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

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

1 National Renewable Energy Laboratory
2 ICF Inc.

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

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Contract No. DE-AC36-08GO28308

Technical Report
NREL/TP-5400-82298
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Suggested Citation
Brown, Abby, Alexis Schayowitz, and Emily White. 2022. *Electric Vehicle Charging Infrastructure Trends from the Alternative Fueling Station Locator: Fourth Quarter 2021*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5400-82298. www.nrel.gov/docs/fy22osti/82298.pdf.

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303-275-3000 • www.nrel.gov

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This work was authored in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Vehicle Technologies Office. The views expressed herein do not necessarily represent the views of the DOE or the U.S. Government.

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Acknowledgments

Funding for this report came from the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Vehicle Technologies Office. The Station Locator team collected the data used to generate this report with the help of electric vehicle (EV) charging networks, charging infrastructure providers and developers, Clean Cities Coalition Network coordinators, industry associations, original equipment manufacturers, state and local government agencies, utilities, fleets, EV drivers, and other industry stakeholders. The authors relied on the valuable contributions of reviewers, including:

Dan Bowerson……………………………………………..Alliance for Automotive Innovation

Kevin Wood……………Center for Sustainable Energy/San Diego Clean Cities (now Energetics)

Lori Clark………………………………………………………Dallas-Fort Worth Clean Cities

Sam Pournazeri…………………………………………………………………………ICF

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List of Acronyms

AFDC	Alternative Fuels Data Center
AMPUP	AmpUp network
API	application program interface
BIL	Bipartisan Infrastructure Law
BN	Blink network
CCS	Combined Charging System
CHARGELAB	ChargeLab network
CPN	ChargePoint network
DC	direct current
E85	ethanol blend containing 51% to 83% ethanol, depending on geography and season
EA	Electrify America network
EV	electric vehicle, including all-electric and plug-in hybrid electric vehicles
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
FLO	FLO network
FPLEV	FPL EVolution network
GRN	Greenlots network
HD	heavy duty
KU	Kentucky Utilities Company
L1	Level 1 charger
L2	Level 2 charger
LD	light duty
LG&E	Louisville Gas and Electric Company
LIVINGSTON	Livingston Energy Group network
MD	medium duty
NEVI	National Electric Vehicle Infrastructure
NON	non-networked
NREL	National Renewable Energy Laboratory
OC	OpConnect network
OCPI	Open Charge Point Interface
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's 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 fourth calendar quarter of 2021 (Q4). 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 two different 2030 infrastructure requirement scenarios. This information is intended to help transportation planners, policymakers, researchers, infrastructure developers, and others understand the rapidly changing landscape of EV charging infrastructure. This is the eighth report in a series. Reports from previous quarters 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 Q4, there was a 4.3% increase in the number of electric vehicle supply equipment (EVSE) ports in the Station Locator, including a 4.7% increase in public EVSE ports and a 2.0% increase in private EVSE ports. Among public EVSE ports, direct-current (DC) fast EVSE ports grew by the largest percentage (8.8%). The Mid-Atlantic region of the Clean Cities Coalition Network had the largest increase in public charging infrastructure in Q4 (7.6%), though California, which has one-third of the country's public charging infrastructure, continues to lead the country in the number of available public EVSE ports.

This report uses three different benchmarks to assess the current state of public charging infrastructure with future requirements to support a growing fleet of light-duty EVs. First, the Joseph R. Biden administration has established a goal of building a national public charging network of 500,000 EVSE ports by 2030. To meet this goal by 2030, approximately 12,048 public EVSE port installations will be required each quarter for the next 9 years, requiring a significant increase from the 5,077 public EVSE ports that have been installed each quarter, on average, since the start of 2020. Second, NREL's 2017 *National Plug-In Electric Vehicle Infrastructure Analysis* estimated that 27,500 DC fast and 601,000 Level 2 public and workplace EVSE ports would be required in the United States to support a scenario in which 15 million light-duty EVs are on the road by 2030 (Wood et al. 2017). Based on this analysis, 79.0% and 16.8% of the required DC fast and Level 2 EVSE ports, respectively, have been installed as of Q4. Third, Atlas Public Policy's 2021 *U.S. Passenger Vehicle Electrification Infrastructure Assessment* estimated that an additional 252,000 DC fast and 244,000 Level 2 public and workplace EVSE ports beyond today's installations would be required by 2030 to support a scenario in which 100% of passenger vehicle sales are electric by 2035 (McKenzie and Nigro 2021). Based on this assessment, the number of DC fast and Level 2 EVSE ports is 8.1% and 30.2%, respectively, of the way toward meeting 2030 infrastructure requirements. It is important to note, however, that the majority (58.0%) 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's 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 2022a). 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 given the Joseph R. Biden administration's goal of building a national EV charging network of 500,000 EV chargers by 2030 and the newly available funds from the Bipartisan Infrastructure Law (BIL) to support it. Using Station Locator data, this report explores the growth of both public and private EV charging infrastructure in the United States for the fourth calendar quarter of 2021 (Q4). This is the eighth report in a series. Reports from previous quarters 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.

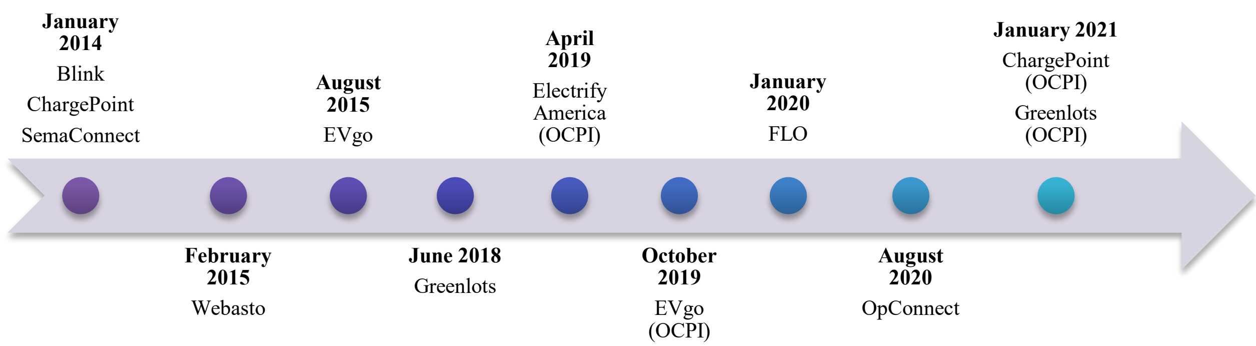

Figure 2. Timeline of API integrations in the Station Locator

As of December 2021, there were 50,054 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 2022b). Of those, approximately 67% are automatically updated daily via EVSP-provided APIs, whereas the rest are managed and updated manually.

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, 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 semiregular data in the form of spreadsheets from EVSPs that have networked stations but do not currently have an API available. These EVSPs include, but are not limited to, EV Connect, Tesla, and Volta. In Q4, The Station Locator team received an updated list of Tesla Supercharger stations from Tesla. 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 electric vehicle supply equipment (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 as opposed to 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. Public EV charging infrastructure is accessible to any EV driver.

