American new car buyers who live in apartments have access to an electrical outlet with which to charge an EV within 25 feet of where they park their vehicle.[16]

Barriers to installing charging equipment in MUDs

Installing charging equipment at a single-family home is usually a straightforward and inexpensive proposition. However, the same is not always true at MUDs. Parking configurations in apartments, condos and other MUDs make installing chargers difficult and expensive. Moreover, many MUD residents rent their homes. Therefore, decisions to install charging infrastructure largely rest with the property owner. In some cases, particularly in areas with older buildings, MUD residents may have no off-street parking at all.

Installing charging infrastructure in MUDs can be expensive. In an assessment of common MUD building types in the South Bay Region of Los Angeles County, Turek and DeShazo (2016) found expense to be a significant barrier to installation at MUDs.[17] Although level 2 (L2) equipment[18] has dropped in price since that study, the potential construction costs of getting electricity from an apartment's electrical room to a parking spot remain high. This is particularly the case for parking areas that have no existing electrical access. Moreover, for L2 charging, additional 220-voltcircuits[19] will almost certainly be required along with submeters or management software to accurately bill residents for the electricity they consume. Turek and DeShazo found that these costs can add up to prohibitively expensive bills for installing charging equipment in MUDs, averaging about $5,400, with some costing as much as $17,800 per installation.[20]

Complicating matters, MUD residents are often renters. While California law gives tenants the opportunity to install charging equipment in their rental building,[21]

[11] Calif. Exec. Order N-79-20, 2 (2020). https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-text.pdf

[12] California Clean Vehicle Rebate Project. (2017) EV Consumer Survey Dashboard. https://cleanvehiclerebate.org/eng/survey-dashboard/ev

[13] Tal, G., Lee, J.H. & Nicholas, M.A. (2018). Observed Charging Rates in California. UC Davis Institute of Transportation Studies

[14] United States Census Bureau. (2019). American Community Survey.

[15] Hardman, S. et al. A review of consumer preferences of and interactions with electric vehicle charging infrastructure. Transportation Research Part D: Transport and Environment. 62, (July 2018), 508-523.

[16] Axsen, J. & Kurani, K.S. (2012). Who can recharge a plug-in electric vehicle at home? Transportation Research Part D: Transport and Environment, 17 (5), 349-353.

[17] Turek, A. & DeShazo, G.M. (2016) Overcoming Barriers to Electric Vehicle Charging in Multi-unit Dwellings: A South Bay Case Study. Prepared for the California Energy Commission by UCLA Luskin Center for Innovation and the South Bay Cities Council of Governments. https://innovation.luskin.ucla.edu/wp-content/uploads/2019/03/Overcoming_Barriers_to_EV_Charging_in_MUDs-A_South_Bay_Case_Study.pdf

[18] Level 2 chargers are 220-volt charging equipment that provide a faster charge than a typical wall outlet.

[19] Higher power than typical 110-volt residential electrical circuits

[20] Turek, A. & DeShazo, G.M. (2016)

[21] A.B. 2565, California Legislature - 2013-14 Reg. Sess. (Calif. 2014) https://www.smgov.net/departments/Council/agendas/2014/20140513/s2014051313-C.pdf

few are likely to be willing to pay for improvements in a building they do not own. Property owners also have few incentives to undertake costly upgrades to their property without clear evidence of a return on investment. Thus far, charging access has yet to be seen by the rental industry as an amenity capable of drawing additional rent. Although that may change as EVs gain more prominence in the passenger vehicle market, high upgrade costs will make justifying charger installation difficult on a return on investment basis, particularly in older, down-market properties.

These factors combine to create a charging landscape where few MUDs currently have charging on-site. Moreover, between high upgrade costs at some locations, limitations on on-site parking or building electrical capacity, and a general reluctance to undertake costly improvements among many building owners, lack of charger availability at MUDs will likely remain a problem well into the future.

MUD-focused direct current fast chargers

Direct current fast charger (DCFC) sites (like those EVgo constructed in its HPCP pilot) are one potential solution to lift barriers to charging for MUD residents. DCFC are high powered charging stations that deliver power at least six times faster than L2 charging equipment and as much as 45 times faster with state-of-the-art DCFC chargers.[22]

Because they can deliver charge quickly, DCFC sites can work similarly to gas stations, where MUD users can fit a recharge of their vehicle into their normal travel as they would do when refueling a gasoline vehicle. For some drivers, fast charging location can provide the bulk of their charging needs. Others might use such chargers as critical secondary options to supplement another primary nonresidential charging option such as at their workplace.

Importantly, this solution does not rely on landlord buy-in. Charging network providers, utilities or other parties interested in providing vehicle charging to MUD customers can quickly begin offering that service to residents of many different MUD properties with a single nearby installation.

Furthermore, though DCFC installations are more expensive than L2 charging stations, public DCFC can deliver more electricity to more users in any given time frame, potentially providing a better return on investment over the life of the project than individual L2 chargers near or within an apartment or condo complex.

However, fast chargers are not without limitations. While DCFC are loosely analogous to gas stations, DCFC refuel EVs considerably slower than gas stations dispense fuel, meaning that EV drivers who rely on fast charging will spend more time refueling their vehicle, likely needing to refuel more frequently and for longer periods.[23] In addition, longer charging times can lead to congestion at fast charging sites if there is an inadequate number of individual charging stations.

While DCFC can provide value in both time and cost saving versus a paid public L2 charger, fast charging is more expensive than home charging at residential electricity rates. Average residential electricity rates in California are about 20 cents per kilowatt-hour (kWh).[24] By comparison, charging at a DCFC (using EVgo's network as an example) costs around 31 cents per kWh on average.[25] Heavy reliance on DCFC charging, therefore, can undercut some of the fuel-cost savings of driving an EV over a gasoline vehicle.

The HPCP pilot program

EVgo's HPCP pilot program is designed with the intention to expand fast charging access to MUD residents. The program has deployed 20 fast charging locations with at least three charging stations that provide charge rates of at least 50kW.[26] The HPCP are sited within Public Use Microdata Areas (PUMA) with above-median number of MUD units according to U.S. Census data.

The key HPCP intervention design component is the siting strategy. By constructing HPCPs in PUMAs with high proportions of MUDs, the program is meant to provide MUD residents more convenient access to fast charging. PUMAs are Census Bureau-defined geographic regions designed for the dissemination of census microdata. They contain at least 100,000 people and thus vary in geographic size depending on population density. In urban areas (where MUD concentrations are highest) PUMAs typically cover an area analogous to a small to medium-sized city.

[22] Six times faster figure based on typical 50kW DCFC compared to typical 7.7kW L2 charging. State-of-the-art DCFC can deliver power at up to 350kW. However, few current vehicles can accept charge at that rate.

[23] Gas station pumps can provide as much as 270 miles of range per minute to a vehicle that gets 27 miles per gallon. A 50kW DCFC delivers about 2.9 miles per minute to a BEV rated at 29kWh/100mi. A state of the art 350kW charger improves that figure to nearly 20 miles per minute.

[24] U.S. Energy Information Administration. (2019, August & 2020, August). Table 5.6.A. Average Price of Electricity to Ultimate Customers by End-Use Sector. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a

[25] 31 cents per kWh based on a $0.26/minute charging fee at a 50kW charger.

[26] The HPCP program allowed for the upgrade of previously smaller EVgo charging locations to larger HPCP installations. One of the 20 stations is an expansion of a previous station. The rest are new station locations.

Within candidate PUMAs, individual sites were selected that met practical requirements of hosting fast charging infrastructure, including reasonable acquisition costs, available space and electrical hosting capacity. The program sought to site chargers near MUD residences or common destinations of MUD residents; however, those considerations were not applied systematically or otherwise determined by a common metric or metrics. Additionally, four DCFC locations were selected because they were in PUMAs where the median income is in the bottom tercile relative to the region or state as a whole.

In addition to siting considerations, HPCP stations all have at least three DCFC, in comparison to typical EVgo locations, which usually have only one or two. Also, while some HPCP locations offer 80kW and 150kW chargers, most EVgo chargers can supply only 50kW of charge. More and faster charging stations should ensure faster charges and less congestion, potentially making HPCPs a more convenient charging option.

Easing barriers to EV adoption for MUD residents is an important component of California meeting its ZEV adoption goals. Moreover, because MUD residents are more likely to be low or moderate income and live in areas more heavily impacted by environmental harms, there are important equity considerations to expanding EV ownership among MUD residents.

To date, programs focused on removing barriers to EV adoption for MUD residents have targeted incentivizing the installation of charging equipment on-site at MUD properties. However, it may be prudent for state and local governments to extend additional policy support to developing MUD-focused DCFC locations (like the HPCP program) if they show promise toward easing barriers to EV ownership among MUD residents.

Chapter 2. Data, survey collection and COVID-19 impacts

The analysis in this report is based primarily on administrative data of vehicle charging sessions provided by EVgo and responses from a survey of 1,470 EVgo users. Survey responses are tied to account-level charging data, providing a rich dataset of user characteristics, attitudes and real-world charging behaviors. In addition, we use public data from the American Communities Survey and road network data from openstreetmap.org to augment session and survey data with information about MUD density and the network distances between users' approximate home locations and the stations where they charge.

The data collection period included the COVID-19 shutdowns of nonessential services starting in March 2020. Dramatic reductions in passenger vehicle travel limited the quantity of data collected during the study period, reducing our ability to do comprehensive assessments at the individual site level. However, enough data has been collected to draw initial conclusions on the overall performance of the program.

EVgo administrative (session) data

For the purposes of this study, EVgo shared detailed account-level data on more than 1 million charging sessions for the 24,382 users included in this study. EVgo staff retrieved this data from EVgo's internal customer and billing database. The session dataset includes the following data attributes:

1. anonymous user ID
2. user's census tract of residence[27]
3. residence type (MUD or non-MUD)[28]
4. session station ID and location
5. session start time and date
6. session end time and date
7. energy delivered (kWh)

We included users in the dataset if they met one of two criteria: 1) they had charged at an HPCP location during the study period or 2) they used one of the other 50 designated comparison (non-HPCP) site chargers on EVgo's network during the study period. User data includes all charging activity beginning six months prior to their first use of a HPCP or comparison site and extending until September 30, 2020.

Survey data and methods

Participants in the survey included 1,470 EVgo users who responded to email surveys in September and October of 2020. The survey included questions about the user's home type, charging access, typical charging behavior, the use of their vehicle and preference for different charging location attributes. See Appendix B for a survey instrument sample.

EVgo staff administered the survey instrument using the online survey provider surveymonkey.com® and recruited survey respondents using EVgo's customer communication infrastructure. We targeted EVgo users who fit into three categories: 1) HPCP users, 2) users of comparison non-HPCP locations (non-HPCP user), and 3) users who lived within three-quarters of a mile from a HPCP (HPCP-adjacent nonuser). Those who completed the survey were awarded $4-$6 in charging value credited to

Figure 1: HPCP openings and study timeline

[27] Residence GEOID determined by geocoding user billing addresses. See Appendix A for geocoding methods description.

[28] Residence type based on customer address. See Appendix A for classification methods description.

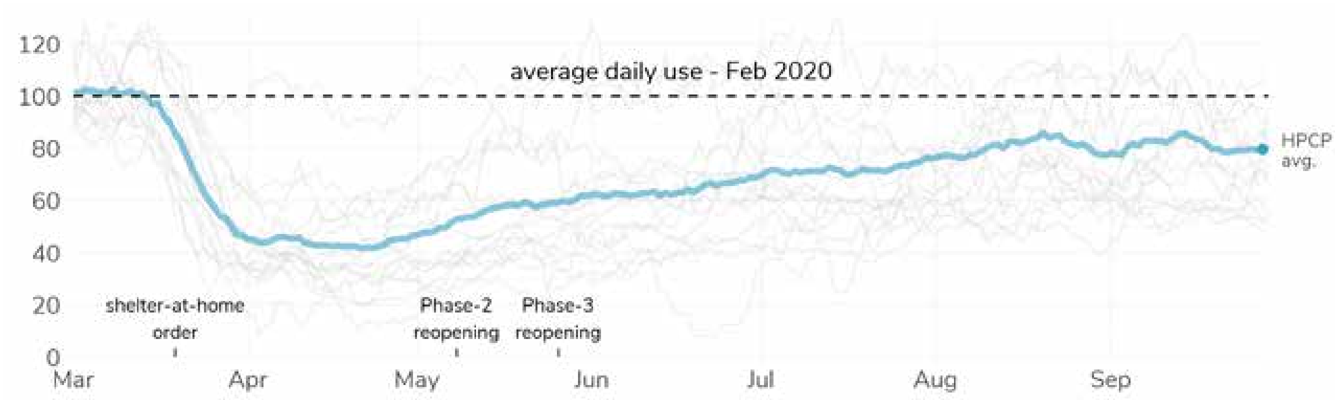


Figure 2: 14-day rolling average utilization indexed to February 2020. (February usage = 100, gray lines represent individual stations.)

Table 1: Survey responses

Recruitment	HPCP users	non-HPCP user	HPCP-adjacent nonuser
population	2,236	1,438	5,300
no. responses	460	223	787
response rate	20.5%	15.5%	14.8%

their EVgo account.[29] Surveys were not sent to those who had opted out of receiving marketing materials when they signed up for EVgo's service. Survey recruitment and response statistics are listed in Table 1.

The reader should note that the survey sampling method oversampled users of HPCPs and those who live near a HPCP and is thus not necessarily representative of EVgo's overall population of users in California.

In addition, because surveys were not sent to users who had opted out of receiving marketing material, any systematic difference between those who opted out and those who did not opt out would introduce bias into the sample.

Impacts of HPCP delays and COVID-19 shutdowns

Project delays and other difficulties in developing and powering HPCP locations have shortened the data collection period for many HPCP stations. In addition to project delays, COVID-19-related closures that started in March 2020 limited the quantity of data acquired in the last seven months of the data collection period.

Figure 2 shows how session use fell significantly in March and April and had not returned to pre-pandemic levels by the end of the study period. Because post-COVID charging behaviors changed so significantly, the data collected after March 2020 will have less explanatory power to answer questions about typical fast charger use.

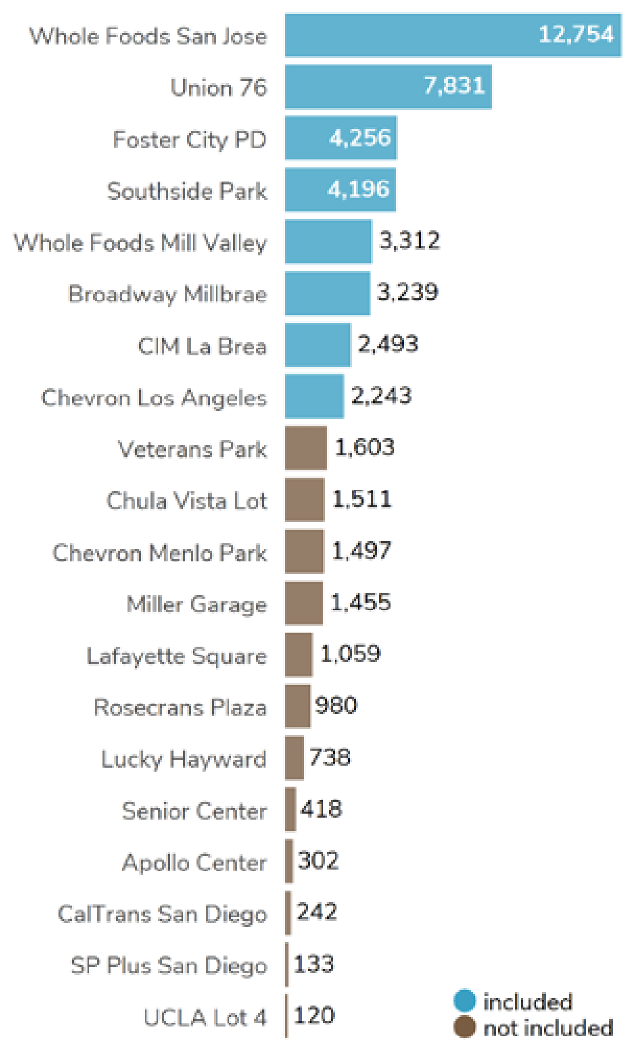


Figure 3: Number of charging instances at each HPCP from opening until September 30, 2020

[29] We increased the incentive from $4 to $6 in order to attract a higher response rate.

In effect, COVID-19 related slowdowns have truncated the useful data collection period by seven months. Due to the shortened data collection period, session data is relatively limited for many of the HPCP stations. Figure 3 shows the reported sessions for each station. Only eight stations have had more than 2,000 qualifying sessions during the study period, and more than half of the stations have fewer than 1,500 sessions. With 12,754 sessions, the Whole Foods San Jose location is a notable outlier in terms of data availability, likely because that location was a regular EVgo station prior to its conversion to a HPCP in January 2019.

Chapter 3. Fast charging preferences and behavior

While research on the charging behavior of EV drivers has grown in volume in the last several years, little detailed information exists about how multi-unit dwelling (MUD) residents use direct current fast charging (DCFC). The *High Power Charging Plaza* (HPCP) program is predicated on assumptions that MUD residents favor charging close to home and likely rely on DCFC more so than non-MUD residents. Therefore, understanding how MUD resident charging preferences and behavior diverge from (or are similar to) non-MUD residents is key information needed to evaluate the HPCP program and the concept of MUD-focused DCFC as a whole.

Access to charging is critical to electric vehicle (EV) adoption. Prior research on EV charging behaviors has established that the majority of EV charging events (50–80%) occur at home.[30] However, access to charging away from home is necessary to grow the EV market and enable EVs to drive more miles.[31,32] In the literature, away-from-home charging is typically further subdivided as at-workplace charging, public charging and intercity travel corridor charging. EV drivers without access to home charging (including many MUD residents) will need to charge their vehicle at public or workplace chargers.

In a survey of California EV drivers, Lee et al. (2020) found that over a seven-day period, 3% of respondents charged exclusively at public chargers, 3% of respondents charged at both work and public charging, and 8% charged exclusively at work. Those who charge only at public chargers or at a combination of public and workplace charging reported using public DCFC approximately twice as frequently as L2 public chargers. Respondents who charged exclusively at public chargers, or a combination of work and public chargers, are significantly less likely to own a detached home.[33]

By analyzing a limited number of survey responses and charging session data collected from EVgo DCFC users, Nicolas and Tal (2017) found that EVgo users who lacked access to charging at home were more likely to live in apartment buildings and that 61% of those who lived in apartments indicated they had no charging at home. Furthermore, they found that MUD residents used EVgo DCFC more frequently and closer to home than non-MUD residents.[34]

This chapter builds on existing research of charging behavior and preferences by analyzing survey responses and session-level data of a subset of EVgo's California user base to examine how EVgo's MUD resident customers use its network of DCFC and by comparing the charging behaviors of MUD resident customers to those who do not live in MUDs.

First, we assess whether MUD resident users' stated preferences for charging station location attributes differ from non-MUD resident users. These station location attributes include: within close proximity to their home, with three or more charging stations, and with faster charging equipment (which are the three interventions explicitly employed in the HPCP pilot). We also assess whether preferences differ between MUD and non-MUD resident customers on other common DCFC station attributes.

The analyses of session data in this chapter are meant to directly explore differences between MUD and non-MUD resident charging behavior that have been reported but not deeply examined in prior research. We focus our attention on how three key charging behaviors — use frequency, use intensity and spatial patterns of use — differ between MUD users and non-MUD users as well as across other factors associated with MUD residency. This information is important for building a better understanding of the MUD residents that the HPCP pilot program is meant to serve.

Summary of data

The analysis in this chapter is based on a dataset constructed from survey responses of EVgo customers matched to

[30] California Air Resources Board, 2017. California's Advanced Clean Cars Midterm Review Appendix G: Plug-in Electric Vehicle In-Use and Charging Data Analysis 29

[31] Caperello, N., Kurani, K. & TyreeHageman, J. (2014, November 21). *I Am Not An Environmentalist Wacko! Getting From Early Plug-in Vehicle Owners to Potential Later Buyers*. UC Davis Plug-In Hybrid and Electric Vehicle Research Center. https://phev.ucdavis.edu/files/Caperello-Interviews-11-12-14.pdf

[32] Neaimeh, M., Salisbury, S.D., Hill, G.A., Blythe, P.T., Scoffield, D.R. & Francfort, J.E. (2017). Analyzing the usage and evidencing the importance of fast chargers for the adoption of battery electric vehicles. *Energy Policy,* 108, 474-486. https://www.sciencedirect.com/science/article/pii/S0301421517303877?via%3Dihub

[33] Lee, J.H., Chakraborty, D., Hardman, S.J. & Tal, G. (2020). Exploring electric vehicle charging patterns: Mixed usage of charging infrastructure. Transportation Research Part D: *Transport and Environment, 79.* https://www.sciencedirect.com/science/article/pii/S136192091831099X?via%3Dihub

[34] Nicholas, M.A. & Tal, G. (2017) *Survey and Data Observation on Consumer Motivations to DC Fast Charge*. Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-17-21

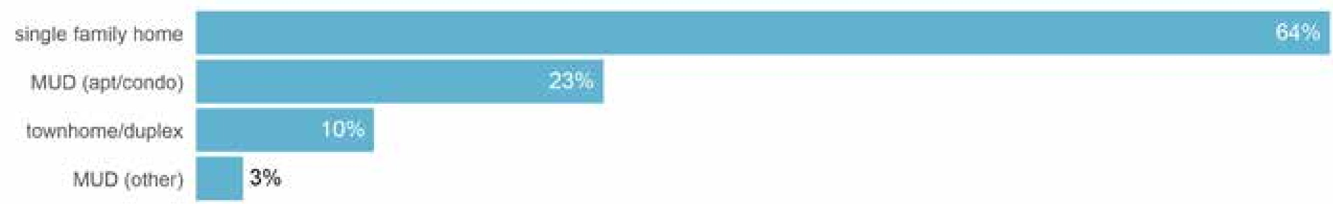


Figure 4: Survey response frequency by home type

charging session data for those users.[35] Of the users who responded to the survey, 31 could not be matched to session data, bringing the matched dataset down to 1,439. Not all survey respondents responded to each question nor were all matched to a home location to determine distance from home to charger, meaning that some analyses have slightly smaller sample sizes.

In order to obtain enough statistical power to detect differences between MUD customers and non-MUD customers, our sampling strategy was designed to oversample MUD residents. Additionally, we do not know enough about the population of EVgo users to appropriately weight this survey. Because of this, it is inappropriate to draw broad inferences across this sample about EVgo's customer base. For example, it would be erroneous to infer the overall distribution of housing types across EVgo's customers based on the distribution of that variable in the survey dataset.

Readers should also note that because the sample is drawn solely from EVgo's customers, it cannot be expected to perfectly represent EV owners who are not EVgo customers.

About the survey respondents

Because this study is concerned with identifying possible differences between MUD residents and non-MUD residents, the most important survey response category in this analysis is home type. Survey respondents were asked to choose the response that best described their housing type. Options in the survey included: *single family home (detached)*, *townhome or duplex*, *apartment or condo building/complex*, and *other multifamily*.

