Electric Vehicle Charging Infrastructure Trends from the Alternative Fueling Station Locator: First Quarter 2021

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

1 National Renewable Energy Laboratory
2 ICF

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
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National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
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List of Acronyms

AFC	Alternative Fuel Corridors
AFDC	Alternative Fuels Data Center
AMPUP	AmpUp network
API	application program interface
BN	Blink network
CCS	Combined Charging System
CHARGELAB	ChargeLab network
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
EVCS	EV Charging Solutions network
EVGATEWAY	evGateway network
EVN	EVgo network
EVSE	electric vehicle supply equipment
EVSP	electric vehicle service provider
FCN	Francis Energy network
FHWA	Federal Highway Administration
FLO	FLO network
FPLEV	FPL EVolution
GRN	Greenlots network
HD	heavy-duty
LD	light-duty
L1	Level 1 charger
L2	Level 2 chargerMD medium-duty
NON	non-networked
NREL	National Renewable Energy Laboratory
OC	OpConnect network
OCPI	Open Charge Point Interface
OEM	original equipment manufacturer
PEV	plug-in electric vehicle
POWERFLEX	Powerflex network
Q1	quarter 1, or first quarter of the calendar year
Q2	quarter 2, or second quarter of the calendar year
Q3	quarter 3, or third quarter of the calendar year
Q4	quarter 4, or fourth quarter of the calendar year
SCN	SemaConnect network
TESLA	Tesla Supercharger network
TESLAD	Tesla Destination network
VLTA	Volta network
WEB	Webasto network
ZEFNET	ZEF network

Executive Summary

The U.S. Department of Energy (DOE) Alternative Fueling Station Locator contains information on public and private nonresidential 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 first calendar quarter (Q1) of 2021. 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 target infrastructure volume for 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 fifth report in a series. Previous reports from 2020 can be found in the Alternative Fuels Data Center (AFDC) and National Renewable Energy Laboratory (NREL) publication databases, as well as the AFDC Charging Infrastructure Trends page (https://afdc.energy.gov/fuels/electricity_infrastructure_trends.html).

In Q1, the Station Locator reached an important milestone of 100,000 public electric vehicle supply equipment (EVSE) ports. All types of EVSE ports grew, except for public Level 1 EVSE ports, which decreased by 2.4%. Overall, there was a 7.3% increase in the number of EVSE ports in the Station Locator, with Level 2 EVSE ports contributing to the majority of that growth. The South Central region had the largest increase in public charging infrastructure in Q1 (7.9%), though California, which has almost one-third of the country's public charging infrastructure, continues to lead the country in the number of available public EVSE ports.

In Q1, the Biden administration announced the American Jobs Plan, which aims to build a national public charging network of 500,000 EVSE ports by 2030. Using this figure as a benchmark, the United States has installed 20.2% of those EVSE ports as of Q1. Additionally, 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 needs for a central scenario in which 15 million light-duty plug-in electric vehicles (PEVs) are on the road by 2030 (601,000 Level 2 and 27,500 DC fast EVSE ports) (Wood et al. 2017). Based on this analysis, about 63.8% and 15.2% of the necessary DC fast and Level 2 EVSE ports, respectively, have been installed as of Q1. However, the number of DC fast EVSE ports and Level 2 EVSE ports per 1,000 PEVs on the road was 10.1 and 52.4, 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—forecasted needs. It is important to note, however, that the majority (56.7%) of public DC fast EVSE ports in the Station Locator are on the Tesla network and are therefore only readily accessible to Tesla drivers.

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1 Overview of the Station Locator

The U.S. Department of Energy (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 2021a). 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, the National Renewable Energy Laboratory (NREL) partnered with National Resources Canada to expand the data set 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 nonresidential 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.

Although 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 the federal government recently increased its investment in transportation electrification, original equipment manufacturers (OEMs) double down on their electrification commitments, more utilities begin offering incentives for EVs and infrastructure, and states and municipalities set electrification goals and mandates. Using Station Locator data, this report explores the growth of both public and private EV charging infrastructure in the United States for the first calendar quarter (Q1) of 2021. This is the fifth report in a series. Previous reports for 2020 can be found in the AFDC and NREL publication databases, as well as the AFDC Charging Infrastructure Trends page (https://afdc.energy.gov/fuels/electricity_infrastructure_trends.html).

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, otherwise known as a network, 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. For a group of networked EVSE to be considered a network, it cannot be considered part of another network and it must have a dedictaed platform that allows users to locate EV charging stations, as well as initiate and pay for charging events.

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 program interface (API) and importing each network's API data into the database. Using APIs ensures the efficiency, accuracy, and completeness of the data are 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 the OCPI protocol.

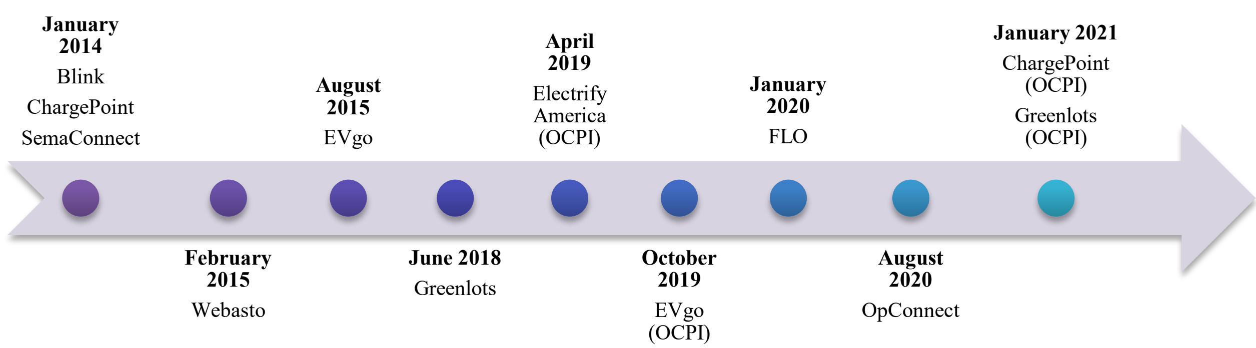

Figure 2. Timeline of API integrations in the Station Locator

As of March 2021, there were 44,715 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 2021b). Of those, approximately 67% are automatically updated daily via EVSP-provided APIs, whereas the rest are managed and updated manually. As shown in Figure 2, the Station Locator team integrated Greenlots and ChargePoint's OCPI APIs into the Station Locator in January 2021. This resulted in jumps in station counts on both networks because of the way in which station data are now being shared. In many cases, one station was split into several new stations to represent different physical locations of electric vehicle supply equipment (EVSE) ports at one address. Although the new stations share the same street address, they have different coordinates. The new API integrations also resulted in an overall increase in ChargePoint's EVSE port count and a decrease in Greenlots' EVSE port count. See Sections 2.1.1 and 2.1.2 for additional details.

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

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, OEMs, 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 semiregular data in the form of spreadsheets from EVSPs that do not have an API available. These EVSPs include EV Connect, Tesla, and Volta. In Q1, the team received updates from the EV Connect, Francis Energy, PowerFlex, and Volta networks. Additionally, the team receives regular updates from Chargeway that include stations on all networks. The team is greatly appreciative of our partners' 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 these reports reflect a snapshot of the number of available EVSE ports in the Station Locator at the end of each quarter. Therefore, notable changes may be attributed to the manual data collection process, as new manually added EVSE ports are counted in the quarter in which they are added to the Station Locator rather than when the infrastructure was installed. Additionally, stations that are temporarily out of service are not included in these reports.

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 although fleet data exist 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 such stations moving forward. See Section 2.2.4 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 multifamily buildings. See Section 2.2.3 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 ports, and connectors (EVRoaming Foundation 2019), as shown in Figure 3 and described in this section. With this transition, the Station Locator is now counting the number of EVSE ports at a station location, rather than the number of connectors as previously counted.

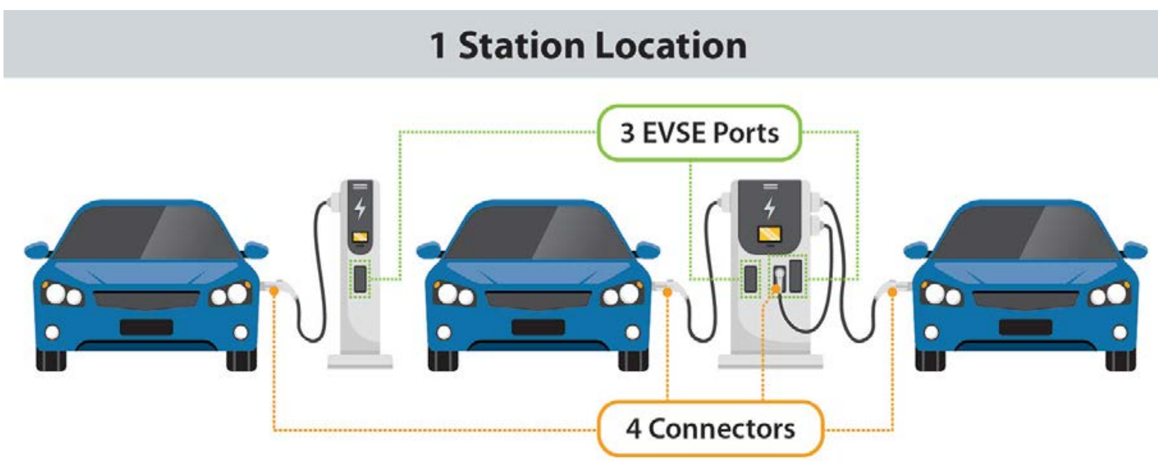

Figure 3. EV charging infrastructure hierarchy

Source: Alternative Fuels Data Center (2021e)

The following fuel-specific fields are tracked in the Station Locator for EV charging stations (Alternative Fuels Data Center 2021d):

- EV charger information:
  - Station location: A site with one or more EVSE ports located at the same address
  - EVSE port count: The number of outlets or ports available to charge a vehicle (i.e., the number of vehicles that can simultaneously charge at a charging station)
  - EVSE port type

    - Level 1 (L1): 120 V; 1 hour of charging = 2–5 miles of range
    - Level 2 (L2): 240 V; 1 hour of charging = 10–20 miles of range
    - DC fast: 480+ V; 20 minutes of charging = 60–80 miles of range
  - Connectors (number and type): What is plugged into a vehicle to charge it; multiple connectors and connector types can be available on one EVSE port, but only one vehicle will charge at a time:
    - 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 (kW)
- Open date
- Workplace
- 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 report is to identify EV charging infrastructure trends for Q1 of 2021. 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 ports and EV charging stations in the Station Locator over the last 10 years (Brown et al. 2020).

In Q1, the number of EVSE ports in the Station Locator grew by 7.3%, or 8,079 EVSE ports. Public EVSE ports grew by 4.7% and account for the majority of EVSE ports in the Station Locator (Figure 4). As a result of a large update of federally owned stations, private EVSE ports increased by 23.8% (Figure 4).

