Electric Vehicle Charging Infrastructure Trends from the Alternative Fueling Station Locator: Second Quarter 2020

Abby Brown,[1] Stephen Lommele,[1] Alexis Schayowitz,[2] and Emily Klotz[2]

1 National Renewable Energy Laboratory
2 ICF

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List of Acronyms

AFDC	Alternative Fuels Data Center
API	application program interface
BN	Blink network
CCS	Combined Charging System
CPN	ChargePoint network
DC	direct-current
DOE	U.S. Department of Energy
E85	ethanol blend containing 51% to 83% ethanol, depending on geography and season
EA	Electrify America network
EV	all-electric vehicle
EVC	EV Connect network
EVN	EVgo network
EVSE	electric vehicle supply equipment
EVSP	electric vehicle service provider
FCN	Francis network
FLO	FLO network
GRN	Greenlots network
kW	kilowatt
L1	Level 1 charger
L2	Level 2 charger
MUD	multi-unit dwelling, also referred to as multi-family building
NON	non-networked
NREL	National Renewable Energy Laboratory
OC	OpConnect network
OCPI	Open Charge Point Interface
PEV	plug-in electric vehicle
Q1	quarter 1, or first quarter of the calendar year
Q2	quarter 2, or second quarter of the calendar year
SCN	SemaConnect network
TESLA	Tesla Supercharger network
TESLAD	Tesla Destination network
VLTA	Volta network
WEB	Webasto network

Executive Summary

The U.S. Department of Energy's (DOE's) Alternative Fueling Station Locator contains information on public and private non-residential alternative fueling stations in the United States and Canada and currently tracks ethanol (E85), biodiesel, compressed natural gas, electric vehicle (EV) charging, hydrogen, liquefied natural gas, and propane stations. Of these fuels, EV charging continues to experience rapidly changing technology and growing infrastructure. This report provides a snapshot of the state of EV charging infrastructure in the United States in the second calendar quarter of 2020 (Q2). Using data from the Station Locator, this report breaks down the growth of public and private charging infrastructure by charging level, network, and location. Additionally, this report measures the current state of charging infrastructure compared with the amount projected to meet charging demand by 2030. This information is intended to help transportation planners, policymakers, researchers, infrastructure developers, and others understand the rapidly changing landscape for EV charging. This is the second report in a new series. The first report for the first calendar quarter of 2020 can be found in the publication databases of the Alternative Fuels Data Center and the National Renewable Energy Laboratory (NREL).

In Q2, all categories of electric vehicle supply equipment (EVSE) grew, except for public Level 1 EVSE, which decreased by 1.1%. Overall, there was a 3.4% increase in the number of EVSE in the Station Locator. The majority of EVSE in the Station Locator are Level 2, though direct-current (DC) fast charger EVSE grew by the largest percentage in Q2. The South Central region had the largest increase in public charging infrastructure in Q2, though California continues to lead the country in the number of available public EVSE.

NREL's 2017 "National Plug-In Electric Vehicle Infrastructure Analysis" estimated how much public and workplace charging infrastructure would be required in the United States to meet charging demand for a central scenario in which 15 million light-duty plug-in electric vehicles (PEVs) are the road by 2030 (601,000 Level 2 and 27,500 DC fast EVSE) (Wood 2017). Based on this analysis, about 52.9% and 12.4% of the necessary DC fast and Level 2 EVSE, respectively, have been installed as of Q2. However, in Q2 the number of DC fast EVSE and Level 2 EVSE per 1,000 PEVs was 10.0 and 51.0 respectively, compared with NREL's projected need of 1.8 and 40.1, respectively. This indicates that infrastructure development is keeping up with, and even surpassing, charging demand. It is important to note that the majority (54.9%) of public DC fast EVSE in the Station Locator are on the Tesla network and are therefore only readily accessible to Tesla drivers.

Table of Contents

List of Figures

List of Tables

1 Overview of the Station Locator

The U.S. Department of Energy's (DOE) Alternative Fuels Data Center (AFDC) launched in 1991 in response to the Alternative Motor Fuels Act of 1988 and the Clean Air Act Amendments of 1990 (Alternative Fuels Data Center, n.d.a.). Originally, it served as a hard copy resource for alternative fuel performance data and eventually became an internet resource in 1995. Since then, the AFDC has evolved dramatically into a robust online resource that provides a broad range of information on alternative fuels and advanced transportation technologies, including fueling and charging station data. In 2017, NREL partnered with National Resources Canada to expand the dataset to include the location of those same alternative fuel stations across Canada as the Electric Charging and Alternative Fueling Stations Locator, or Localisateur de stations de recharge et de stations de ravitaillement en carburants de remplacement (Levene et al. 2019). The Station Locator database now includes information on public and private non-residential alternative fueling stations in the United States and Canada and currently tracks ethanol (E85), biodiesel, compressed natural gas, electric vehicle (EV) charging, hydrogen, liquefied natural gas, and propane stations.

While historical data for all fuel types in the Station Locator are available, it is especially important to take an in-depth look at EV charging due to rapidly changing technology and growing infrastructure. This trend is likely to continue as original equipment manufacturers offer more EV models, more utilities begin offering incentives for EVs and infrastructure, and states and municipalities set electrification goals. Using Station Locator data, this paper explores the growth of both public and private EV charging infrastructure in the United States for the second calendar quarter of 2020 (Q2). This is the second report in a series. The report for the first calendar quarter of 2020 (Q1) can be found in the AFDC and National Renewable Energy Laboratory (NREL) publication databases.

1.1 EV Charging Data Sources

NREL and its data collection contractor and collaborator, ICF, use a variety of methods to gather and verify EV charging data in the Station Locator. Electric vehicle service providers (EVSPs), responsible for managing a network of EV charging stations (Figure 1), share data directly with the Station Locator team and are the largest data source for EV charging in the Station Locator.

In addition, data are collected through industry outreach, Clean Cities coordinators, and other manual methods.

Non-Networked Stations

Non-networked EV charging stations are not connected to the internet and provide basic charging functionality without advanced communications capabilities. Because of this, non-networked charging is generally free or offered as an amenity for those who pay for parking or to access a business.

Networked Stations

Networked EV charging stations are connected to the internet via a cable or wireless technology and can communicate with the backend computer system of an EVSP. Being connected to a network lets station owners or site hosts manage who can access stations and control how much it costs drivers to charge their vehicle. An EVSP typically manages a group of networked EVSE and may use its communication capabilities to communicate directly with drivers, other EVSPs, or utilities; monitor and share real-time station status; broadcast location information; collect and store usage data; control access; or facilitate payment.

Figure 1. Non-networked vs. networked EV charging stations.

1.1.1 Data from Charging Network APIs

Prior to 2014, NREL manually collected all EV charging data, including EV charging stations managed by EVSPs. In 2014, to keep up with the rapid growth of charging infrastructure, NREL began incorporating daily updates on networked charging station data directly from EVSPs, when available. NREL does this by accessing the network's application programming interface (API) and importing each network's API data into the database. Using APIs ensures that the efficiency, accuracy, and completeness of the data is maintained.

Figure 2 shows a timeline of the integration of the network APIs into the Station Locator data management process. Open Charge Point Interface (OCPI)-based APIs that have been integrated into the Station Locator are also shown in Figure 2. See section 1.2 for more information on OCPI.

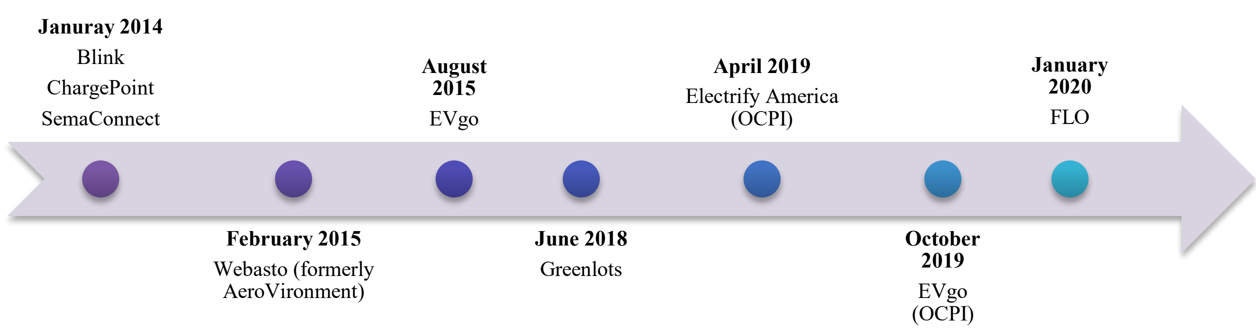

Figure 2. Timeline of API integrations in the Station Locator.