The primary concern about MUD residents is that they may lack access to charging infrastructure. The survey asked respondents about both home charging and work charging because they are both well suited to serving everyday charging needs. Figure 5 shows negative responses (do not have access) for home or work charging.

As expected, proportions of home charger availability vary substantially between MUD respondents and single-family residence (SFR) and townhome/duplex respondents.

Notably, fewer than half of MUD residents reported not having access to home charging. Overall, access to home charging among MUD residents is thought to be very

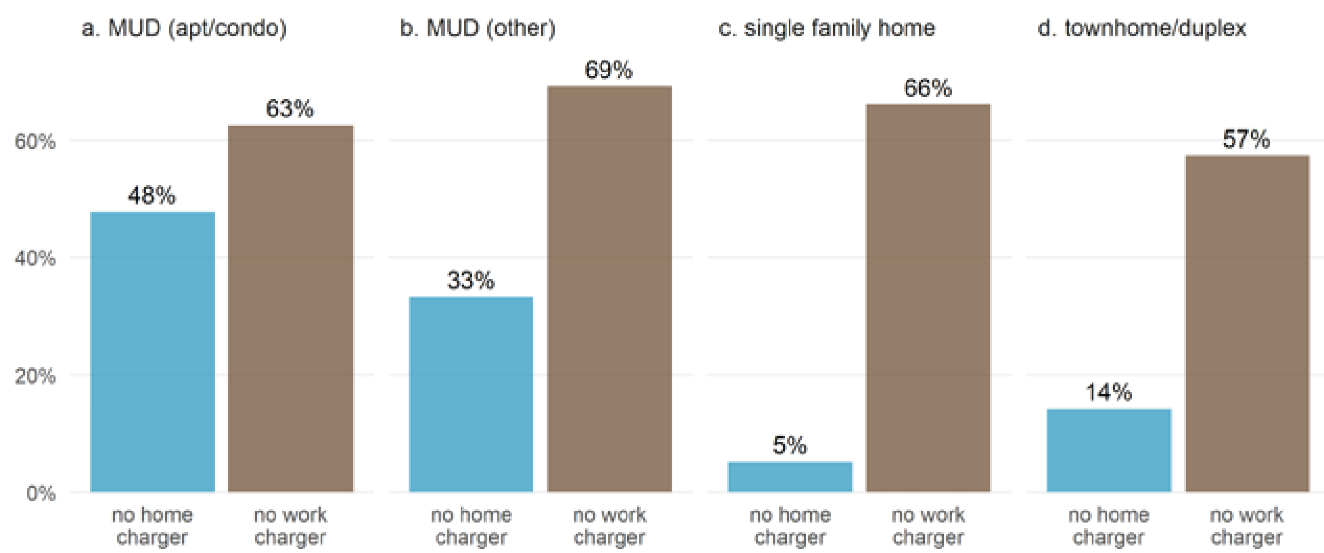


Figure 5: Respondent charger availability

[35] The datasets are described in more detail in Chapter 2.

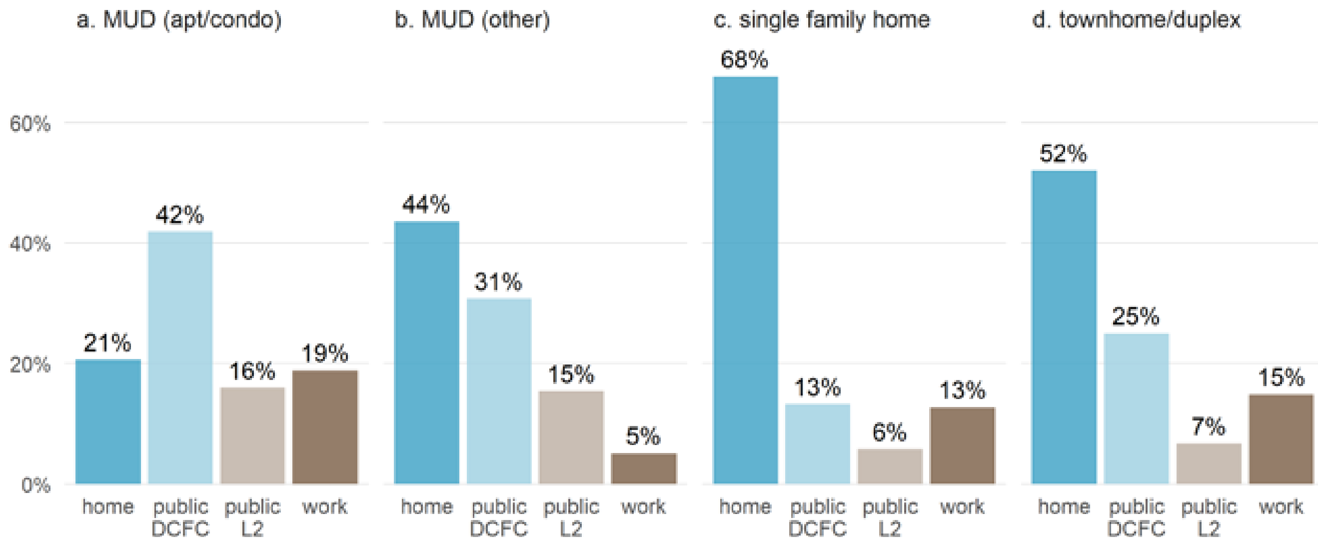


Figure 6: Respondent primary charging mode

limited. We expect that this discrepancy between our sample and the broader population of MUD residents can be attributed to selection bias. EVgo users have already opted to purchase EVs and thus are probably more likely to have home charging than the average MUD resident.

Unlike access to home charging, access to work charging is relatively similar across housing types. We expected that MUD resident EVgo customers might be more likely to have access to charging at work because at-work charging could potentially be an enabling factor for those without home charging to nonetheless decide to purchase an EV. However, based on the responses to the survey, this does not seem to be a significant factor, at least among EVgo customers.

We also asked respondents to state where they charge their vehicle most. Respondents could choose *at home, at work, at a public DCFC or at a public L2 charger.* As Figure 6 shows, there is significant variation in this response across housing types.

Notably, apartment and condominium respondents (who more commonly lack access to home charging) reported far more reliance on public charging and far less reliance on home charging when compared to residents of SFRs. Forty-two percent of apartment/condo residents and 31% of residents of other MUD types reported that they charge primarily at public DCFC. While we cannot directly infer the number of EVgo users who rely on DCFC from these data, they do suggest that a significant number of MUD residents who signed up for EVgo's services are heavily reliant on DCFC to meet their charging needs.

Due to ambiguity among multifamily housing types, we included an *other multifamily housing* category. There appears to be some variability between responses between apartment/condo residents and those who chose *other multifamily*. However, because only a small portion of survey respondents selected that category, there are not enough respondents to find statistical differences between that housing type and others. For the purposes of this analysis "MUD other" respondents are combined with MUD apartments and condos in a single MUD category.

Characteristics of MUD residents

In addition to lacking home charging infrastructure, being an MUD resident correlated with a number of other factors that might influence charging preferences and behavior. To adjust for those factors and better understand their potential contributions to differences in MUD resident charging behavior, we asked survey respondents whether they: *owned or rented their home, owned gasoline vehicles, or drove for an app-based service.* In addition, we also asked what model EV they drive.

Figure 7 shows a correlation matrix of the categorical indicator variables encoded from survey responses. The first column shows the correlation between living in an MUD and all other indicators. As expected, living in an MUD is significantly correlated with no access to home charging but is not significantly correlated with no access to work charging. In addition, living in an MUD is: a) positively correlated with being a renter and primarily using public or workplace charging options, b) negatively correlated with owning one or more gasoline vehicles in addition to their EV and primarily charging at home, and c) not correlated with driving for an app service.

Figure 7: Correlation matrix of categorical survey responses. Non-statistically significant correlation coefficients denoted with "X."

The positive correlation between living in an MUD and being a renter is not surprising given that many MUD properties are rentals. No home charging is also correlated with renter. This in part reflects the correlation of renter with living in an MUD but is also likely capturing the added difficulty in installing home charging caused by landlord-tenant relationships.

The observed negative correlation between owning a gas vehicle and living in an MUD might be explained by smaller average household size and limited parking available to MUD residents. Household income might also be a limiting factor for household fleet sizes given that MUD residents are lower income than SFR residents on average.

We asked survey respondents whether they drove for an app-based service such as Uber or Lyft because we suspected that those drivers would use DCFC more intensively and might also be more likely to reside in MUDs. However, among survey respondents, only being a renter correlated significantly with being an app-based driver.

In addition to the categorical metrics shown in Figure 7, we also asked survey respondents what EV they drove in order to adjust for any systematic relationships that might exist between vehicle range and residence type.[36] However,

[36] We encoded vehicle range based on range estimates provided by fueleconomy.gov.

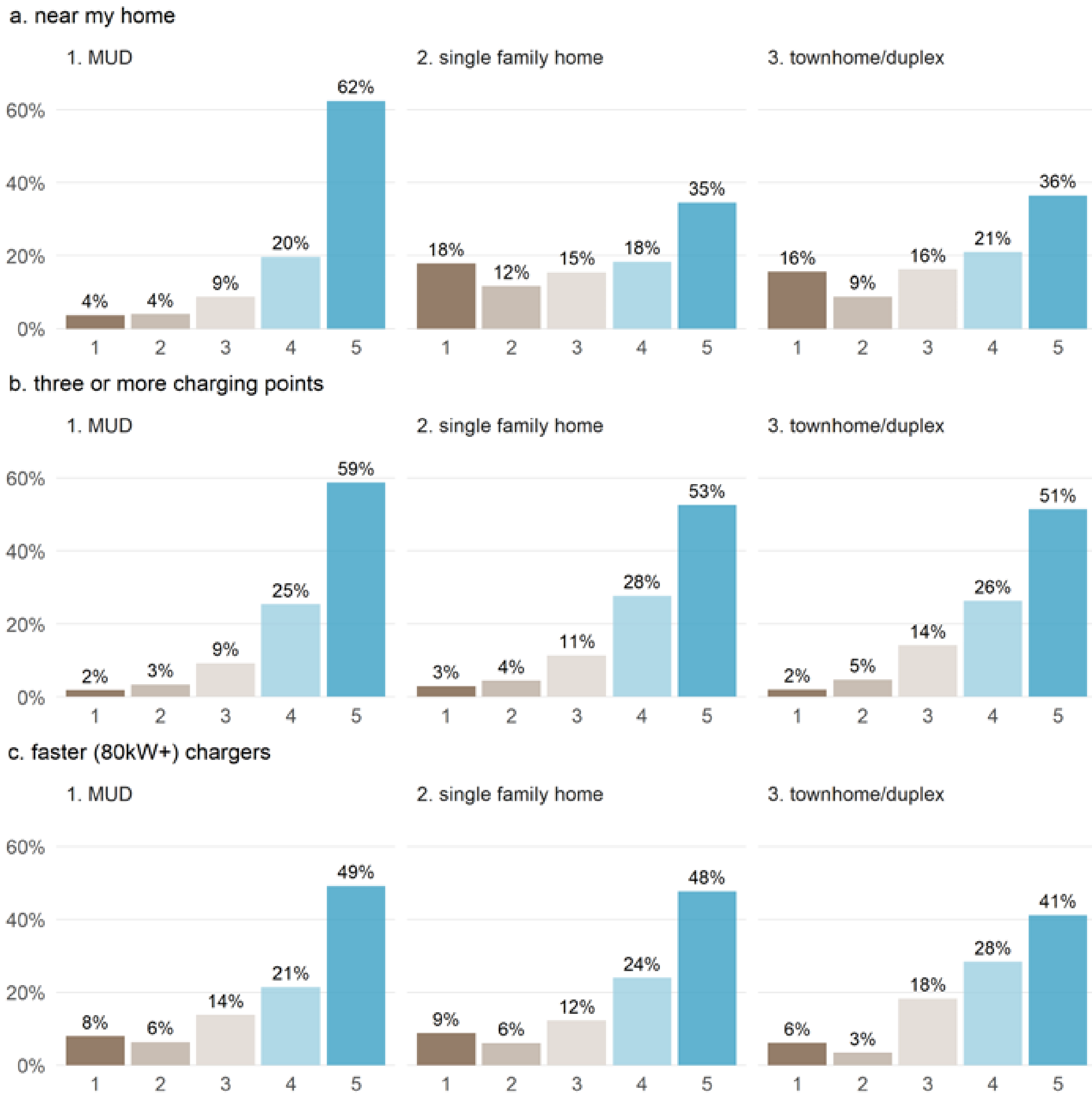


Figure 8: Likert scale responses for intervention specific questions (1 = not important, 5 = very important)

there are no significant differences between the vehicle ranges of MUD and non-MUD residents. Respondents in both groups drove vehicles with ranges averaging about 160 miles.

Charging station preferences

The HPCP pilot intervention design is predicated on the hypothesis that charging stations that are closer to MUD resident users' homes, have more charging stations and are able to charge vehicles faster will better serve the MUD resident customer segment. We asked survey respondents to rank the importance of these attributes of a charging station between not important (1) and very important (5).

As Figure 8a shows, there is variation between how those who do and do not live in an MUD answer the question about whether a charging station being near their home is important. Conversely, the distribution of responses in Figures 8b-c suggest that there is not significant variation

Table 2: Results of ordinal logit regression model predicting response to *important that DCFC is near my home*

	(1) near my home		(2) near my home		(3) near my home	
	β (SE)	OR	β (SE)	OR	β (SE)	OR
lives in MUD	1.260*** (0.124)	3.524	0.900*** (0.136)	2.459	0.627*** (0.156)	1.872
no home charger			0.981*** (0.158)	2.667	0.218 (0.185)	1.244
no work charging			-0.076 (0.102)	0.927	-0.127 (0.117)	0.881
renter					0.345** (0.126)	1.412
EV range (mi)					-0.002* (0.001)	0.998
owns ICE car(s)					0.184 (0.127)	1.202
drives for app service					0.244 (0.208)	1.277
primary: DCFC public					1.489*** (0.156)	4.433
primary: l2 public					1.285*** (0.207)	3.615
primary: at work					0.681*** (0.171)	1.976
not/somewhat important	-1.588*** (0.078)	0.204	-1.589*** (0.103)	0.204	-1.368*** (0.210)	0.255
somewhat/ moderately important	-0.936*** (0.066)	0.392	-0.929*** (0.094)	0.395	-0.658** (0.206)	0.518
moderately important/ important	-0.235*** (0.060)	0.791	-0.215* (0.089)	0.806	0.110 (0.204)	1.116
important/very important	0.601*** (0.062)	1.824	0.637*** (0.091)	1.891	1.029*** (0.206)	2.799
N	1,439		1,439		1,380	

p = *** < 0.001, ** < 0.01, * < 0.05

between residence types on the questions relating to more and faster chargers. However, those attributes are consistently rated as desirable among respondents irrespective of home type.

Preferences for near home charging

We test the differences in preferences for charging station proximity to home using an ordinal logistic regression model. This model estimates the probability (or odds) that a survey respondent will rank *near my home* higher, conditioned on the coefficient of the model. In a multivariable model, the effects of other regressors are adjusted for by holding those values at zero. In the model, statistical significance denotes that we are able to measure the conditional relationship between the regressor and survey responses with enough precision to confidently assume that the association is not a product of chance or random noise.

Table 2 shows the results of three regression models. The first predicts the response based only on whether the respondent lives in an MUD. The second model adds variables related to charging access, and the third model includes additional factors, including respondents' stated primary charging mode.

Model 1 shows that those living in an MUD are 3½ times more likely to rank near home charging as important than those who do not live in an MUD.

When variables for access to home and work charging are added to the regression model, the coefficient on MUD resident is diminished but remains a significant predictor. The coefficient on no home charging is also a significant predictor.

When coefficients for renter, EV range, internal combustion engine (ICE) car ownership, app-service driver and primary charging mode indicators are added to model 3, the coefficient for MUD resident is further diminished, but remains significant. The coefficient for no home charging is no longer significant, but all three non-home primary charging indicators are significant. In addition, being a renter is associated with a small independent increase in odds while the electric range of the driver's vehicle is associated with a small reduction in odds.

Across all three models, MUD residency significantly predicts an increased preference for charging station locations near home. Because adding variables indicating charging availability and non-home primary charging diminish the coefficient on MUD resident and are themselves significant predictors, it is safe to assume that some of the preference for closer charging observed in model one is mediated by charging access and ultimately where specific respondents reported primarily charging their vehicle. However, MUD residency remains a significant factor even when holding those mediators constant, indicating an independent association between MUD residency and preference for nearer to home charging.

Having DCFC locations near their home is strongly preferred by MUD residents who do not have access to home charging and is particularly advantageous to those who primarily charge at DCFC. This suggests that those users anticipate close to home charging as an important part of meeting their charging needs.

It is unclear why even those MUD residents who have access to home charging and primarily charge at home show an increased preference for closer to home charging. One potential answer may be that MUD residents find their home charging options to be less reliable than non-MUD residents and therefore prefer to have a backup option nearby. Furthermore, because home charging is less readily available in MUD properties, those MUD residents may have faced some difficulty securing home charging access, which in turn might make them value nearby charging alternatives more despite not needing to use them regularly.

Also of note is that users who rely on away from home charging at work or at a public L2 charger also more strongly prefer closer to home DCFC locations. This is likely because they find their usual method of charging is not always reliable or adequate for all their charging needs and a nearby DCFC provides a convenient supplementary charging option.

Preferences for other charging location attributes

We ran the same ordinal logistic regression model on preferences for higher number of DCFC at charging locations and faster charging equipment. In neither case did we find that MUD residence or other regressors in the model significantly predicted stronger or weaker preference for either location attribute. Overall, users of all residence types ranked these two attributes highly, suggesting that reduced risk of congestion and faster charging are equally desirable for all users. Notably, preference for faster DCFC is high even though very few respondents drove vehicles that can accept 80kW+ charging.

The reader should be aware that in addition to the above station attributes, we also asked respondents to rank the importance of charging station locations: *near amenities such as grocery stores and retail, near their workplace, near freeways and on travel corridors.* We did not find any significant association between MUD residency and responses to these questions.

Charging behavior of MUD residents

An understanding of how MUD residents use DCFC is important information for planners and other stakeholders to have when deploying solutions meant to better serve MUD residents. The lessons learned from this analysis offer important context with which to evaluate the HPCP pilot program and to inform future expansions of MUD-focused DCFC projects.

We evaluate charging behavior using ordinary least squares (OLS) regression, a statistical model that determines whether one or more independent variables are related to a dependent variable, or in other words, how the dependent variable changes in relation to changes in the independent variable or variables. In these models, the dependent variables are behavioral metrics of interest (such as charging frequency) while the independent variables (regressors) are attributes of the DCFC user.

Unlike the ordinal logistic model used above, OLS regression coefficients do not predict changes in probability, but the associated numeric change in the dependent variable conditioned on a unit change in the dependent variable. Categorical variables, like MUD residency, are encoded as binary variables, where a unit change is the move between

0 (not an MUD resident) to 1 (MUD resident).

As with the ordinal logit model, when multiple regressors are included in the model, coefficients should be interpreted as being the association between the dependent and independent variable when the other independent variables are held at zero. Also like the above model, statistical significance denotes that we are able to measure the relationship between the dependent and independent variables with enough precision to assume that the association we have measured is not the product of random noise in the data.

We evaluate each behavioral metric across four different models. Model 1 includes only MUD resident as a regressor. Model 2 includes respondent attributes on access to home and workplace charging, the two charging modes that offer the most consistent charging opportunities for EV owners. Model 3 adds variables describing non-charging attributes of: renter, EV range, gasoline (ICE) vehicle ownership, and app-based driver that might impact charging behaviors and potentially mediate some of the relationships between MUD residency and those behaviors. Model 4 adds explicit indicators for which mode respondents report primarily charging at. Showing the results for each of these models individually and in sequence lets us unpack relationships between charging behavior, MUD residency and the additional attributes in the model.

While regressors are often described as explanatory variables, the reader should note that determining causality requires a carefully developed experimental framework. Although we believe that we are likely capturing causal relationships between user attributes and charging behaviors, the most we can confidently report given our methods is an association between those factors and user behavior.

Frequency and intensity of use

The first behavioral metrics we examine are use frequency and use intensity. The difference in usage patterns between MUD residents and non-MUD residents is a key implicit assumption underlying the HPCP program. The implication of targeting this program toward MUD residents is that they are more likely to be reliant on DCFC to meet their charging needs.

Frequency and intensity of use are the two primary behavioral metrics we use to measure DCFC dependency. Higher frequency and intensity of use indicate more dependence on DCFC charging. The two metrics are related but differ in their implications.

Frequency is a measure of how many times a user visits a DCFC that indicates distinct patterns of use but carries less information on how much charge (and therefore useful range) the user is obtaining when they charge. Use intensity is a measure of how much energy (in kWh) the user demands and is an approximate measure of how much of the user's driving (in absolute terms) is supported by DCFC charging on EVgo's network.

Use frequency and intensity metrics are only meaningful when measured over a set time period. To construct these metrics from session data, we took a weekly average of each user's session count and energy use over the data collection period. While any length of time would work in this analysis, sessions and energy per week offered the most easily interpretable results.

Use frequency

Model 1 in Table 3 shows the simple univariate relationship between living in an MUD and average number of weekly sessions. Living in an MUD is on average associated with 0.255 additional sessions per week (about one more per month) relative to a non-MUD resident. This result is statistically significant. Because this is a univariate model where the regressor is a binary variable, the model constant (0.767) can be interpreted as the predicted number of weekly sessions if a user does not live in an MUD, meaning that the model predicts that MUD users charge approximately one time per week on average.

Model 2 includes regressors for at home and at work charging access, the charging modes that provide the most and second most regular access to charging. In this model the statistical significance of the coefficient for living in an MUD disappears. However, both lack of access to charging at work and home are significant predictors of increased weekly session counts. In particular, the coefficient on no home charging is very significant and is nearly twice as large as the coefficient on MUD residency in model one. These results suggest that the statistically weaker positive coefficient on MUD residency observed in model one is the result of that variable carrying information about whether a user has access to home charging.

Model 3 adds additional, non-charging related attributes to the model. The effect of doing so eliminates the previously identified significance on the coefficient on no workplace charging and slightly increases the coefficient on no home charging. Perhaps unsurprisingly, additional vehicle range is significantly associated with fewer charging events, likely because those users can drive longer without needing charge. In a similarly predictable fashion, driving for an app-based service also significantly predicts more charging events. While the addition of these variables increased the explanatory power of the overall model (as measured by the adjusted r-squared statistic), their effect on the coefficient for no home charging is small.