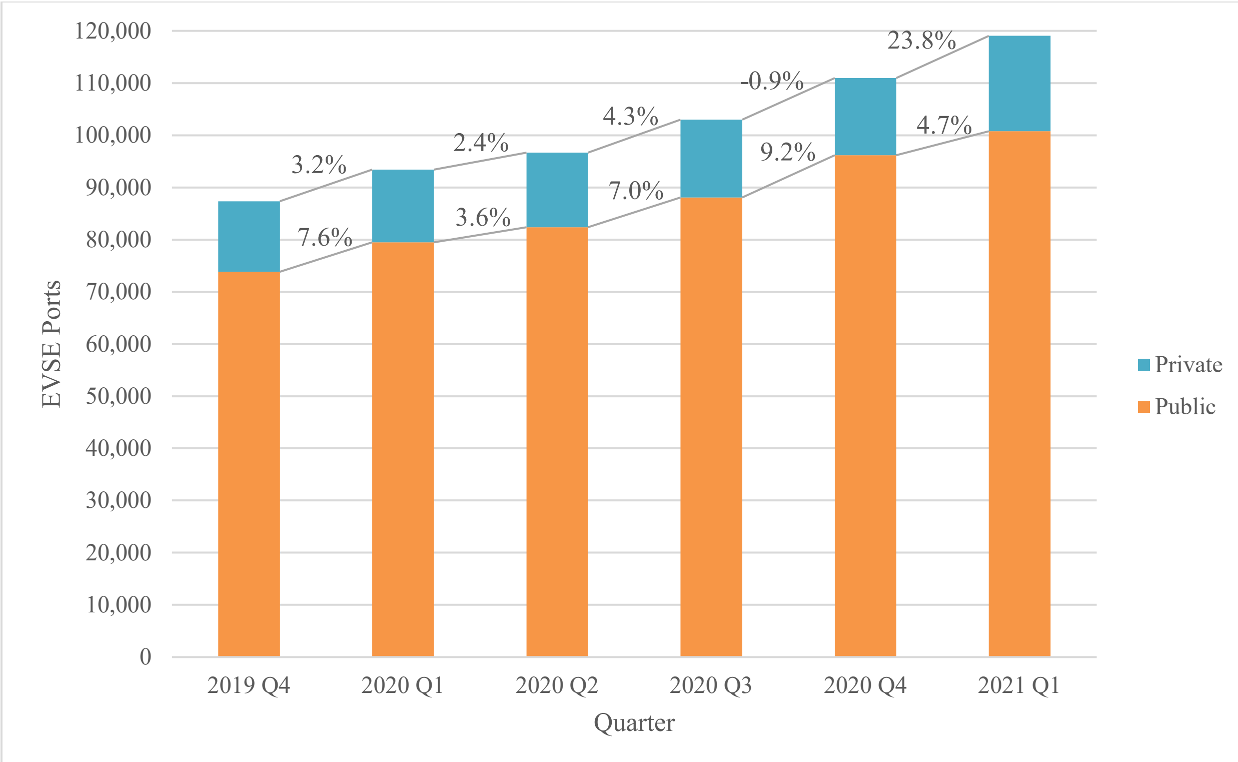

Figure 4. Quarterly growth of EVSE ports by access

The following sections break down the growth of public and private EVSE ports further to highlight what types of EV infrastructure grew in Q1 and where EV infrastructure has grown geographically. Because the number of EVSE ports represents the number of vehicles that can charge simultaneously at an EV charging station, the remainder of this report will focus on EVSE port 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 Q1, the number of public EVSE ports in the Station Locator increased by 4,566, bringing the total number of public EVSE ports in the Station Locator to 100,709 and representing a 4.7% increase since Q4. The following sections break down the growth of public EVSE ports by charging level, network, region, and state.

2.1.1 By Charging Level

As shown in Figure 5, the majority of public EVSE ports in the Station Locator are Level 2, followed by DC fast and Level 1. In Q1, Level 2 EVSE ports increased by the greatest percentage (5.8%), whereas Level 1 EVSE ports decreased by 2.4% (Figure 5). The decrease in public Level 1 EVSE ports can be attributed to closures of ChargePoint stations that were installed in 2016 or earlier, though the ChargePoint network grew overall in Q1, driven by new Level 2 EVSE port installations.

The relatively small growth in DC fast EVSE ports is due to the previously mentioned integration of ChargePoint and Greenlots' OCPI-based APIs. Before the integration, any DC fast EVSE ports with both a CHAdeMO and a CCS connector on the ChargePoint and Greenlots' networks in Q4 had an EVSE port count of two, reflecting the number of connectors on the port. After the integration, these EVSE ports now have an EVSE port count of one, reflecting the number of vehicles that can charge simultaneously at a port. This resulted in a decrease of the DC fast EVSE port count on these two networks.

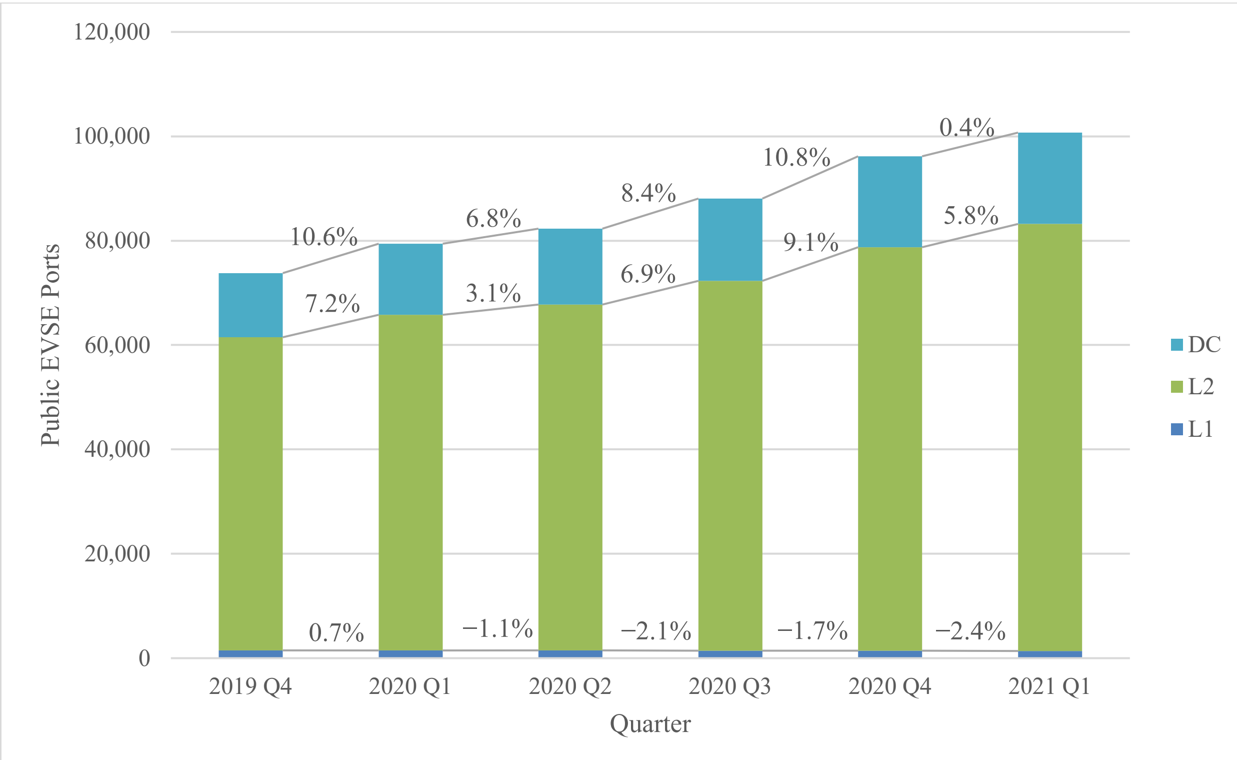

Figure 5. Quarterly growth of public EVSE ports by charging level

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. As shown in Figure 6, DC fast EVSE ports with these higher power levels still remain a minority in the Station Locator.

It is important to point out that of the 17,508 public DC fast EVSE ports in the Station Locator, power output data are currently only available for 39.0%; Figure 6 is therefore based on power output data for 6,821 DC fast EVSE ports. NREL is in the process of integrating updated OCPI-based APIs to streamline the collection of power output data and create a more complete data set. Additionally, if a DC fast EVSE port 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 ports with a power output between 51 kW and 299 kW grew by the largest percentage in Q1 (78.3%). In Q1, Chargeway began including power output data in their updates to the Station Locator team, which is the primary driver of this large increase. For example, in Q4, the Station Locator had power output data for 40 EVSE ports on the Tesla Supercharger network. As of Q1, the Station Locator had power output data for 506 Tesla Supercharger EVSE ports, all of which have a power output between 51 kW and 299 kW.

While the overall number of DC fast EVSE ports with power output data increased by 5% in Q1, the number of EVSE ports with a power output of 50 kW or less decreased by 30.8% (Figure 6). Again, this decrease can be primarily attributed to the integration of ChargePoint's OCPI-based API and the resulting decrease in DC fast EVSE port counts, as over 90% of the DC fast EVSE ports prior to the integration had a power output of 50 kW or less. After the integration, almost 75% of ChargePoint's DC fast EVSE ports have a power output between 51 kW and 299 kW, which reflects new installations as well as power adjustments for existing stations from 50 kW up to 62.5 kW, 175 kW, and 200 kW.

Additionally, Electrify America temporarily adjusts the power output of its DC fast chargers down to 50 kW while maintenance or upgrades are being performed. This contributed to the decreases seen in Q3 and the increases seen in Q4 and Q1, as the chargers that had been adjusted down to 50 kW were adjusted back to their original, higher power output (Figure 6). The Station Locator team expects to continue to see fluctuations in DC fast power output data as a result of these adjustments.

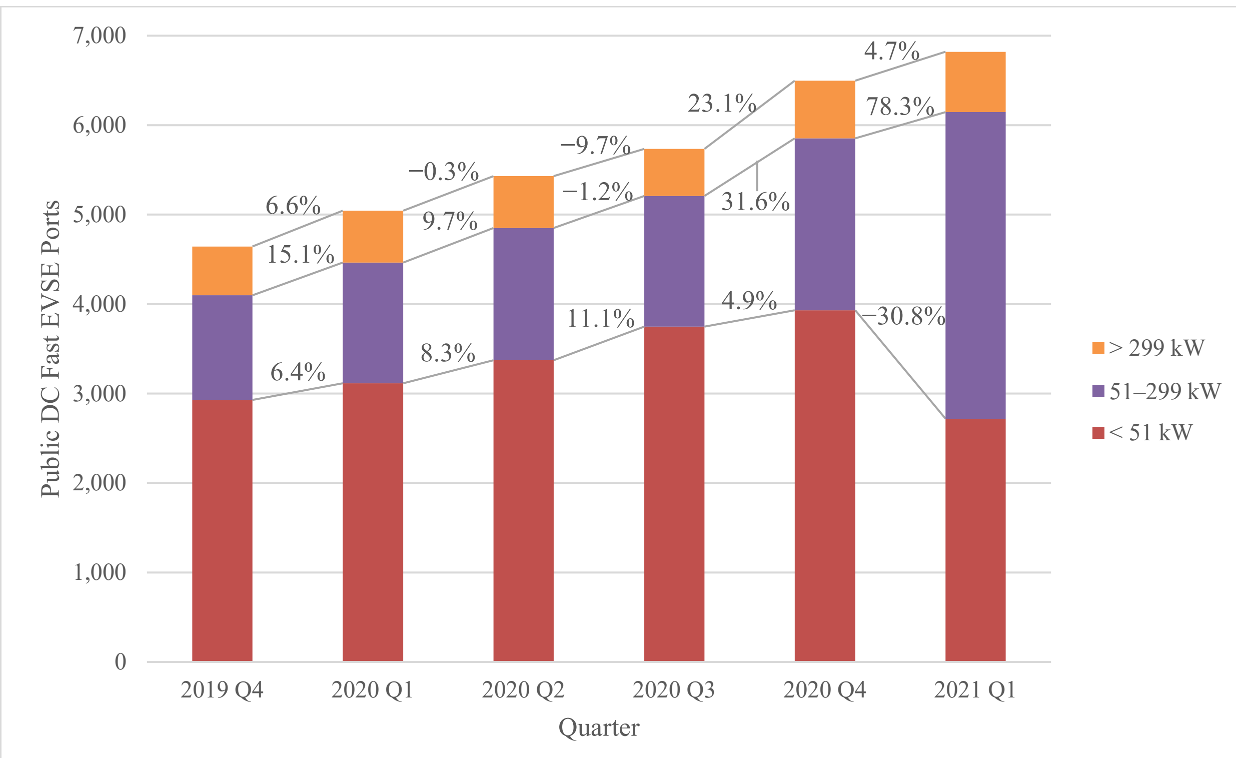

Figure 6. Quarterly growth of public DC fast EVSE ports by power output

There are currently three types of connectors available for DC fast chargers: CHAdeMO, CCS, and Tesla. Of the 21,187 DC fast connectors in the Station Locator as of Q1, Tesla connectors made up the largest proportion of connectors, though CCS connectors grew by the largest proportion (10.2%) (Figure 7).