- **Workplace:** EV charging intended to provide charging to employees during the workday. Workplace charging infrastructure is accessible only to employees of a business and is therefore classified as private in the Station Locator.
- **Commercial/Fleet:** EV charging intended to provide charging for electric fleet vehicles, including municipal/private fleets, car sharing, and transportation network companies. Fleet charging infrastructure is classified as private in the Station Locator.

The Station Locator does not maintain data on single-family residential charging and has minimal, yet expanding, data on charging at multifamily buildings. EV charging infrastructure at multifamily buildings is also classified as private in the Station Locator. 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 2020), as shown in Figure 3 and described below. 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.

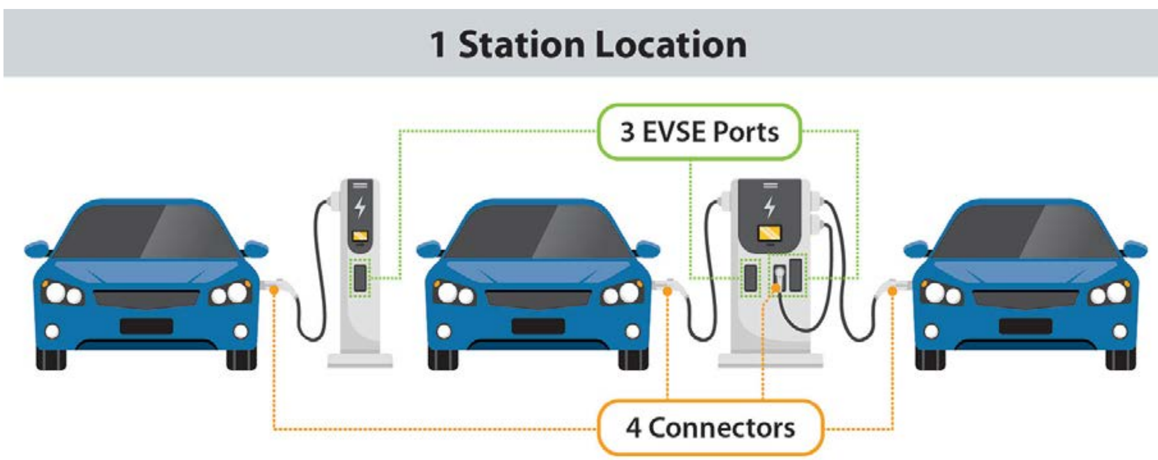

Figure 3. EV charging infrastructure hierarchy

Source: Alternative Fuels Data Center (2022d)

The following fuel-specific fields are tracked in the Station Locator for EV charging stations (Alternative Fuels Data Center 2022c):

- 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[1]
    - J1772: for Level 1 and Level 2 chargers
    - Combined Charging System (CCS): for DC fast chargers for most vehicle models
    - CHAdeMO: for DC fast chargers for select vehicle models
    - 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 Q4 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 Q4, the number of EVSE ports in the Station Locator grew by 4.3%, or 5,544 EVSE ports. Public EVSE ports grew by 4.7%, or 5,175 ports, and account for the majority of EVSE ports in the Station Locator (Figure 4). Private EVSE ports increased by 2.0%, or 369 EVSE ports (Figure 4).

[1] Most, if not all, EVs will come with a Level 1 cordset, so no additional charging equipment is required. On one end of the cord is a standard NEMA connector (for example, a NEMA 5-15, which is a common three-prong household plug), and on the other end is an SAE J1772 standard connector (often referred to simply as J1772, shown in Figure 3). The J1772 connector plugs into the car's J1772 charge port, and the NEMA connector plugs into a standard NEMA wall outlet.

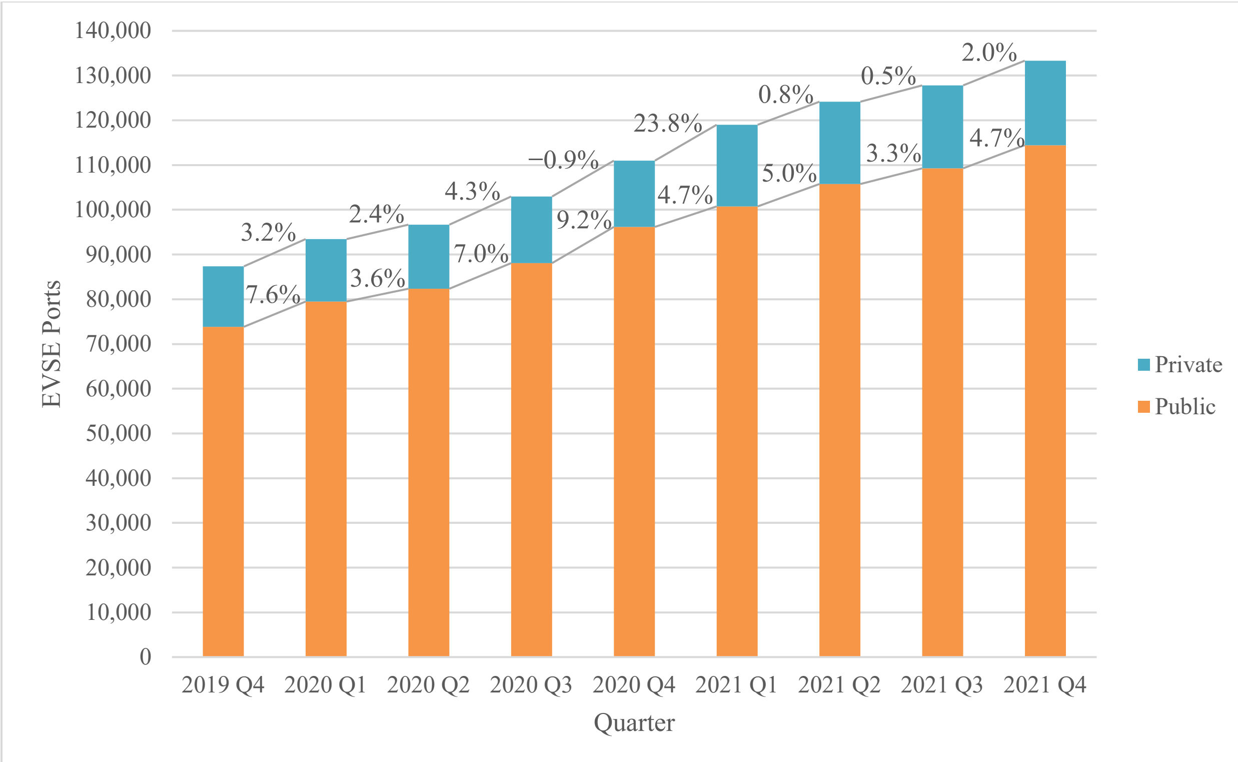

Figure 4. Quarterly growth of EVSE ports by access

The following sections break down the growth of public and private EVSE ports further to highlight what types of EV infrastructure grew in Q4 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 Q4, the number of public EVSE ports in the Station Locator increased by 5,175, bringing the total number of public EVSE ports in the Station Locator to 114,451 and representing a 4.7% increase since Q3. 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. However, DC fast EVSE ports increased by the greatest percentage (8.8%) in Q4 (Figure 5). Level 1 EVSE ports decreased by 8.7% (Figure 5). The decrease in public Level 1 EVSE ports can be attributed to closures on the ChargePoint and OpConnect networks, though the number of both ChargePoint and OpConnect EVSE ports grew overall in Q4, driven by new Level 2 and DC fast EVSE port installations.