Table 3: Results of OLS model predicting average number of user sessions per week

	(1) sessions/wk	(2) sessions/wk	(3) sessions/wk	(4) sessions/wk
lives in MUD	**0.255*** **(0.109)**	0.065 (0.123)	0.034 (0.132)	-0.074 (0.131)
no home charger		**0.462***** **(0.138)**	**0.521***** **(0.141)**	0.185 (0.148)
no work charging		**0.208*** **(0.094)**	0.166 (0.094)	0.124 (0.102)
renter			0.021 (0.110)	-0.075 (0.109)
EV range (mi)			**-0.002***** **(0.001)**	**-0.002***** **(0.001)**
owns ICE car(s)			-0.006 (0.109)	0.039 (0.107)
drives for app service			**1.244***** **(0.175)**	**1.157***** **(0.172)**
primary: DCFC public				**0.914***** **(0.127)**
primary: l2 public				0.251 (0.178)
primary: at work				0.204 (0.150)
(constant)	**0.767***** **(0.051)**	**0.599***** **(0.081)**	**0.914***** **(0.169)**	**0.743***** **(0.172)**
N	1,291	1,291	1,265	1,265
adj r-squared	0.003	0.014	0.061	0.097

β (SE), p = *** < 0.001, ** < 0.01, * < 0.05

In the final model, we add indicators for users' stated primary charging mode. In this model, no home charging is not significant, while the coefficient on primarily charges at DCFC is nearly double (nearly one whole additional session per week) the coefficient for no home charging in model two and very statistically significant. This again suggests that the coefficient on no home charging in the previous model was carrying information about whether the user primarily uses DCFC to charge their vehicle.

Use intensity

Model one in Table 4 is the univariate relationship between living in an MUD and the average amount of energy a user charges from an EVgo DCFC per week. Similar to the model for charging sessions, living in an MUD significantly predicts more energy use (4.71 kWh) in an average week. Model one predicts that on average non-MUD residents obtain 10.65 kWh of charge from an EVgo charger per week while MUD residents on average charge 15.36 kWh.

Progressing to model two shows a pattern similar to the model on weekly session count in Table 3. This pattern carries the same implications that the significant coefficient on MUD resident in model one is carrying information on lack of home charging access.

However, model three diverges slightly from the same model predicting weekly session count. When holding the additional factors in this model constant, no home charging remains a significant predictor of additional energy demand. It is also notable that EV range is not significantly predictive of additional energy demand, which suggests that lower range EV drivers charge more frequently only because of their limited range.

Notably, unlike the weekly charging session model, the model with indicators for primary charge mode in the energy demand model also indicates a statistically significant relationship between weekly energy demand and lack of a home charger. The model suggests that users without home charging who don't primarily rely on DCFC

Table 4: Results of OLS model predicting weekly average user energy demand (kWh) at EVgo DCFC

	(1) kWh/wk	(2) kWh/wk	(3) kWh/wk	(4) kWh/wk
lives in MUD	**4.713**** **(1.440)**	1.099 (1.623)	0.590 (1.756)	-1.000 (1.726)
no home charger		**8.758***** **(1.823)**	**9.209***** **(1.870)**	**4.166*** **(1.950)**
no work charging		**3.526**** **(1.243)**	3.057* (1.242)	2.286 (1.336)
renter			0.276 (1.464)	-1.193 (1.436)
EV range (mi)			-0.001 (0.009)	0.002 (0.009)
owns ICE car(s)			-0.732 (1.443)	-0.006 (1.408)
drives for app service			**15.445***** **(2.325)**	**14.107***** **(2.268)**
primary: DCFC public				**14.111***** **(1.671)**
primary: l2 public				2.535 (2.343)
primary: at work				2.623 (1.978)
(constant)	**10.650***** **(0.680)**	**7.736***** **(1.067)**	**7.563***** **(2.236)**	**5.071*** **(2.264)**
N	1,291	1,291	1,265	1,265
adj r-squared	0.007	0.028	0.059	0.110

β (SE), p = *** < 0.001, ** < 0.01, * < 0.05

would obtain more energy at EVgo stations than those with home charging.

Session level energy demand

While the regressions on customer-level session and energy demand (frequency and intensity) evaluate differences in average use between MUD and non-MUD customers, they do not provide direct insight into relationships between residence type and charging at the session level.

In this analysis we also examine whether MUD customers differ from non-MUD users in how much energy they obtain on a per-session basis. The dependent variable is energy delivered in a session. Coefficients in the model indicate whether a regressor is associated with more, or less, charging in an individual session.

The reader should note that by modeling this relationship at the session level, we increase our sample size almost tenfold, which provides additional precision to identify statistically significant differences that might be smaller in magnitude than in the customer level model. This additional statistical power is immediately apparent in the regression results in Table 5, which show highly statistically significant coefficients on all variables except primarily charging at work.

MUD residency significantly predicts more energy delivered per session across all four sets of model regressors, indicating that MUD residents obtain more energy per session than non-MUD residents independent of any other variable included in the model. As with models at the customer level, the coefficient on MUD residency diminishes when information on home charging access is added to the model, though it increases slightly in the last two models compared to the charging access only model. In model one, living in an MUD is associated with 1.3 additional kWh of session energy demand. With all additional variables held constant in model four, that coefficient decreased to just over one half of a kWh.

Coefficients on no home charging and no work charging

Table 5: Results of OLS model predicting per-session energy demand (kWh) at EVgo DCFC

	(1) session kWh	(2) session kWh	(3) session kWh	(4) session kWh
lives in MUD	**1.288*** (0.068)**	**0.322*** (0.080)**	**0.589*** (0.078)**	**0.520*** (0.079)**
no home charger		**1.955*** (0.084)**	**1.470*** (0.081)**	**1.179*** (0.085)**
no work charging		**0.796*** (0.062)**	**0.445*** (0.058)**	**0.234*** (0.064)**
renter			**-0.327*** (0.067)**	**-0.437*** (0.067)**
EV range (mi)			**0.056*** (0.000)**	**0.056*** (0.000)**
owns ICE car(s)			**-0.627*** (0.064)**	**-0.567*** (0.064)**
drives for app service			**-1.306*** (0.075)**	**-1.407*** (0.075)**
primary: DCFC public				**0.905*** (0.068)**
primary: l2 public				**-0.590*** (0.109)**
primary: at work				-0.019 (0.096)
(constant)	**13.396*** (0.033)**	**12.675*** (0.054)**	**5.596*** (0.103)**	**5.527*** (0.110)**
N	71,100	71,100	69,944	69,944
adj r-squared	0.005	0.015	0.177	0.180

β (SE), p = *** < 0.001, ** < 0.01, * < 0.05

remain significant across models two through four. As with MUD residency, coefficients diminish in size as more regressors are added to the model. While the coefficients on MUD residency and charging access remain significant in the models with more regressors, this pattern suggests that those additional factors are mediating some of the magnitude of the coefficients in models one and two.

The inclusion of the additional variables in model three increases the predictive power of the overall model relative to models one and two (as measured by the adjusted r-squared metric). This means that those added variables explain a comparatively larger portion of the variation in per-session kWh usage than the variables in model two.

Among the coefficients on primary charging mode added in model four, both public DCFC and public L2 charging significantly predict variation in session energy demand. Holding other variables constant, users who charge primarily at DCFC obtain nearly one additional kWh per charge on average relative to those who do not charge primarily at a DCFC. Conversely, those who charge at a public L2 charger obtain half a kWh less charge on average.

This analysis reveals a somewhat surprising relationship between MUD residency and per-session energy demand that remains significant despite holding attributes such as charger availability and primary charging mode constant. The coefficient estimate is small (about half a kWh) but is very precise, indicating that something related to MUD residency other than the observed factors held constant in our model is associated with this particular charging behavior.

This analysis reveals a number of additional interesting statistical associations. First, those who primarily charge with public L2 chargers charge less per session than those using other primary charge modes. This is possibly because those users rely on DCFC primarily as an emergency backup to their typical charging mode and, because DCFC charging is typically more expensive than L2 charging, limit their DCFC sessions to the least amount of energy necessary. Second, for reasons that defy obvious explanations, being a renter is strongly associated with

Table 6: Results of OLS model predicting per-user average distance between home and charger

	(1) avg miles from home	(2) avg miles from home	(3) avg miles from home	(4) avg miles from home
lives in MUD	**-11.521*** (3.438)**	-5.884 (3.877)	-5.498 (4.079)	-2.583 (4.073)
no home charger		**-13.311** (4.347)**	**-15.949*** (4.289)**	-7.111 (4.547)
no work charging		2.142 (2.988)	2.160 (2.877)	1.051 (3.157)
renter			-3.194 (3.416)	-0.900 (3.404)
EV range (mi)			**0.205*** (0.021)**	**0.203*** (0.020)**
owns ICE car(s)			**-7.630* (3.306)**	**-8.412* (3.286)**
drives for app service			-6.849 (5.258)	-4.927 (5.210)
primary: DCFC public				**-20.584*** (3.898)**
primary: l2 public				**-13.752* (5.551)**
primary: at work				**-12.039** (4.631)**
(constant)	**41.409*** (1.622)**	**40.970*** (2.570)**	**15.724** (5.112)**	**21.706*** (5.259)**
N	1,173	1,173	1,149	1,149
adj r-squared	0.009	0.016	0.106	0.127

β (SE), p = *** < 0.001, ** < 0.01, * < 0.05

charging fewer kWh per session than a homeowner. As renters tend to have lower incomes than homeowners, users with rental housing tenure may seek to reduce fuel costs by avoiding unnecessary DCFC charging.

Spatial charging behavior

The primary intervention in the HPCP pilot is siting new charging stations in areas that have many MUD properties nearby. This intervention rests on the implicit assumption that MUD residents seek to charge at locations closer to their home to support daily travel needs. DCFC have historically been viewed as secondary charging options, best suited for destinations, regional attractions and on travel corridors. Intentionally siting stations near users' homes is a significant deviation from that planning paradigm.

In order to develop an understanding of MUDs charging behavior as it relates to proximity to residence, we take the distance[37] between a user's home and the chargers they use as a dependent variable and relate it to user attributes on a per-user and per-session basis. Due to missing data on the home locations of some users in the survey, this analysis is based on a smaller sample of user data.

For the per-user metric we compute the average distance between home and charger for all charging events during the data collection period. A negative coefficient on this metric indicates that a user charges closer to home on average and a positive one indicates charging further away on average. The same concept applies to the model on per-session distance metric, although that metric measures distance from home to charger on a session by session basis.

Model one in Table 6 shows the result of a univariate

[37] Distance from home is the computed network distance between the charger and the population weighted centroid of the user's census tract of residence. Census tract location was used to mask the exact address of the user in our dataset. The population weighted centroid of a census tract should be reasonably close to the user's actual address and should not significantly affect distance estimates for most charger-home pairs. However, estimates of distances between a user's home tract and very nearby chargers will be imprecise.

model that relates residency in an MUD with the average distance between charger and home for all charging events during the data collection period. The coefficient of MUD residency in this simple model predicts that MUD residents' average charging distance is 11.52 miles shorter than residents of non-MUDs.

As with models of session count and session energy, when charging access attributes are added as regressors in model two the coefficient on MUD resident diminishes relative to the univariate model and is not statistically significant. Again, because no home charging in that model is a significant predictor of closer average charge distance, we infer that the coefficient on MUD resident in model one is mostly carrying information about lack of home charging. Moving to model three, a similar dynamic to prior models plays out with the coefficient on no home charging increasing slightly in quantity and precision. The coefficient on EV range is positive and significant, probably accounted for by long-range EVs enabling long-distance trips. Owners of gasoline cars tend to charge closer to home on average, in this case probably because those with access to gasoline vehicles tend to use them on longer distance trips. As with previous models, when these non-charging attributes are accounted for, the overall predictive power of the model increases significantly.

When regressors for primary charging mode are added into the model, a similar pattern to prior analyses again shows up with no home charging not statistically significant, but primary DCFC public charging showing up as highly significant with a large (20.58 miles closer on average) coefficient. In this model, the other two away from home primary charging mode indicators, workplace and L2 public, also are associated with a shorter average distance from charger. However, both coefficients are less statistically significant than that of DCFC primary charging.

The final model we present in this analysis analyzes the relationship between distance from home and user attributes across each session with a valid distance metric in the dataset. Unlike the previous model, which implicitly weights the charging event distance of each user as equal, even if one user charges more than another, this model identifies the raw relationship between a session user's attributes and how far that session occurred from the user's home. Because the number of observations for this model is effectively 40 times larger than the previous model where the unit of analysis was an individual user, it has significantly more power to identify smaller distinctions with more statistical precision.

The regression results in Table 7 are less straightforward than previous models in this analysis. In the first two models, the pattern seen in previous models asserts itself again, with MUD resident strongly predicting closer to home charging sessions relative to non-MUD sessions. Model two again shows MUD resident as insignificant while lack of charging availability at home is a strong predictor that a charging session will occur closer to a user's home.

However, in model three, once additional user characteristics are accounted for, the coefficient on MUD resident is once again statistically significant. While not shown in Table 7, we conducted individual runs of the model where each additional attribute in model three is added to the model individually. From that exercise, we find that the attributes renter and owns ICE cars both contribute to the model finding a significant association between distance from home and MUD resident.

In model four, the coefficient on MUD resident returns to statistical insignificance. The coefficient on no home charging is diminished but is still statistically significant, even when holding stated primary charging mode constant. Each primary charging mode indicator coefficient is statistically significant, and all are related to shorter distances between home and charging location on a per-session basis.

The coefficient on renter in both model three and four is statistically significant and positive, suggesting that renters travel farther (8–11 miles depending on the model) to obtain a charge on average than non-renters. While it is impossible to determine exactly why this may be the case, a likely explanation is that, on average, renters live farther away from DCFC than non-renters. This explanation is consistent with the observation that holding ownership status — which is significantly correlated with living in an MUD — constant increases the precision and coefficient estimate on living in an MUD.

Key takeaways and implications for HPCP program

The key takeaway of the analyses in this chapter is that MUD resident preferences and DCFC behavior generally align with the intuition underlying the HPCP pilot program. Nearly half of MUD resident EVgo customers report that DCFC are their primary charging mode. This aligns with session data analysis showing that MUD residents charge more frequently and obtain more charge at EVgo stations than non-MUD residents. While user-stated reliance on DCFC is the strongest predictor of higher DCFC usage, lack of home charging is independently related to an increase in energy demand from DCFC. This suggests that even those users who have a reliable non-home charging option rely on DCFC more so than those who have home charging.

Table 7: Results of OLS model regressing per-session distance from home on MUD residency

	(1) miles from home	(2) miles from home	(3) miles from home	(4) miles from home
lives in MUD	-6.294*** (0.540)	-0.499 (0.628)	-3.584*** (0.669)	-0.939 (0.667)
no home charger		-11.539*** (0.650)	-15.894*** (0.657)	-9.747*** (0.689)
no work charging		2.981*** (0.480)	0.255 (0.482)	3.634*** (0.526)
renter			8.458*** (0.555)	11.661*** (0.557)
EV range (mi)			0.189*** (0.004)	0.183*** (0.004)
owns ICE car(s)			-1.893*** (0.524)	-3.946*** (0.521)
drives for app service			-1.088 (0.669)	0.285 (0.662)
primary: DCFC public				-19.783*** (0.581)
primary: l2 public				-14.878*** (0.872)
primary: at work				-4.110*** (0.769)
(constant)	26.144*** (0.259)	25.242*** (0.417)	-0.463 (0.853)	5.071*** (0.906)
N	48,168	48,168	47,666	47,666
adj r-squared	0.003	0.010	0.054	0.078

β (SE), p = *** < 0.001, ** < 0.01 * < 0.05

MUD residents are significantly more likely to desire charging stations nearer to their homes than non-MUD residents. This stated preference by users is backed up by analysis of user session data that reveals a significant statistical association between MUD residency and closer to home charging, both on a per-user and by-session basis. Moreover, while this relationship seems to be driven largely by users who primarily use DCFC to charge, when analyzing individual sessions, the lack of access to home charging independently predicts shorter distances between home and charger, suggesting that those who have other reliable charging options still tend to charge closer to home than those who have no home charging access.

Overall, MUD residents are more likely to rely on DCFC as their primary charging mode, shown both by their survey responses and demonstrated by higher DCFC use. This pattern suggests that MUD-focused charging stations can play an important role in supporting BEV adoption in MUD-dense neighborhoods. MUD residents are also more likely to rank near home charging options as more important and, on average, charge closer to home than their non-MUD resident counterparts. This demonstrates that developing charging stations closer to MUD residences is a sound strategy to target the MUD customer segment.

Although we found no difference between preferences for more or faster chargers, those attributes were widely popular among residents of all housing types. Moreover, because MUD residents charge more than their non-MUD counterparts, more and faster charging stations could become key congestion mitigation mechanisms as EV adoption grows.

These observed differences in behavior between MUD residents and non-MUD residents appear to be most consistently influenced by MUD residents' common lack of access to home charging and reliance on non-home charging modes. When comparing behavior on a per-usage basis and holding charging access constant, we do not find any differences between MUD and non-MUD residents, suggesting that MUD residents who do have home charging behave similarly to non-MUD residents who have home charging and vice versa. This is consistent with the intuitive reasoning that targeting MUD residents with more convenient fast charging is important specifically because MUD residents often lack home charging.

Chapter 4. High Power Charging Plaza pilot evaluation

The *High Power Charging Plaza* (HPCP) program consists of 20 urban DCFC installations (shown on the map in Figure 9) intended to serve the public charging needs of multi-unit dwelling (MUD) residents. The program is governed by a settlement agreement between the California Public Utilities Commission and NRG, EVgo's former parent company. The reader should note that the commissioning of this report evaluating the HPCP program is a stipulation of the settlement agreement.

As stipulated in the settlement agreement, HPCP program sites must contain at least three DCFC that support both CHAdeMO and SAE charging standards.[38] In addition, program parameters also require charging equipment to be capable of delivering at least 50kW of service. EVgo's initial program plan envisioned that most sites would have chargers with higher power (80kW or 150kW). However, practical constraints limited the deployment of those higher power chargers to a small number of sites.

Figure 9: Map of HPCP locations

[38] CHAdeMO and SAE are the leading non-Tesla charging standards. Support for those two plugs ensure compatibility with a wide array of vehicles.

Table 8: Individual HPCP location summaries

Whole Foods San Jose	The Whole Foods San Jose HPCP is near Downtown San Jose. It has four DCFC stations and is sited in a grocery store parking lot. The location is directly adjacent to a number of midrise multifamily buildings and is also in proximity to many single-family homes.
Southside Park	The Southside Park is just south of Downtown Sacramento near Highway 50. It has six DCFC stations and is sited curbside adjacent to a city park. The immediate surrounding neighborhood is mixed, with mostly single-family homes and low-density multifamily buildings.
Union 76	The Union 76 HPCP is just off the 101 freeway in the Valley Village neighborhood of Los Angeles. It has four DCFC stations and is sited in a gas station. The location is directly adjacent to a neighborhood of medium-density multifamily buildings.
Foster City PD	The Foster City PD HPCP is in central Foster City. It has four DCFC stations and is sited in a civic complex that includes a library and community center. The location is surrounded by a combination of commercial buildings and medium-density multifamily housing.
Whole Foods Mill Valley	The Whole Foods Mill Valley HPCP is west of Central Mill Valley. It has three DCFC stations and is located in a grocery store parking lot. A small number of multifamily complexes are nearby; however, the area is mostly dominated by single-family home neighborhoods.
Broadway Millbrae	The Broadway Millbrae HPCP is in central Millbrae. It has three DCFC stations and is located in a city-owned parking lot. The HPCP is located in a predominantly commercial/retail area, and nearby housing is mostly single-family homes.
CIM La Brea	The CIM La Brea HPCP is in the Mid-Wilshire neighborhood of Los Angeles. It has three DCFC stations and is sited in a small retail complex. The surrounding neighborhood is a mix of medium-density multi-family housing and single-family homes.
Chevron Los Angeles	The Chevron Los Angeles HPCP is in the Westwood neighborhood of Los Angeles. It has four DCFC stations and is sited in a gas station. The surrounding area is mostly commercial buildings and multifamily homes.

The agreement also laid out these parameters for siting and distributing charging stations:

1. Located in public use microdata areas (PUMAs) with an above-median percentage of residents living in MUDs
2. Distributed across California in both Northern and Southern California
3. Easily accessible, accessible to the public for much of day, proximity to MUD residences or where MUD residents frequently visit.
4. Twenty percent of the stations must be located in PUMAs where median incomes are in the lowest third compared to their region or the state.

Figure 9 shows the geographic distribution of HPCP locations across California. There are two major concentrations of HPCP in Los Angeles and the San Francisco Bay Area. Three additional sites are in San Diego and one is in Sacramento.

The reader should note that as long as the specified conditions were met, these siting parameters left EVgo with significant latitude to place the stations using the business indicators that they would normally employ for siting stations. In other words, EVgo did not install HPCPs in random places that met the program criteria but in locations where its experience had shown that DCFC generally do well. EVgo's internal site selection methods are proprietary and competitive information. However, it is likely that they incorporate information on the number of EV registered in an area, as well as other metrics that positively predict EV traffic and charging demand.

HPCP individual evaluation locations

In addition to the core quantitative analysis presented in this chapter, we also have produced quantitative and qualitative assessments for the eight stations that have accrued more than 2,000 user sessions during the study period. Those assessments can be found in Appendix C. Table 8 includes a short summary about each station in the individual evaluation group.

Evaluation framework

A typical evaluative framework is built around a program logic model that consists of inputs, activities, outputs and outcomes. Inputs are any resources brought to bear in the program; activities are the program interventions themselves; outputs are the direct products of the intervention; and outcomes are the expected changes (often separated into short or long term) caused by the program.

Table 9 shows a simple logic model of the HPCP program. Inputs are straightforward, including only EVgo's investments in developing the HPCP sites. Activities are the interventions of the DCFC program. Of the interventions, only siting chargers in MUD areas and number of charging stations are fully evaluable because they are the only ones that are consistently applied across all HPCP pilot locations and limited data availability prohibits individual evaluation.

Both faster chargers and lower-income areas interventions were implemented only in a small number of HPCP installations and thus do not provide enough information for a useful comparison. Furthermore, although the settlement agreement stipulates additional siting criteria (like proximity to MUD user destinations), these interventions are not applied systematically enough to be well suited for evaluation.

The concrete output of each HPCP are the charges they deliver and the customers they serve. Outcomes are less straightforward to assess as, ideally, they require linking an outcome or impact (such as better serving MUD residents) to program interventions in a causal manner. Causal inference requires an experimental design in which treatments are assigned randomly and data are collected not just for those that are treated (get a HPCP) but those that are untreated (do not get a HPCP). The HPCP program design was not set up to enable this analysis. Moreover, the timeline of the study is too short to adequately measure long-term impacts.

Core evaluative analyses

Given this limitation, our evaluation focuses on the outputs and how they might relate to the two most important interventions. To better understand the role of HPCPs in serving MUD residents, we conducted two separate analyses.

The first analysis is a comparison of program outputs to comparable outputs from EVgo's non-HPCP sites. This comparison can be thought of like an A/B test, where we compare two variants of DCFC development — the first which is governed by the parameters outlined by the HPCP program and the second which follows EVgo's typical development process. Specifically, we compare the performance of HPCP chargers to a selection of 50 charging locations that were not explicitly subject to the HPCP interventions on site selection, distribution and attributes. Those 50 non-HPCP locations are selected randomly to represent EVgo's average DCFC location in California.