As of June 2020, there were 29,059 public and private charging stations in the database, which are available on the Station Locator or accessible via API or data download (Alternative Fuels

Data Center, n.d.b.). Of those, approximately 54% are automatically updated daily via EVSP-provided APIs while the rest are managed and updated manually.

The Station Locator team is working with additional EVSPs to access and integrate existing APIs or to provide them with best practices on developing an API if they have not yet automated their data sharing. This will help ensure that station data is as current and accurate as possible, while also increasing the efficiency of the update process for EV charging data.

1.1.2 Manually Collected Data

For non-networked (i.e., not connected to the internet) stations, data sources include trade media, Clean Cities coordinators, a Submit New Station form on the Station Locator website, EV charging station manufacturers, electric utilities, original equipment manufacturers, state and municipal governments, private companies, and others. The Station Locator team regularly monitors news outlets for press releases on new EV charging station openings and seeks out more information as appropriate to confirm and add the EV charging data to the Station Locator.

The Station Locator team also receives semi-regular data in the form of spreadsheets from EVSPs that do not have an API available. These EVSPs include EV Connect, Tesla, and Volta. The team is greatly appreciative of their continued collaboration and willingness to share regular data updates.

Finally, Clean Cities coalitions (see section 2.1.3) proactively provide information on station updates and additions throughout the year. Coalitions also serve as a valuable on-the-ground resource for stations that ICF is not able to confirm through normal station confirmation processes. Unconfirmed stations are sent to coalitions throughout the year for confirmation; if the coalition is not able to provide any additional information, the station is subsequently removed from the Station Locator.

It is important to state that these reports reflect a snapshot of the number of electric vehicle supply equipment (EVSE) in the Station Locator at the end of each quarter. Therefore, notable changes may be attributed to the manual data collection process, as the Station Locator team counts new manually added EVSE in the quarter in which it is added to the Station Locator as opposed to when the infrastructure was installed. For example, as discussed in section 2.1.2, the number of EVSE on the Francis Energy network grew significantly in Q2, which is due to the Station Locator team adding Francis Energy as a new network in Q1, and then adding several Francis Energy EVSE to the Station Locator in Q2 based on an update that Francis Energy shared.

1.2 EV Charging Data Fields

Current charging infrastructure in the Station Locator generally falls into the following categories:

- **Public:** A broad category that includes EV charging located in publicly accessible areas or along highway corridors.
- **Workplace:** EV charging intended to provide charging to employees during the workday.

- **Commercial/Fleet:** EV charging intended to provide charging for electric fleet vehicles, including municipal/private fleets, car sharing, and transportation network companies.

Note that while fleet data exists in the Station Locator, stations solely for fleet use are not yet designated as such in the Station Locator. The Station Locator team has recently added this level of tracking and will therefore be able to designate stations as such moving forward. See section 3.4 for more details.

Additionally, the Station Locator does not maintain data on single-family residential charging and has minimal, yet expanding, data on charging at multi-unit dwellings (MUDs, also referred to as multi-family buildings). See section 3.3 for additional details.

In 2019, the Station Locator team began transitioning its counting logic to align with the hierarchy defined in the OCPI protocol: locations, EVSE, and connectors (EVRoaming Foundation, n.d.), as shown in Figure 3 and described below. With this transition, the Station Locator is now counting the number of EVSE at a station location, rather than the number of connectors previously counted.

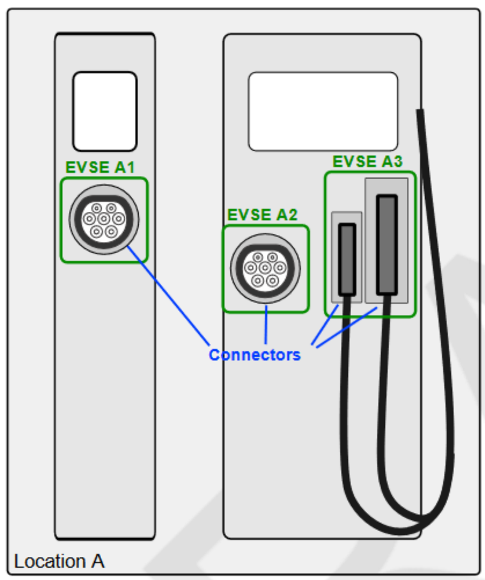

Figure 3. EV charging infrastructure hierarchy as defined in OCPI (EVRoaming Foundation, n.d.).

The following fuel-specific fields are tracked in the Station Locator for EV charging stations (Alternative Fuels Data Center, n.d.c.):

- EV charger information:
  - EV charging station: one or more EVSE located at the same address
  - EVSE count: the number of outlets or ports (i.e., the number of vehicles that can simultaneously charge at a charging station)
  - Charger type
    - Level 1 (L1): 120V; 1 hour of charging = 2-5 miles of range
    - Level 2 (L2): 240V; 1 hour of charging = 10-20 miles of range

        - Direct-current (DC) fast: 480V+; 20 minutes of charging = 60-80 miles of range
    - Connectors (number and type)
        - NEMA: for Level 1 chargers
        - J1772: for Level 1 and Level 2 chargers
        - Combined Charging System (CCS): for DC fast chargers
        - CHAdeMO: for DC fast chargers
        - Tesla: for all charging levels for Tesla vehicles
    - Network
    - Manufacturer
    - Power output (kilowatts, kW)
- Open date
- Workplace (yes/no)
- Pricing
- On-site renewable electricity source.

These fields and the associated definitions are used in the analysis that follows.

2 Electric Vehicle Charging Infrastructure Trends

The purpose of this paper is to identify EV charging infrastructure trends for Q2 of 2020. However, as previously mentioned, the Station Locator has been collecting data on alternative fueling stations since the 1990s and therefore has historical EV charging station data for several years that can serve as a baseline for more analysis. See the first report in this series for the growth of EVSE and EV charging stations in the Station Locator over the last ten years.

In Q2, the number of EVSE in the Station Locator grew by 3.4%, or 3,222 EVSE. Public EVSE grew by 3.6% and account for the majority of EVSE in the Station Locator (Figure 4). Private EVSE grew by 2.4% (Figure 4).

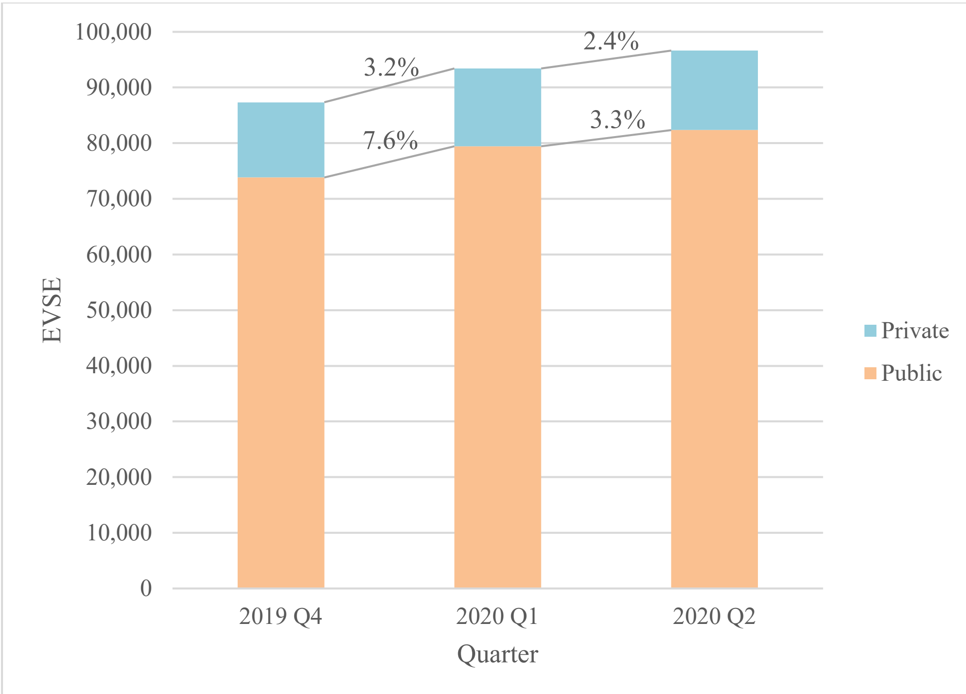

Figure 4. Quarterly growth of EVSE by access.

The following sections break down the growth of public and private EVSE further to highlight what types of EV infrastructure grew in Q2 and where EV infrastructure has grown geographically. Since the number of EVSE represents the number of vehicles that can charge simultaneously at an EV charging station, the remainder of this report will focus on EVSE growth.