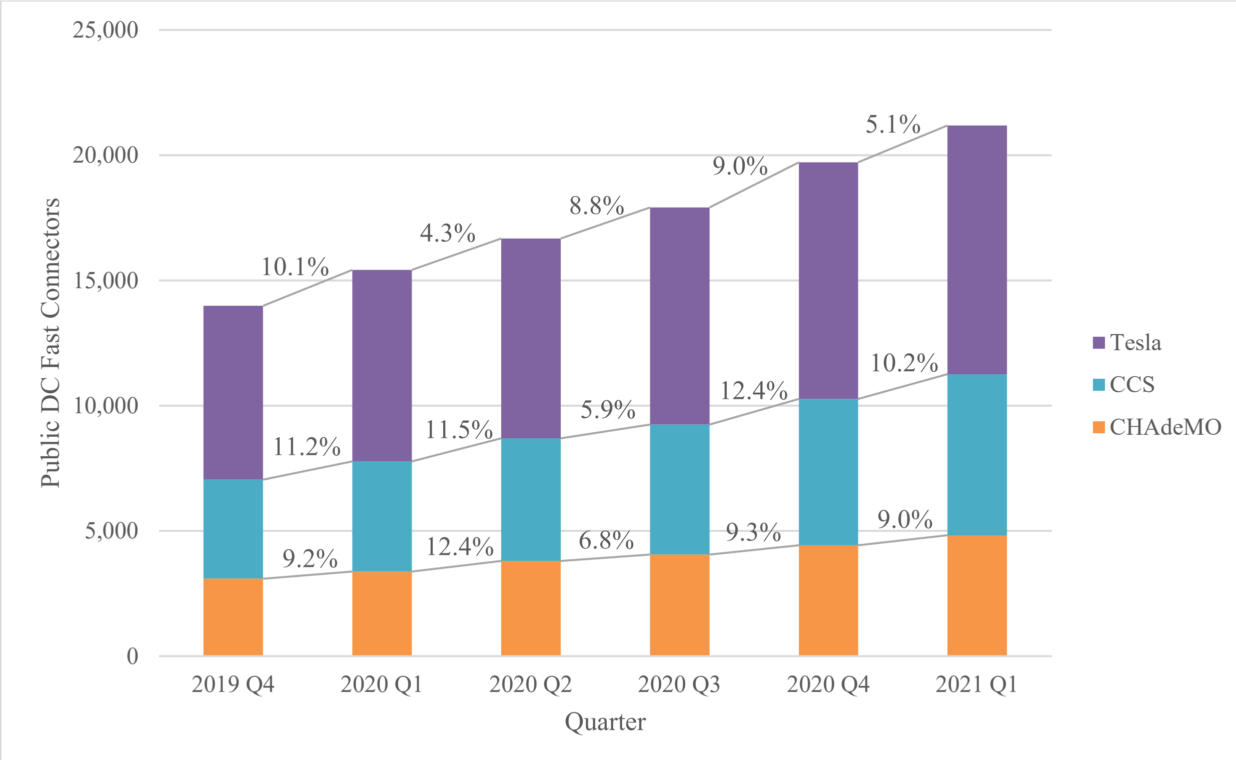

Figure 7. Quarterly growth of public DC fast connectors by type

2.1.2 By Network

As discussed in Section 1.1, the Station Locator team works with most major EVSPs to collect EV charging infrastructure data for the Station Locator. Currently, the Station Locator includes stations on the networks listed in this section. The ZEF Network was new to the Station Locator as of Q1, bringing the total number of networks in the Station Locator to 22 (Figure 8). In addition, the Station Locator contains non-networked (NON) station data, which includes stations that were previously networked.

- AmpUp (AMPUP)
- Blink (BN)
- ChargeLab (CHARGELAB)
- ChargePoint (CPN)
- Electrify America (EA)
- EV Connect (EVC)
- EV Charging Solutions (EVCS)
- evGateway (EVGATEWAY)
- EVgo (EVN)
- Francis Energy (FCN)
- FLO (FLO)
- FPL EVolution (FPLEV)
- Greenlots (GRN)
- OpConnect (OC)
- Powerflex (POWERFLEX)
- SemaConnect (SCN)
- Tesla Supercharger (TESLA)
- Tesla Destination (TESLAD)
- Volta (VLTA)
- Webasto (WEB)
- ZEF Network (ZEFNET)

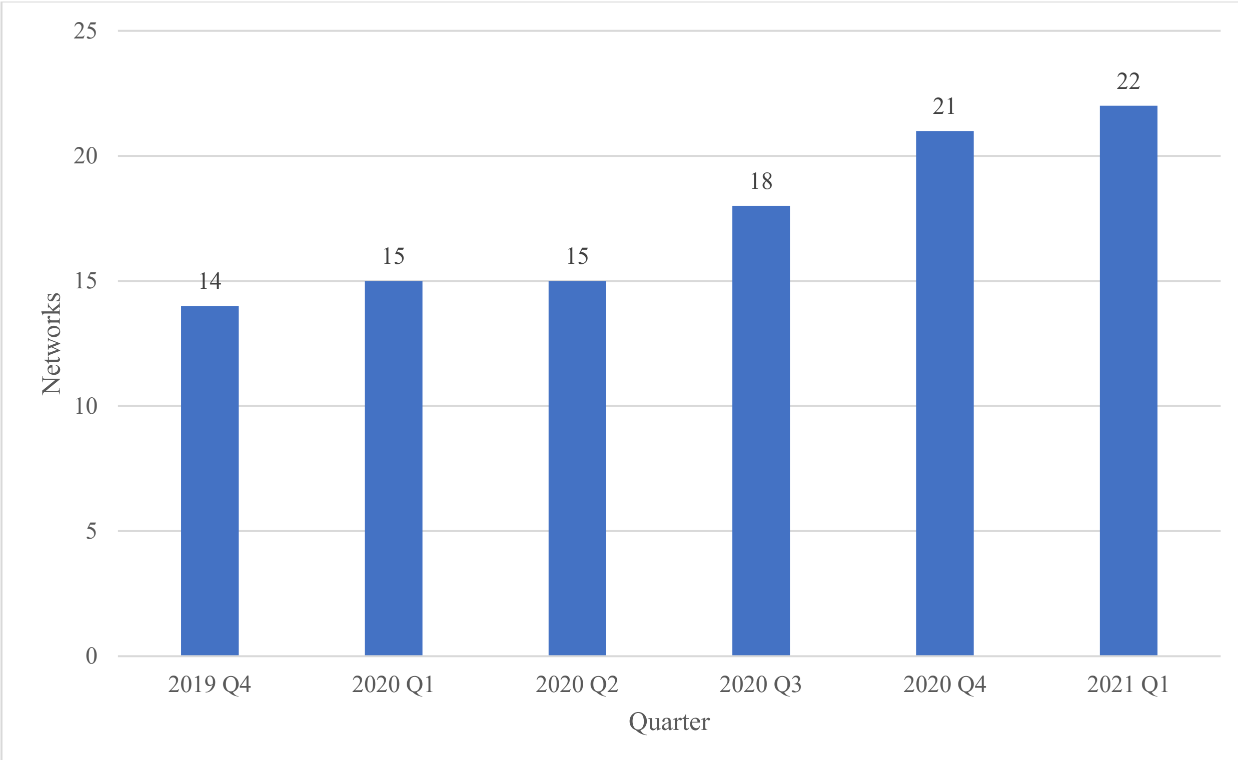

Figure 8. Quarterly growth of networks in the Station Locator

As of the end of Q1, the ChargePoint network accounted for the largest number of public EVSE ports (42.1%) in the Station Locator, and Level 2 chargers constituted the majority of ChargePoint's network (Figure 9). This holds true for many of the networks in the Station Locator, except for the Electrify America, EVgo, Francis Energy, FPL EVolution, and Tesla Supercharger networks. These networks are predominately, if not completely, made up of DC fast chargers. Of the networks with DC fast chargers, Tesla Supercharger has the largest share of public DC fast EVSE ports (56.7%), followed by Electrify America (14.4%) and ChargePoint (8.0%) (Figure 10).