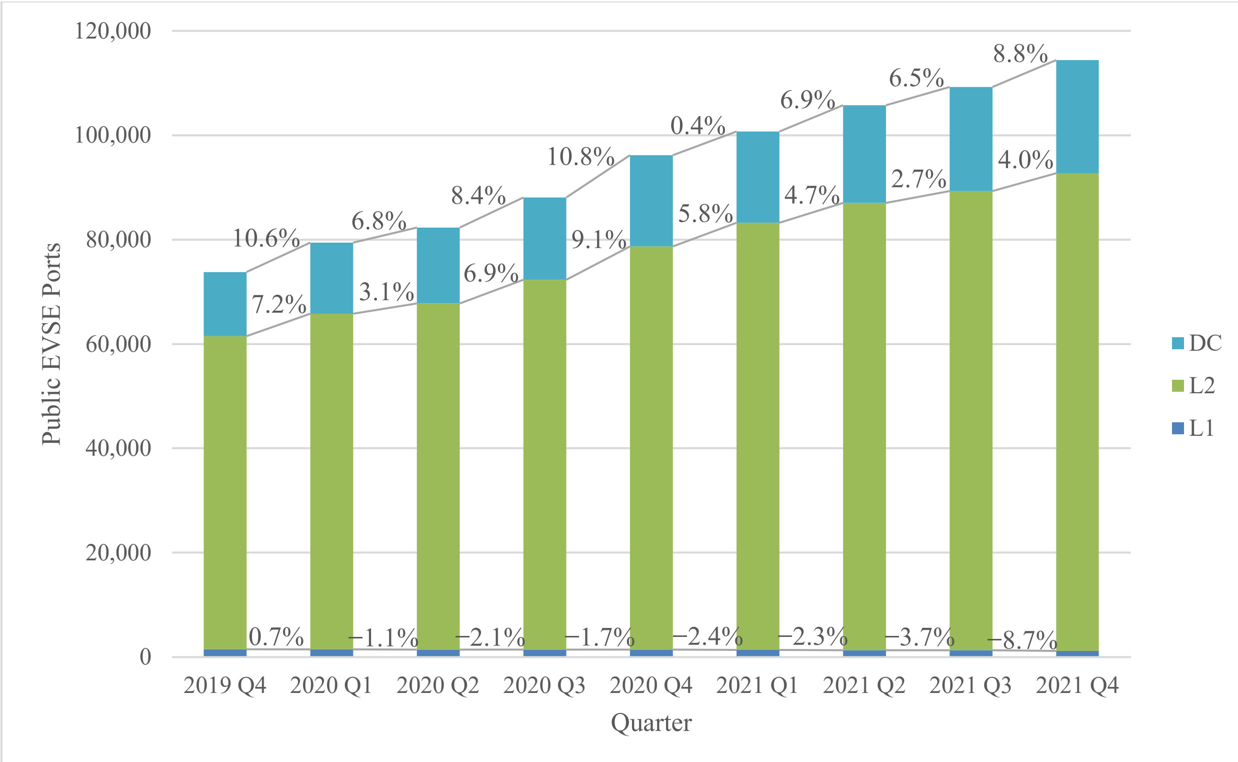

Figure 5. Quarterly growth of public EVSE ports by charging level

Note: Figure excludes legacy EVSE ports that are not classified by charging level and are no longer manufactured.

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. Building out the country's network of public DC fast chargers will be critical to supporting EV adoption in the United States, and it is therefore important to highlight trends in the growth of DC fast EVSE ports in the Station Locator. Whereas the power output for Level 1 chargers is about 1 kW and Level 2 chargers can operate at up to 19 kW, DC fast chargers have a typical power output of 50 kW, and DC fast chargers with higher levels of power output are increasingly more available. Extreme fast charging infrastructure, which has a power output of 350 kW or more, was introduced in 2018. The number of DC fast EVSE ports with these higher power levels remain a minority in the Station Locator, yet are steadily increasing, as seen in Figure 6.

It is important to point out that of the 21,676 public DC fast EVSE ports in the Station Locator, power output data are currently only available for 49.2%; Figure 6 is therefore based on power output data for 10,673 DC fast EVSE ports. Additionally, if a DC fast EVSE port has two connectors with different power outputs, only the maximum power output is counted in Figure 6. 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, as well as making power data publicly available for CCS and CHAdeMO connectors.

As shown in Figure 6, the number of EVSE ports with a power output between 250 kW and 349 kW grew by the largest percentage in Q4 (45.5%). This increase is primarily driven by new installations of DC fast EVSE ports on the Tesla Supercharger network with a power output of

250 kW. For an explanation of the large changes seen in 2021 Q1, see the 2021 Q1 report (Brown, Schayowitz, and Klotz 2021).