For the comparison, we use the following two separate, but related metrics:

- **MUD session share —** This metric is the fraction of a site's total hosted sessions that were initiated by an MUD resident. In other words, it is the number of MUD resident sessions divided by the number of total sessions. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.
- **MUD user share —** This metric is the fraction of a site's total unique users who are identified as MUD residents. In other words, it is the number of MUD users divided by the total number of users. A higher user share indicates relatively more MUD users use that station and a lower share indicates relatively fewer MUD users use that station.

The MUD session share metric tells us about absolute usage and thus would be higher if: a) there are more MUD users using the location but at a similar rate as non-MUD users, b) there are fewer MUD users using the location but at a higher rate as non-MUD users, or something in between.

The MUD user share metric provides information only on how many MUD residents have used the charger relative to non-MUD residents. We interpret a higher share on either metric as indicative that a charger is better serving MUD residents than a charger with a lower share.

These metrics are focused on relative MUD resident session and user performance to control for absolute differences in session activity between DCFC locations. This in an important consideration when many of the HPCP stations have been operational for only a short time and therefore might have fewer absolute MUD customers or sessions than non-HPCP sites simply because they have been open for less time.

Our second analysis analyzes differences between those users who have or have not used an HPCP. We compare the survey responses of users across three categories:

- **HPCP users —** Survey respondents who have charged at an HPCP location.
- **Non-HPCP users —** Survey respondents who have charged at one of the 50 comparison non-HPCP locations, but have not charged at an HCPC location.

- **HPCP-adjacent nonusers —** Survey respondents who live within three-quarters of a mile from a HPCP but have not used that HPCP station.

This analysis allows us to compare the user base of HPCP and non-HPCP users across additional metrics, such as whether they have access to charging at home and whether they primarily charge at DCFC. If, for example, the average HPCP user is more likely to be an MUD resident than a non-HPCP user, we interpret that as further evidence that HPCP are better serving MUD residents than non-HPCP.

MUD classification

The MUD customer share evaluation relies on being able to determine an MUD resident from a non-MUD resident. Because we do not have survey responses from all users at HPCP and non-HPCP sites, we used information contained in user account addresses (specifically the presence of a unit identifier) to classify users as MUD or non-MUD residents.

When tested against the information about housing type provided by survey respondents, we find that the classifier has a high degree of specificity (ratio of true positives to false positives), which means very few non-MUD residents are misclassified as MUD. However, the method is not highly sensitive, meaning that many MUD residents get falsely identified as non-MUD residents.

This measurement error will cause us to systematically underestimate MUD counts at individual stations. However, because we have no reason to believe that this measurement error is related at all to the differences between HPCP and control stations, the metric remains useful to compare between stations. Relatively speaking, a higher portion of identified MUD users should mean a higher number of true MUD users (and vice versa) for any given station.

HPCP customer comparison

Figure 10 shows the proportional and absolute share of MUD sessions at each HPCP. Stations that have been open longer naturally have accrued more uses than those in operation for a shorter period, particularly because the last seven months depicted in the figure occurred during an unprecedented period of reduced vehicle travel.

Comparing HPCP and non-HPCP sites

To test whether HPCP stations are better targeting MUD customers than a typical EVgo station, we compare the mean share of MUD user sessions and users at HPCP stations against the 50 non-HPCP comparison EVgo sites not specifically sited to serve MUD residents.

Table 9: HPCP Program Logic Model

Inputs	EVgo's investment of resources and staff time to select, plan and develop HPCP sites
Activities (interventions)	Build DCFC charging locations: ○ in an MUD-dense area ○ with three or more chargers ○ with some stations having faster chargers † ○ with some stations in lower-income areas† ○ using other siting criteria†
Outputs	HPCP utilization: ○ number of customers served ○ share of MUD customers ○ share of customers who live in MUD ○ Number of frequent users
Outcomes (short term)	Better serve EVgo's existing MUD resident users
Outcomes (long term)	Meet the charging needs of MUD residents served by HPCP and enable more EV adoption

†excluded from evaluation

Figure 11 shows the distribution of MUD session and user share for HPCP and non-HPCP chargers. Both metrics vary significantly within categories. There is overlap between stations in the HPCP users and the non-HPCP users, with some comparison group stations outperforming some HPCP stations. However, the two distributions appear to be meaningfully different from each other on average. The median HPCP location receives approximately the same MUD session share as the 75th percentile comparison station. The median non-HPCP station receives approximately the same MUD user share as the 25th percentile HPCP charger.

That some of the non-HPCP locations outperform some of the HPCP stations is to be expected as the determinants of those metrics are likely to be the result of a more complex set of factors than those targeted by the HPCP program interventions. Moreover, a sizable portion of the comparison group meets the HPCP siting criteria, though not specifically by intent of serving more MUD residents. The important question in determining the efficacy of the HPCP interventions is whether the HPCP locations outperformed the non-HPCP sites on average.

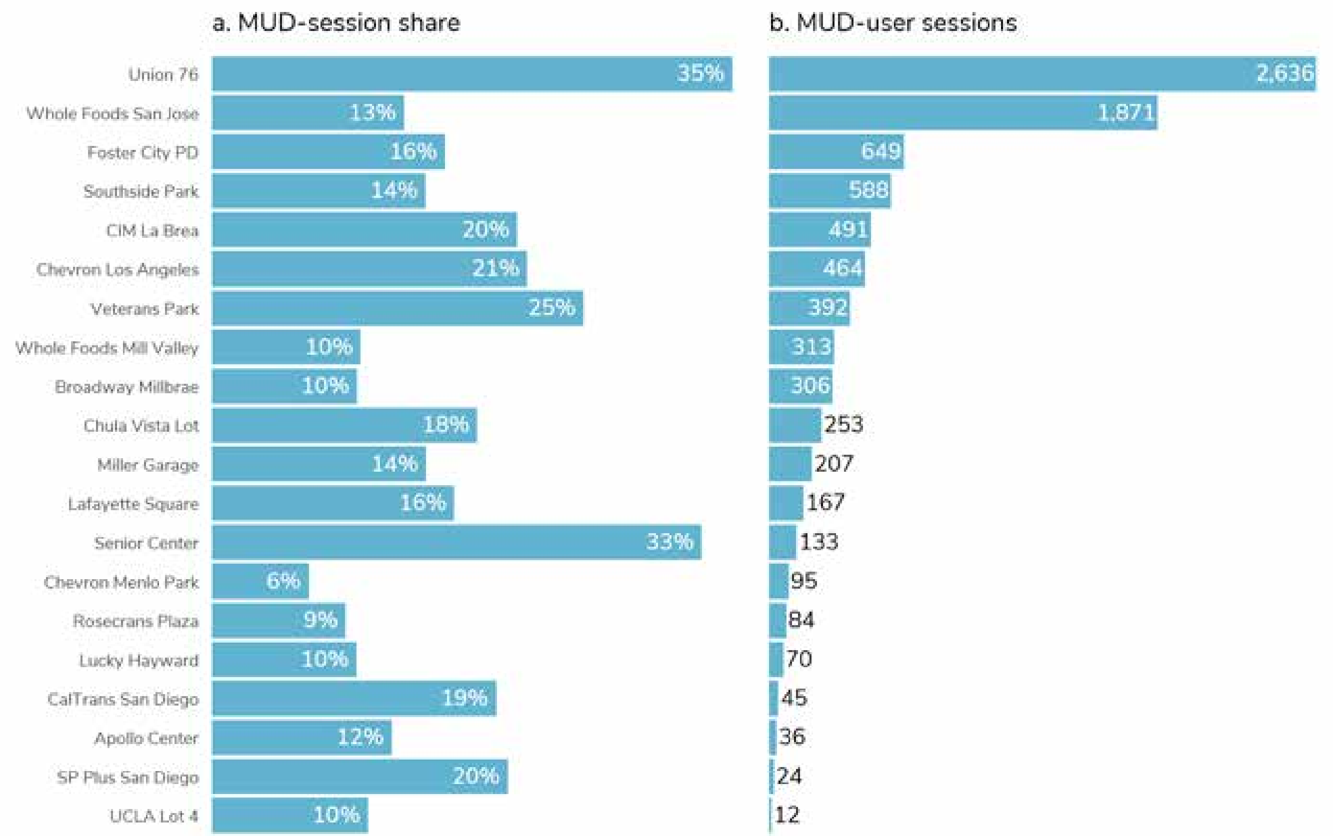


Figure 10: Identified MUD-user sessions and share of sessions by HPCP location

To assess whether HPCP locations outperform comparison stations on average we employ a statistical test called a Welch's two-sample t-test. This test is used to test the null hypothesis that the two populations (HPCP and non-HPCP) have equal means.

By rejecting the null hypothesis, we can assume that the differences between the two populations of locations are statistically significant or, in other words: unlikely to be the product of chance.

Table 10 shows the results of the statistical test for both metrics. In both cases the difference in means is statistically significant (p value < 0.05), meaning that in both cases we reject the null hypothesis that the means are equal. On average, HPCP's identified-MUD session share is 4.1 points greater than non-HPCP sites and shares of MUD identified-users are 4.3 points greater. That difference represents a relative difference in means of 33% in MUD session share and 29% in MUD user share.

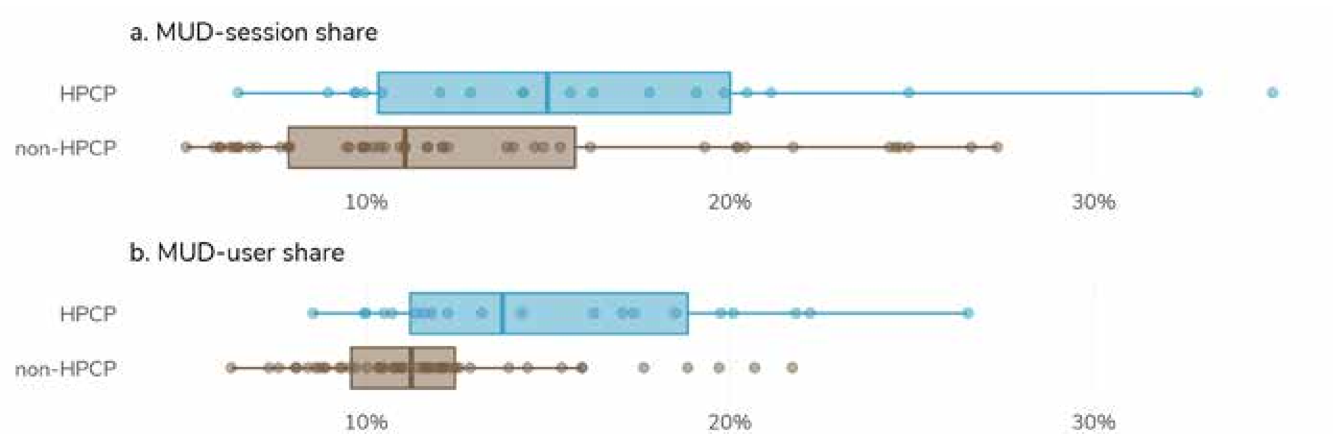


Figure 11: Box plot showing the distribution of MUD session share (a) and user share (b) across HPCP and non-HPCP locations

Table 10: Results of Welch's t-test results comparing outcome means

metric	HPCP mean	non-HPCP mean	t-stat	p-value
session share	16.5%	12.4%	2.130	**0.041***
user share	15.1%	11.8%	2.763	**0.010***

The reader should note that the raw estimates and differences in means we find are likely smaller than the true measurements because of the downward bias introduced by measurement error. Regardless, we find a modest but appreciable difference in both MUD session and user share between HPCP and non-HPCP charging locations. This finding is suggestive that the interventions employed in the HPCP program have been successful in creating stations that on average attract a higher share of MUD resident users and MUD user sessions than EVgo's typical DCFC location.

Drivers of MUD share metrics

The HPCP pilot program consistently employs two interventions: geographic proximity to MUD- dense areas and more DCFC per site. While the comparison between HPCP and comparison sites is convincing evidence that the interventions are effective, it does not provide any information about the individual contributions of the two interventions.

The siting intervention employed the HPCP program is based on a binary criterion of having an above-median number of MUD residents within a PUMA. However, the underlying assumption is that DCFC in PUMAs with higher densities of MUD residents are better positioned to serve MUD residents than those with fewer MUD residents. Similarly, the requirement that a HPCP have a minimum number of DCFC implies that sites with more DCFC are better suited to serve MUD residents than sites with fewer DCFC.

We test those underlying assumptions by running an OLS regression with MUD session share as the dependent variable and HPCP station, MUD units in PUMA and number of DCFC at charging location as regressors. The results of these regressions are shown in Table 11.

Consistent with the earlier reported t-test, HPCP location positively and significantly predicts an average of four points of additional MUD session share in model one. When a regressor for the number of MUD units within the station's PUMA are added to the regression equation in model two, whether or not the station is a HPCP is not a significant predictor of user share, while MUD units in PUMA is a very significant predictor.

This suggests that the HPCP location coefficient in model one is primarily driven by the information it conveys about MUD residents in the PUMA. Models three and four reinforce that finding by showing that the number of DCFC has no measurable association with MUD resident share. Although not presented in the table, we ran the models with the same regressors where MUD user share was dependent variable and found the same patterns of significance and insignificance.

The reader should note that there is much less variation in number of DCFC across the dataset, and so the lack of statistical significance for the coefficient on the number of DCFC might be a result of low statistical power. Furthermore, because of the measurement error in the MUD classifier, each of these coefficients are likely biased downward, meaning that the association between MUD session metrics and the regressors is probably stronger than shown in our analysis.

Refinement of siting criteria

In the analysis of session data presented in Chapter 3, we noted that MUD residents tend to charge significantly closer to home than non-MUD users. PUMAs typically cover a relatively large geographic area, which leads us to suspect that a more geographically precise targeting criteria might perform better than the PUMA-based metric used in the HPCP program.

To test that theory, we compare the predictive power of PUMA-level MUD counts against a series of travel sheds centered on each station. A travel shed is defined as the area around a destination that can be reached within a certain travel time on a travel network. In this case the travel sheds we examine are the area around the charging location that can be reached within 5, 7 or 10 minutes of driving.

Because travel sheds roughly approximate a circle, the area covered by a 10-minute travel time will be approximately four times larger than the 5-minute travel shed. The regression results in Table 12 show a series of models that regress MUD user share on the number of MUDs within a 5-, 7- or 10-minute travel shed of the charger site and within the charger's PUMA.

The regression results show that the number of MUD units within a 5-minute travel radius (model 1) predicts 33% more MUD session share than the PUMA-level MUD unit count (model four). The coefficient on 7-minute travel time (model two) is about equivalent to the PUMA estimate, and the 10-minute travel time coefficient is smaller than the PUMA-level estimate.

In most cases, a 7-minute travel time covers approximate-

Table 11: Regression of MUD session share on proximate MUD units and number of DCFC

	(1) MUD session share	(2) MUD session share	(3) MUD session share	(4) MUD session share
HPCP location	0.041* (0.018)	0.020 (0.017)	0.061* (0.028)	0.049 (0.025)
1,000 MUD units in PUMA		0.002*** (0.000)		0.002*** (0.000)
number of DCFC at location			-0.008 (0.008)	-0.012 (0.007)
(constant)	0.124*** (0.010)	0.085*** (0.013)	0.139*** (0.019)	0.105*** (0.018)
N	70	70	70	70
adj. r-squared	0.057	0.241	0.055	0.258

β (SE), p = *** < 0.001, ** < 0.01, * < 0.05

ly the same area as a PUMA and the 10-minute travel shed exceeds the size of a PUMA. For each increment in travel time, the coefficient reduces by about one-third while remaining statistically significant. This result suggests that more systematic targeting of MUD-dense areas at sub-PUMA geographies might yield charging locations that exceed the performance of the average HPCP location on the MUD share metric.

Survey response evaluation

This analysis departs from the site-by-site comparison of user and session share to compare the attributes of HPCP users versus non-HPCP users. It is meant to complement the prior analysis of site-specific MUD user and session share by comparing the profiles of: HPCP users, users of the 50 non-HPCP stations (non-HPCP users), and those users who live nearby HPCPs but have yet to use them (HPCP-adjacent nonusers).

HCPC user surveys are reasonably representative of the different HPCP locations. Each HPCP site is represented by between four and 88 users in the survey, with older, more heavily trafficked, locations having more representation and newer, lightly trafficked, locations less.

As in the previous analysis, we interpret the non-HPCP users as closely representing the *average* non-HPCP

Table 12: Regression results of MUD usage fraction travel sheds and PUMA

	(1) MUD session share	(2) MUD session share	(3) MUD session share	(4) MUD session share
1,000 units within 5 minutes	0.003*** (0.001)			
1,000 units within 7 minutes		0.002*** (0.000)		
1,000 units within 10 minutes			0.001*** (0.000)	
1,000 MUD units in PUMA				0.002*** (0.000)
(constant)	0.118*** (0.009)	0.110*** (0.010)	0.103*** (0.011)	0.087*** (0.013)
N	70	70	70	70
adj r-squared	0.163	0.203	0.213	0.236

(SE), p = *** < 0.001, ** < 0.01, * < 0.05

EVgo user. Surveys were sent to a random subset of the users who have used a comparison non-HPCP site and thus should be approximately representative of non-HPCP users.

The third group (HPCP-adjacent nonuser) live within three-quarters of a mile of the HPCP but have not used them. These EVgo customers have been targeted by the HPCP intervention but have not taken advantage of their new charging option. Surveys of this group allow us to identify whether systematic differences might exist between HPCP users and this group, giving us additional clues as to how the HPCP program has performed.

To identify statistically significant associations between two categorical variables (such as comparison group and home type), we employ the Pearson's Chi-squared statistical test. This method tests a null hypothesis of whether the values of the two variables being compared are statistically independent from each other. If the two variables are independent, we would assume that any observed differences in frequency might simply be a result of noise in our sample of users. On the other hand, if we reject the null hypothesis, we expect that the values of each variable are conditional upon each other and thus indicate a statistically significant relationship between the variables in our population.

Table 13 shows the housing types frequencies of each comparison group. The Chi-squared test p-value indicates a very significant relationship between these two variables.

When comparing HPCP users with non-HPCP users, we see that HPCP users has a higher proportion of users living in condo or apartment buildings and a smaller portion of users who live in single-family homes. This finding supports the findings of the earlier analysis that HPCP locations are attracting more MUD resident users than the non-HPCP locations.

The customers in the HPCP-adjacent nonuser group have a very similar distribution of housing types. When holding non-HPCP user respondents out of the Pearson's Chi-squared test, we are not able to reject the null hypothesis that there is no relationship between housing type and the HPCP users and HPCP-adjacent nonuser.

Table 14 shows the cross tabulation of the survey groups and reported home charging access. The Chi-squared test p-value is just slightly larger than the under-0.05 value that is typically used as the threshold for determining statistical significance. However, it is low enough to be suggestive of a relationship between the variables. Moreover, when we hold HPCP-adjacent nonuser out of the Chi-Squared test we find that home charging access is statistically related to whether a user is in the HPCP or non-HPCP user group (p-value = 0.016). On the other hand, we find no such relationship between HPCP and HPCP-adjacent nonuser.

HPCP users reports having no home charging with greater frequency than non-HPCP users. This tracks with the findings in Table 13 and correlational analysis presented in Chapter 3 that shows that MUD residents are more likely to not have home charging.

While we do not find a statistical relationship between the HPCP users and HPCP-adjacent nonuser, it is notable that the portion that reports not having charging at home in that group is slightly lower than the HPCP users. If that finding is measuring a real difference between the groups, it could partially account for why some users in the HPCP-adjacent nonuser group have not used the nearby HPCP even though they live in similar housing types as the HPCP users.

The last comparison we make between users in the different survey groups is between their self-reported primary charging modes. The Chi-squared test shows a very statistically significant association between where users primarily charge and to which comparison group they belong.

HPCP users reported using public DCFC as their primary charging location more frequently than users in the two other groups. This suggests that HPCP locations are not only reaching targeted MUD users but also are especially useful to users who most rely on DCFC to fuel their vehicles.

Interestingly, HPCP-adjacent nonusers reported relying on DCFC the least among the three groups. Moreover,

Table 13: Cross tabulation of survey groups and housing type

	apt/condo	other MUD	SFR	townhome/duplex	total
HPCP users	129 (28%)	10 (2.2%)	270 (59%)	51 (11%)	**460**
non-HPCP users	147 (19%)	18 (2.3%)	547 (70%)	75 (10%)	**787**
HPCP-adjacent nonusers	63 (28%)	11 (5%)	127 (57%)	22 (10%)	**223**
total	**339**	**39**	**944**	**148**	**1,470**

Pearson's Chi-squared: 27, df = 6, p = 0.00012

Table 14: Cross tabulation of survey groups and home charging access

	no charging	L2 charging	shared charging	L1 charging	total
HPCP users	95 (21%)	208 (45%)	9 (2%)	148 (32%)	460
non-HPCP users	110 (14%)	389 (49%)	11 (1%)	277 (35%)	787
HPCP-adjacent nonusers	40 (18%)	99 (44%)	6 (3%)	78 (35%)	223
total	**245**	**696**	**26**	**503**	**1,470**

Pearson's Chi-squared: 12, df = 6, p = 0.058

those respondents also reported the most reliance on other non-home charging options. This is another potentially explanatory factor for why some HPCP-adjacent nonuser customers have not charged at a HPCP location despite being similar to the HPCP users on the types of homes they live in. If those users who live in MUDs and do not have home charging normally rely on other non-home charging options, then the HPCP that is nearby may not be especially useful to them.

It is unclear why the 15% of respondents in HPCP-adjacent nonuser that rely on DCFC as their primary charging solution have not used their nearest HPCP location. However, possible explanations might include preference for charging near a common destination further from home or availability of DCFC from another network provider nearby. The explanation might simply be lack of awareness of the HPCP location, many of which have not been in operation for a long time.

Pilot period usage outcomes

We have found compelling evidence that HPCP locations show a modest but appreciable advantage in serving MUD residents compared to comparison stations. While that comparison is important to demonstrate the efficacy of the HPCP intervention, this evaluation is incomplete without an accounting of raw outcomes in terms of EV drivers served and the social benefits of the HPCP station.

Over the short course of data collection for this evaluation from January 2019 to September 2020, HPCPs delivered 725,000 kWh of energy across 51,000 sessions to the users included in this study. That is enough to power approximately 2.75 million miles[39] of travel. Had the travel supported by HPCPs been completed in an average 25 mpg gasoline vehicle it would have required 110,000 gallons of gasoline and would have emitted additional 960 metric tons of CO_2.[40]

Of that total energy delivery, we have identified that at least 133,000 kWh were used by MUD customers, enabling them to travel approximately half a million miles. Because our identification method undercounts MUD residents, true MUD customer use has almost certainly been higher.

During the data collection period, HPCP stations served 6,798 unique individual account users. At least 912 of those users are identified as MUD residents. Across the 20 pilot locations, 243 users (39 of which are identified MUD residents) use a single HPCP to obtain one or more charges per week, a frequency we assume is sufficient to cover the bulk of most users' charging needs.