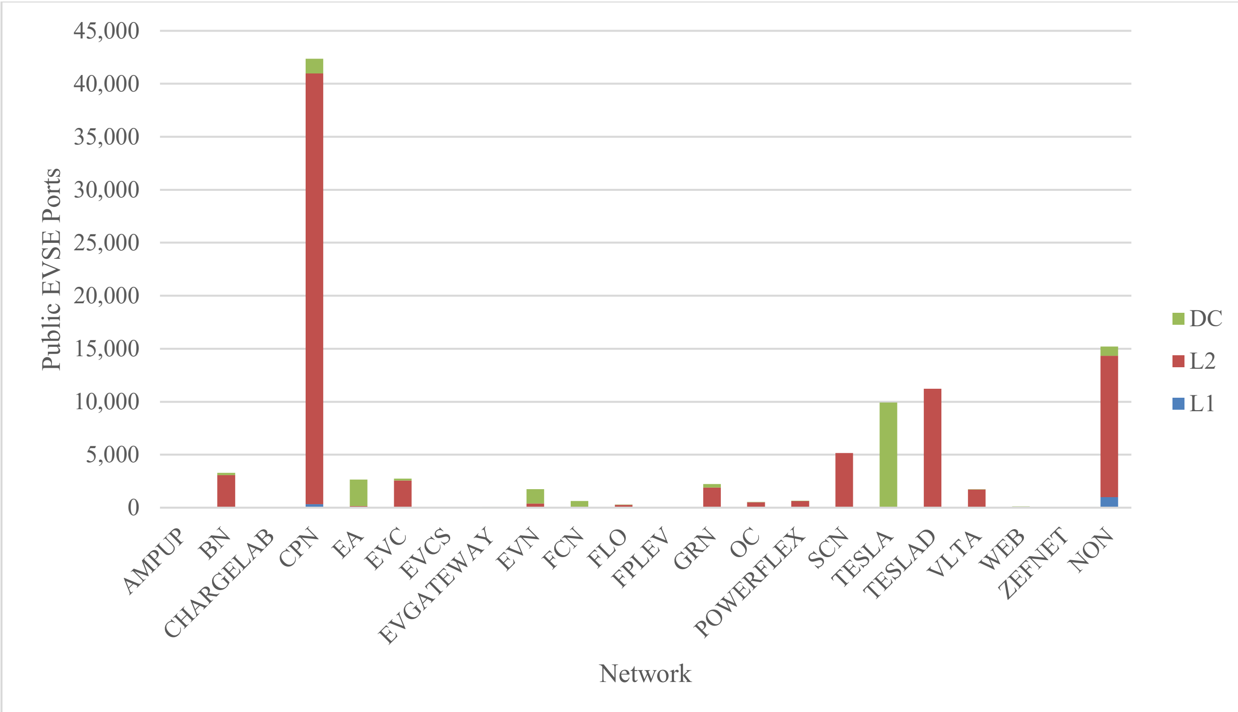

Figure 9. Breakdown of public EVSE ports by network and charging level in Q1

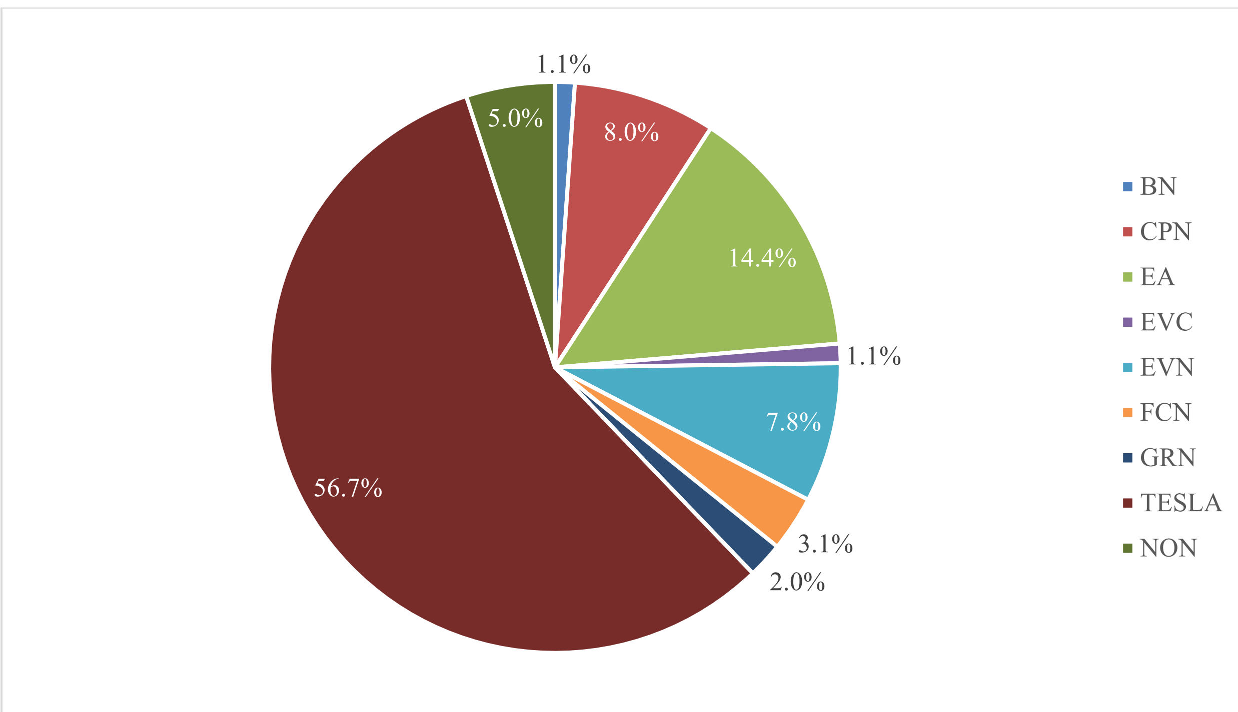

Figure 10. Breakdown of public DC fast EVSE ports by network in Q1

Note: This figure excludes networks that make up less than 1% of public DC fast EVSE ports

Figure 11 shows the growth of each network in Q1, and Table 1 includes the percent growth of each network in Q1. ZEF Network is excluded from Table 1 because it was new to the Station Locator in Q1. The number of public EVSE ports on all networks grew in Q1 with the exceptions of the EVgo and Greenlots networks (Table 1). The decrease of the EVgo network is due to a decrease in Level 2 EVSE ports, though the number of DC fast ports increased. The decrease on the Greenlots network is due to the integration of its OCPI-based API, as discussed in Sections 1.1.1 and 2.1.1. Additionally, although the transition resulted in the addition of new EVSE ports that had not been added to the Station Locator via Greenlots' legacy API, more EVSE ports were removed than were added. The Station Locator team expects EVSE ports on the Greenlots network to increase in future quarters based on the network's strong 2020 growth. Additionally, Shell, Greenlots' parent company, announced plans in February 2021 to reach 500,000 EVSE port installations globally by 2025 (Shell Global 2021). Though specifics of where these installations will be located have not been released, Greenlots CEO Andreas Lips has indicated that many of these EVSE ports will be deployed through Greenlots (Hitch 2021).

The networks with the largest percent growth in Q1 were Powerflex (133.7%) and Francis Energy (101.0%) (Table 1). Notably, the number of DC fast EVSE ports on the Francis Energy network more than doubled, while the number of Level 2 EVSE ports on the Powerflex network more than doubled. The increases on the Powerflex and Francis Energy networks can be attributed to large updates that both networks shared with the Station Locator team in Q1. As discussed in Section 1.1.2, Powerflex and Francis Energy are two of the networks that provide periodic updates to the Station Locator team, which results in large jumps in their station counts.

FLO also grew considerably in Q1 (35.9%), representing an increase of 71 EVSE ports and expansion into three new states: Ohio, Oklahoma, and Pennsylvania (Table 1).

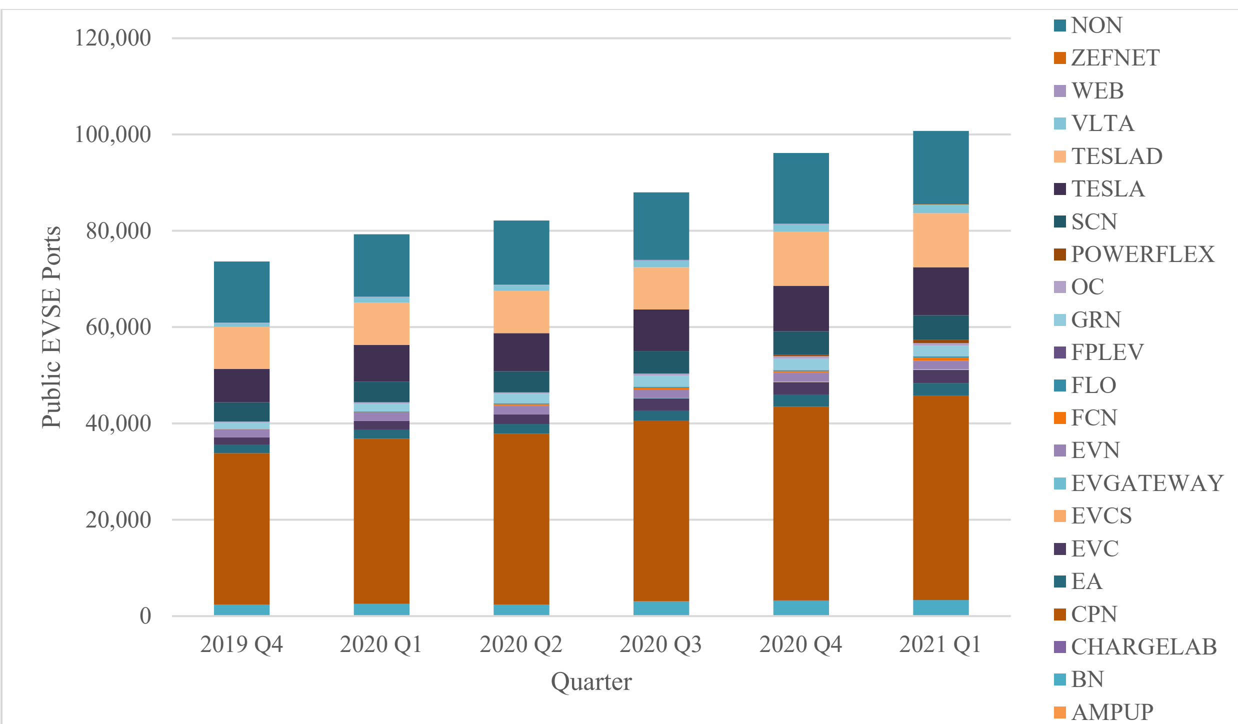

Figure 11. Quarterly growth of public EVSE ports by network

Table 1. Quarterly Growth of Public EVSE Ports by Network

Network	2020 Q1 Growth	2020 Q2 Growth	2020 Q3 Growth	2020 Q4 Growth	2021 Q1 Growth
NON	1.8%	3.0%	5.0%	5.0%	3.7%
WEB	0.9%	−0.9%	0.0%	0.0%	0.0%
VLTA	53.5%	0.0%	17.9%	11.8%	10.8%
TESLAD	0.2%	0.0%	0.2%	27.5%	0.3%
TESLA	10.1%	4.3%	8.8%	9.0%	5.1%
SCN	7.6%	2.6%	6.6%	5.6%	5.3%
POWERFLEX	N/A	N/A	N/A	13,400.0%	133.7%
OC	0.0%	4.9%	87.2%	13.7%	0.0%
GRN	24.2%	18.9%	13.0%	5.0%	−6.7%
FPLEV	N/A	N/A	N/A	0.0%	0.0%
FLO	N/A	25.8%	3.7%	−0.5%	35.9%
FCN	0.0%	31,100.0%	0.0%	0.0%	101.0%
EVN	3.2%	2.2%	1.2%	−0.3%	−3.3%
EVGATEWAY	N/A	N/A	N/A	2.9%	2.8%
EVCS	N/A	N/A	N/A	N/A	8.3%
EVC	17.7%	11.2%	29.8%	3.2%	4.1%
EA	11.9%	2.3%	1.2%	23.9%	6.8%
CPN	9.0%	3.4%	5.7%	7.1%	5.4%
CHARGELAB	N/A	N/A	N/A	N/A	0.0%
BN	5.5%	−3.4%	27.3%	3.5%	2.8%
AMPUP	N/A	N/A	N/A	N/A	10.0%
Total	**7.6%**	**3.3%**	**7.0%**	**9.2%**	**4.7%**

2.1.3 By Region

The Clean Cities Coalition Network is broken down into seven regions (Figure 12), which were used to analyze the growth of public EV charging infrastructure across the country (Clean Cities Coalition Network 2021a). See the first report in this series for more information about the Clean Cities Coalition Network (Brown et al. 2020).

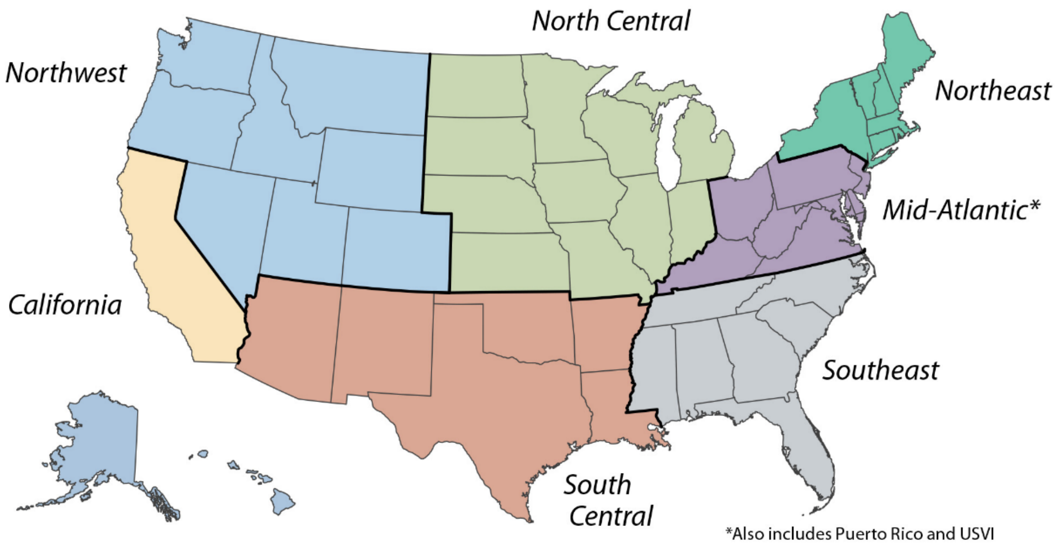

Figure 12. Clean Cities regions

Source: Clean Cities Coalition Network (2021b)

As shown in Figure 13, the California region had the largest share of the country's public EVSE ports (32.0%) in Q1. However, the South Central region grew by the largest percentage (7.9%) due to the large update received from the Francis Energy network, which operates in Oklahoma (Figure 13).