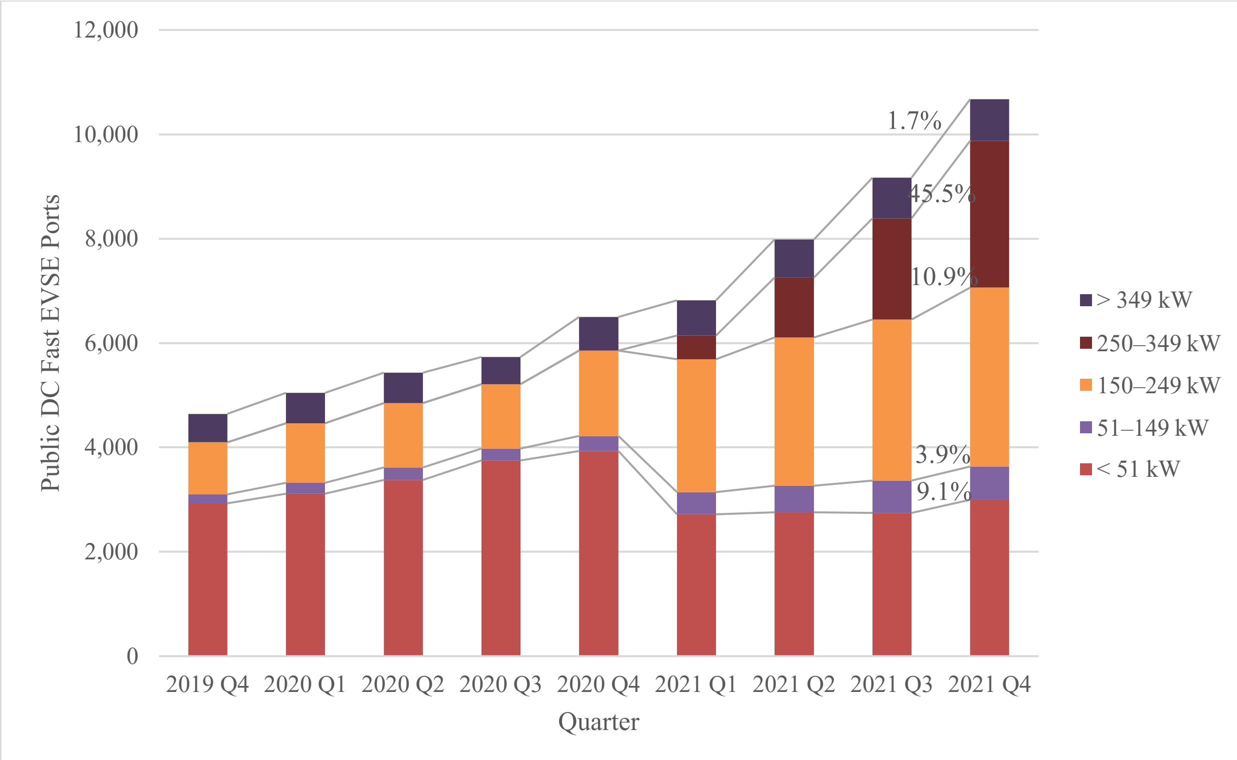

Figure 6. Quarterly growth of public DC fast EVSE ports by power output

Finally, there are currently three types of connectors available for DC fast chargers: CHAdeMO, CCS, and Tesla. As noted in Section 1.2, not all EVs are compatible with each connector type. Most EV models entering the market today can charge using the CCS connector, while the all-electric Nissan LEAF and Mitsubishi Outlander plug-in hybrid electric vehicles are the only models still being produced in the United States with the CHAdeMO connector standard. Only Tesla vehicles can charge with the Tesla connector. Although Tesla vehicles do not have a CHAdeMO charge port and do not come with a CHAdeMO adapter, Tesla does sell an adapter, allowing Tesla vehicles to charge at DC fast chargers that have a CHAdeMO connector. Additionally, Tesla is in the process of making a CCS adapter for Tesla vehicles.

At the end of 2020, 50% of registered EVs in the United States were compatible with the CCS connector, 42.5% of registered EVs were Teslas, and 7.5% of registered EVs were compatible with the CHAdeMO connector (Experian Information Solutions 2020). Of the 25,937 DC fast connectors in the Station Locator as of Q4, Tesla connectors made up 48.6%. Tesla connectors also grew by the largest percentage in Q4 (9.9%), though, as noted in Section 1.1.2, this is in part due to the large Tesla Supercharger update that the Station Locator team received in Q4 (Figure 7). CSS connectors grew by 7.0%, and made up 29.9% of DC fast connectors as of Q4. Finally, despite CHAdeMO-compatible vehicles only making up 7.5% of registered EVs, the number of CHAdeMO connectors in the Station Locator continues to grow and made up 21.5% of DC fast connectors in Q4. One possible reason for this is that, historically, some grant programs have required that public DC fast stations have both CHAdeMO and CCS connectors available to be eligible for funding.

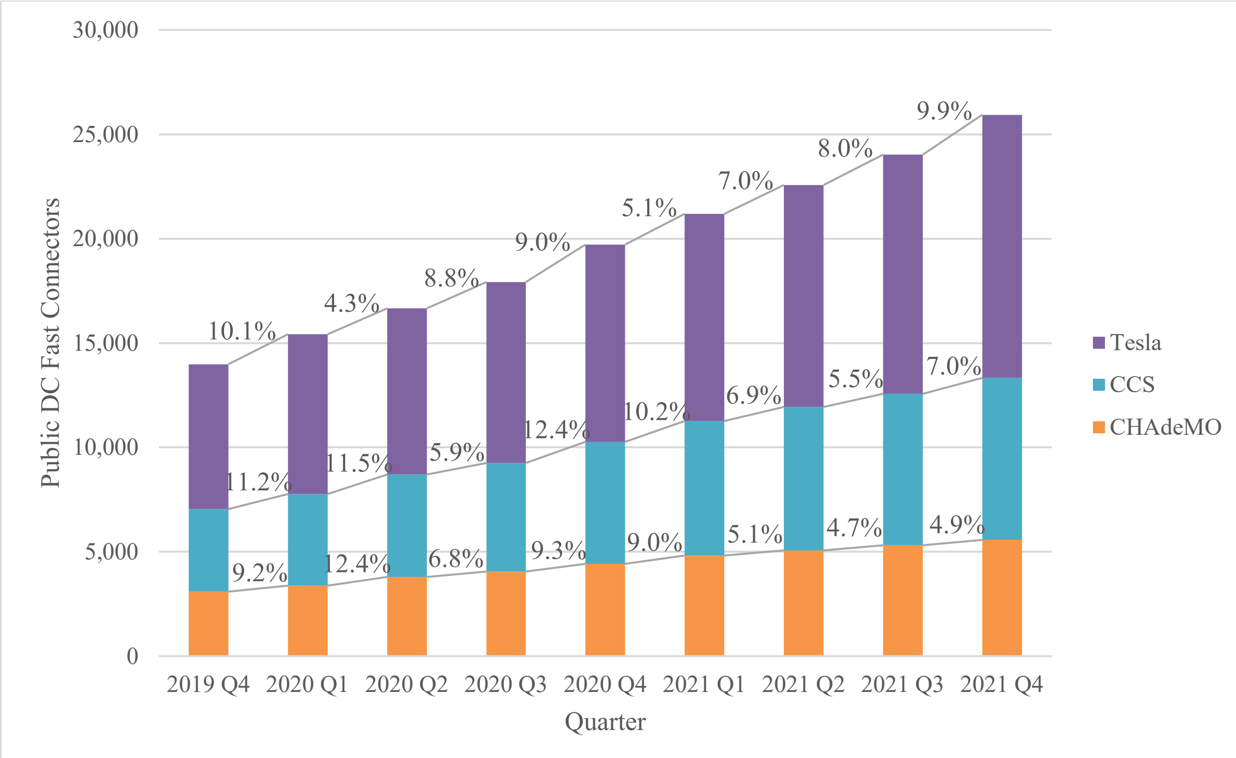

Figure 7. Quarterly growth of public DC fast connectors by type

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 22 networks listed below, 9 of which update on a nightly basis. 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)
- Livingston Energy Group (LIVINGSTON)
- OpConnect (OC)
- Powerflex (POWERFLEX)
- SemaConnect (SCN)
- Tesla Supercharger (TESLA)
- Tesla Destination (TESLAD)
- Volta (VLTA)
- Webasto (WEB)
- ZEF (ZEFNET).

As of the end of Q4, the ChargePoint network accounted for the largest number of public EVSE ports (42.8%) in the Station Locator, and Level 2 chargers constituted the majority of ChargePoint's network (Figure 8). 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 (58.0%), followed by Electrify America (14.4%) and EVgo (7.9%) (Figure 9).