2.1 Public Charging Trends

As previously mentioned, public EV charging refers to EV charging stations that are available to all EV drivers and located in publicly accessible locations, such as commercial locations or along highway corridors. In Q2, the number of public EVSE in the Station Locator increased by 2,886, bringing the total number of public EVSE in the Station Locator to 82,351 and representing a 3.6% increase since Q1. The following sections break down the growth of public EVSE by charging level, network, region, and state.

2.1.1 By Charging Level

As shown in Figure 5, the majority of public EVSE in the Station Locator are Level 2, followed by DC fast and Level 1. In Q2, DC fast EVSE increased by the greatest percentage (6.8%), while Level 1 EVSE decreased by 1.1% (Figure 5). The decrease in public Level 1 EVSE can be attributed to a decrease in Level 1 EVSE on the ChargePoint network, though the ChargePoint network grew overall in Q2.

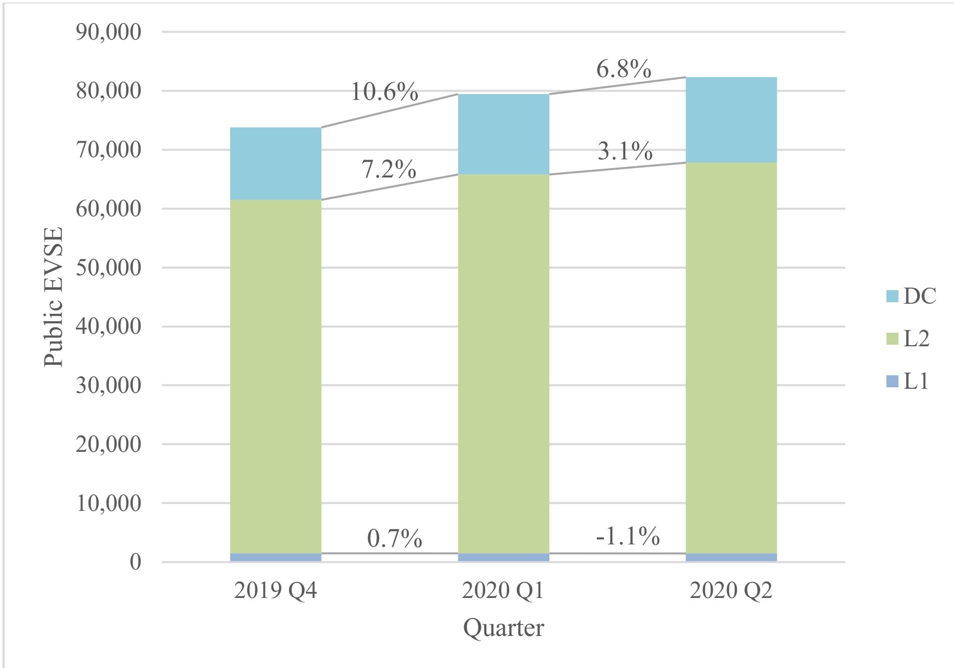

Figure 5. Quarterly growth of public EVSE by charging level.

When compared with Level 1 and Level 2 chargers, DC fast chargers have the highest power output and therefore provide the most charge in the least amount of time. DC fast chargers have a standard power output of 50 kW, though DC fast chargers with higher levels of power output are available. Extreme fast charging infrastructure, which has a power output of 350 kW or more, was introduced in 2018. However, as shown in Figure 6, the majority of DC fast EVSE in the Station Locator still currently have the standard power output of 50 kW or less.

It is important to point out that of the 14,514 public DC fast EVSE in the Station Locator, power output data is currently only available for 37.4%; Figure 6 is therefore based on power output data for 5,432 DC fast EVSE. NREL is in the process of integrating updated OCPI-based APIs to streamline the collection of power output data and create a more complete set of data. Additionally, if a DC fast EVSE has two connectors with different power outputs, only the maximum power output is counted in Figure 6.

As shown in Figure 6, the number of EVSE with a power output between 51 kW and 299 kW grew by the largest percentage in Q2 (9.7%). The number of EVSE with a power output of 300 kW or greater decreased by -0.3%, which represents a decrease of two EVSE.

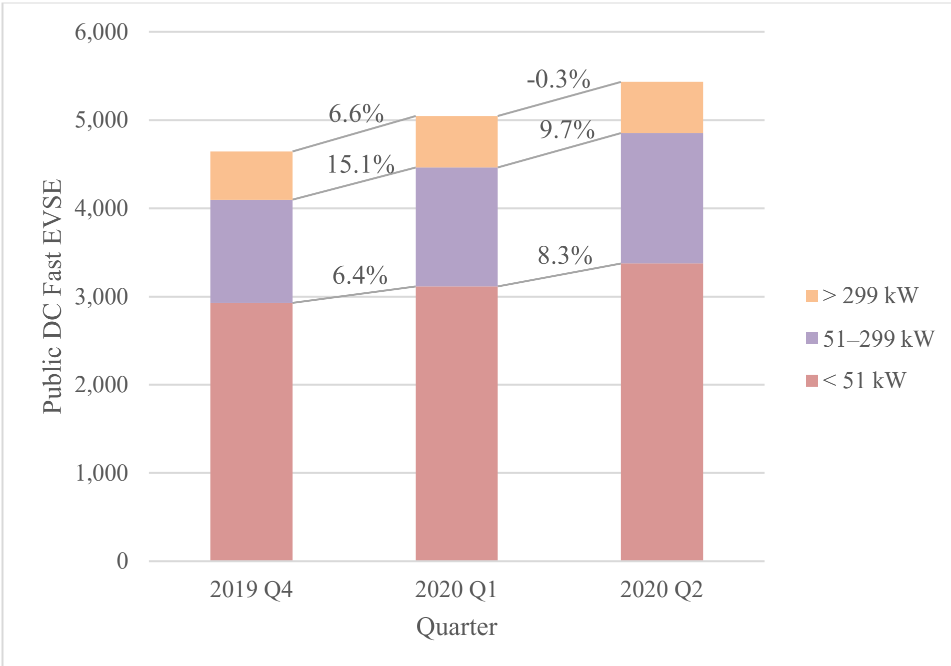

Figure 6. Quarterly growth of public DC fast EVSE by power output.

There are currently three types of connectors that are available for DC fast chargers: CHAdeMO, CCS, and Tesla. Of the 16,670 DC fast connectors in the Station Locator as of Q2, Tesla connectors made up the largest proportion, followed by CCS and CHAdeMO connectors (Figure 7). However, CHAdeMO connectors grew the most in Q2 (12.4%) (Figure 7).

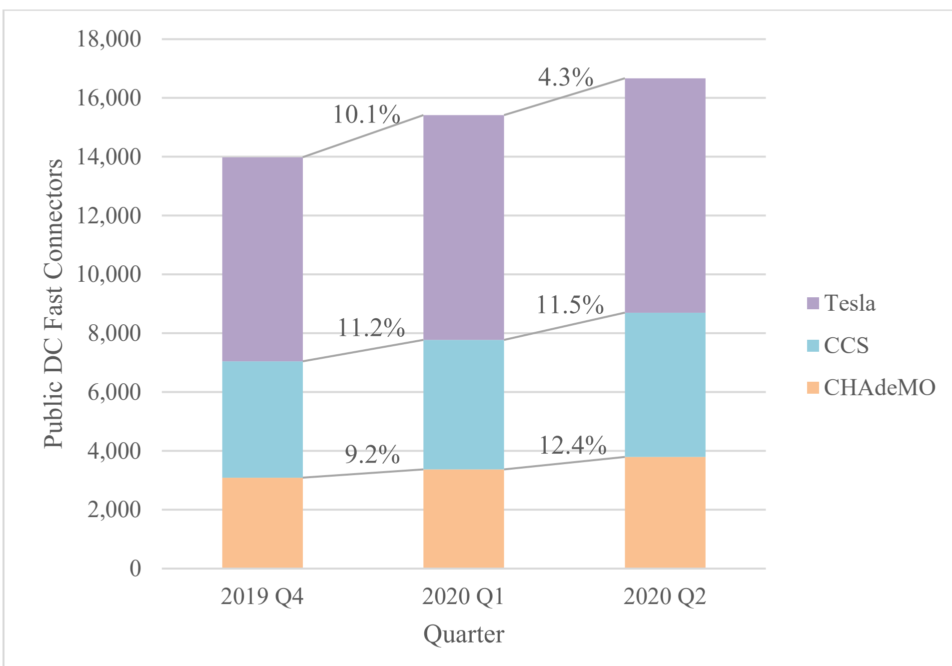

Figure 7. Quarterly growth of public DC fast connectors by type.

2.1.2 By Network

As discussed in section 1.1, the Station Locator team works with several EVSPs to collect EV charging infrastructure data for the Station Locator. Currently, the Station Locator includes stations on the below networks. In addition, the Station Locator collects non-networked (NON) station data, which includes stations that were previously networked.