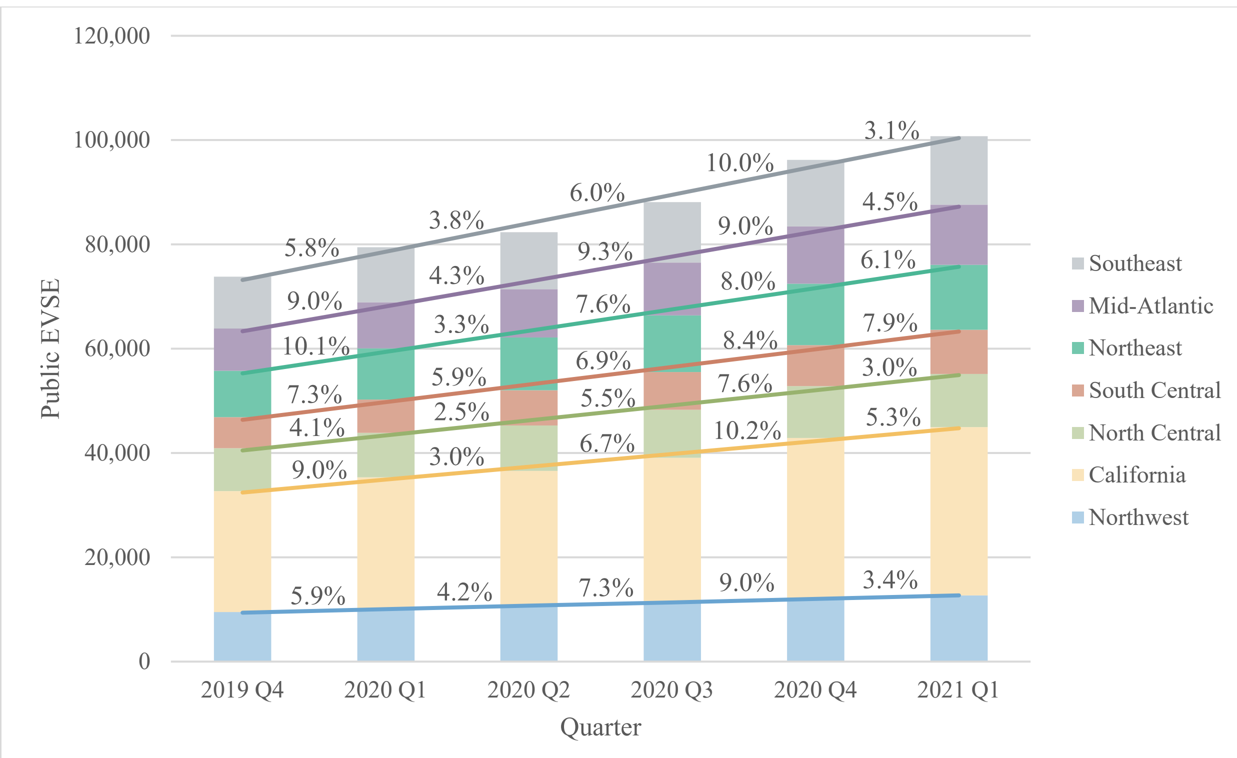

Figure 13. Quarterly growth of public EVSE ports by Clean Cities region

2.1.4 By State

To track the growth of EVSE ports by state, the Station Locator team calculated the number of public EVSE ports per 100,000 people in each state. The team 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 are based on the U.S. Census Bureau's 2020 estimates (U.S. Census Bureau 2020).

As of the end of Q1, the number of EVSE ports per 100,000 people ranged from 7.0 in Louisiana to 125.8 in Vermont. The five states with the highest number of EVSE ports per 100,000 people were Vermont; Washington, D.C.; California; Hawaii; and Colorado (Table 2). However, the five states that had the largest growth of EVSE ports per 100,000 people were Oklahoma, North Dakota, Michigan, Pennsylvania, and Massachusetts (Table 3). As previously discussed, the large growth in Oklahoma can be attributed to the update received from the Francis Energy network.

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

State	EVSE Ports per 100,000 People
Vermont	125.8
Washington, D.C.	88.1
California	82.0
Hawaii	52.5
Colorado	52.2

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

State	Q1 Growth of EVSE Ports per 100,000 People
Oklahoma	52.3%
North Dakota	16.7%
Michigan	10.8%
Pennsylvania	10.5%
Massachusetts	9.7%

2.1.5 Highway Corridors

The Federal Highway Administration (FHWA) Alternative Fuel Corridors (AFC) program, created by the Fixing America's Surface Transportation (FAST) Act of 2015, works with states to establish a national network of alternative fueling and charging infrastructure along the National Highway System. A state must first nominate a segment of the National Highway System that they believe meets the criteria for an AFC. FHWA then reviews nominations and designates segments as either corridor-ready or corridor-pending. For a segment to be designated as EV corridor-ready, it must include at least two public DC fast charging stations that are no more than 50 miles apart and no more than 5 miles off the highway (Federal Highway Administration 2020). Additionally, as of 2019, each DC fast charging station must have both CCS and CHAdeMO connectors available. For a segment to be designated as EV corridor-pending, it must include at least one public DC fast charging station and a plan from the nominating state for developing a second public DC fast charging station. The planned station may be more than 50 miles from the existing station, but no more than 5 miles off the highway. Stations on the Tesla network are excluded from the AFC program because only Tesla vehicles can use them. The Station Locator aids the corridor designation process through its Fuel Corridors tool, which allows users to measure the driving distance along highways and roadways between EV charging stations that meet the FHWA's aforementioned criteria (Alternative Fuels Data Center 2021c). In addition, the AFDC provides downloadable state-specific data for stations that meet the FHWA AFC program criteria (Alternative Fuels Data Center 2021f).

Since 2016, there have been five rounds of corridor designations. The fifth and final round of corridor designations under the FAST Act of 2015, announced April 22, 2021, designated an additional 10,800 miles of highway spanning 25 states as either EV corridor-ready or EV corridor-pending (Figure 14).

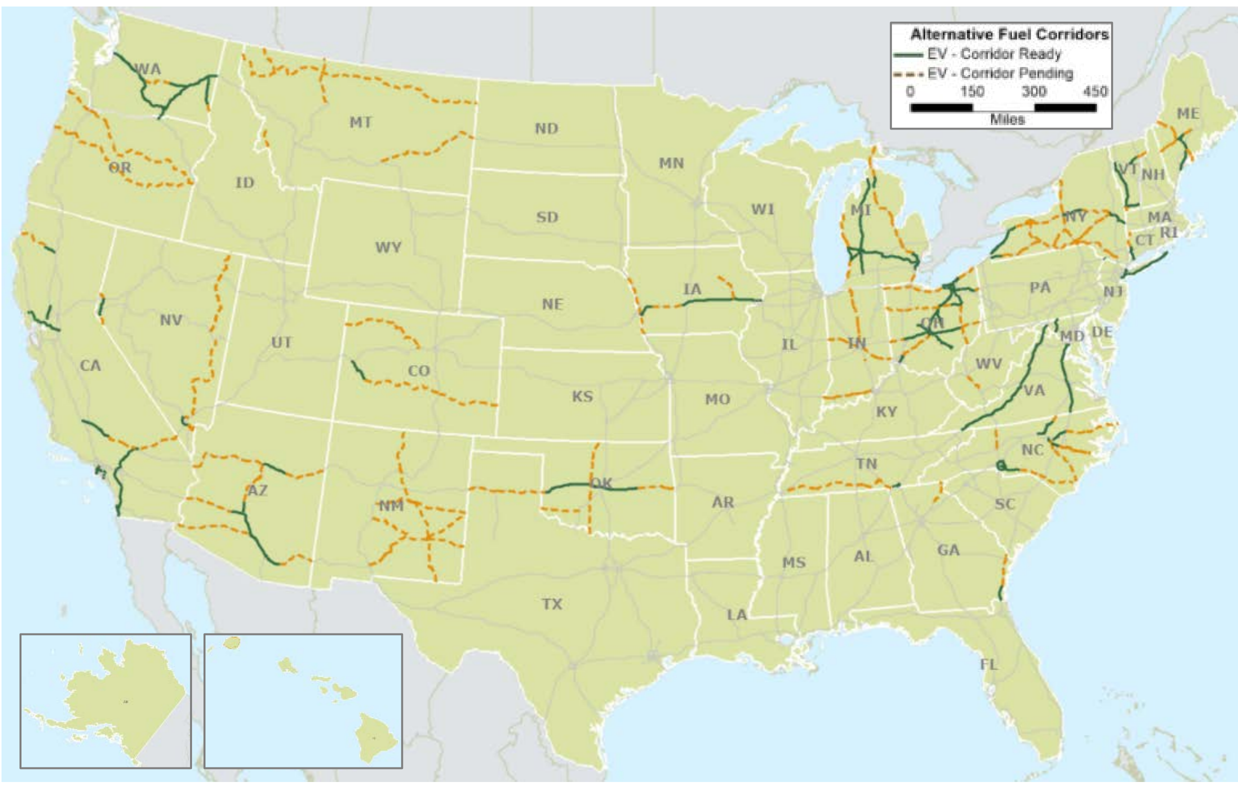

Figure 14. Fifth round of EV corridor designations

Source: Federal Highway Administration (2021b)

There are now approximately 58,980 miles of U.S. highway that have been designated as an EV corridor since the start of the program (see Figure 15), or approximately 36% of the National Highway System (Federal Highway Administration 2021c). As shown in Figure 15, there are currently only two states, Mississippi and South Dakota, that do not have EV corridors. As of Q1, both states had just over 50 public DC fast EVSE ports, but Mississippi only had three stations that meet FHWA criteria, whereas South Dakota did not have any.

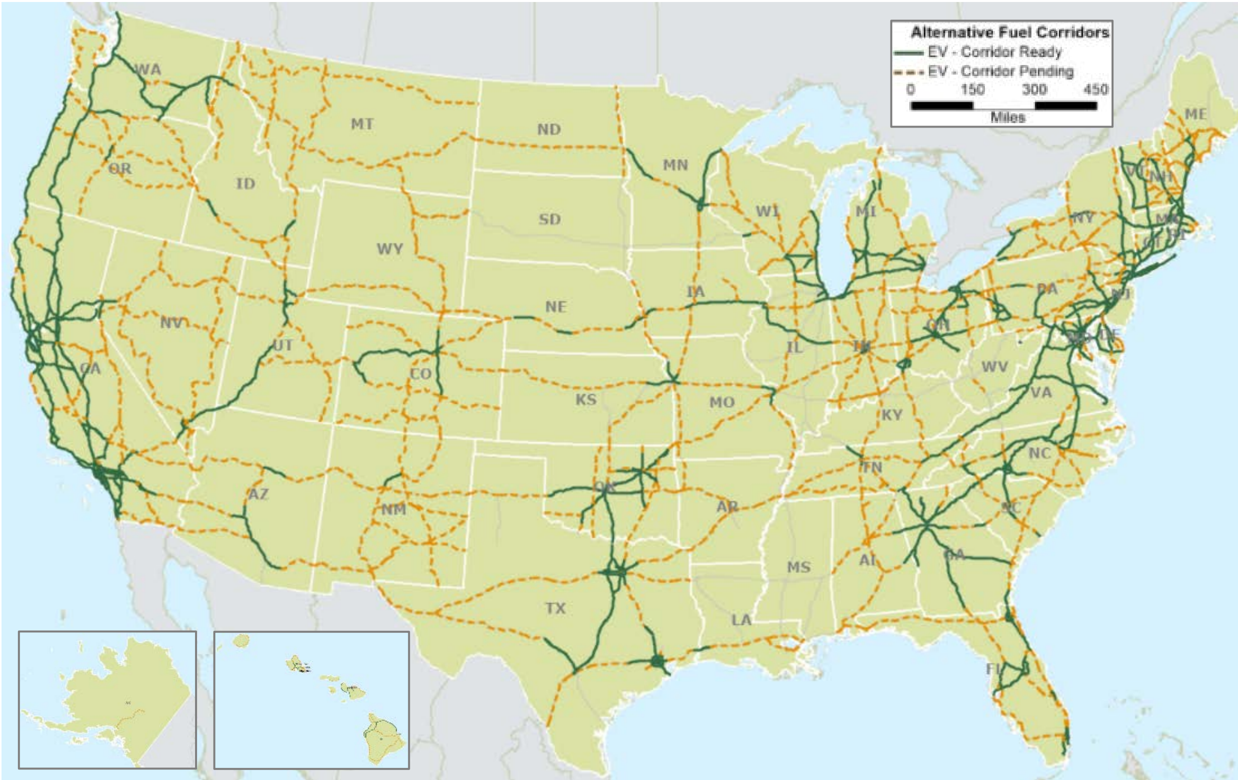

Figure 15. Rounds 1–5 of EV corridor designations

Source: Federal Highway Administration (2021a)

Although the fifth round fulfilled the requirements of the AFC program under the FAST Act of 2015, next steps are still being determined. As discussed in Section 4, the Station Locator team expects infrastructure development along highway corridors to continue to grow through federal funding sources that are available, as well as regional initiatives.