An additional 478 users (72 of which are identified MUD users) use a single HPCP more than two times a month, and 798 (133 MUD) users use an HPCP at least once a month, frequencies that would suggest that those locations are a key component of those users' overall charging patterns. The reader should note that the final seven months of data collection occurred during a period of unprecedented reductions in travel due to the COVID-19

Table 15: Cross tabulation of survey groups and primary charge mode

	public DCFC	public L2	home	workplace	total
HPCP users	131 (29%)	47 (10%)	214 (47%)	63 (14%)	455
non-HPCP users	151 (19%)	45 (6%)	471 (60%)	110 (14%)	777
HPCP-adjacent nonusers	34 (15%)	33 (15%)	117 (53%)	35 (16%)	219
total	316	125	802	208	1,451

Pearson's Chi-squared: 12, df = 6, p = 0.058

[39] On EVs with an average efficiency of 3.66 miles per kWh.

[40] Figure based on 0.022 kg/kWh California grid average electricity emissions factor and 8.89kg/gallon emissions factor for gasoline.

Figure 12: Number of frequent users at HPCP stations

pandemic. Because of reduced travel, the frequent user metric may not be capturing as many HPCP-dependent users as it would during a time of normal travel behavior.

Key takeaways

During the study period of this evaluation, the HPCP program has shown itself to be successfully providing improved services to the MUD resident customer segment. We find that HPCP locations are, on average, attracting a larger share of MUD resident customer and sessions than EVgo's typical locations, suggesting that the parameters under which EVgo developed the HPCP locations are more effective at targeting MUD resident users than their typical approach.

Specifically, we find strong evidence that the parameters of the HPCP site development are the driving factor in securing more MUD resident use. Furthermore, we find that a more precise siting method could yield even better results. We do not find evidence that more DCFC stations per site is associated with more MUD resident use.

Chapter 5. Conclusion

California's transition to electrified transportation faces a speed bump if residents in MUDs are resistant to EV adoption because they lack access to charging infrastructure. However, the success of the HPCP pilot program has demonstrated that MUD-resident-focused DCFC locations may be a solution that can help increase EV adoption among those users.

The HPCP program was designed to provide DCFC charging options that better serve MUD residents. On the basis of the share of their customers who live in an MUD, the HPCP sites did just that, outperforming the comparison EVgo stations on both share of total customers who live in an MUD and share of total sessions served to MUD residents. On these metrics, the average HCPC stations served 29% more MUD resident customers and had 33% more MUD sessions than non-HPCP stations.

In addition, compared to users of non-HPCP comparison DCFC sites, HPCP users more frequently report living in an MUD, not having home charging, and using DCFC as their primary charging mode. With the MUD user and session share metrics, these results show that HPCP sites are, on average, performing better among EVgo's MUD resident customers than non-program stations.

We find that the crucial intervention of the HPCP program is that locations were selected in areas with high concentrations of MUD residents. However, a geographic selection criterion that is narrower than what was employed in the pilot program might produce better results. We do not find evidence that sites with more individual DCFC stations are more successful at attracting MUD resident customers, nor do MUD residents appear to differ from non-MUD residents in their preferences for more chargers at a given site.

MUD resident charging behavior

In our analysis of EVgo's MUD resident users' behavior, we that many MUD residents without access to home charging are already finding DCFC to be a suitable primary charging solution, enabling them to choose to drive electric vehicles. MUD resident EV owners charge more frequently and obtain more charge at DCFC than their non-MUD resident counterparts and are more likely to identify DCFC as their primary charging mode. They are also more likely to prefer DCFC locations that are closer to their home. On average, MUD residents choose to charge closer to home than those who do not live in MUDs.

Takeaways for DCFC deployment and planning

EVgo and other charging network providers should note that MUD residents who drive EVs are, on average, heavier users of DCFC than non-MUD residents. Catering to those customers could become a revenue driver for DCFC providers. There is a strong business case for DCFC providers to unlock the MUD resident market. Developing a large base of customers who are reliant on DCFC to meet their charging needs could prove to be a key pathway toward revenue growth.

Infrastructure planners should also note MUD users' stronger preferences for DCFC locations near home. In addition to the locations most commonly associated with targeted DCFC deployments, such as regional attractors, MUD-dense neighborhoods should be considered potentially important locations for DCFC expansion.

Future research

This analysis has shown some evidence that MUD-focused stations can better serve existing MUD resident EV drivers, particularly those without home charging. While that suggests that DCFC access can be an enabling factor for MUD resident EV adoption, it does not provide conclusive evidence that the expansion of such stations will necessarily lead to more adoption of EVs.

It appears that among EVgo's customers, the MUD resident early adopters of EVs are much more likely to have access to home charging than the typical MUD resident. However, examples of EV adopters who don't have home charging were not uncommon among our survey respondents. Future research should focus on developing a better understanding of the circumstances under which an MUD resident who doesn't have home charging chooses to purchase an EV. Such information could enhance efforts to develop interventions that increase adoption among MUD residents who face persistent barriers to charging at home.

Future study should also focus on identifying whether MUD-focused DCFC installations have a causal effect on EV adoption among MUD residents. Such a study would require a careful experimental or quasi-experimental design. However, its results would be invaluable for policymakers who might be faced with a choice between differing strategies for targeting EV adoption in the MUD segment. With a causal estimate of the impact of DCFC installations in hand, analysts could predict the effect of future programs and compare it to other programs within a decision analysis framework.

Appendix A: Methods

In addition to the statistical methods described in the text, this report required a number of data processing methods to prepare session data for analysis. The following sections describe those methods.

Cleaning and preprocessing admin data

Approximately 9% of reported sessions showed zero-length and/or zero or negative energy delivered. These errors stemmed from data reporting in EVgo's internal process and were filtered out accordingly. A very small number of reported sessions (<0.01%) reported energy use above 100 kWh. Because there are no production model light-duty EVs with larger than 100 kWh batteries, we assume that these data are also erroneous.

In the raw session data we found a pattern of cases where one user would have multiple sessions registered on the same charger within minutes of each other. We assume that in these instances the session was interrupted, causing two distinct sessions to be recorded. For the purposes of our analysis, those sessions should count as only one. To address this concern we combined any sessions by the same user at the same charger that occurred within half an hour of each other. After this combination, the session dataset had 4.5% fewer individual sessions.

Spatial analysis methods

To protect the anonymity of individual users, locations of those users' homes were masked. The location data shared by EVgo includes only the census tract in which the user resides. EVgo staff used the Census Bureau's geocoding application programming interface (API) to identify the census tract in which EVgo users' addresses are located. Approximately 2% of user addresses could not be geocoded to a census tract.

We calculated the network distance between users' homes and charging stations using the routing engine provided by Openrouteservice.org distance matrix API. OpenRouteService uses roadway network data from OpenStreetMap to calculate distances between two points. Because we did not have information on users' exact locations, this distance estimation is approximate, based on the center of population in each census tract. This has the effect of introducing small, but random, errors into the distance estimates. Those errors will be more significant between home and charging locations that are closer together.

MUD identification

Whether a user lives in a multi-unit dwelling (MUD) is a key component of the evaluation of HPCP chargers. However, this is not information that EVgo regularly collects, nor are there convenient or comprehensive databases of home type available as cross reference.

To overcome that limitation, we developed an identification method that uses unit information embedded in user-reported billing addresses to identify whether a user lived in an MUD. The method works by matching addresses to preset unit identifier patterns such as unit, apt, and no., among other common unit-identifying patterns.

We tested this identifier against the user-reported housing type provided by our survey respondents. Based on comparison to this ground truth the method proved to have a high degree of specificity (0.947). In other words, there were few false positives (non-MUDs identified as MUDs) in relation to true negatives. This means that a non-MUD resident is unlikely to be classified as a MUD resident.

However, the method's sensitivity is relatively low (0.404). In other words, the ratio of true positives (is MUD and identified as MUD) to false negatives (is MUD but not identified as MUD) is low. This means that a large number of actual MUD residents are categorized as non-MUD residents. In further diagnosis of the classifier method, we found that the source of the low-sensitivity performance is because the addresses provided by users who indicated they live in an MUD often did not contain unit information.

Appendix B: Survey Instrument

1) Which of the following best describes where you live?
   a) Single family home (detached)
   b) Townhome or duplex
   c) Apartment/condo building or complex
   d) Other multifamily housing
2) Do you rent or own your home?
   a) Own
   b) Rent
3) What type of Plug-in Electric Vehicle do you drive?
   a) make and model - drop down
4) In addition to your EV(s), does your household own any gasoline/diesel vehicles?
   a) No
   b) Yes, 1
   c) Yes, 2
   d) Yes, 3 or more
5) Which best describes your home charging options?
   a) Charging station (220v or level 2)
   b) Standard wall outlet (110v or level 1)
   c) Shared/communal charging
   d) Cannot charge at home
6) What other charging options are available to you? (select all that apply)
   a) At my workplace
   b) Public charging along my commute route
   c) Public charging at retail or other destinations
   d) Public charging near my home
7) Where do you most frequently charge your vehicle? (Select one)
   a) At home
   b) At or near my workplace
   c) At a public fast charger
   d) At a public level 2 charger
   e) Other
8) How important are the following fast charging station location attributes to you?
   Likert scale 1- 5 *(not important, slightly important, moderately important, important, very important)*
   a) Near my home
   b) Near my workplace
   c) Located near shopping, restaurants or other amenities
   d) Charging station has three or more plugs
   e) Higher power (80kW+) EVSE
   f) Located near a freeway entrance
   g) Located along travel corridors
9) Do you drive for an app-based passenger or delivery service? (Uber, Lyft, Postmates, etc.)
   a) Yes, part time
   b) Yes, full time
   c) No

Appendix C: Individual station evaluation reports

This appendix includes standalone reports of summary data on location and performance for the eight *High Power Charging Plaza* (HPCP) locations that accrued 2,000 or more individual charging sessions during the study period.

San Jose Whole Foods High Power Charging Plaza

The San Jose Whole Foods HPCP is located at 777 The Alameda, San Jose, CA. The site consists of four 80kW DCFC. The HPCP is located in a Whole Foods Market® parking lot that is west of downtown San Jose. Prior to conversion to a HPCP, the San Jose Whole Foods location hosted two DCFC. The location was upgraded to a HPCP that commenced operations on Jan 18, 2019. It was the first HPCP station to open and had been in operation 13 months at the point of the COVID-19 safer-at-home orders and 20 months in total over the data collection period.

Table 1. HPCP usage statistics

	sessions	individual users
MUD users	**1,871**	**214**
All users	14,543	1,881

Among the HPCP locations, San Jose Whole Foods ranked second in number of identified MUD users served, but first in total number of users served. The San Jose Whole Foods HPCP is unique among other HPCP in that it had been an already established location before reopening as an HPCP. However, both its MUD session share[41] and MUD user share[42] figures are lower than the average HPCP.

Figure 1. HPCP site MUD session and user share compared to non-HPCP site average

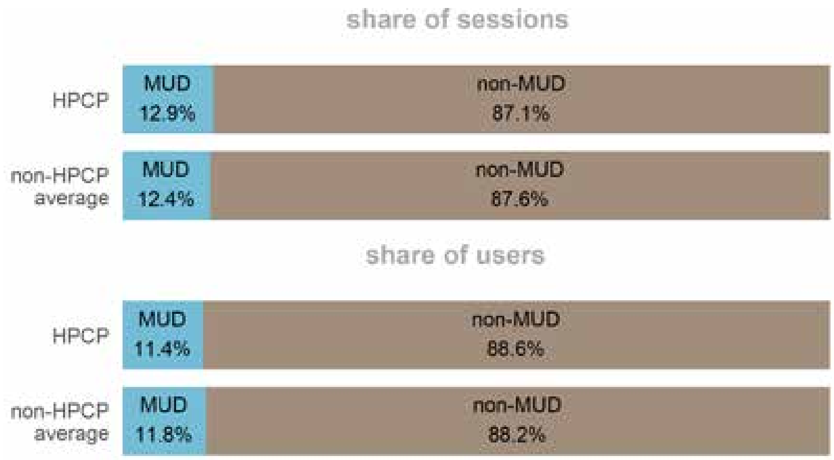


Figure 1 shows the comparison between San Jose Whole Foods' MUD session share and MUD user share and the average of those metrics across comparison non-HPCP sites.[43] The San Jose Whole Foods location marginally outperformed the comparison site average on the session share metric, indicating that it hosted a slightly higher-than-average percentage of MUD resident customer sessions. However, it also marginally underperformed on the MUD resident user metric, indicating that a lower-than-average share of its total users were MUD residents.

[41] The fraction of a site's total hosted sessions that were initiated by an MUD resident. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.

[42] The fraction of a site's total unique users who are identified as MUD residents. A higher user share indicates relatively more MUD users use that station and a lower share indicate relatively fewer MUD users use that station.

[43] The comparison sites are 50 randomly selected EVgo locations across California not developed under the HPCP program.

Figure 2. Frequent users at San Jose Whole Foods HPCP

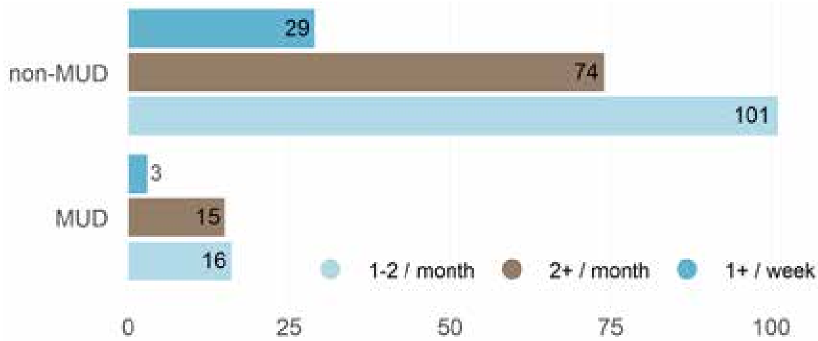


Figure 2 shows the number of frequent repeat users at San Jose Whole Foods. We consider users who charge at least once a week to be significantly dependent on the HPCP. Users who are regular monthly visitors are at least partially dependent on the location. Because a significant portion of data reporting occurred as traffic declined during the COVID-19 pandemic, this metric may not fully describe user dependence on this location.

About the San Jose Whole Foods HPCP

The service area map (Figure 3) shows three progressively larger travel sheds from 5, 7 and 10 minutes. This represents the geographic area from which a driver can reach the HPCP within each of the three time increments. Although we report statistics for each of the three travel sheds, we view the 5-minute increment as the important residential service area because we find it the geographic area most strongly related to MUD user and session share.

Figure 4 shows that the San Jose Whole Foods HPCP has fewer MUD units within a 5-minute travel shed than the average non-HPCP site (5,521), but more MUD units within 7- and 10-minute travel sheds (11,731 and 26,302). Compared to the average HPCP site, the San Jose Whole Foods has fewer MUD units in all three travel sheds.

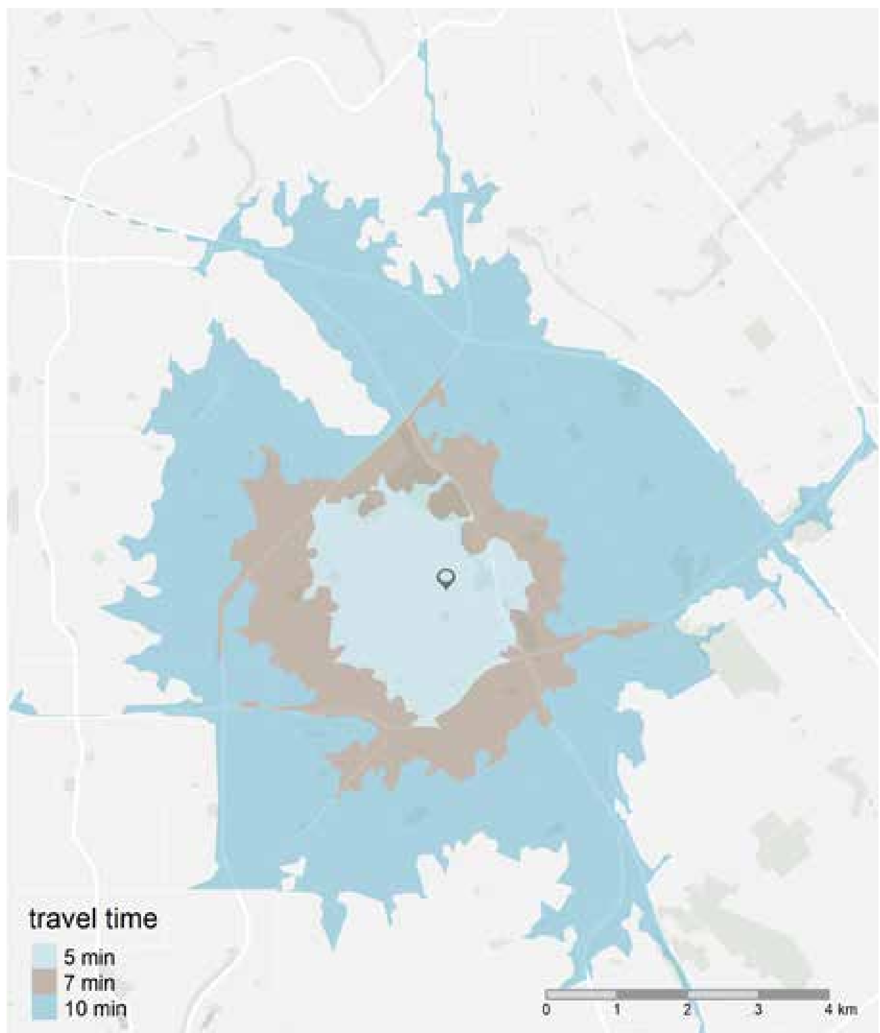
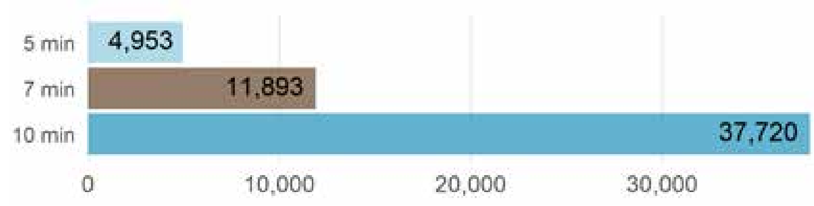


Figure 3. San Jose Whole Foods HPCP service area map

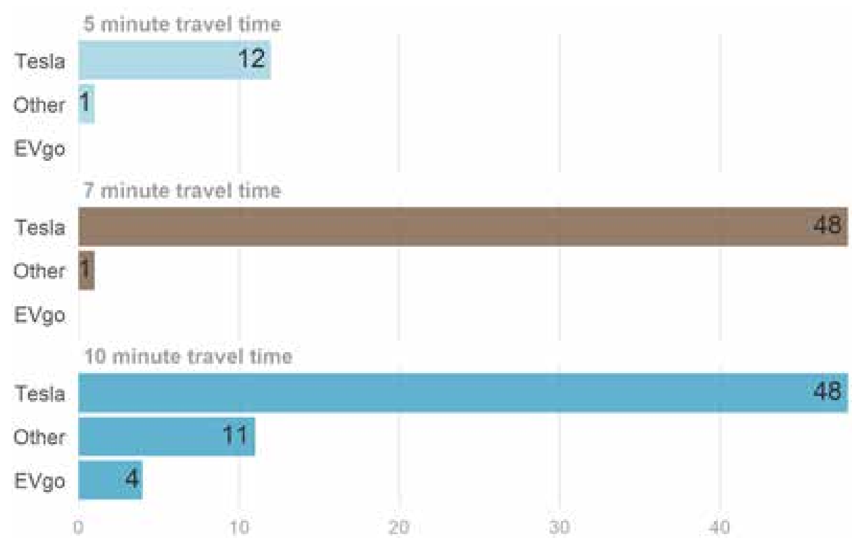
Figure 4. MUD units within the San Jose Whole Foods HPCP service area



Other DCFC charging options

The HPCP locations add to existing stations that also might serve MUD residents. On average there are more DCFC public charging options near HPCP locations and non-HPCP locations, likely because HPCPs are located by design in dense urban areas. However, there is significant variation in DCFC access between individual HPCP service areas.

Figure 5. Number of DCFC stations (individual charging points) in or within half a mile of each travel shed



With the exception of Tesla stations, which only serve Tesla vehicles, the San Jose Whole Foods HPCP is collocated with few other DCFC, particularily in the close 5-minute travel shed where there is only one DCFC in addition to the HPCP's four. The San Jose Whole Foods HPCP has fewer nearby public DCFC than both the average HPCP and the average non-HPCP. With the other charging option, the HPCP brings the number of non-Tesla DCFC in the immediate area to 5.

Southside Park High Power Charging Plaza

The Southside Park HPCP is located at 2201 6th Street, Sacramento, CA. The site consists of six total stations with three 175kW and three 50kW DCFC. The HPCP is located at curbside parking adjacent to Southside Park, a city park directly south of downtown Sacramento. The Southside Park HPCP began operations on May 2, 2019 and had been in operation 10 months at the point of the COVID-19 safer-at-home orders and 16 months in total over the data collection period.

Table 1. HPCP usage statistics

	sessions	individual users
MUD users	**588**	**83**
All users	4,110	831

Among the HPCP locations, Southside Park ranked forth in number of identified MUD users served. Both its MUD session share[44] and MUD user share[45] figures are lower than the average HPCP.

Figure 1. HPCP site MUD session and user share compared to non-HPCP site average

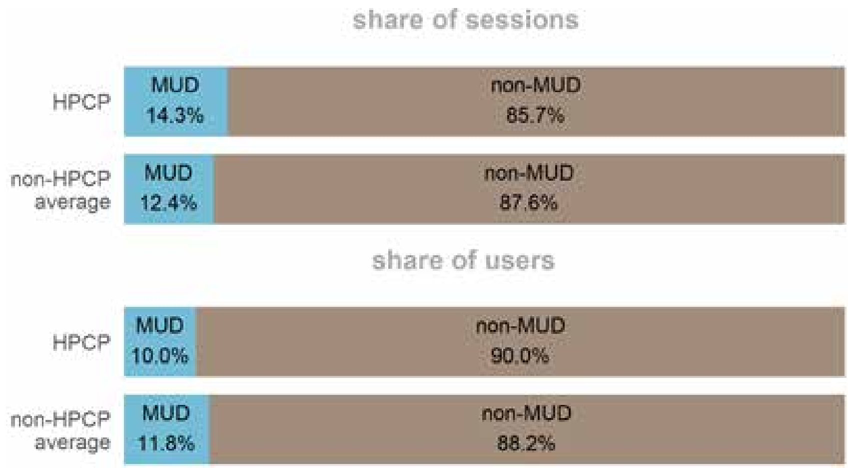


Figure 1 shows the comparison between Southside Park's MUD session share and MUD user share and the average of those metrics across comparison non-HPCP sites.[46] The Southside Park location outperformed the comparison site average on the session share metric, indicating that it hosted a higher-than-average percentage of MUD resident customer sessions. However, it underperformed on the MUD resident user metric, indicating that a smaller than average share of its total users were MUD residents.