- Blink (BN)
- ChargePoint (CPN)
- Electrify America (EA)
- EV Connect (EVC)
- EVgo (EVN)
- FLO (FLO)
- Francis Energy (FCN)
- Greenlots (GRN)
- OpConnect (OC)
- SemaConnect (SCN)
- Tesla Supercharger (TESLA)
- Tesla Destination (TESLAD)
- Volta (VLTA)
- Webasto (WEB)

As of the end of Q2, the ChargePoint network accounted for the largest number of public EVSE (43.1%) in the Station Locator, and Level 2 chargers comprised the majority of ChargePoint's network (Figure 8). Many of the networks in the Station Locator are also primarily composed of Level 2 chargers, except for the Electrify America, EVgo, and Tesla Supercharger networks, which are predominately, if not completely, made up of DC fast chargers.

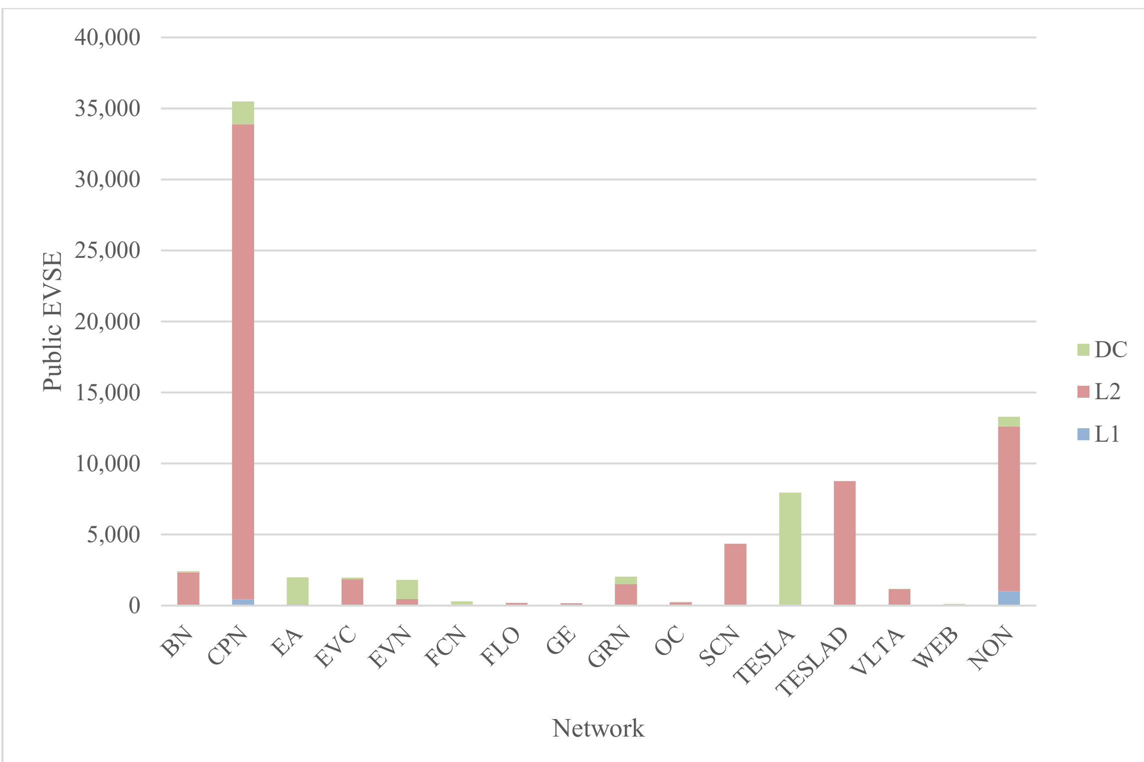

Figure 8. Breakdown of public EVSE by network and charging level in Q2.

Figure 9 shows the growth of each network in Q2, while Table 1 includes the percent growth of each network in Q2. With the exception of three networks, the number of public EVSE on all networks grew in Q2. Tesla Destination and Volta did not grow in Q2 as the Station Locator team did not receive updates for these two networks, as discussed in section 1.1.2. However, we expect any stations added in Q2 to be reflected in future quarters. The number of public EVSE on the Blink network decreased by 3.4%. The decrease in Blink EVSE can largely be explained by older stations being decommissioned; 73% of the decrease can be attributed to the removal of stations that were installed in 2015 or earlier. However, the Station Locator team anticipates that the number of public Blink EVSE will grow in future quarters as Blink works to replace their first-generation chargers and continues efforts to expand their network. See section 5 for an example of such efforts.

The number of EVSE on the Francis Energy network increased by the largest amount in Q2, from 1 EVSE to 312 EVSE, due to the previously mentioned update that the Station Locator team received from Francis Energy in Q2. The FLO network was new to the U.S. Station Locator as of Q1 and grew by just over 25% in Q2.

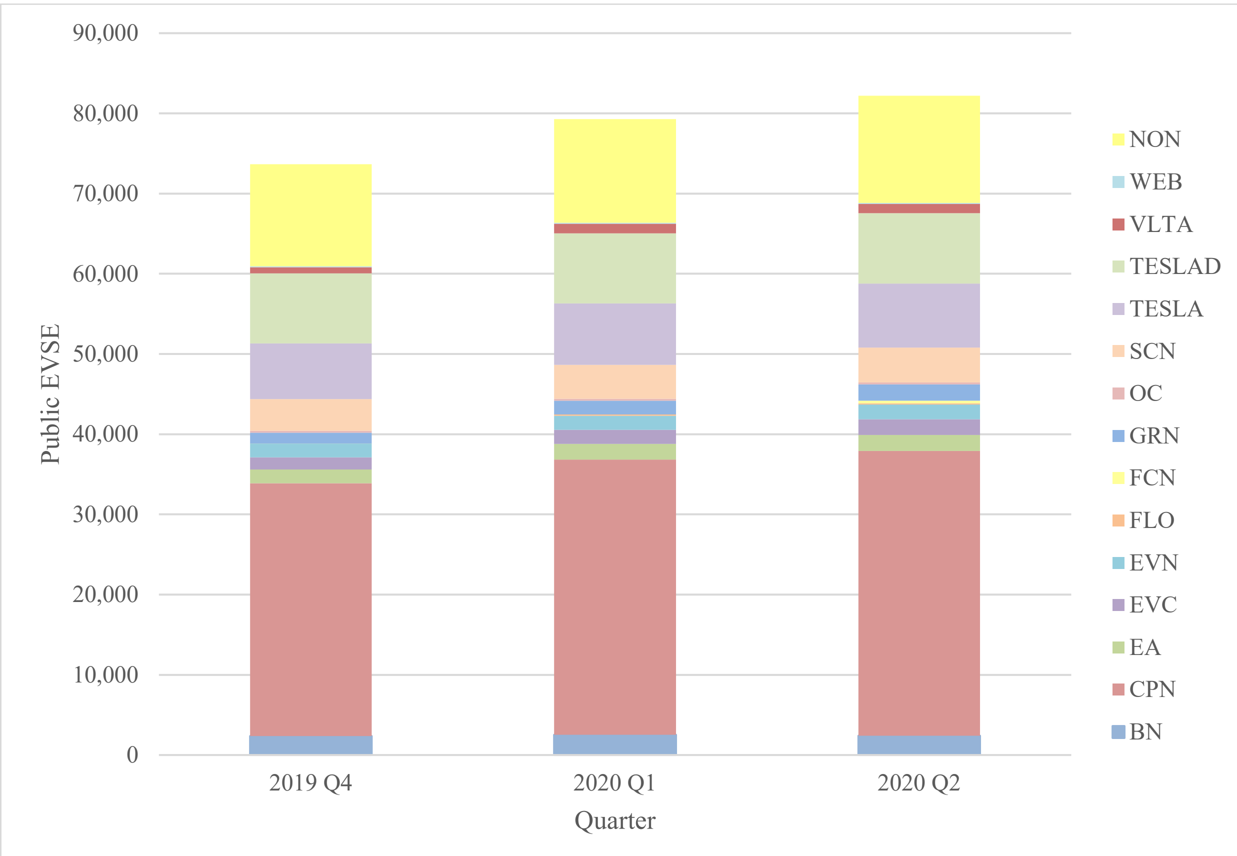

Figure 9. Quarterly growth of public EVSE by network.