2.2 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 workplaces. Although the Station Locator team proactively seeks out new station openings to include, 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 these data, the number of private, nonresidential charging stations in the Station Locator is likely underrepresented; however, the Station Locator team is continually working to improve the data collection in these areas.

In Q1, the number of private EVSE ports in the Station Locator increased by 3,514, bringing the total number to 18,269 and representing a 23.8% increase since Q4, the largest percent growth in private EVSE ports seen to date. This growth is driven by the Station Locator's annual update of federally owned EV charging stations, as well as a large update of multifamily housing EVSE ports from EV Connect. The following sections break down the growth of private EVSE ports by level, as well as by three specific types: workplace, multifamily building, and fleet charging.

2.2.1 By Charging Level

As shown in Figure 16, the majority of private EVSE ports in the Station Locator are Level 2. Although DC fast and Level 1 EVSE ports grew by a significant percentage in Q1—75.3% and 64.6%, respectively—Level 2 EVSE ports experienced the largest absolute growth with the addition of 2,610 EVSE ports (Figure 16). As discussed in the following section, the large increase in private stations in Q1 is primarily attributed to an update of federally owned EV charging stations from NREL's Federal Fleets team.

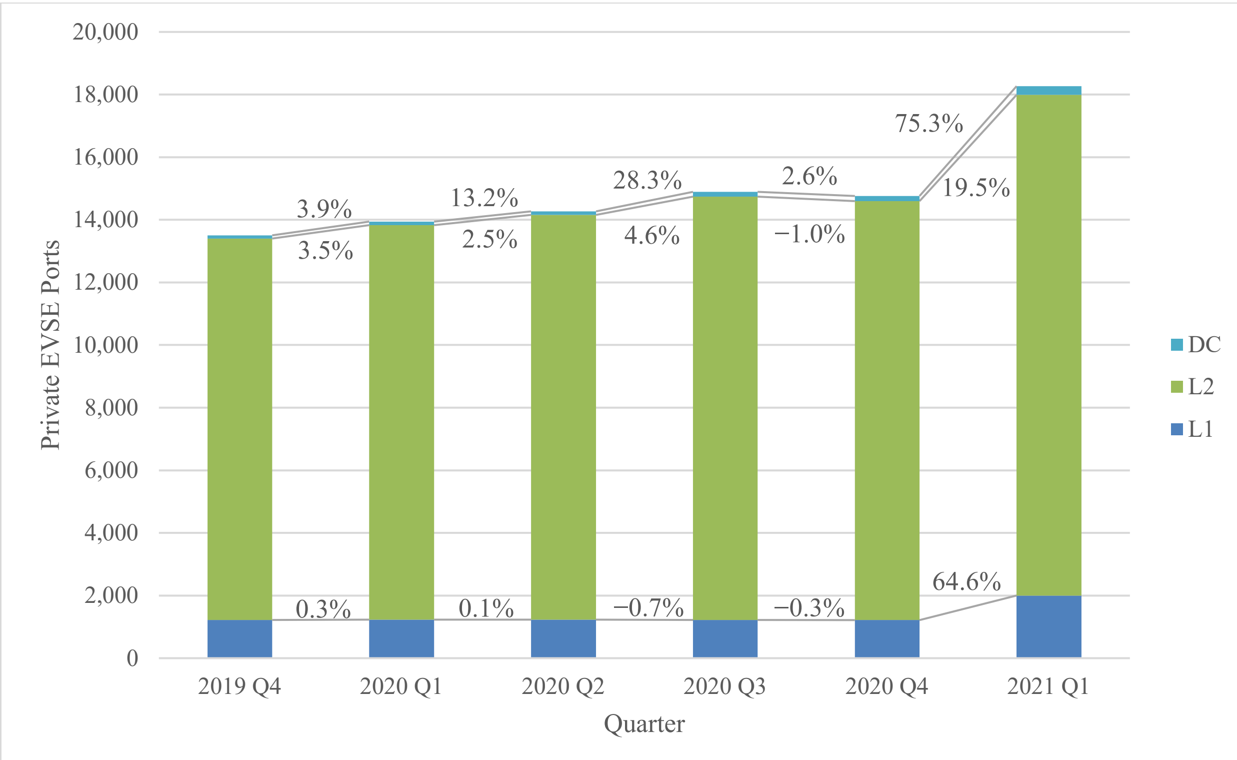

Figure 16. Quarterly growth of private EVSE ports by charging level

2.2.2 Workplace Charging

Workplace EV charging infrastructure includes charging stations that are private and designated for employee use only. The majority of private workplace EVSE ports in the Station Locator are Level 2 (Figure 17), which is to be expected because employees use workplace chargers while they are parked at work for an extended period, and therefore do not necessarily need rapid charging.

As of the end of Q1, there were 9,894 workplace EVSE ports in the Station Locator. As shown in Figure 17, the number of Level 1 EVSE ports grew by the greatest percentage (35.5%) at workplaces in Q1. DC fast EVSE ports also increased by a large percentage (19.0%), though this only represents an increase of eight EVSE ports. The large increase seen across all charging levels in Q1 is due to the annual update of federally owned EV charging stations that the Station Locator team receives once a year from NREL's Federal Fleets team, which resulted in the addition of 408 workplace EVSE ports located at federal buildings. Note that some workplace

EVSE ports are also used to charge fleet vehicles, and are therefore counted in Section 2.2.4 as well.

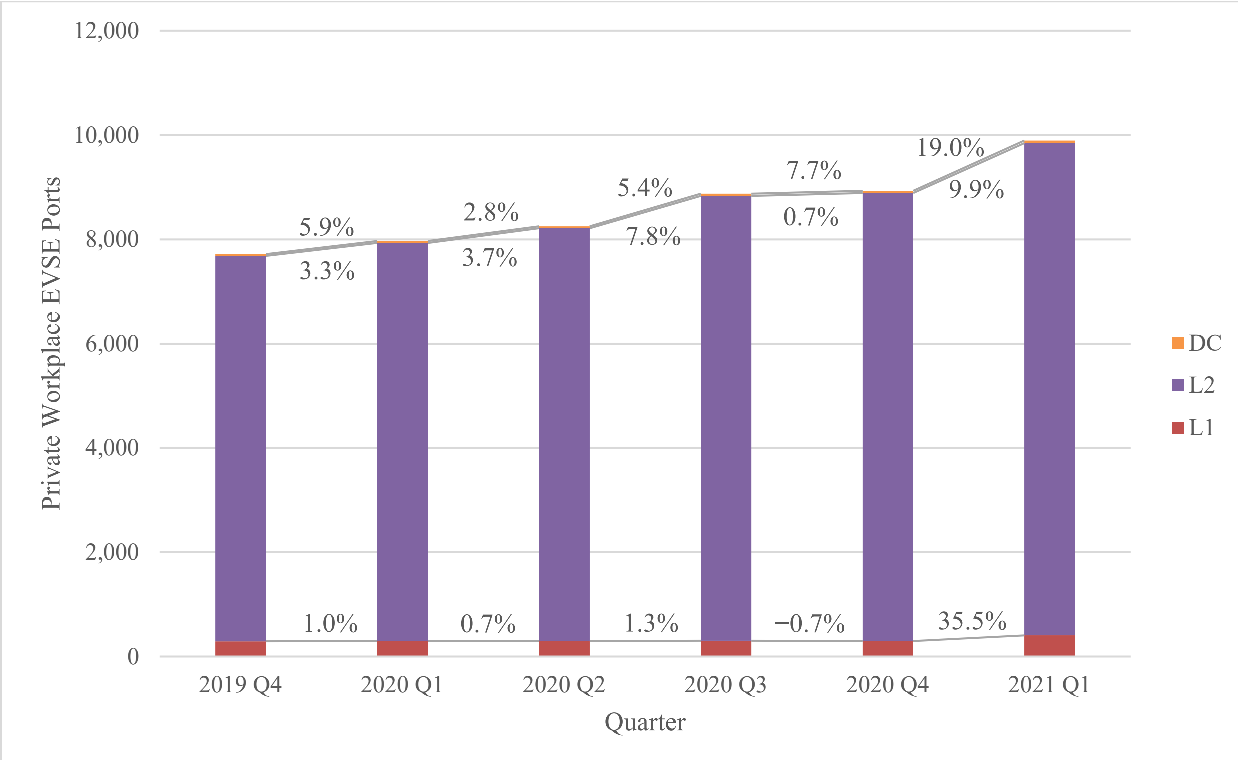

Figure 17. Quarterly growth of private workplace EVSE ports by charging level

2.2.3 Multifamily Building Charging

In 2019, the Station Locator team began a focused effort to capture private charging infrastructure installed at multifamily buildings that is available for resident use only. In Q1, there was a 53.9% increase in EVSE ports at multifamily buildings, bringing the total number of EVSE ports to 853 (Figure 18). Multifamily building EVSE ports in the Station Locator are either Level 1 or Level 2, but, as with previous quarters, only Level 2 EVSE ports grew in Q1 (Figure 18). The large increase in Level 2 EVSE ports is attributable to the Q1 update that the Station Locator received from EV Connect, which contained many multifamily building EVSE ports.

The Station Locator team continues its concerted efforts to collect data on EVSE ports at multifamily buildings, and the number of these EVSE ports is likely to continue to grow in future quarters.