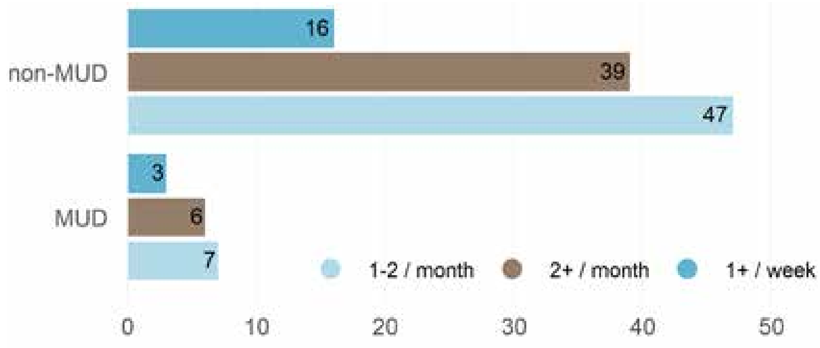
Figure 2 shows the number of frequent repeat users at Southside Park. We consider users who charge at least once a week to be significantly dependent on the Southside Park. Users who are regular monthly visitors are at least partially dependent on the location. Because a significant portion of data reporting occurred as traffic declined during the COVID-19 pandemic, this metric may not fully describe user dependence on this location.

[44] The fraction of a site's total hosted sessions that were initiated by an MUD resident. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.

[45] The fraction of a site's total unique users that are identified as MUD residents. A higher user share indicates relatively more MUD users use that station and a lower share indicate relatively fewer MUD users use that station.

[46] The comparison sites are 50 randomly selected EVgo locations across California not developed under the HPCP program.

Figure 2. Frequent users at Southside Park HPCP



This service area map shows three progressively larger travel sheds from 5, 7 and 10 minutes. This represents the geographic area from which a driver can reach the HPCP within each of the three time increments. Although we report statistics for each of the three travel sheds, we view the 5-minute increment as the important residential service area because we find it the geographic area most strongly related to MUD user and session share.

About the Southside Park HPCP

Figure 3. Southside Park HPCP service area map

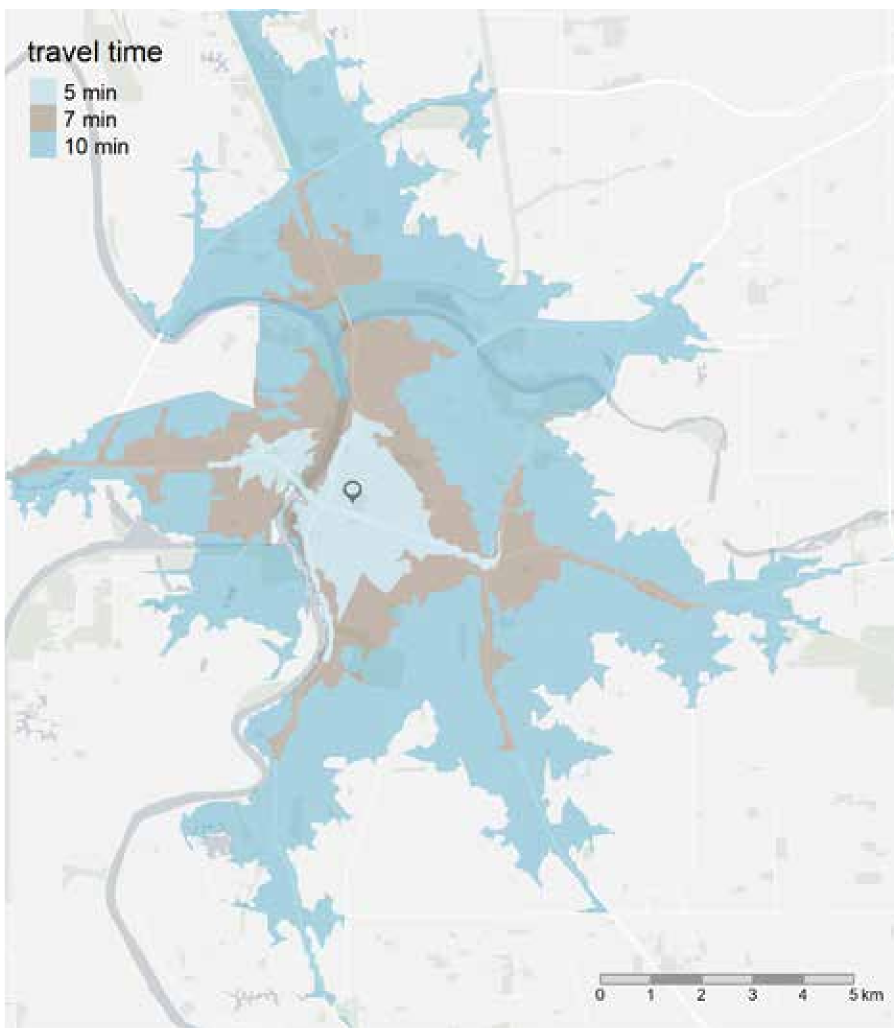
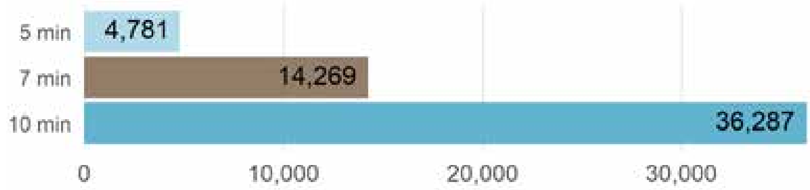


Figure 4. MUD units within the Southside Park HPCP

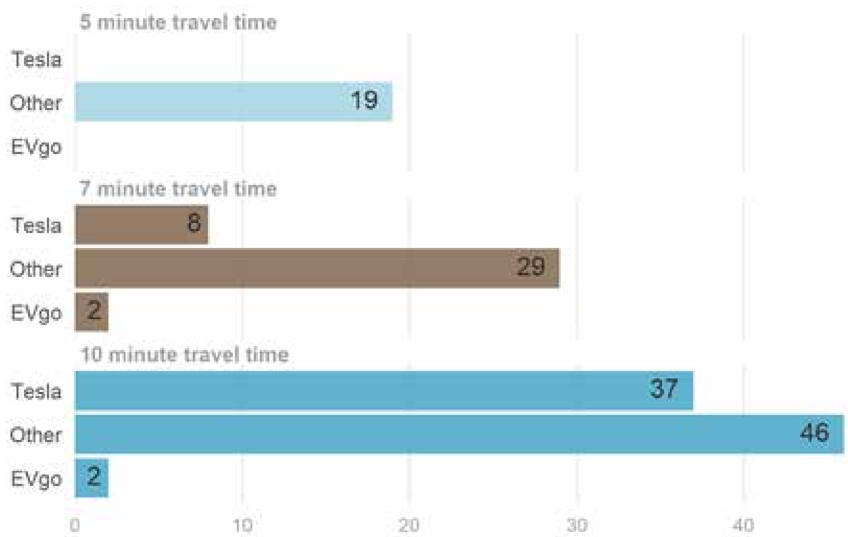


The Southside Park HPCP has fewer MUD units within a 5-minute travel shed than the average non-HPCP site (5,521) but more MUD units within 7- and 10-minute travel sheds (11,731 and 26,302). Compared to the average HPCP site, the Southside Park has fewer MUD units in all three travel sheds.

Other DCFC charging options

The HPCP locations add to existing stations that also might serve MUD residents. On average there are more DCFC public charging options near HPCP locations and non-HPCP locations, likely because HPCPs are located by design in dense urban areas. However, there is significant variation in DCFC access between individual HPCP service areas.

Figure 5. Number of DCFC stations (individual charging points) in or within half a mile of each travel shed



The Southside Park HPCP is collocated with a relatively large number of other DCFC stations, particularily in the close 5-minute travel shed, where there are twice as many nearby stations as the average HPCP location. With the other charging options, the HPCP brings the number of DCFC in the immediate area to 25.

Valley Village Union 76 High Power Charging Plaza

The Valley Village Union 76 HPCP is located at 4654 Laurel Canyon Blvd, Valley Village, CA. The site consists of four 50kW DCFC. The HPCP is located at a Union 76® gas station in the Valley Village neighborhood of Los Angeles. The Valley Village Union 76 commenced operations on June 11, 2019. It had been in operation eight months at the point of the COVID-19 safer-at-home orders and 15 months in total over the data collection period.

Table 1. HPCP usage statistics

	sessions	individual users
MUD users	**2,636**	**220**
All users	7,550	991

Among the HPCP locations, Valley Village Union 76 ranked first in absolute number of identified MUD users served but second in total number of users served. The Vallley Village Union 76 HPCP is the best performing HPCP in terms of MUD session share[47] and MUD user share.[48]

Figure 1. HPCP site MUD session and user share compared to non-HPCP site average

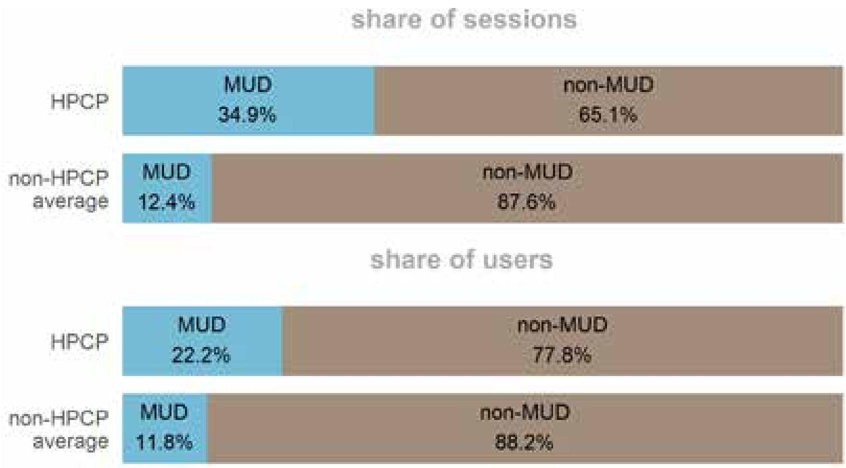


Figure 1 shows the comparison between Valley Village Union 76's MUD session share and MUD user share and the average of those metrics across comparison non-HPCP sites.[49] The Valley Village Union 76 location outperformed the non-HPCP site average on the session share metric by a large margin, indicating that it hosted a much higher-than-average percentage of MUD resident customer sessions. It also highly outperformed the MUD resident user metric, indicating a larger than average share of its total users were MUD residents.

[47] The fraction of a site's total hosted sessions that were initiated by an MUD resident. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.

[48] The fraction of a site's total unique users that are identified as MUD residents. A higher user share indicates relatively more MUD users use that station and a lower share indicate relatively fewer MUD users use that station.

[49] The comparison sites are 50 randomly selected EVgo locations across California not developed under the HPCP program.

Figure 2. Frequent users at Valley Village Union 76 HPCP

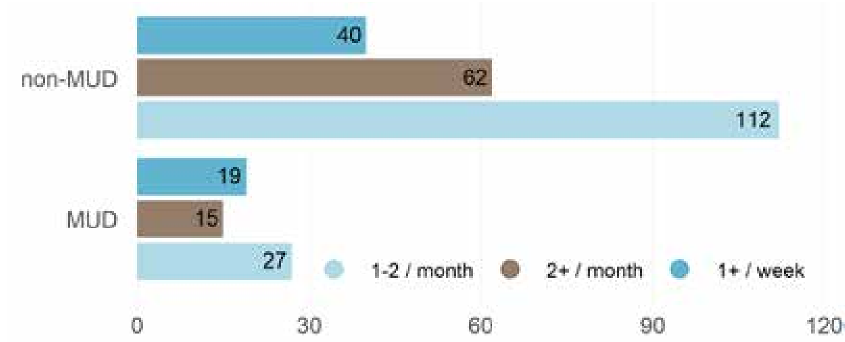
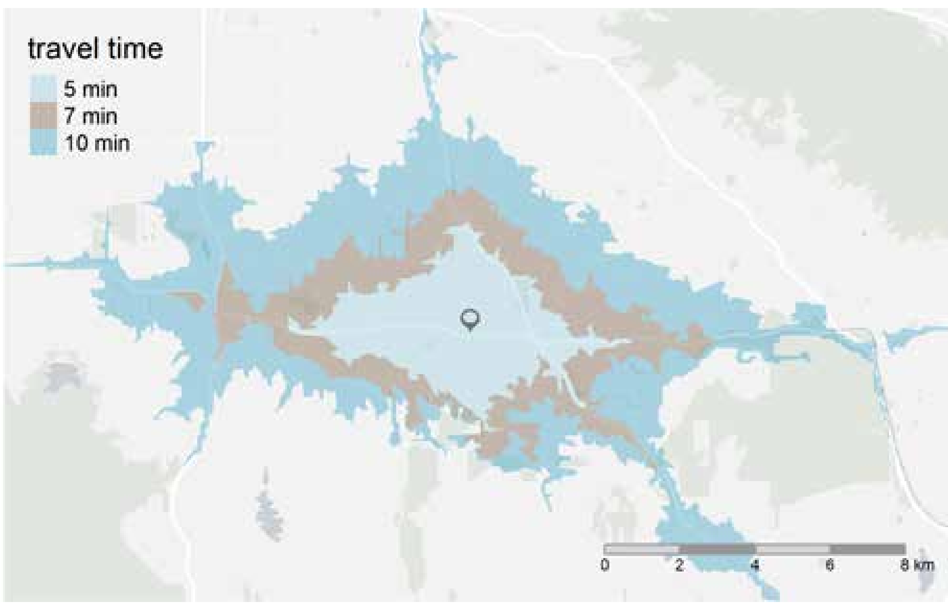


Figure 2 shows the number of frequent repeat users at Valley Village Union 76. We consider users who charge at least once a week to be significantly dependent on the Valley Village Union 76. Users who are regular monthly visitors are at least partially dependent on the location. Because a significant portion of data reporting occurred as traffic declined during the COVID-19 pandemic, this metric may not fully describe user dependence on this location.

About the Valley Village Union 76 HPCP

Figure 3. Valley Village Union 76 HPCP service area map



The service area map (Figure 3) shows three progressively larger travel sheds from 5, 7 and 10 minutes. This represents the geographic area from which a driver can reach the HPCP within each of the three time increments. Although we report statistics for each of the three travel sheds, we view the 5-minute increment as the important residential service area because we find it the geographic area most strongly related to MUD user and session share.

Figure 4. MUD units within the Valley Village Union 76 HPCP service

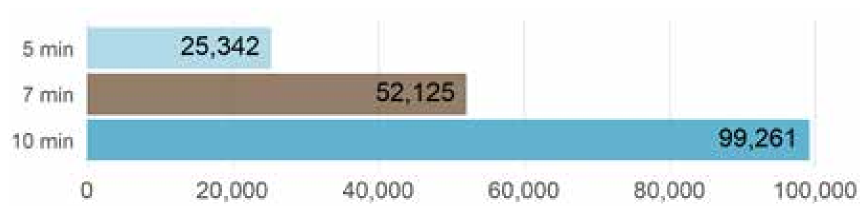
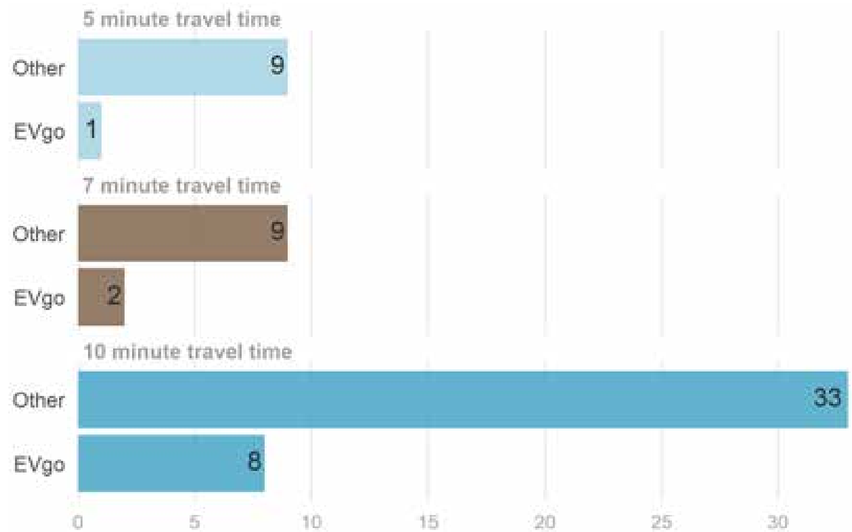


Figure 4 shows that the Valley Village Union 76 HPCP has nearly five times the number of MUD units within a 5-minute travel shed than the average non-HPCP site (5,521), and still significantly more MUD units within 7- and 10-minute travel sheds (11,731 and 26,302). Compared to the average HPCP site, the Valley Village Union 76 has far more MUD units in all three travel sheds.

Other DCFC charging options

The HPCP locations add to existing stations that also might serve MUD residents. On average there are more DCFC public charging options near HPCP locations and non-HPCP locations, likely because HPCPs are located by design in dense urban areas. However, there is significant variation in DCFC access between individual HPCP service areas.

Figure 5. Number of DCFC stations (individual charging points) in or within half a mile of each travel shed



Valley Village Union 76 HPCP is collocated with an average number of DCFC as compared to other HPCP station, particularily in the close 5-minute travel shed where there are 10 DCFC in addition to the HPCP's four. With the other charging options, the HPCP brings the number of DCFC in the immediate area up to 14.

Foster City Police Department High Power Charging Plaza

The Foster City Police Department HPCP is located at 1000 E. Hillsdale Blvd, Foster City, CA. The site consists of four 80kW DCFC. The HPCP is located at in a civic building complex that hosts a police department as well as a library and community center. The Foster City Police Department HPCP commenced operations on June 17, 2019. It had been in operation eight months at the point of the COVID-19 safer-at-home orders and 15 months in total over the data collection period.

Table 1. HPCP usage statistics

	sessions	individual users
MUD users	**649**	**65**
All users	4,156	513

Among the HPCP locations, Foster City Police Department ranked third in absolute number of identified MUD users served. The Foster City Police Department HPCP performs below average on MUD session share[50] and MUD user share[51] compared to other HPCP locations.

Figure 1. HPCP site MUD session and user share compared to non-HPCP site average

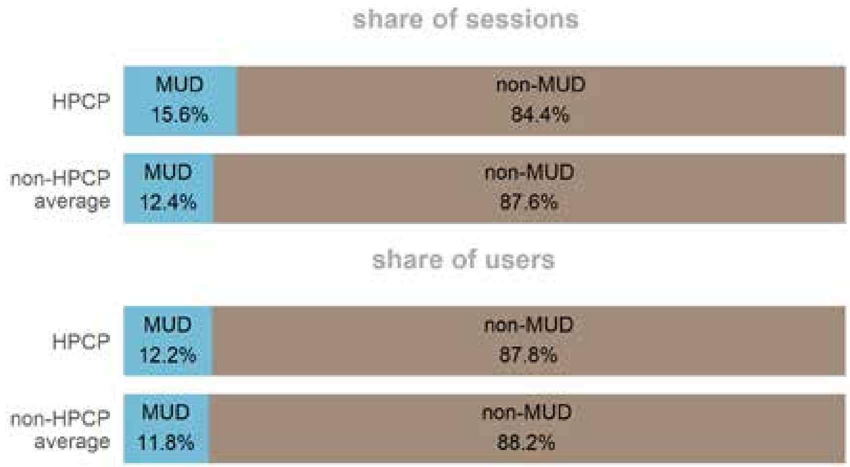


Figure 1 shows the comparison between Foster City Police Department's MUD session share and MUD user share and the average of those metrics across comparison non-HPCP sites.[52] The Foster City Police Department location outperformed the non-HPCP site average on the session share metric, indicating that it hosted a higher-than-average percentage of MUD resident customer sessions. It also marginally outperformed the MUD resident user metric, indicating that a slightly larger than average share of its total users were MUD residents.

[50] The fraction of a site's total hosted sessions that were initiated by an MUD resident. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.

[51] The fraction of a site's total unique users that are identified as MUD residents. A higher user share indicates relatively more MUD users use that station and a lower share indicate relatively fewer MUD users use that station.

[52] The comparison sites are 50 randomly selected EVgo locations across California not developed under the HPCP program.

Figure 2. Frequent users at Foster City Police Department HPCP

Figure 2 shows the number of frequent repeat users at Foster City Police Department. We consider users who charge at least once a week to be significantly dependent on the Foster City Police Department. Users who are regular monthly visitors are at least partially dependent on the location. Because a significant portion of data reporting occurred as traffic declined during the COVID-19 pandemic, this metric may not fully describe user dependence on this location.

About the Foster City Police Department HPCP

The service area map (Figure 3) shows three progressively larger travel sheds from 5, 7 and 10 minutes. This represents the geographic area from which a driver can reach the HPCP within each of the three time increments. Although we report statistics for each of the three travel sheds, we view the 5-minute increment as the important residential service area because we find it the geographic area most strongly related to MUD user and session share.

Figure 4 shows that the Foster City Police Department HPCP has a slightly higher number of MUD units within a 5-minute travel shed than the average non-HPCP site (5,521), though fewer MUD units within 7- and 10-minute travel sheds (11,731 and 26,302). Compared to the average HPCP site, the Foster City Police Department location has fewer MUD units in all three travel sheds.