Table 1. Quarterly Growth of Public EVSE by Network.[1]

Network	Q1 Growth	Q2 Growth
NON	1.8%	3.0%
WEB	0.9%	-0.9%
VLTA	53.5%	0.0%
TESLAD	0.2%	0.0%
TESLA	10.1%	4.3%
SCN	7.6%	2.6%
OC	0.0%	4.9%
GRN	24.2%	18.9%
FCN	0.0%	31,100.0%
FLO	N/A	25.8%
EVN	3.2%	2.2%
EVC	17.7%	11.2%
EA	11.9%	2.3%
CPN	9.0%	3.4%
BN	5.5%	-3.4%
Total	**7.6%**	**3.3%**

2.1.3 By Region

The Clean Cities Coalition Network is broken down into regions (Figure 10), which were used to analyze the growth of public EV charging infrastructure across the country (Clean Cities Coalition Network, n.d.b.). See the first report in this series for more information about the Clean Cities Coalition Network.

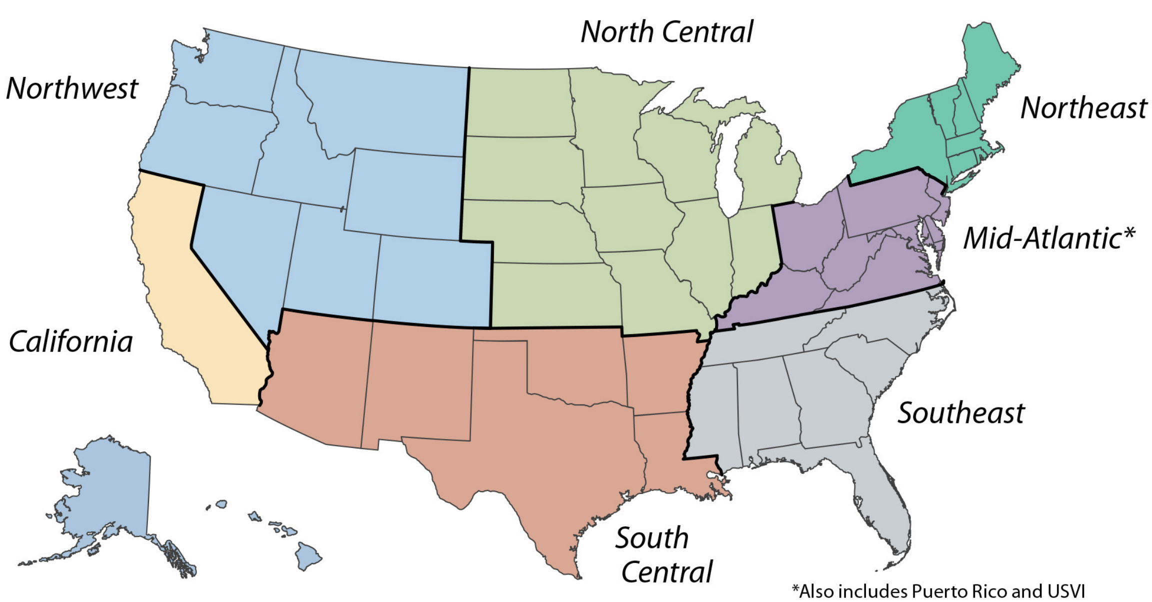

Figure 10. Clean Cities regions.

[1] Networks with 0% growth in Q2 did not provide an update to the Station Locator team in Q2.

As shown in Figure 11, the California region had the largest share of the country's public EVSE in Q2 (31.7%), while the South Central region had the smallest share (8.2%). However, in Q2, the number of public EVSE in the South Central region grew by the largest percentage (5.9%). This is due to a large update from the Francis Energy network, as all EVSE on this network are in Oklahoma. The number of public EVSE in the North Central region grew by the smallest percentage in Q2 (2.5%) (Figure 11).

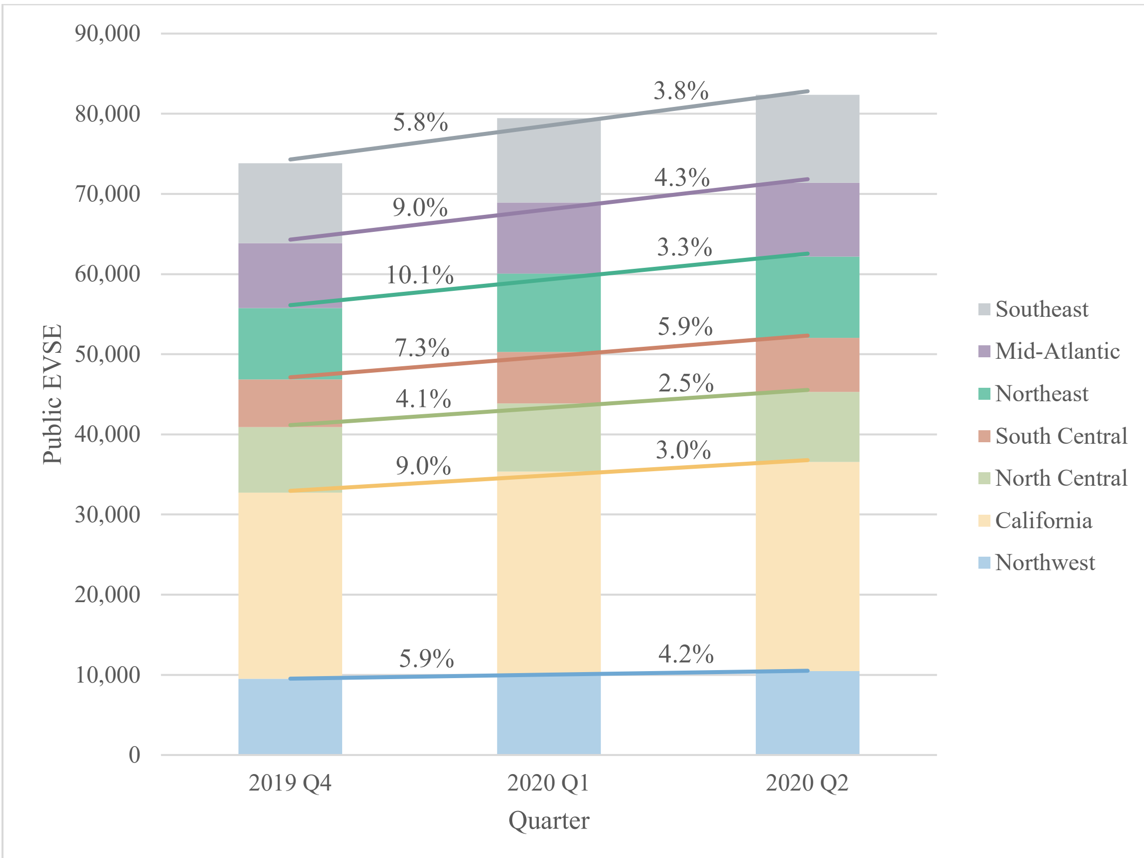

Figure 11. Quarterly growth of public EVSE by Clean Cities region.

2.1.4 By State

To track the growth of EVSE by state, we calculated the number of public EVSE per 100,000 people in each state. We chose this metric to compare charging infrastructure development across states on a basis that accounts for proportional impact. Washington, D.C., is considered a state for the purpose of this analysis, and the population data used is based on the U.S. Census Bureau's 2019 estimates (U.S. Census Bureau 2019).

As of the end of Q2, the number of EVSE per 100,000 people ranged from 4.8 in Alaska to 106.6 in Vermont. The five states with the highest number of EVSE per 100,000 people were Vermont, California, Washington, D.C., Hawaii, and Colorado (Table 2). However, the five states that had the largest growth of EVSE per 100,000 people were Oklahoma, North Dakota, Utah, Alabama, and Idaho (Table 3). As previously mentioned, the large increase in EVSE in Oklahoma is due to an update provided by Francis Energy in Q2.

Table 2. States with the Highest Rate of EVSE per 100,000 People.

State	EVSE per 100,000 People
Vermont	106.6
California	65.9
Washington, D.C.	65.0
Hawaii	46.4
Colorado	42.6

Table 3. States with the Largest Growth of EVSE per 100,000 People.

State	Q2 Growth of EVSE per 100,000 People
Oklahoma	96.3%
North Dakota	51.2%
Utah	26.0%
Alabama	14.8%
Idaho	8.3%

3 Private Charging Trends

Private EV charging refers to EV charging stations that are available only to certain drivers for specific purposes, such as charging for transit fleets or employee-only charging at places of work. While the Station Locator team proactively seeks out new station openings to include in the Station Locator, the opening of private workplace chargers may not necessarily be shared publicly. The Station Locator team therefore relies on Clean Cities coalitions, industry partners, and Station Locator users to share this information. Due to the challenge in collecting this data, the number of private, non-residential charging stations in the Station Locator is likely underrepresented.

In Q2, the number of private EVSE in the Station Locator increased by 336, bringing the total number of private EVSE in the Station Locator to 14,274 and representing a 2.4% growth since Q1. The following sections break down the growth of private EVSE by level, as well as by two specific types: workplace charging and MUD charging.