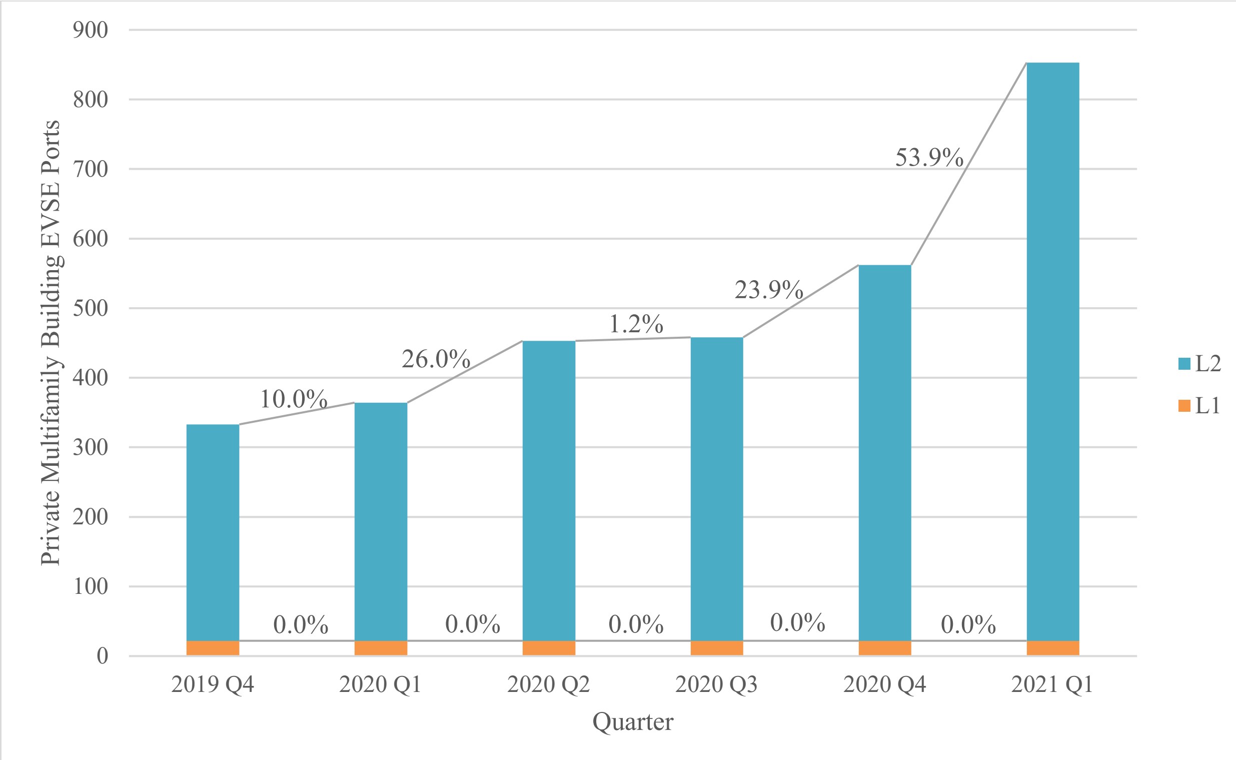

Figure 18. Quarterly growth of private multifamily building EVSE ports by charging level

2.2.4 Fleet Charging

In 2020, the Station Locator team began collecting data on whether stations are dedicated fleet charging stations, and if so, what types of vehicles charge at the station based its FHWA weight class—light-duty (LD), medium-duty (MD), or heavy-duty (HD). As of Q1, the team has collected this information for 83.1% of private EVSE ports, of which 47.3% are being used for fleet charging purposes. Note that some fleet EVSE ports are also used by employees, and are therefore counted in Section 2.2.2 as well.

Figure 19 shows the breakdown of these EVSE ports by fleet type and charging level. The fleet type indicates the largest vehicle type that charged at the station as of Q1, though other vehicle types may charge at the station as well. The majority of EVs on the road are LD vehicles, such as sedans, sport utility vehicles (SUVs), and pickup trucks; unsurprisingly, the majority of fleet charging EVSE ports are used to charge LD vehicles, and the majority of fleet charging EVSE ports are Level 2 (75.1%).

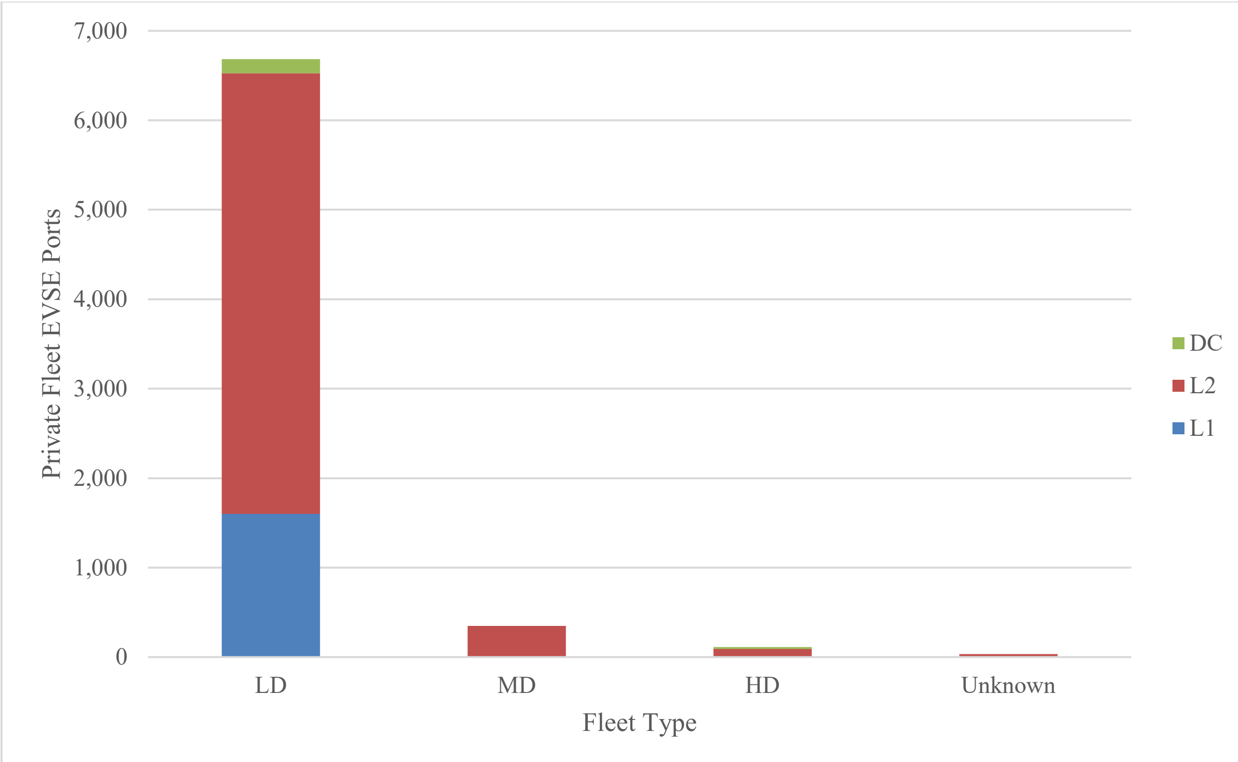

Figure 19. Breakdown of private fleet EVSE ports by fleet type and charging level in Q1

In 2021, the Station Locator team will continue to expand its private fleet data collection efforts, especially for fleets that are installing charging infrastructure for MD and HD vehicles such as school bus fleets and public transit fleets. Additionally, the Station Locator team is tracking the development of MD and HD charging infrastructure and will collect additional data, such as new connector types, as the technology evolves and is deployed.

3 Projecting Future Charging Infrastructure Needs

As discussed in more detail in the next section, the Biden administration's American Jobs Plan establishes grant and incentive programs for the state, local, and private sectors to build a network of 500,000 public EVSE ports in the United States by 2030 (The White House 2021b). As the corresponding legislation and budget have not yet passed, installations funded as a result of this plan have not begun. However, this figure serves as a useful benchmark for where the country's charging infrastructure is headed. As of Q1, there were 100,759 public EVSE ports available in the United States, or 20.2% of the Biden administration's goal. To meet this goal by 2030, approximately 11,407 public EVSE ports will need to be installed each quarter for the next 9 years.[1]

Details regarding how many Level 2 versus DC fast EVSE ports installations will be required under the American Jobs Plan have not yet been released; however NREL's 2017 *National Plug-*

[1] The American Jobs Plan establishes a goal of reaching 500,000 public charging stations by 2030, but does not specifically outline whether a charging station means a location or an EVSE port, as defined in Section 1.2. For the purposes of this report, it was assumed that charging station refers to a single-port charger, and therefore 500,000 EVSE ports.

In Electric Vehicle Infrastructure Analysis estimated how much public and workplace EV charging infrastructure would be required in the United States to support a growing fleet of LD plug-in electric vehicles (PEVs), including both plug-in hybrid electric vehicles and all-electric vehicles (Wood et al. 2017). Based on the central scenario with 15 million light-duty PEVs on the road by 2030, this analysis estimated a total of 27,500 DC fast EVSE ports and 601,000 Level 2 EVSE ports would need to be available across the United States to meet charging needs. This equates to 1.8 DC fast EVSE ports per 1,000 PEVs and 40.1 Level 2 EVSE ports per 1,000 PEVs by 2030.

As of Q1, there were 17,558 public and workplace DC fast EVSE ports and 91,266 public and workplace Level 2 EVSE ports available in the United States (Figure 20). Based on NREL's 2017 analysis, the amount of DC fast and Level 2 EVSE ports installed is 63.8% and 15.2%, respectively, of the way toward meeting projected 2030 infrastructure requirements (Figure 20). As with previous quarters, it is important to note that 56.7% of public DC fast EVSE ports in the Station Locator are on the Tesla Supercharger network and therefore only readily accessible to Tesla drivers. Additionally, as of the end of March 2021, over 40% of PEVs on the road were Teslas (IHS Markit 2018; Zhou 2021).[2] When public Tesla EVSE ports are excluded, the amount of DC fast and Level 2 EVSE ports currently installed is 27.7% and 13.3%, respectively, of the way toward meeting projected 2030 infrastructure requirements.

[2] This percentage is based on the number of cumulative Tesla sales in the United States from 2011 through March 2021, 2018 PEV registration data, and 2019–2021 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 between 2019–2021.

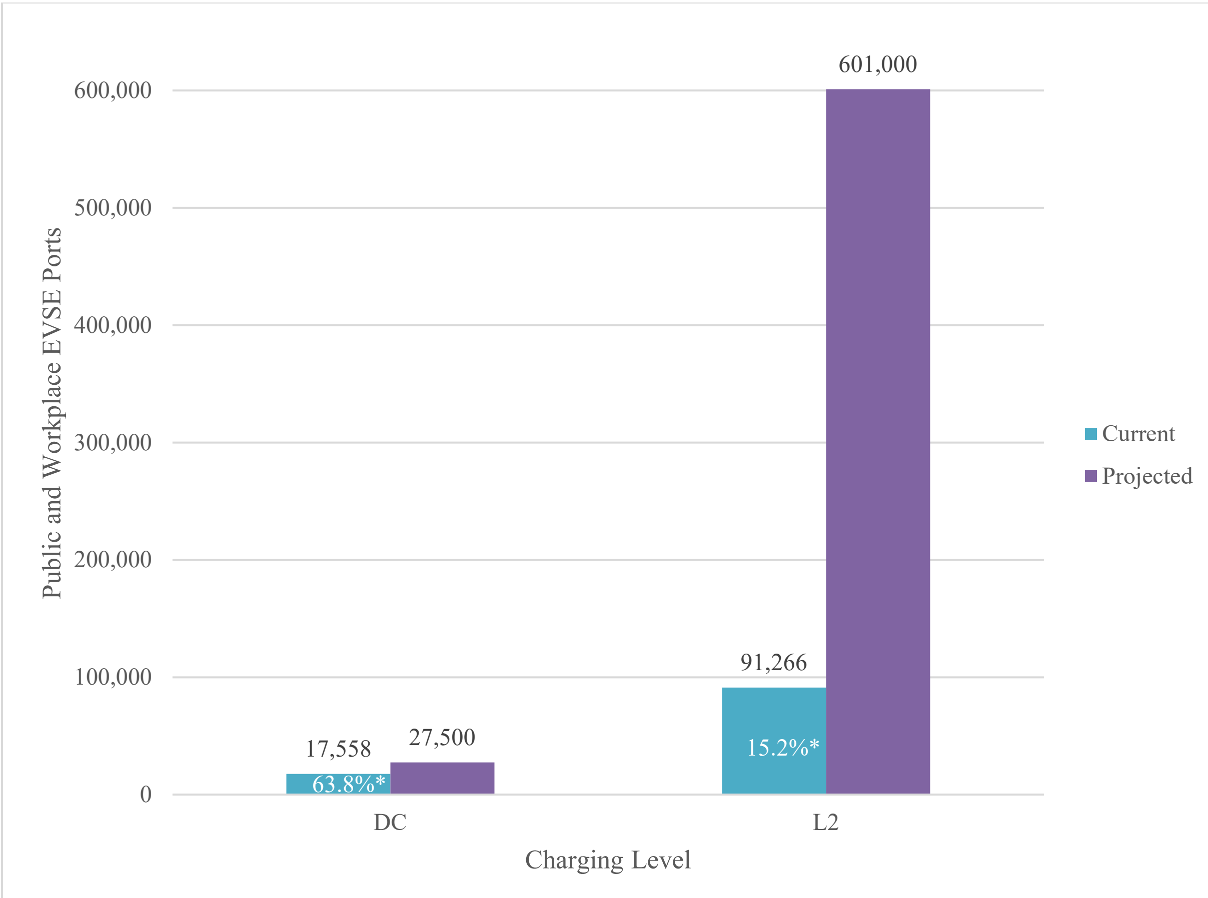

Figure 20. Current availability and projected 2030 need of public and workplace charging in the United States

*Indicates the percent of projected EVSE ports that have been installed as of Q1

As of Q1, there were approximately 1.7 million PEVs in the United States' light-duty fleet (IHS Markit 2018; Zhou 2021).[3] The ratio of DC fast and Level 2 public and workplace EVSE ports per 1,000 PEVs in Q1 was 10.1 and 52.4, respectively (Figure 21). These ratios decrease to 4.4 and 45.9, respectively, when Tesla EVSE ports are excluded. Using NREL's 2017 analysis' estimated ratio of 1.8 DC fast and 40.1 Level 2 EVSE ports per 1,000 PEVs as a proxy for how much infrastructure is sufficient to meet charging needs, Figure 21 indicates that, as of Q1, there was enough public and workplace DC fast and Level 2 EVSE ports in the United States as a whole to meet projected charging needs. However, this comparison does not speak to whether the geographic distribution of EVSE ports matches where there is charging demand. Future reports will include more granular data on the geographic distribution of EVSE ports across the United States. Additionally, it is notable that only 11.6% of the 15 million light-duty PEVs projected for 2030 were on the road as of Q1, though as discussed in Section 4, PEV sales are on the rise (Zhou 2021).