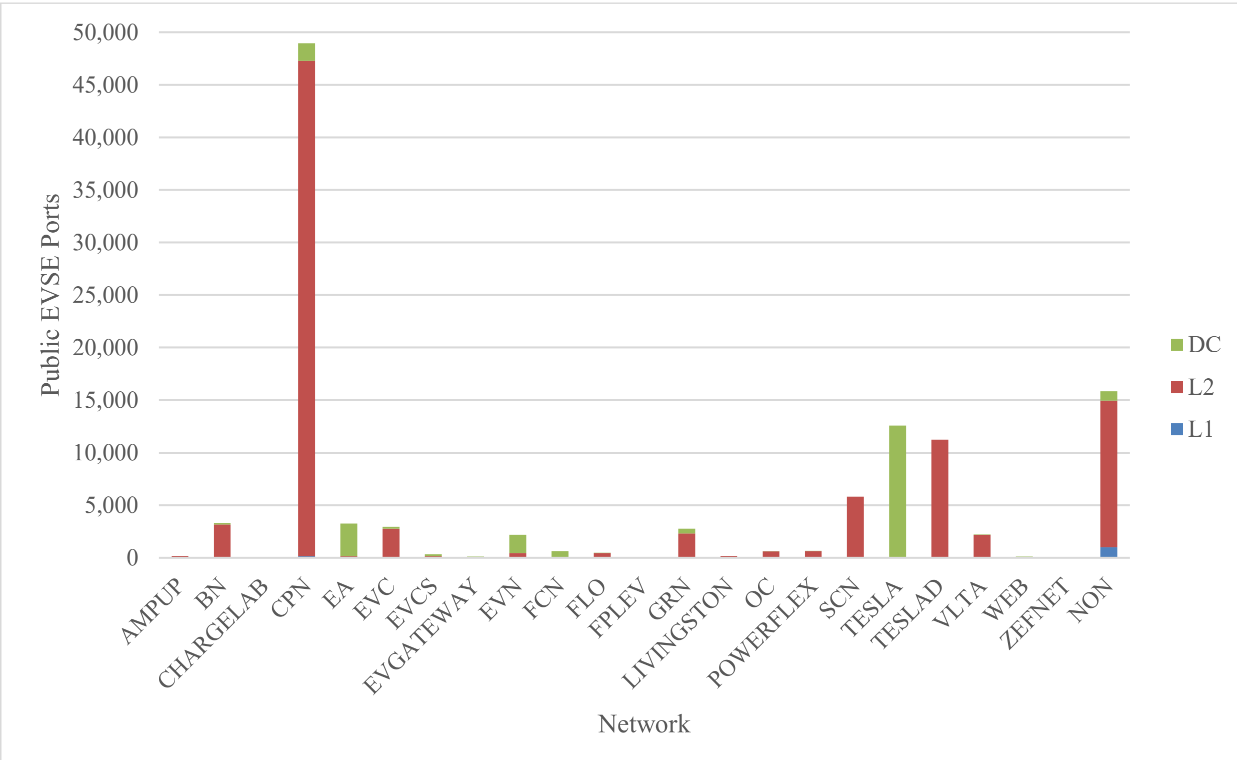

Figure 8. Breakdown of public EVSE ports by network and charging level in Q4

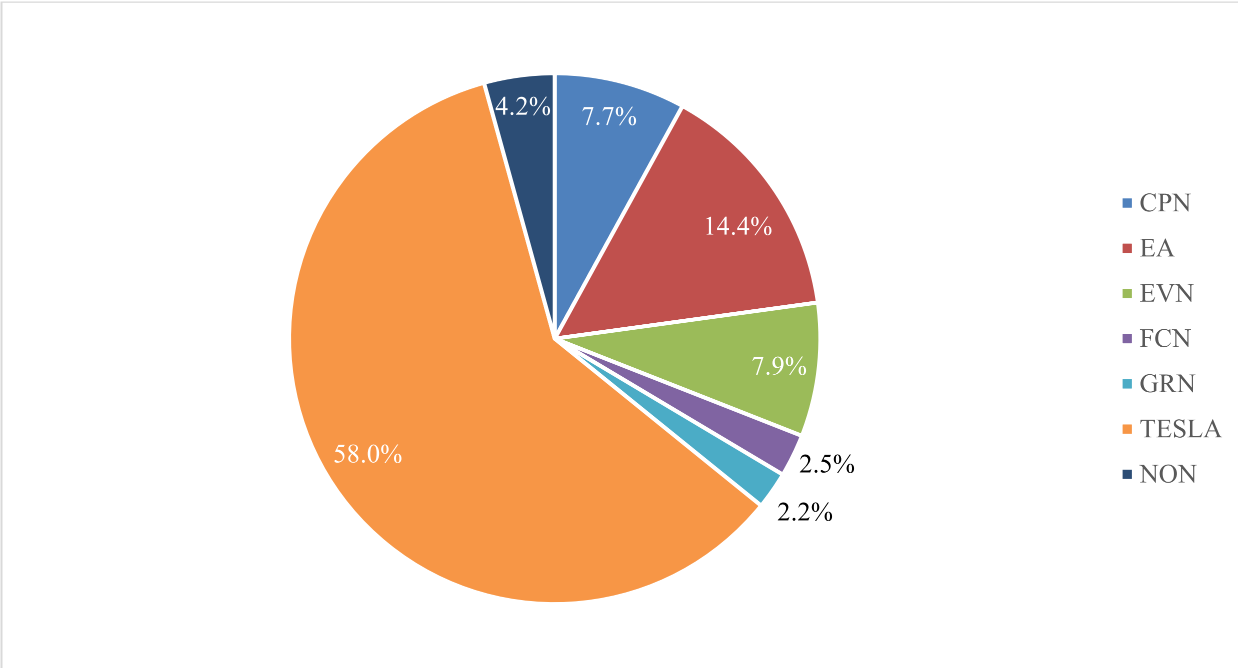

Figure 9. Breakdown of public DC fast EVSE ports by network in Q4

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

Figure 10 shows the growth of each network in Q4, and Table 1 includes the percent growth of each network in Q4. The number of public EVSE ports for the majority of networks increased in Q4, with the exception of Blink, which decreased by 1.1%, and a handful of networks that experienced no growth (Table 1). The decrease in Blink EVSE ports can be primarily attributed to a decrease of DC fast EVSE ports. The networks that show no growth in Q4 are those that provide periodic updates to the Station Locator team, and the team did not receive updates for these networks in Q4.

EVCS grew by the largest percentage (409.7%) in Q4 (Table 1), reflecting an increase of 254 EVSE ports from 62 to 316. This growth does not reflect new installations, but rather the acquisition of non-networked stations as well as stations from other networks. EVCS informed the Station Locator team that EVCS has been awarded a contract from the Oregon Department of Transportation to upgrade stations that are part of the West Coast Electric Highway, and that EVCS has plans to install at least three new stations. Therefore, the Station Locator team expects to see the EVCS network grow in future quarters.