3.1 By Charging Level

As shown in Figure 12, the majority of private EVSE in the Station Locator are Level 2. However, DC fast EVSE grew by the largest percentage overall (13.2%) in Q2 (Figure 12). The private DC fast EVSE in the Station Locator are predominately for government fleets, including a few public transit authorities, or otherwise serve as workplace charging.

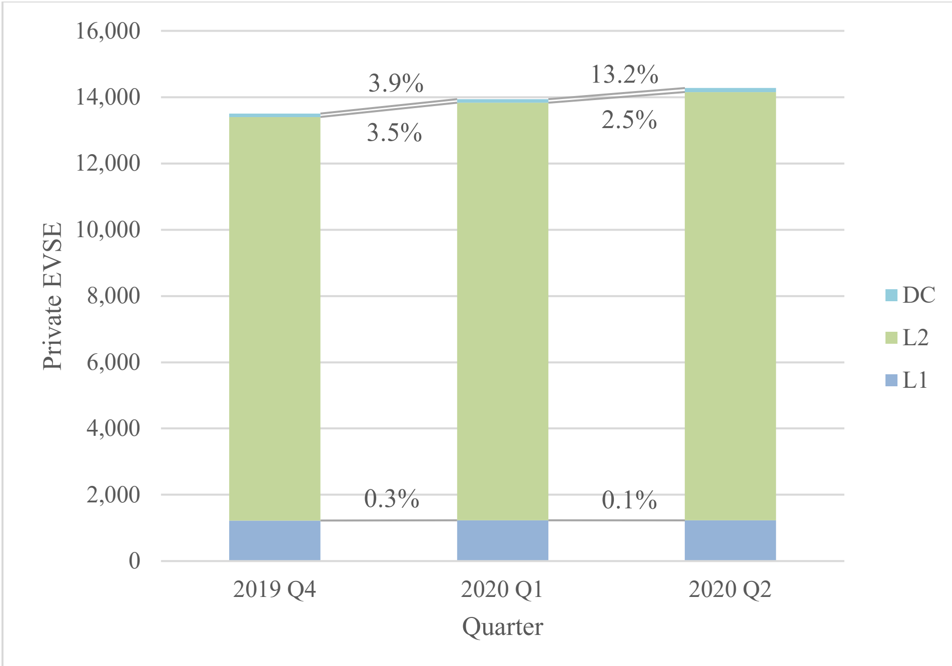

Figure 12. Quarterly growth of private EVSE by charging level.

3.2 Workplace Charging

Workplace EV charging infrastructure includes charging stations that are private or otherwise designated for employee use. The majority of private workplace EVSE in the Station Locator are Level 2 (Figure 13). This is to be expected since workplace chargers are used by employees while they are parked at work for an extended period and therefore do not necessarily need rapid charging.

As of the end of Q2, there were 8,249 workplace EVSE in the Station Locator. As shown in Figure 13, the number of Level 2 EVSE grew by the greatest amount (3.7%) at workplaces in Q2.

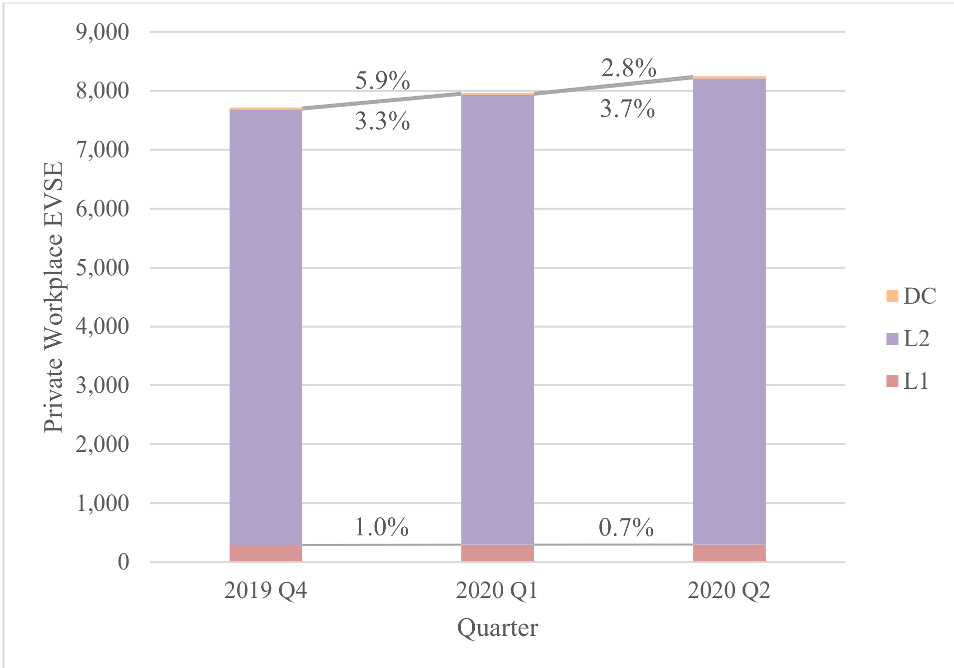

Figure 13. Quarterly growth of private workplace EVSE by charging level.

3.3 Multi-Unit Dwelling Charging

In 2019, the Station Locator team began a focused effort to capture private charging infrastructure installed at MUDs that is available for resident use only. In Q2, there was a 24.5% increase in MUD EVSE, bringing the total number of private MUD EVSE to 453 (Figure 14). This large increase is due to updates that the Station Locator team received in Q2 from two property management companies. All MUD EVSE in the Station Locator are either Level 1 or Level 2, but only Level 2 EVSE grew in Q2 (Figure 14).

As the Station Locator team continues its concerted MUD data collection efforts in 2020, the number of MUD EVSE is likely to continue to grow as it did in Q2.

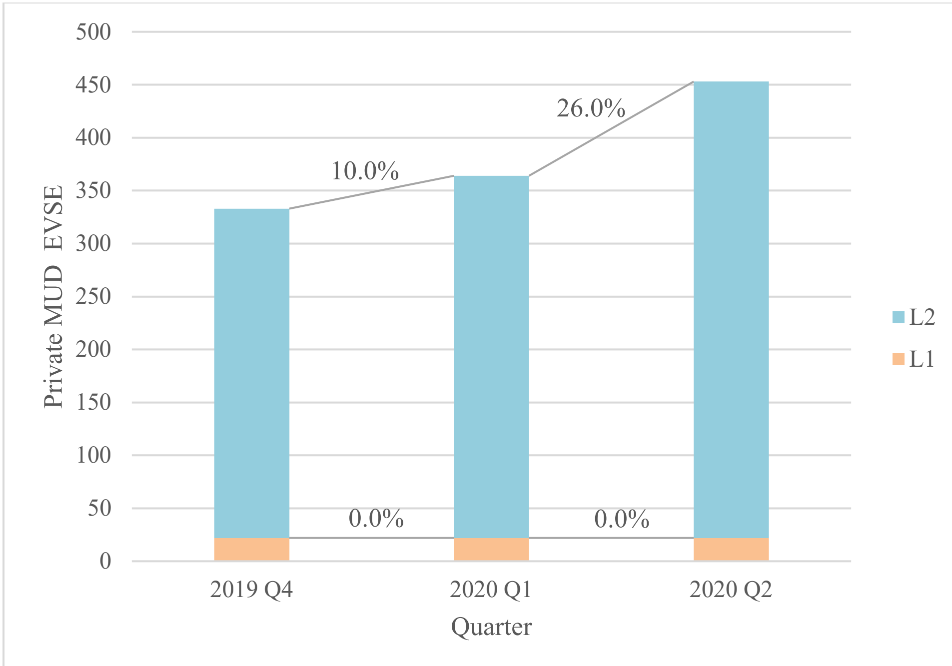

Figure 14. Quarterly growth of private MUD EVSE by charging level.

3.4 Fleet Charging

In 2020, the Station Locator team will focus on expanding its private fleet data collection efforts, especially for fleets that are installing charging infrastructure for medium- and heavy-duty vehicles, such as school bus fleets and public transit fleets. Once a more robust dataset is available, future quarterly reports will include data on this kind of charging infrastructure.

4 Projecting Future Charging Infrastructure Needs

NREL's 2017 "National Plug-In Electric Vehicle Infrastructure Analysis" estimated how much public and workplace EV charging infrastructure would be required in the United States in order to support a growing fleet of light-duty plug-in electric vehicles (PEVs), including both plug-in hybrid electric vehicles and battery electric vehicles (Wood 2017). Based on the central scenario in the analysis in which there are 15 million light-duty PEVs on the road in 2030, this analysis estimated that a total of 27,500 DC fast EVSE and 601,000 Level 2 EVSE would need to be available across the United States to meet demand for charging. This equates to 1.8 DC fast EVSE per 1,000 PEVs and 40.1 Level 2 EVSE per 1,000 PEVs by 2030.