[3] U.S. 2019 and 2020 PEV registration data were not available for this report. The number of PEVs as of March 2021 is based on 2018 PEV registration data and 2019–2021 light-duty PEV sales data. Therefore, the 1.7 million figure does not account for vehicles that were retired in 2019–2021 and may overestimate the number of PEVs on the road.

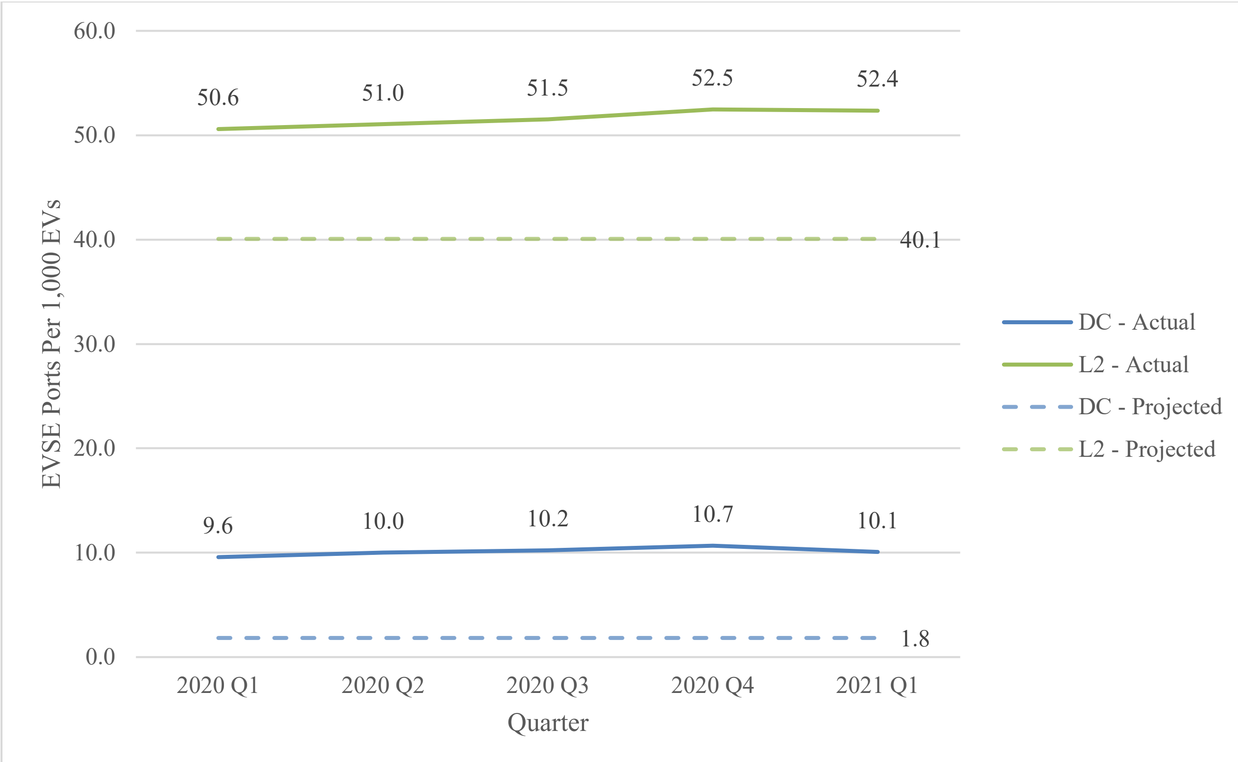

Figure 21. Quarterly availability and projected 2030 need of public and workplace EVSE ports per 1,000 EVs in the United States

It is important to point out that this analysis may underrepresent the trajectory of the industry given that it is based on projections from 2017. Since then, some states have established more ambitious electrification plans or have passed regulations to phase out new sales of gasoline-powered light-duty vehicles and increase sales of zero-emission light-duty vehicles. These regulations will therefore increase the number of PEVs on the road and the charging infrastructure required to support them. As a result, individual states are likely to set charging infrastructure targets for their states that may not align with this analysis. For example, in January 2021, the California Energy Commission released the *Assembly Bill 2127 EV Charging Infrastructure Assessment*, which estimates that 714,000 public and shared private EVSE ports—including 24,000 public DC fast EVSE ports and 466,000 public and workplace Level 2 EVSE ports—will be required to support the state's target of 5 million PEVs on the road by 2030 (Crisostomo et al. 2021). By 2035, the assessment estimates that 1.2 million public and shared private EVSE ports, including 37,000 public DC fast EVSE ports and 797,000 public and workplace Level 2 EVSE ports, will be required to meet the charging demand of 8 million PEVs on the road as a result of California's Executive Order N-79-20, which phases out the sale of new gasoline-powered light-duty vehicles.

4 Developments That Could Impact Future Quarters

2021 is already shaping up to be an important year for the U.S. PEV market. President Biden began his presidency by issuing Executive Order 14008, directing all federal, state, local, and tribal fleets, including the U.S. Postal Service, to establish fleet electrification plans (U.S. President 2021). Shortly after, the Biden administration released the American Jobs Plan, which includes a $174-billion investment in transportation electrification goals, including $15 billion for EV charging infrastructure (The White House 2021a, 2021b). The American Jobs Plan aims to provide point-of-sale rebates and tax incentives for consumers to buy PEVs, and to establish grant and incentive programs for both the public and private sectors to reach 500,000 EV chargers installed across the United States by 2030. Additionally, this plan aims to replace 50,000 diesel transit buses and electrify at least 20% of the U.S. school bus fleet through the U.S. Environmental Protection Agency's Clean Buses for Kids program.

States also continued to push forward policies in Q1 that would benefit the U.S. PEV market. Notably, Virginia Governor Ralph Northam signed HB 1965, which directs the Virginia Air Pollution Control Board to establish a zero-emissions vehicle program requiring a certain percentage of new in-state vehicle sales be zero-emissions vehicles beginning with model year 2025 vehicles (Va. H.B. 1965 § 10.1-1307.04 (2021)). Including Virginia, 14 states and the District of Columbia have now adopted zero-emissions vehicle requirements modeled after California's Advanced Clean Cars program, meaning that 35% of new vehicle sales in the United States would be required to meet zero-emissions requirements, according to IHS Markit (Adler 2021). Additionally, more states have begun to follow California's lead to completely phase out the sale of new gasoline-powered passenger vehicles in their states by 2035. Massachusetts' new interim 2030 Clean Energy and Climate Plan includes plans to do so, and, in February 2021, Washington introduced HB 1204, which would require that all model year 2030 or later passenger vehicles to be electric in order to be registered in the state (Massachusetts Executive Office of Energy and Environmental Affairs 2020; Wa. H.B. 1204 § 1 (2021)).

Although it will take time before the full impacts of these plans and regulations are seen, PEV sales were already off to a strong start in Q1. January, February, and March each set records for the highest sales in those months to date, and March set an all-time record for the highest monthly PEV sales in the United States to date, with 55,253 PEVs sold (Atlas Public Policy 2021a, 2021b). Additionally, several vehicle manufacturers announced plans to only produce PEVs by a certain date, including Mini (2025), Jaguar (2025), Volvo (2030), Nissan (2030), and General Motors (2035). To date, seven manufacturers have committed to doing so, while most others have made commitments to have a certain number of PEV models available in the next decade (Brown et al. 2021).

It is now more important than ever to build out charging infrastructure in the United States to support the rapidly growing fleet of PEVs, and utilities continue to play an important role in doing so. Notably, six utilities in the Southeast and Midwest, including American Electric Power, Dominion Energy, Duke Energy, Entergy Corporation, Southern Company, and the Tennessee Valley Authority, formed the Electric Highway Coalition in March 2021 (Lewis 2021). This coalition aims to build a network of DC fast chargers along major highways, with each utility focusing on their respective service territory. The Station Locator team will work with these utilities to ensure that the stations installed through the coalition are included the Station Locator.

Finally, the Station Locator data collection and management processes will continue to impact future EVSE ports 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: station locations, EVSE ports, and connectors (EVRoaming Foundation 2019). With this transition, the Station Locator is now counting the number of EVSE ports at a station location rather than the number of connectors previously counted. For example, a charging location with one EVSE ports and two connectors was previously counted twice, but is now only counted once using the OCPI protocol's counting logic. As of Q1, all manually collected data, as well as EVSE ports on the ChargePoint, Electrify America, EVgo, and Greenlots networks, are counted according to the OCPI logic. Additionally, as discussed in Section 1.1.1, as additional OCPI APIs are integrated into the Station Locator, the Station Locator team continues to see increases in station counts due to cases where one station is split into several new stations to represent different physical locations of EVSE ports at one address. Finally, NREL is continuously working with EVSPs to add new APIs to the Station Locator, and as these new APIs come online, there will likely be a corresponding increase in the number of EVSE ports.

5 Conclusion

This report examines the growth of EV infrastructure in the AFDC Station Locator, 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, multifamily building, and fleet) in Q1 of 2021. With such rapid growth and change in EV charging infrastructure, the information presented in this report aims to help readers understand how and where the 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 Q1, Level 2 chargers accounted for the majority of both public and private EVSE ports in the Station Locator (81.3% and 87.5%, respectively). Overall, there was a 7.3% increase in the number of EVSE ports in the Station Locator, with Level 2 EVSE ports contributing to the majority of that growth. California continues to lead the country in terms of the total number of public EVSE ports available (32,267), though public charging infrastructure grew by the largest percentage in the South Central region in Q1 (7.9%).

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 ports is 63.5% and 14.3%, respectively, of the way toward meeting projected 2030 needs (Wood et al. 2017). The number of DC fast EVSE ports and Level 2 EVSE ports per 1,000 PEVs was 10.7 and 52.5, respectively, compared with NREL's projected need of 1.8 and 40.1, respectively. Using NREL's ratios as a proxy for current charging needs, this indicates that infrastructure development is keeping up with, and even surpassing, projected charging needs in terms of the total amount available across the United States. It is important to note, however, that the majority (54.2%) of public DC fast EVSE ports 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 multifamily building and fleet charging data, there will continue to be large increases in the number of EVSE ports available.

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

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