FLO also grew by a considerable percentage in Q4 (20.3%) (Table 1). As with Q3, this is primarily due to the installation of Level 2 EVSE ports in Cincinnati, Ohio, and New York, New York. The growth in Cincinnati may be attributed to FLO's partnership with Electrada, a Cincinnati-based electric mobility startup that is working with a variety of stakeholders to deploy EV charging stations in the Midwest (FLO 2020). Electrada has a goal of installing over 300 EV charging stations throughout the Midwest (Erpenbeck 2021). In New York, FLO has partnered with the New York City Department of Transportation and Consolidated Edison to install 100 curbside Level 2 EVSE ports, contributing to the growth seen in Q4 (FLO 2021).

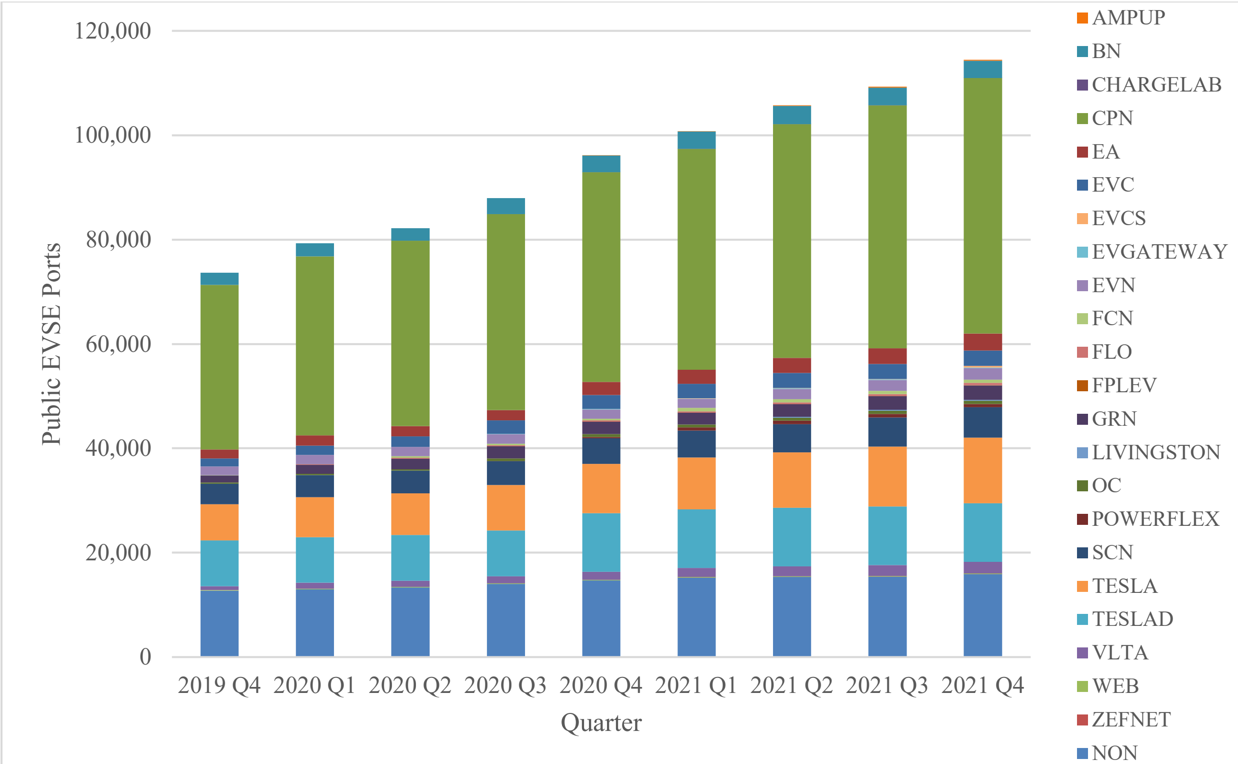

Figure 10. Quarterly growth of public EVSE ports by network

Table 1. Quarterly Growth of Public EVSE Ports by Network in 2021

Network	2021 Q1 Growth	2021 Q2 Growth	2021 Q3 Growth	2021 Q4 Growth
AMPUP	10.0%	154.5%	0.0%	3.6%
BN	2.8%	5.0%	−2.8%	−1.1%
CHARGELAB	0.0%	0.0%	0.0%	0.0%
CPN	5.4%	5.8%	3.9%	5.1%
EA	6.8%	9.0%	4.0%	8.1%
EVC	4.1%	5.1%	0.9%	1.6%
EVCS	8.3%	0.0%	19.2%	409.7%
EVGATEWAY	2.8%	0.0%	34.2%	12.2%
EVN	−3.3%	12.4%	4.6%	5.2%
FCN	101.0%	0.0%	0.0%	0.5%
FLO	35.9%	5.6%	33.8%	20.3%
FPLEV	0.0%	0.0%	0.0%	0.0%
GRN	−6.7%	10.9%	6.0%	5.1%
LIVINGSTON	N/A	N/A	0.0%	0.0%
OC	0.0%	0.4%	12.0%	1.5%
POWERFLEX	133.7%	0.0%	0.0%	0.0%
SCN	5.3%	4.5%	4.3%	3.2%
TESLA	5.1%	7.0%	7.7%	9.9%
TESLAD	0.3%	0.1%	0.0%	0.0%
VLTA	10.8%	12.2%	9.5%	5.8%
WEB	0.0%	0.0%	0.0%	0.0%
ZEFNET	N/A	0.0%	0.0%	0.0%
NON	3.7%	0.7%	0.4%	3.1%
Total	4.7%	5.0%	3.3%	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 2022a). See the 2020 Q1 report for more information about the Clean Cities Coalition Network (Brown et al. 2020).

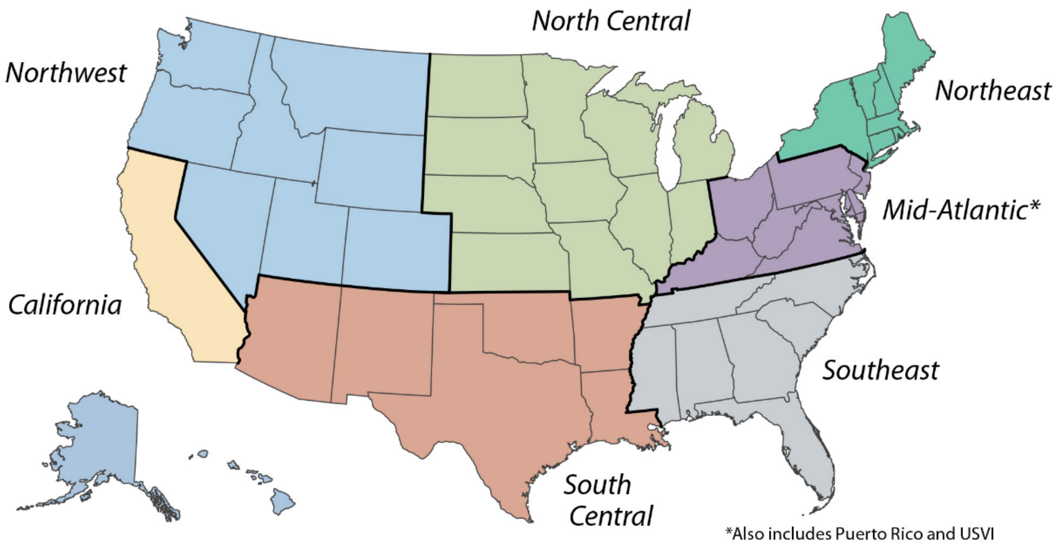

Figure 11. Clean Cities regions

Source: Clean Cities Coalition Network (2022b)

As shown in Figure 12, the California region continues to have the largest share of the country's public EVSE ports (33.6%). However, the Mid-Atlantic region grew by the largest percentage in Q4 (7.6%) (Figure 12). Across every region, DC fast EVSE ports grew at a faster rate than Level 2 EVSE ports in Q4, with the Northeast region also seeing the largest percentage growth in DC fast EVSE (Table 2).