As of Q2, there were 14,551 public and workplace DC fast EVSE and 74,238 public and workplace Level 2 EVSE available in the United States (Figure 15). Based on NREL's 2017 analysis, the amount of DC fast and Level 2 EVSE installed is 52.9% and 12.4%, respectively, of the way toward meeting projected 2030 infrastructure requirements. As with Q1, it is important to note that 54.9% of public DC fast EVSE in the Station Locator are on the Tesla network and therefore only readily accessible to Tesla drivers. As of July 2020, approximately 40% of PEVs on the road are Teslas (IHS Markit 2018; Zhou 2020).[2]

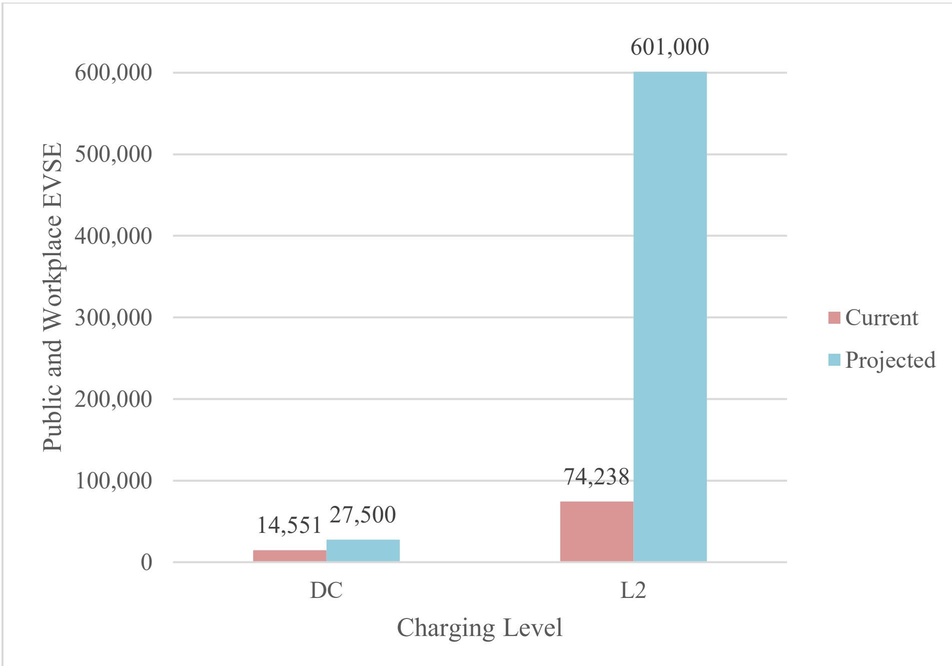

Figure 15. Current availability and projected 2030 need of public and workplace charging in the United States.

As previously noted, NREL's 2017 analysis estimated that a ratio of 1.8 DC fast and 40.1 Level 2 EVSE per 1,000 PEVs is sufficient to meet charging demand. As of Q2, there were approximately 1.4 million PEVs in the United States' light-duty fleet (IHS Markit 2018; Zhou 2020).[3] The ratio of public and workplace EVSE per 1,000 PEVs in Q2 was 10.0 and 51.0, respectively (Figure 16). Though this does not speak to geographic distribution of EVSE, it does indicate that, as of Q2, there was enough public and workplace DC fast and Level 2 EVSE across the United States as a whole to meet charging demand. It is notable, however, that only 9.3% of the 15 million light-duty PEVs projected for 2030 were on the road as of Q2. Light-duty PEV sales hit a record high in 2018, but declined in 2019, and are suffering in 2020 due to the coronavirus pandemic, as discussed in section 5 (Zhou 2020).

[2] This percentage is based on the number of cumulative Tesla sales in the U.S. from 2011 through July 2020; 2018 PEV registration data; and 2019 and 2020 light-duty PEV sales data. This figure does not account for Teslas that have been retired since 2011 or total light-duty PEVs that were retired in 2019 and 2020.

[3] 2019 and 2020 PEV registration data are not yet available. The number of PEVs as of June 2020 is based on 2018 PEV registration data and 2019 and 2020 light-duty PEV sales data. Therefore, the 1.4 million figure does not account for vehicles that were retired in 2019 and 2020, and may overestimate the number of PEVs on the road.

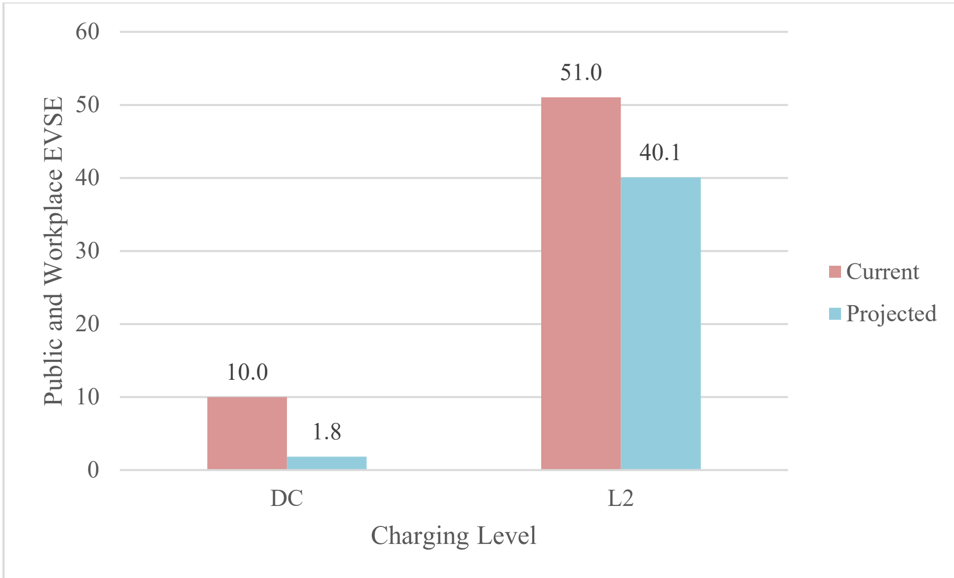

Figure 16. Current availability and projected 2030 need of public and workplace EVSE per 1,000 EVs in the United States.

5 Developments That Could Impact Future Quarters

While some states began lifting coronavirus restrictions towards the end of Q2, the pandemic continued to impact the EV market. Compared to the first five months of 2019, U.S. EV sales were down by 20% at the end of May; in May alone, U.S. EV sales were down by 54% compared with May 2019 sales (Atlas Public Policy 2020a). Furthermore, several automakers, such as Ford, Tesla, and Rivian, have postponed the release of some new EV models (EV Hub 2020a).

Despite these trends, corporate and government commitments to EV deployment and infrastructure installations continue. In June, the transportation network company (TNC), Lyft, pledged to electrify 100% of its fleet by 2030, including drivers' personal vehicles and vehicles in Lyft's rental and autonomous vehicle programs (Lyft 2020). As part of the EV Shared Mobility project, Seattle, WA, New York, NY, Portland, OR, and Denver, CO, have already begun deploying DC fast chargers throughout their cities to support TNC electrification (Atlas Public Policy 2020b). As of the end of May, Seattle had already installed eight out of 20 planned chargers and expects to complete the installation of the remaining 12 chargers by September 2021 (Atlas Public Policy 2020c).

EV charging infrastructure development in the Mid-Atlantic region is on the rise as well. Blink and Virginia Clean Cities were recently awarded a grant to install 200 Level 2 charging stations in Virginia, Maryland, West Virginia, and Washington, D.C. (Mercure 2020). Additionally, Giant Food, a regional grocery chain, is working with Volta to install 60 EV charging stations at select locations in Delaware, Maryland, Virginia, and Washington, D.C., by the end of 2020, and an additional 200 charging stations by mid-2021 ("Giant partners with Volta" 2020).

It has been two years since the first award from the Volkswagen settlement fund was made, and 80% of the funds still remain (Smith 2020). Almost half of the funding that has been awarded to projects through June is earmarked for EVs and charging infrastructure, with $62 million going toward charging infrastructure development (Smith 2020). Given this trend, it is likely that Volkswagen funding will continue to be allocated to transportation electrification projects. Two recent examples of projects include Florida's plans to install 27 EV charging stations along its major interstates, including Interstates 75 and 95, in its first installment of funding, and phase three of Maine's initiative to expand its charging network, which includes installing DC fast chargers along key routes that support tourism (Calvan 2020; Thill 2020).