Fig. 3. Foster City Police Department HPCP service area map

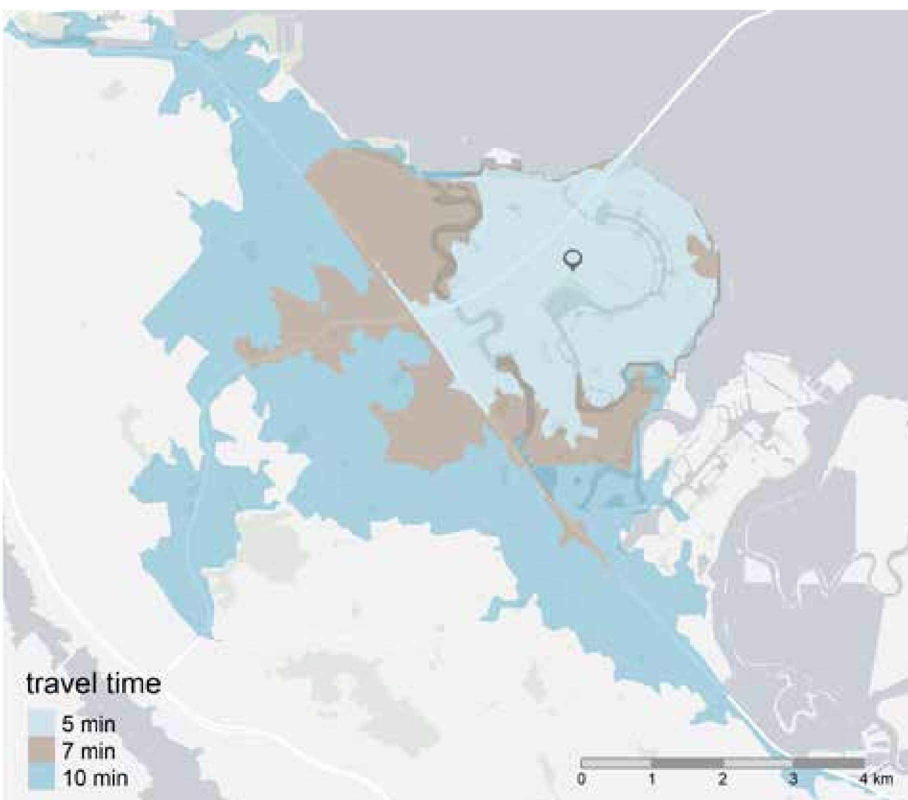
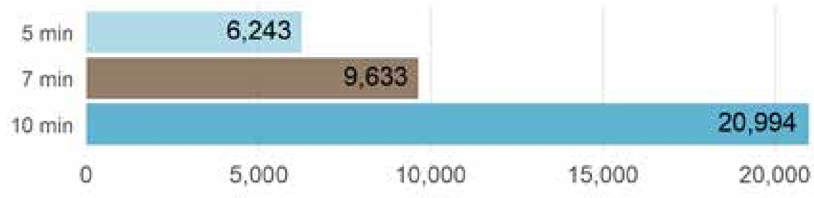


Figure 4. MUD units within the Foster City Police Department HPCP service area

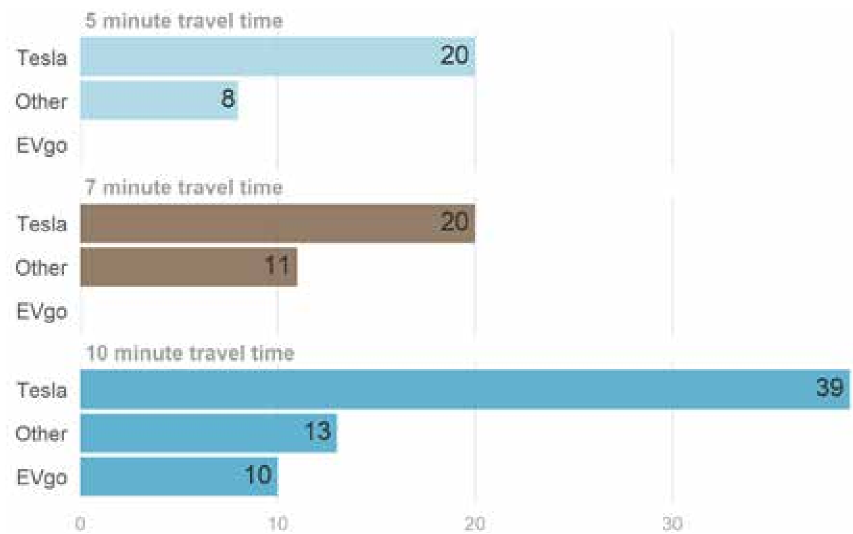


Other DCFC charging options

The HPCP locations add to existing stations that also might serve MUD residents. On average there are more DCFC public charging options near HPCP locations and non-HPCP locations, likely because HPCPs are located by design in dense urban areas. However, there is significant variation in DCFC access between individual HPCP service areas.

Figure 5 shows Foster City Police Department HPCP is collocated with a little less than the average number of non-Tesla DCFC (11) as compared to other HPCP stations, particularily in the close 5-minute travel shed, where there are 10 DCFC in addition to the HPCP's four. With the other charging options, the HPCP brings the number of DCFC in the immediate area up to 14.

Figure 5. Number of DCFC (individual charging points) in or within half a mile of each travel shed.



Mill Valley Whole Foods High Power Charging Plaza

The Mill Valley Whole Foods HPCP is located 731 E Blithedale Ave, Mill Valley, CA. The site consists of three 50kW DCFC. The HPCP is located at a Whole Foods Market east of central Mill Valley and west of the 101 Freeway. The Mill Valley Whole Foods commenced operations on June 21, 2019. It had been in operation eight months at the point of the COVID-19 safer-at-home orders and 15 months in total over the data collection period.

Table 1. HPCP usage statistics

	sessions	individual users
MUD users	**313**	**68**
All users	3,144	648

Among the HPCP locations, Mill Valley Whole Foods ranked eighth in absolute number of identified MUD users served. The Mill Valley Whole Foods HPCP performs below average on MUD session share[53] and MUD user share[54] compared to other HPCP locations.

Figure 1. HPCP site MUD session and user share compared to non-HPCP site average

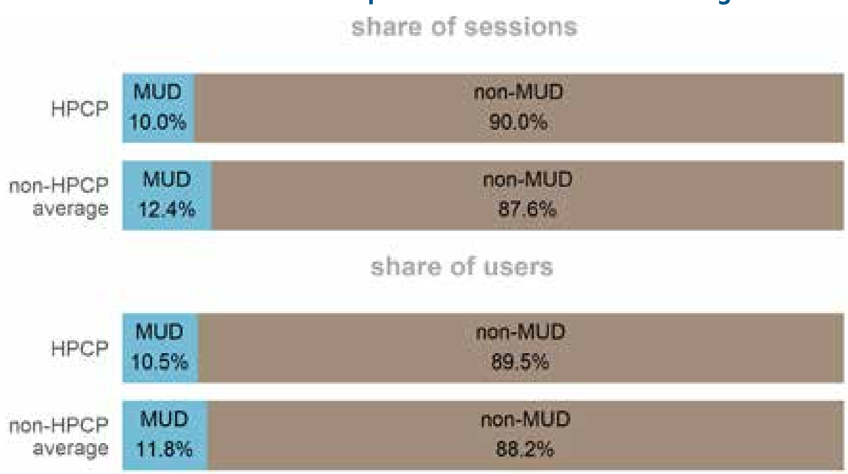


Figure 1 shows the comparison between Mill Valley Whole Foods's MUD session share and MUD user share and the average of those metrics across comparison non-HPCP sites.[55] The Mill Valley Whole Foods location underperformed the non-HPCP site average on the session share metric, indicating that it hosted a lower-than-average percentage of MUD resident customer sessions. It also marginally underperformed the MUD resident user metric, indicating that a slightly smaller-than-average share of its total users were MUD residents.

[53] The fraction of a site's total hosted sessions that were initiated by an MUD resident. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.

[54] The fraction of a site's total unique users that are identified as MUD residents. A higher user share indicates relatively more MUD users use that station and a lower share indicate relatively fewer MUD users use that station.

[55] The comparison sites are 50 randomly selected EVgo locations across California not developed under the HPCP program.

Figure 2. Frequent users at Mill Valley Whole Foods HPCP

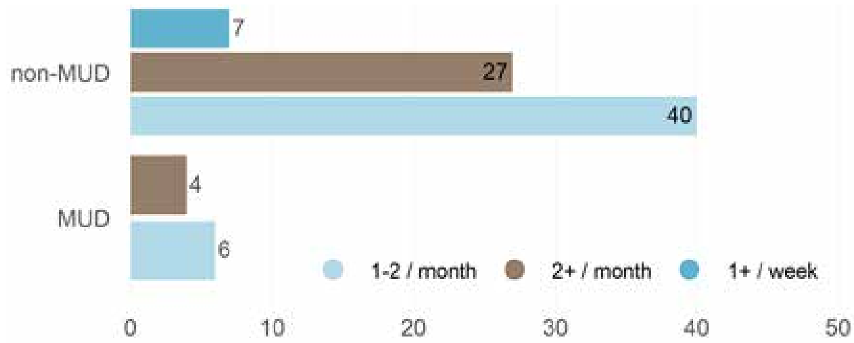


Figure 2 shows the number of frequent repeat users at Mill Valley Whole Foods. There were no identified MUD users at the Mill Valley Whole Foods location who charged at least once a week. We consider users who charge at least once a week to be significantly dependent on the Mill Valley Whole Foods. Users who are regular monthly visitors are at least partially dependent on the location. Because a significant portion of data reporting occurred as traffic declined during the COVID-19 pandemic, this metric may not fully describe user dependence on this location.

About the Mill Valley Whole Foods HPCP

The service area map (Figure 3) shows three progressively larger travel sheds from 5, 7 and 10 minutes. This represents the geographic area from which a driver can reach the HPCP within each of the three time increments. Although we report statistics for each of the three travel sheds, we view the 5-minute increment as the important residential service area because we find it the geographic area most strongly related to MUD user and session share.

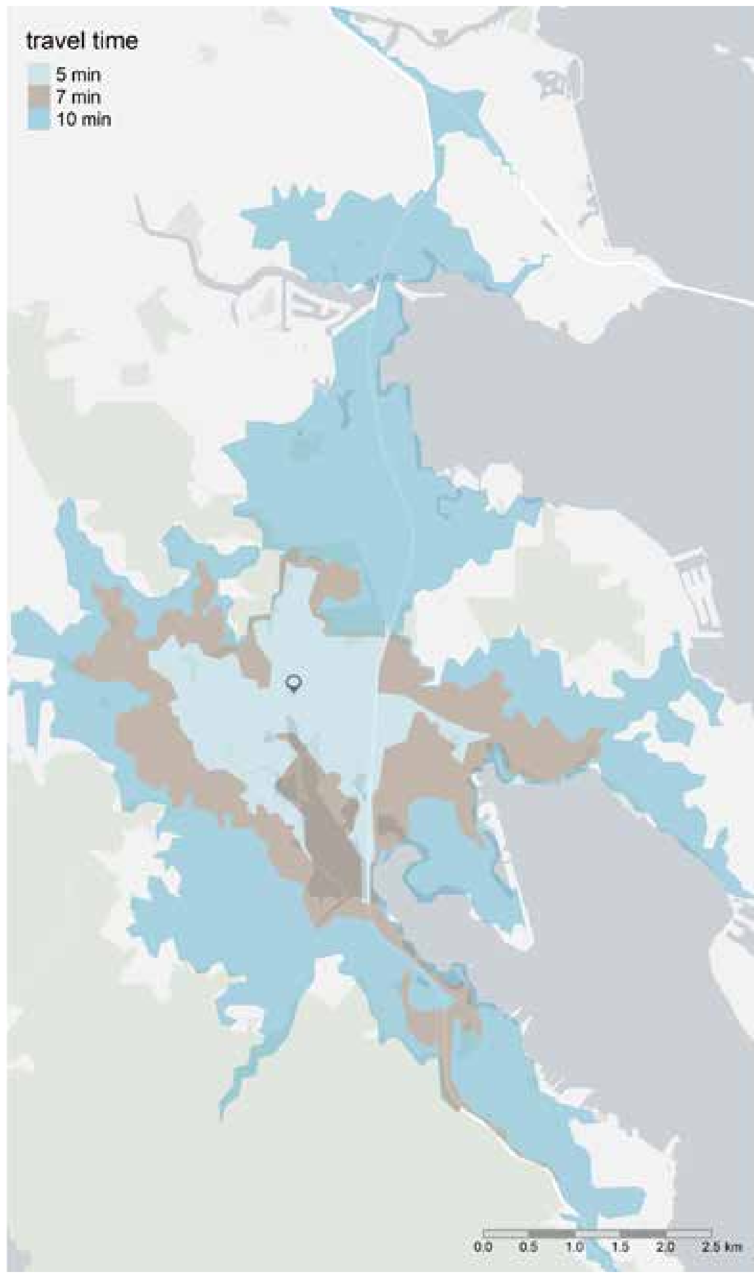
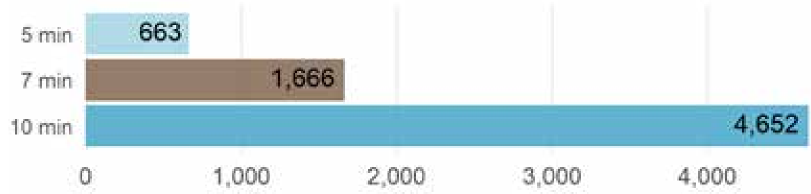


Figure 3. Mill Valley Whole Foods HPCP service area map

Figure 4 shows that the Mill Valley Whole Foods HPCP has nearly 10 times fewer MUD units within a 5-minute travel shed than the average non-HPCP site (5,521), and still significantly fewer MUD units within 7- and 10-minute travel sheds (11,731 and 26,302). Compared to the average HPCP site, the Mill Valley Whole Foods location has much fewer MUD units in all three travel sheds.

Figure 4. MUD units within the Mill Valley Whole Foods HPCP service area



Other DCFC charging options

The HPCP locations add to existing stations that also might serve MUD residents. On average there are more DCFC public charging options near HPCP locations and non-HPCP locations, likely because HPCPs are located by design in dense urban areas. However, there is significant variation in DCFC access between individual HPCP service areas.

Figure 5. Number of DCFC (individual charging points) in or within half a mile of each travel shed

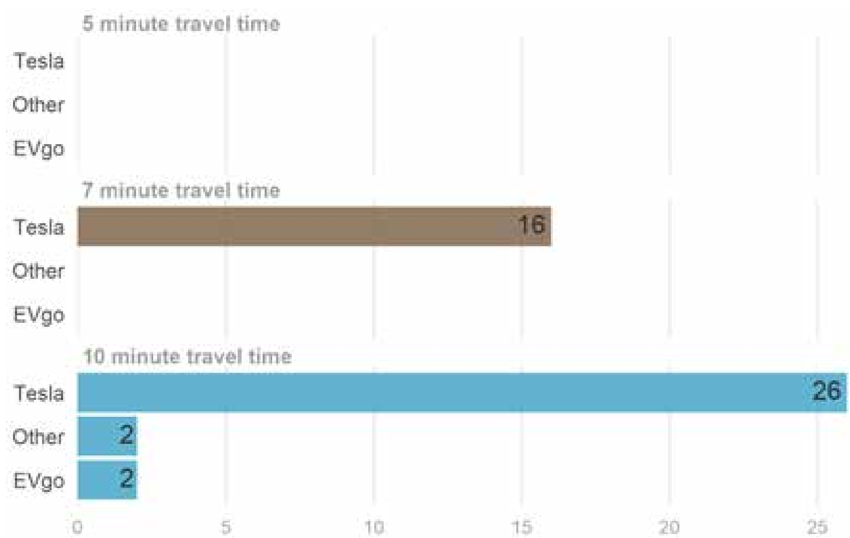


Figure 5 shows Mill Valley Whole Foods HPCP is collocated with no other DCFC in its close 5-minute travel shed, and only Tesla exclusive DCFC in its 10-minute travel shed. This HPCP adds the first three DCFC to its immediate area.

Broadway Millbrae High Power Charging Plaza

The Broadway Millbrae HPCP is located 446 Broadway, Millbrae, CA. The site consists of three 50kW DCFC. The HPCP is located in a city-owned parking lot in Millbrae's central retail district west of the 101 Freeway. The Broadway Millbrae plaza commenced operations on July 19, 2019. It had been in operation seven months at the point of the COVID-19 safer-at-home orders and 14 months in total over the data collection period.

Table 1. HPCP usage statistics

	sessions	individual users
MUD users	**313**	**68**
All users	3,144	648

Among the HPCP locations, Broadway Millbrae ranked ninth in absolute number of identified MUD users served. The Broadway Millbrae HPCP performs below average on MUD session share[56] and MUD user share[57] compared to other HPCP locations.

Figure 1. HPCP site MUD session and user share compared to non-HPCP site average

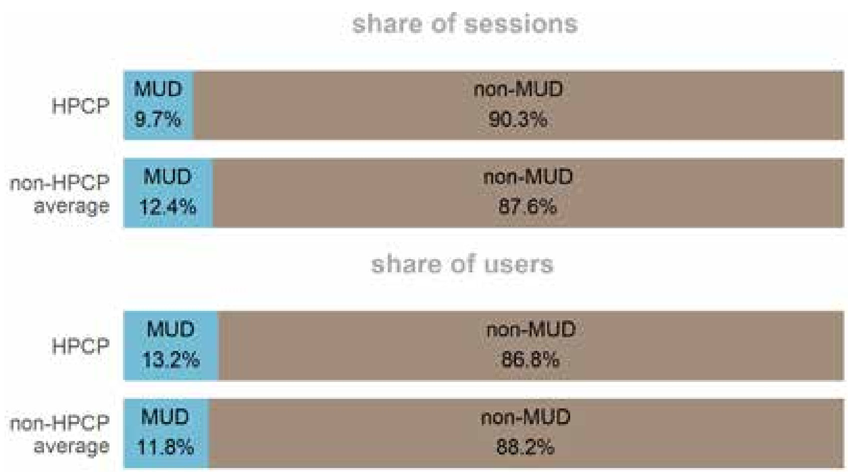


Figure 1 shows the comparison between Broadway Millbrae's MUD session share and MUD user share and the average of those metrics across comparison non-HPCP sites.[58] The Broadway Millbrae location overperformed the non-HPCP site average on the session share metric, indicating that it hosted a higher-than-average percentage of MUD resident customer sessions. It also marginally underperformed the MUD resident user metric, indicating that a slightly smaller-than-average share of its total users were MUD residents.

[56] The fraction of a site's total hosted sessions that were initiated by an MUD resident. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.

[57] The fraction of a site's total unique users that are identified as MUD residents. A higher user share indicates relatively more MUD users use that station and a lower share indicate relatively fewer MUD users use that station.

[58] The comparison sites are 50 randomly selected EVgo locations across California not developed under the HPCP program.

Figure 2. Frequent users at Broadway Millbrae HPCP

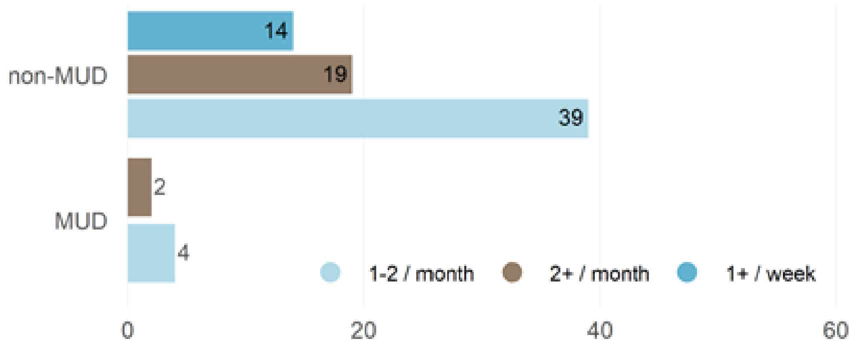


Figure 2 shows the number of frequent repeat users at Broadway Millbrae. There were no identified MUD users at the Broadway Millbrae location who charged at least once a week. We consider users who charge at least once a week to be significantly dependent on the Broadway Millbrae. Users who are regular monthly visitors are at least partially dependent on the location. Because a significant portion of data reporting occurred as traffic declined during the COVID-19 pandemic, this metric may not fully describe user dependence on this location.

About the Broadway Millbrae HPCP

The service area map (Figure 3) shows three progressively larger travel sheds from 5, 7 and 10 minutes. This represents the geographic area from which a driver can reach the HPCP within each of the three time increments. Although we report statistics for each of the three travel sheds, we view the 5-minute increment as the important residential service area because we find it the geographic area most strongly related to MUD user and session share.

Figure 4 shows that the Broadway Millbrae HPCP has significantly fewer MUD units within a 5-minute travel shed than the average non-HPCP site (5,521), and fewer MUD units within 7- and 10-minute travel sheds (11,731 and 26,302) as well. Compared to the average HPCP site, the Broadway Millbrae location has comparatively fewer MUD units in all three travel sheds.

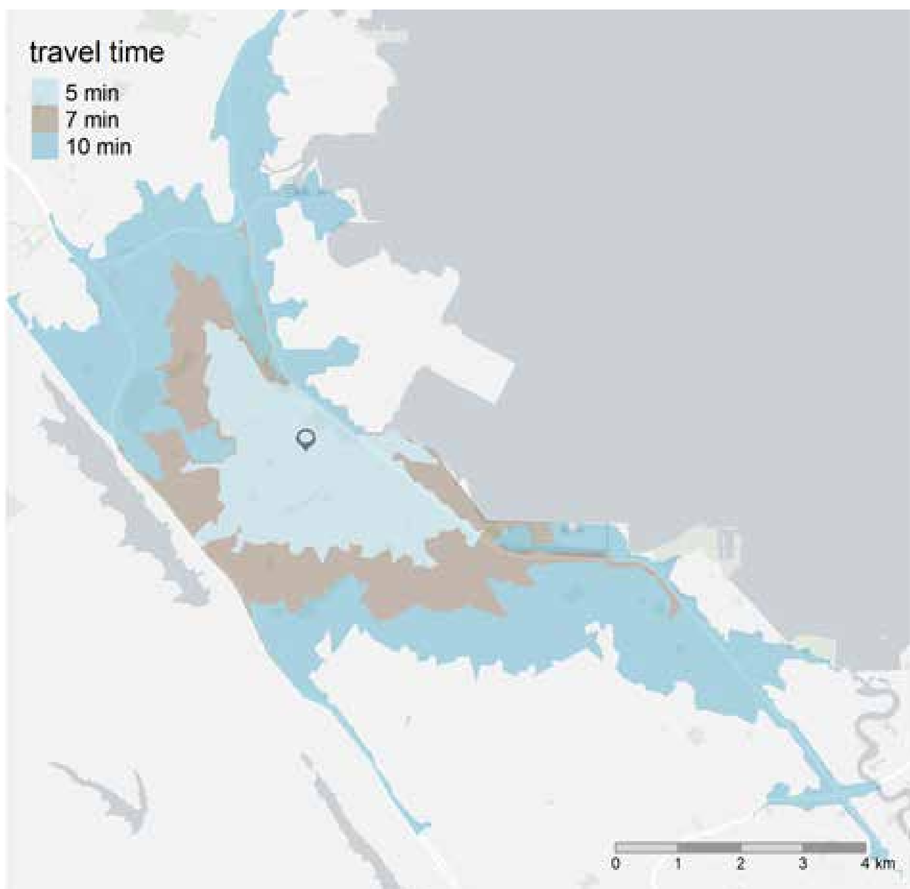
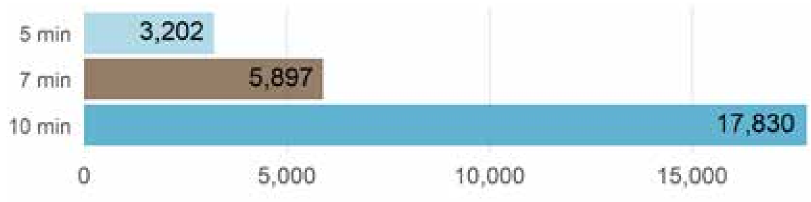


Figure 3. Broadway Millbrae HPCP service area map

Figure 4. MUD units within the Broadway Millbrae HPCP service area

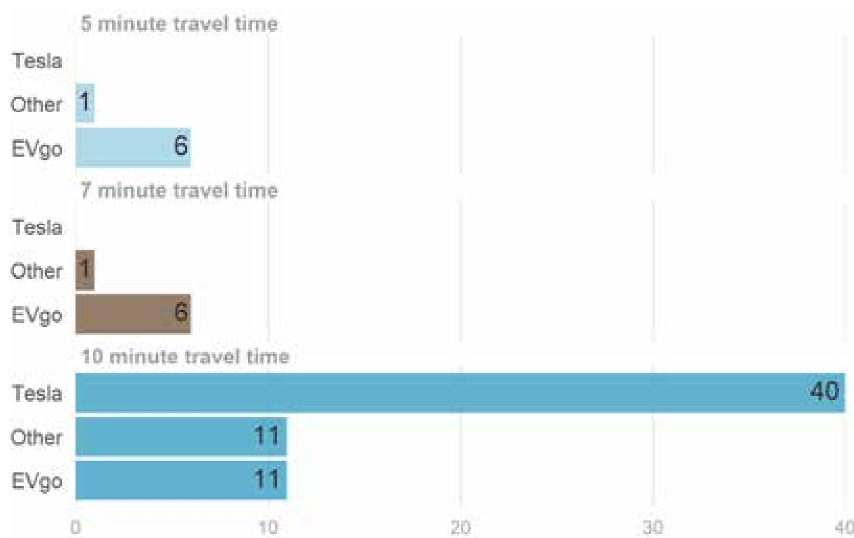


Other DCFC charging options

The HPCP locations add to existing stations that also might serve MUD residents. On average there are more DCFC public charging options near HPCP locations and non-HPCP locations, likely because HPCPs are located by design in dense urban areas. However, there is significant variation in DCFC access between individual HPCP service areas.