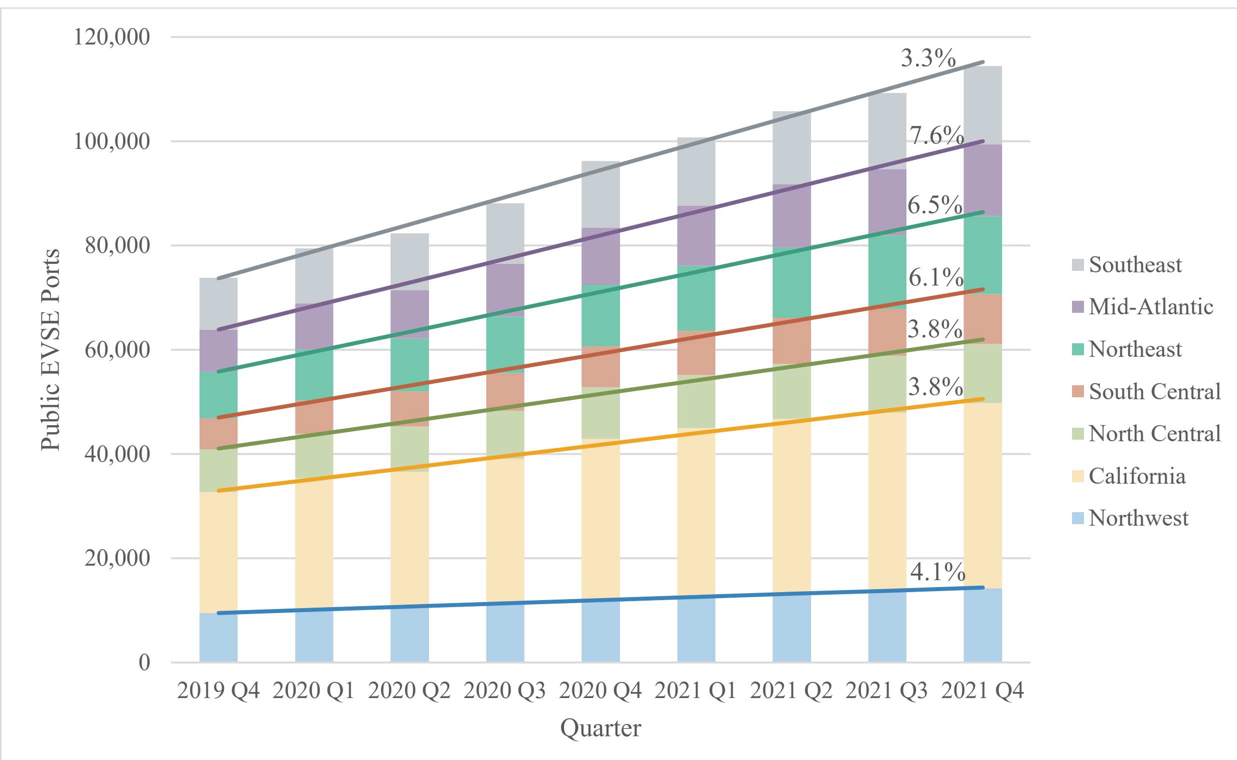

Figure 12. Quarterly growth of public EVSE ports by Clean Cities region

Table 2. Growth of Public Level 2 and DC Fast EVSE Ports by Clean Cities Region in Q4

Clean Cities Region	Level 2 EVSE Port Growth	DC Fast EVSE Port Growth
California	3.0%	8.6%
Mid-Atlantic	6.9%	10.2%
North Central	3.0%	9.6%
Northeast	6.0%	10.8%
Northwest	3.3%	8.1%
Southeast	2.4%	8.1%
South Central	6.2%	6.5%

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 light-duty EV registrations 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 registration data are based on Experian's 2020 registration data (Experian Information Solutions 2020).

In Q4, the five states that had the largest percent growth of EVSE ports per 100 EVs were Kentucky, Massachusetts, Ohio, Arizona, and Maine (Table 3). The growth in Kentucky is significant because it is among the bottom third of states in terms of public EVSE ports and EV registrations. In Q4, the number of public EVSE in the state grew by 104 EVSE ports from 400 to 504. This was largely driven by new Level 2 EVSE port installations. Several of the new installations were in public parking garages in Louisville that are owned and operated by the Parking Authority of River City (Louisville-Jefferson County Metro Government 2022). The Station Locator team expects to see continued growth of EVSE ports in Kentucky, as Louisville Gas and Electric Company (LG&E) and Kentucky Utilities Company (KU) announced plans to install DC fast stations along interstates and freeways throughout 2022 and 2023 (LG&E and KU 2022). LG&E and KU are part of the National Electric Highway Coalition, discussed further in Section 4, and have also worked with commercial customers to install 20 public and private Level 2 charging stations throughout their service territories since 2016 (LG&E and KU 2016).

Table 3. Top Five States With the Largest Growth of EVSE Ports per 100 EVs in Q4[2]

State	EVSE Ports per 100 EVs in 2021 Q3	EVSE ports per 100 EVs in 2021 Q4	Growth of EVSE ports per 100 EVs in Q4
Kentucky	8.4	10.6	26.0%
Massachusetts	83.1	92.3	11.1%
Ohio	7.1	7.8	10.7%
Arizona	147.5	163.3	10.7%
Maine	10.4	11.4	10.1%

[2] See the Appendix for the growth of EVSE ports per 100 EVs in all states in Q4 and the total number of EV registrations by state.

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 Q4, the number of private EVSE ports in the Station Locator increased by 369, bringing the total number to 18,881 and representing a 2.0% increase since Q3. 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 13, the majority of private EVSE ports in the Station Locator are Level 2. However, in Q4, private Level 1 EVSE ports grew by the largest percentage (12.5%), representing the addition of 244 EVSE ports (Figure 13). In Q4, the Station Locator team received an update from NREL's Federal Fleet team containing private EV charging station data, resulting in the addition of 252 private Level 1 EVSE ports.