While there continues to be significant investment in EV charging infrastructure, one area that may receive reduced investment in the future in the United States is DC fast charging infrastructure with CHAdeMO connectors (Goodwin 2020). Nissan, which was part of the association that developed and promoted the CHAdeMO standard, announced that it will use the CCS standard in the new Nissan Ariya in the United States. As of Q2, the only vehicles available in the United States with the CHAdeMO standard were the Nissan LEAF EV and the Mitsubishi Outlander plug-in hybrid electric vehicle (Goodwin 2020). However, this does not mean that chargers with the CHAdeMO connector will be phased out anytime soon. While Mitsubishi has not yet announced which standard will be used in the 2021 Outlander, Nissan will continue manufacturing new models of the LEAF with the CHAdeMO standard for the foreseeable future (Goodwin 2020). Furthermore, approximately 150,000 LEAFs have been sold in the United States over the past ten years (Zhou 2020). These LEAFs, along with the 2020 Outlander and old models of Honda Fit, Hyundai Ioniq, and Kia Soul EVs (which all use the CHAdeMO standard), will continue to rely on DC fast chargers with CHAdeMO connectors for years to come.

Finally, the Station Locator data collection and management processes will continue to impact future EVSE counts as well. As noted in section 1.1.1, since 2019, the Station Locator team has been transitioning its counting logic to align with the hierarchy defined in the OCPI protocol: locations, EVSE, and connectors (EVRoaming Foundation, n.d.). With this transition, the Station Locator is now counting the number of EVSE at a station location rather than the number of connectors previously counted. For example, a charging location with one EVSE and two connectors was previously counted twice but is now only counted once using the OCPI protocol's counting logic. As of Q2, all manually collected data, as well as EVSE on the Electrify America and EVgo networks, are counted according to the OCPI logic. NREL is currently working with ChargePoint and Greenlots to integrate their OCPI APIs into the Station Locator. Additionally, as discussed in section 1.1.1, NREL is continuously working with EVSPs to add new APIs to the Station Locator. As these new APIs come online, there will likely be a large increase in the number of EVSE in the Station Locator. NREL anticipates finalizing the OpConnect API in Q3.

6 Conclusion

This paper examines the growth of EV infrastructure in Q2 of 2020, including the growth of public EV charging by charging level, network, region, and state, and the growth of private EV charging by charging level and use type (i.e., workplace and MUD). With such rapid growth and change in EV charging infrastructure, the information presented in this paper aims to help readers understand how and where infrastructure is developing, where there may be areas of opportunity, and whether development is keeping pace with projected charging demand.

As of the end of Q2, Level 2 chargers accounted for the majority of both public and private EVSE in the Station Locator (80.8% and 90.5%, respectively), though public and private DC fast EVSE grew by the largest percentage (6.8% and 13.2%, respectively). California continues to lead the country in terms of the total number of public EVSE available (29,997 EVSE) and only drops slightly in rank, to second, when compared to other states based on EVSE available per 100,000 people. However, the South Central region led the country in terms of percent growth in Q2 (5.9%) due to a large update from Francis Energy. The number of EVSE in the North Central region grew by the smallest percentage in Q2 (2.4%).

Based on NREL's 2017 projection of the number of public and workplace Level 2 chargers required to meet charging demand in 2030, the number of DC fast and Level 2 EVSE is 52.9% and 12.4%, respectively, of the way toward meeting projected 2030 demand (Wood 2017). The number of DC fast EVSE and Level 2 EVSE per 1,000 PEVs was 10.0 and 51.0 respectively, compared with NREL's projected need of 1.8 and 40.1, respectively. This indicates that infrastructure development is keeping up with, and even surpassing, charging demand in terms of the total amount available across the United States. It is important to note that the majority (54.9%) of public DC fast EVSE in the Station Locator are on the Tesla network and are therefore only readily accessible to Tesla drivers.

Finally, as the Station Locator team adds new charging networks to the Station Locator and continues its concerted effort to collect MUD charging data, we will continue to see large increases in the number of EVSE available, similar to the large increase of public EVSE on the Francis Energy network and private MUD EVSE seen in Q2.

If there are additional metrics that readers are interested in seeing in future reports, please email suggestions to the authors at TechnicalResponse@icf.com.

Bibliography

Alternative Fuels Data Center. n.d.a. “About the Alternative Fuels Data Center.” Accessed June 5, 2020. https://afdc.energy.gov/about.html.

Alternative Fuels Data Center. n.d.b. “Alternative Fueling Station Locator.” Accessed June 5, 2020. https://afdc.energy.gov/stations/#/find/nearest.

Alternative Fuels Data Center. n.d.c. “Data Included in the Alternative Fueling Station Data.” Accessed June 5, 2020. https://afdc.energy.gov/data_download/alt_fuel_stations_format.

Atlas Public Policy. 2020a. “Further Delays Announced for Upcoming EV Models.” *EV Hub Weekly Digest*, July 27, 2020.

Atlas Public Policy. 2020b. “Seattle Installing DCFC for Ride-Hail Drivers.” *EV Hub Weekly Digest*, June 22, 2020.

Atlas Public Policy. 2020c. “Seattle Project Living Case Study 1.0.” *EV Shared Mobility*, June 18, 2020. http://evsharedmobility.org/resource/seattle-project-living-case-study/.

Brown, Abby, Stephen Lommele, Alexis Schayowitz, and Emily Klotz. 2020. *Electric Vehicle Charging Infrastructure Trends from the Alternative Fueling Station Locator: First Quarter 2020*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5400-77508. www.nrel.gov/docs/fy20osti/77508.pdf.

Calvan, Bobby Caina. 2020. “Florida To Install Charging Stations for Electric Vehicles.” *Associated Press*, July 10, 2020. https://apnews.com/9f3ce566d8f71b7d68165b5ddc764d18.

Clean Cities Coalition Network. n.d.a. “About Clean Cities.” Accessed June 5, 2020. https://cleancities.energy.gov/about/.

Clean Cities Coalition Network. n.d.b. “Technology Integration Program Contacts.” Accessed June 5, 2020. https://cleancities.energy.gov/contacts/?open=regional#headingregionalManagers.

EVRoaming Foundation. 2019. *OCPI 2.2: Open Charge Point Interface*. Document Version 2.2, September 30, 2019. https://ocpi-protocol.org/app/uploads/2019/10/OCPI-2.2.pdf.

“Giant Partners with Volta To Provide Electric Vehicle Charging.” *Cape Gazette,* July 12, 2020. https://www.capegazette.com/article/giant-partners-volta-provide-electric-vehicle-charging/204754.

Goodwin, Antuan. 2020. “Cheerio, CHAdeMO: Nissan Adopts CCS Fast-Charging with New Ariya Electric SUV.” *Road Show by CNET*, July 14, 2020. https://www.cnet.com/roadshow/news/nissan-ariya-electric-suv-adopts-ccs-fast-charging/.

IHS Markit. 2018. *Derived Vehicle Registration Data by Fuel Type for the U.S.* Golden, Colorado: National Renewable Energy Laboratory.

Levene, Johanna, Stephen Lommele, Robert Eger, and Wendy Dafoe. 2019. "Developing a Comprehensive Database of Alternative Fuel Station Locations across Canada and the United States of America." In Canadian Transportation Research Forum 54th Annual Conference Proceedings, 2019.

Lyft. 2020. "Leading the Transition to Zero Emissions: Our Commitment to 100% Electric Vehicles by 2030." *Lyft Blog,* June 17, 2020. https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions?mc_cid=9de7a585ad&mc_eid=91b6b5e247.

Mercure, Matthew. 2020. "Blink to Deploy 200 EV Charging Stations in Mid-Atlantic." *NGTNews*, July 22, 2020. https://ngtnews.com/blink-to-deploy-200-ev-charging-stations-in-mid-atlantic-region.

Smith, Conner. 2020. "Nearly 80 Percent of VW Funds Remain Two Years After the First Awards." *EV Hub*, July 10, 2020. https://www.atlasevhub.com/data_story/nearly-80-percent-of-vw-funds-remain-two-years-after-the-first-awards/.

Thill, David. 2020. "Maine Pushed Forward on Electric Vehicle Charging During Pandemic." *Energy News Network*, July 7, 2020. https://energynews.us/2020/07/07/northeast/maine-pushes-forward-on-electric-vehicle-charging-during-pandemic/.

U.S. Census Bureau. 2019. "NST-EST2019-01: Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2019." Accessed June 5, 2020. https://www.census.gov/newsroom/press-kits/2019/national-state-estimates.html.

Wood, Eric, Clément Rames, Matteo Muratori, Sesha Raghavan, and Marc Melaina. 2017. *National Plug-In Electric Vehicle Infrastructure Analysis.* Golden, CO: National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy17osti/69031.pdf.

Zhou, Joann. 2020. *Annual U.S. Plug-In Electric Vehicle Sales, 2020.* Distributed by Argonne National Laboratory.