Figure 5 shows Broadway Millbrae HPCP is collocated with seven other DCFC in its close 5-minute travel shed. Six of the nearby DCFC belong to EVgo's Chula Vista Lot HPCP, which opened after the Millbrae location and did not accrue enough sessions to be included in the individual evaluations.

Figure 5. Number of DCFC (individual charging points) in or within half a mile of each travel shed.



CIM La Brea High Power Charging Plaza

The CIM La Brea HPCP is located at 1302 South La Brea Ave., Los Angeles, CA. The site consists of three 80kW DCFC. The HPCP is located in a shopping center that includes a Target® and Sprouts® Market in the Mid-Wilshire neighborhood of Los Angeles. The CIM La Brea HPCP commenced operations on November 16, 2019. It had been in operation three months at the point of the COVID-19 safer-at-home orders and 10 months in total over the data collection period.

Table 1. HPCP usage statistics

	sessions	individual users
MUD users	**491**	**72**
All users	2,399	389

Among the HPCP locations, CIM La Brea ranked fifth in absolute number of identified MUD users served. The CIM La Brea HPCP performs above average on MUD session share[59] and MUD user share[60] compared to other HPCP locations.

Figure 1. HPCP site MUD session and user share compared to non-HPCP site average

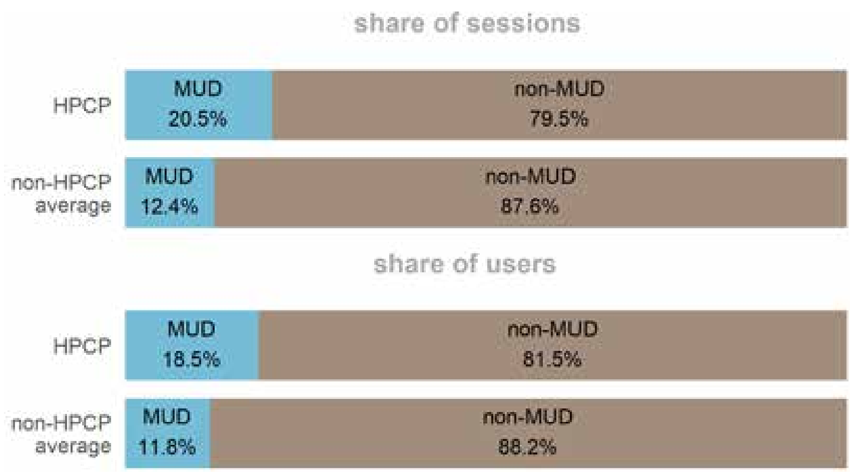


Figure 1 shows the comparison between CIM La Brea's MUD session share and MUD user share and the average of those metrics across comparison non-HPCP sites.[61] The CIM La Brea location significantly overperformed the non-HP-CP site average on the session share metric, indicating that it hosted a higher-than-average percentage of MUD resident customer sessions. The location also overperformed the MUD resident user metric, indicating that a larger-than-average share of its total users were MUD residents.

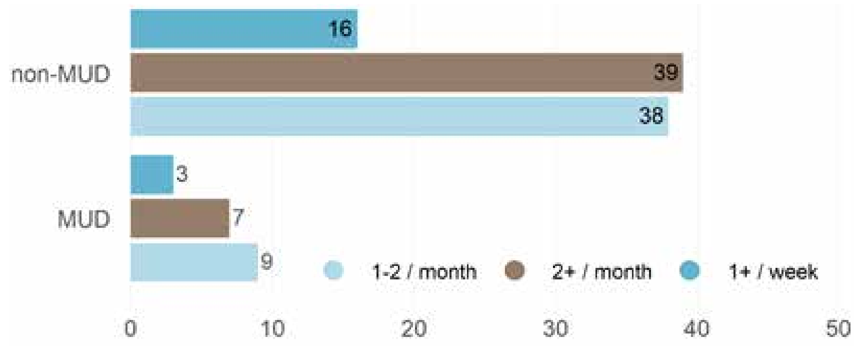
Figure 2 shows the number of frequent repeat users at CIM La Brea. We consider users who charge at least once a week to be significantly dependent on that location. Users who are regular monthly visitors are at least partially dependent on the location. Because a significant portion of data reporting occurred as traffic declined during the COVID-19 pandemic, this metric may not fully describe user dependence on this location.

[59] The fraction of a site's total hosted sessions that were initiated by an MUD resident. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.

[60] The fraction of a site's total unique users that are identified as MUD residents. A higher user share indicates relatively more MUD users use that station and a lower share indicate relatively fewer MUD users use that station.

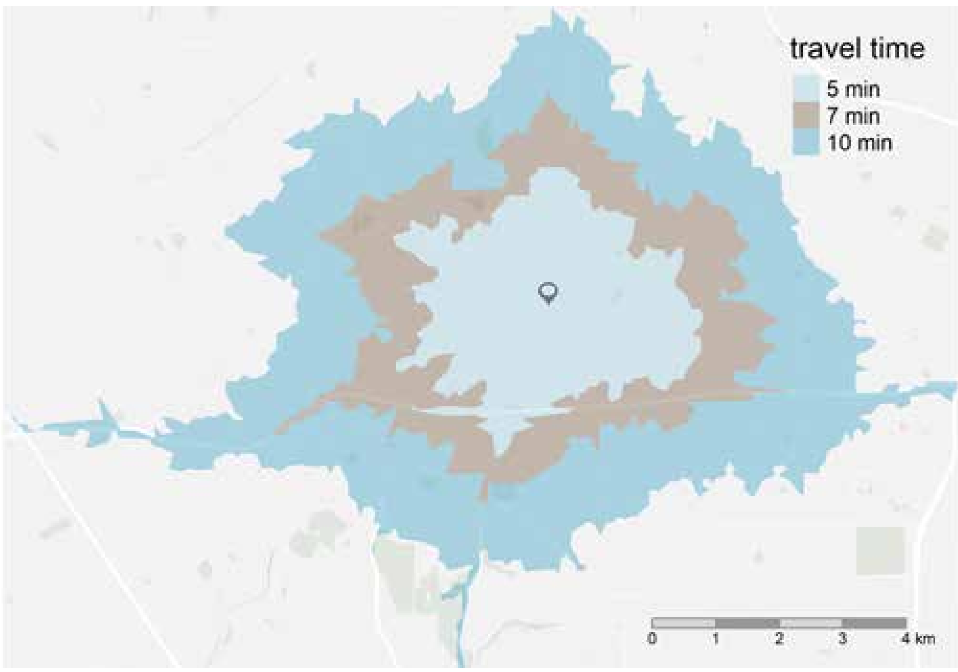
[61] The comparison sites are 50 randomly selected EVgo locations across California not developed under the HPCP program.

Figure 2. Frequent users at CIM La Brea HPCP



About the CIM La Brea HPCP

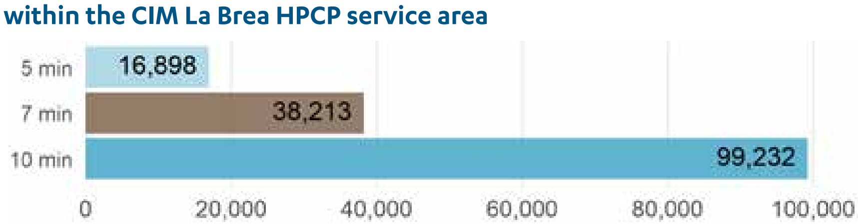
Figure 3. CIM La Brea HPCP service area map



The service area map (Figure 3) shows three progressively larger travel sheds from 5, 7 and 10 minutes. This represents the geographic area from which a driver can reach the HPCP within each of the three time increments. Although we report statistics for each of the three travel sheds, we view the 5-minute increment as the important residential service area because we find it the geographic area most strongly related to MUD user and session share.

Figure 4 shows that the CIM La Brea HPCP has many more MUD units within a 5-minute travel shed than the average non-HPCP site (5,521), and considerably more MUD units within 7- and 10-minute travel sheds (11,731 and 26,302). Compared to the average HPCP site, the CIM La Brea location has many more MUD units in all three travel sheds.

Figure 4. MUD units within the CIM La Brea HPCP service area



Other DCFC charging options

The HPCP locations add to existing stations that also might serve MUD residents. On average there are more DCFC public charging options near HPCP locations and non-HPCP locations, likely because HPCPs are located by design in dense urban areas. However, there is significant variation in DCFC access between individual HPCP service areas.

Figure 5. Number of DCFC (individual charging points) in or within half a mile of each travel shed.

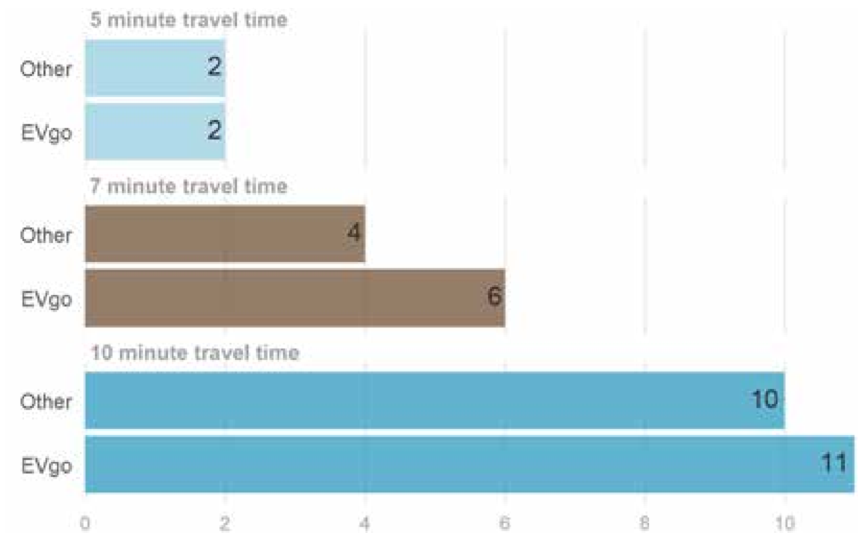


Figure 5 shows CIM La Brea HPCP is collocated with seven other DCFC in its close 5-minute travel shed and the same amount within the 7-minute travel shed. The number of DCFC charging options near this HPCP is about average for the typical non-HPCP station and slightly less than the typical HPCP station.

Chevron Los Angeles High Power Charging Plaza

The Chevron Los Angeles HPCP is located at 10867 Santa Monica Blvd, Los Angeles, CA. The site consists of four 80kW DCFC. The HPCP is located at a Chevron® gas station in the Westwood neighborhood of Los Angeles. The Chevron Los Angeles HPCP commenced operations on November 16, 2019. It had been in operation three months at the point of the COVID-19 safer-at-home orders and 10 months in total over the data collection period.

Table 1. HPCP usage statistics

	sessions	individual users
MUD users	**464**	**96**
All users	2,195	478

Among the HPCP locations, Chevron Los Angeles ranked sixth in absolute number of identified MUD users served. The Chevron Los Angeles HPCP performs above average on MUD session share[62] and MUD user share[63] compared to other HPCP locations.

Figure 1. HPCP site MUD session and user share compared to non-HPCP site average

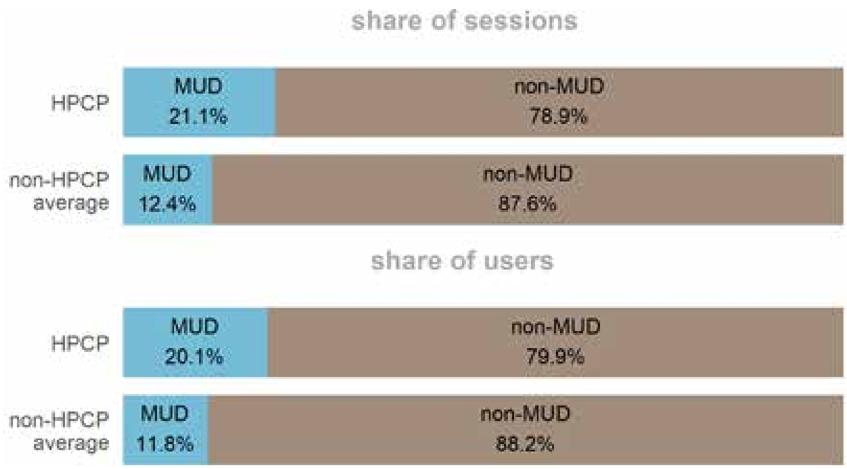
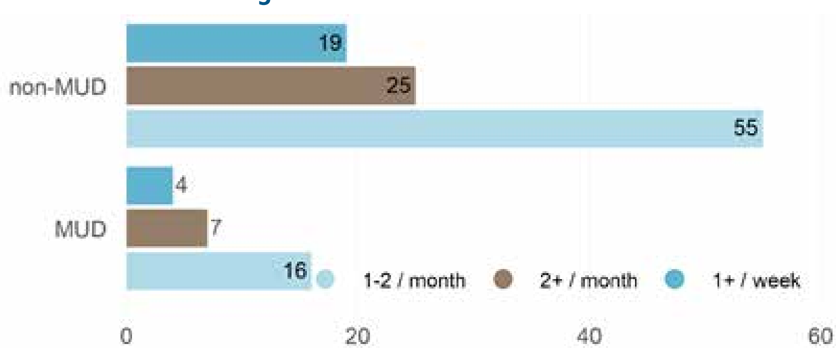


Figure 1 shows the comparison between Chevron Los Angeles's MUD session share and MUD user share and the average of those metrics across comparison non-HPCP sites.[64] The Chevron Los Angeles location significantly overperformed the non-HPCP site average on the session share metric, indicating that it hosted a higher-than-average percentage of MUD resident customer sessions. The location also overperformed the MUD resident user metric, indicating that a larger-than-average share of its total users were MUD residents.

Figure 2. Frequent users at Chevron Los Angeles HPCP



[62] The fraction of a site's total hosted sessions that were initiated by an MUD resident. A higher session share indicates relatively more MUD user usage at a station and a lower share indicates relatively less MUD usage.

[63] The fraction of a site's total unique users that are identified as MUD residents. A higher user share indicates relatively more MUD users use that station and a lower share indicate relatively fewer MUD users use that station.

[64] The comparison sites are 50 randomly selected EVgo locations across California not developed under the HPCP program.

Figure 2 shows the number of frequent repeat users at Chevron Los Angeles. We consider users who charge at least once a week to be significantly dependent on that location. Users who are regular monthly visitors are at least partially dependent on the location. Because a significant portion of data reporting occurred as traffic declined during the COVID-19 pandemic, this metric may not fully describe user dependence on this location.

About the Chevron Los Angeles HPCP

The service area map (Figure 3) shows three progressively larger travel sheds from 5, 7 and 10 minutes. This represents the geographic area from which a driver can reach the HPCP within each of the three time increments. Although we report statistics for each of the three travel sheds, we view the 5-minute increment as the important residential service area because we find it the geographic area most strongly related to MUD user and session share.

Figure 4 shows that the Chevron Los Angeles HPCP has many more MUD units within a 5-minute travel shed than the average non-HPCP site (5,521), and still considerably more MUD units within 7- and 10-minute travel sheds (11,731 and 26,302). Compared to the average HPCP site, the Chevron Los Angeles location has many more MUD units in all three travel sheds.

Figure 3. Chevron Los Angeles HPCP service service map

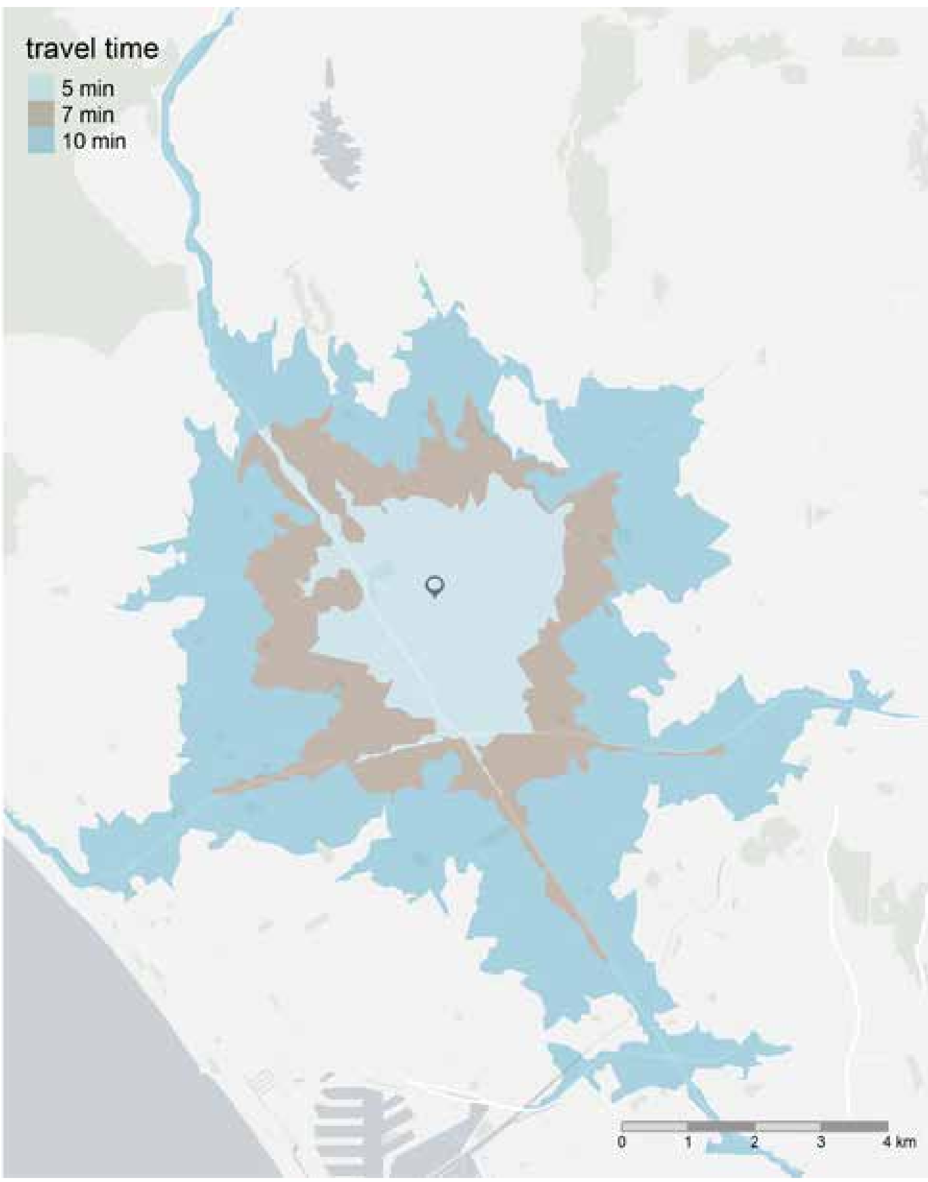
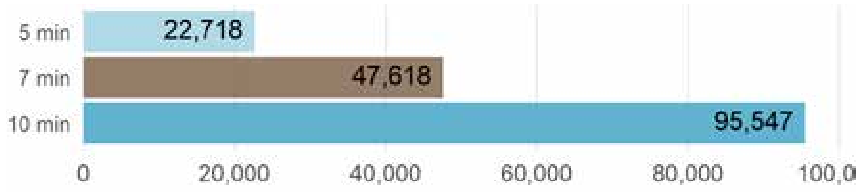


Figure 4. MUD units within the Chevron Los Angeles HPCP service area



Other DCFC charging options

The HPCP locations add to existing stations that also might serve MUD residents. On average there are more DCFC public charging options near HPCP locations and non-HPCP locations, likely because HPCPs are located by design in dense urban areas. However, there is significant variation in DCFC access between individual HPCP service areas.

Figure 5. Number of DCFC (individual charging points) in or within half a mile of each travel shed.

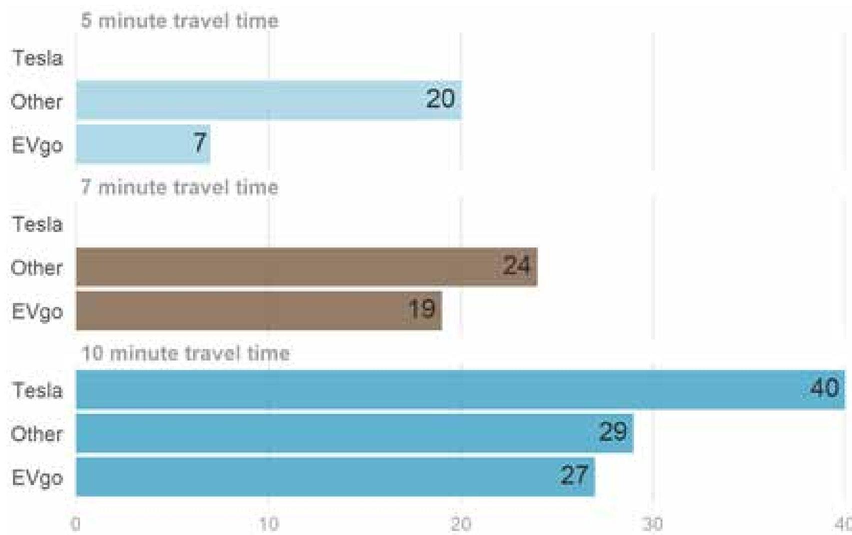


Figure 5 shows Chevron Los Angeles HPCP is collocated with 27 other DCFC in its close 5-minute travel shed. Six of the EVgo DCFC in the 5-minute travel shed are located at the UCLA Lot 4 HPCP, which came online in February 2020 but did not accrue enough sessions to qualify for individual assessment. The number of non-Tesla DCFC charging options near this HPCP are higher than average for the typical non-HPCP station and the typical HPCP station.

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