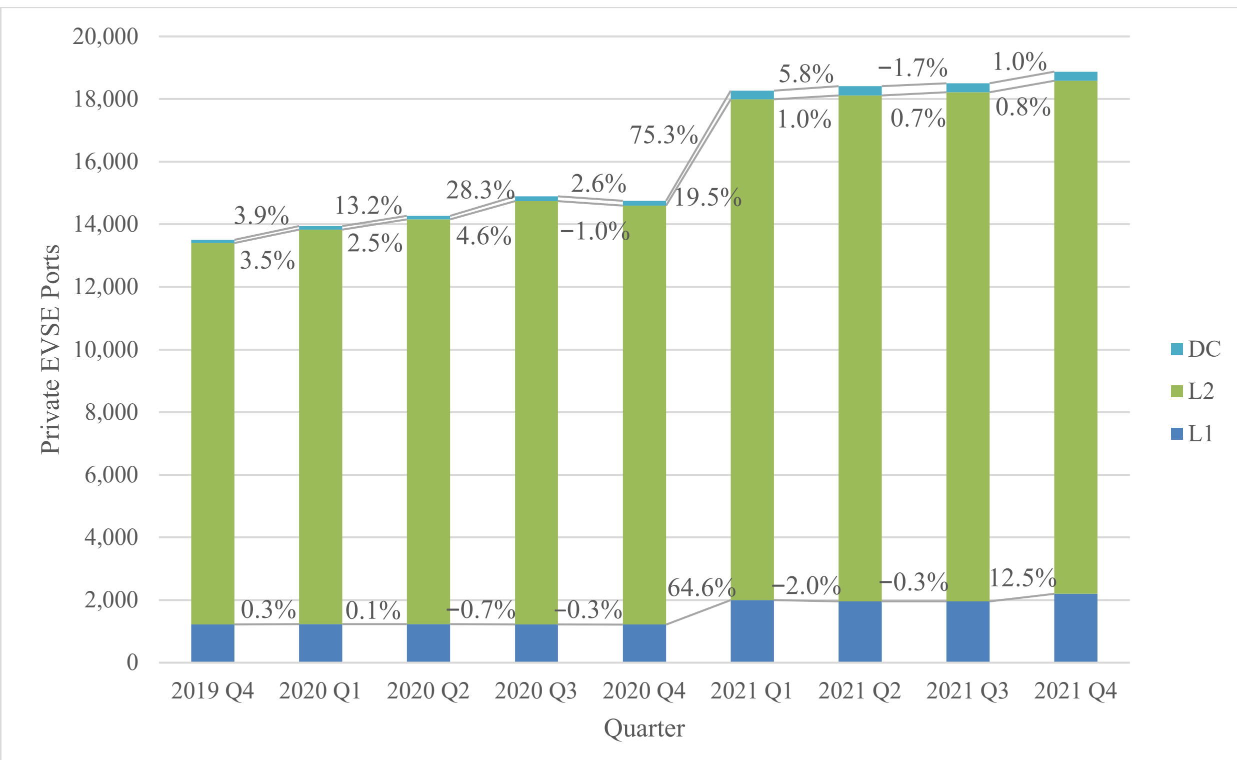

Figure 13. Quarterly growth of private EVSE ports by charging level

Note: Figure excludes legacy EVSE ports that are not classified by charging level and are no longer manufactured.

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 14), 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.

By the end of Q4, there were 10,113 workplace EVSE ports in the Station Locator. There was no growth in the number of Level 2 and DC fast EVSE, and a slight decrease in Level 1 EVSE ports (Figure 14). As discussed in Section 2.2, the lack of growth can likely be attributed to the difficulty of collecting this information as opposed to an actual lack of growth of workplace charging stations.

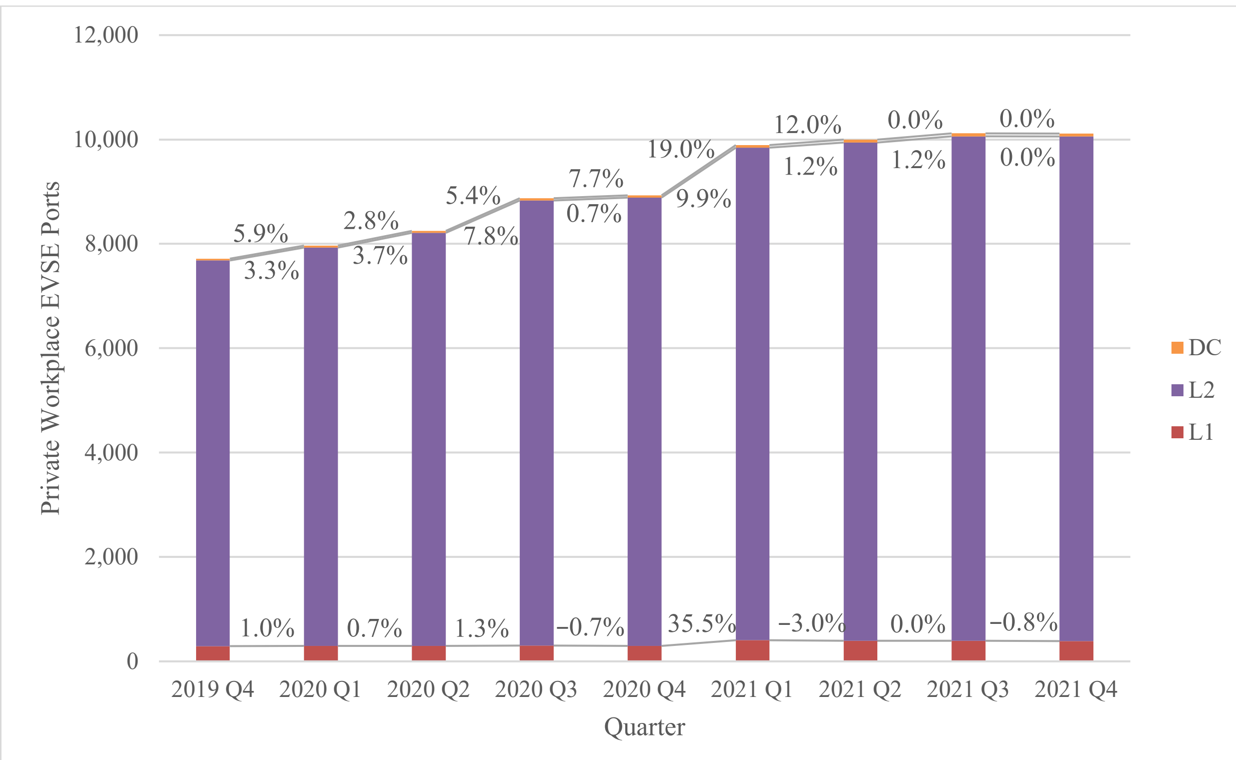

Figure 14. Quarterly growth of private workplace EVSE ports by charging level

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 are available for resident use only. In Q4, there was a decrease of 0.1% in EVSE ports at multifamily buildings, bringing the total number of EVSE ports to 970 compared with 971 in Q3 (Figure 15). As shown in Figure 15, multifamily building EVSE ports in the Station Locator are either Level 1 or Level 2.

As with private workplace EVSE, the lack of growth can likely be attributed to the difficulty of collecting this information as opposed to an actual lack of growth of charging stations at multifamily buildings. The Station Locator team continues its concerted efforts to collect data on

EVSE ports at multifamily buildings and expects the number of these EVSE ports to grow in future quarters.

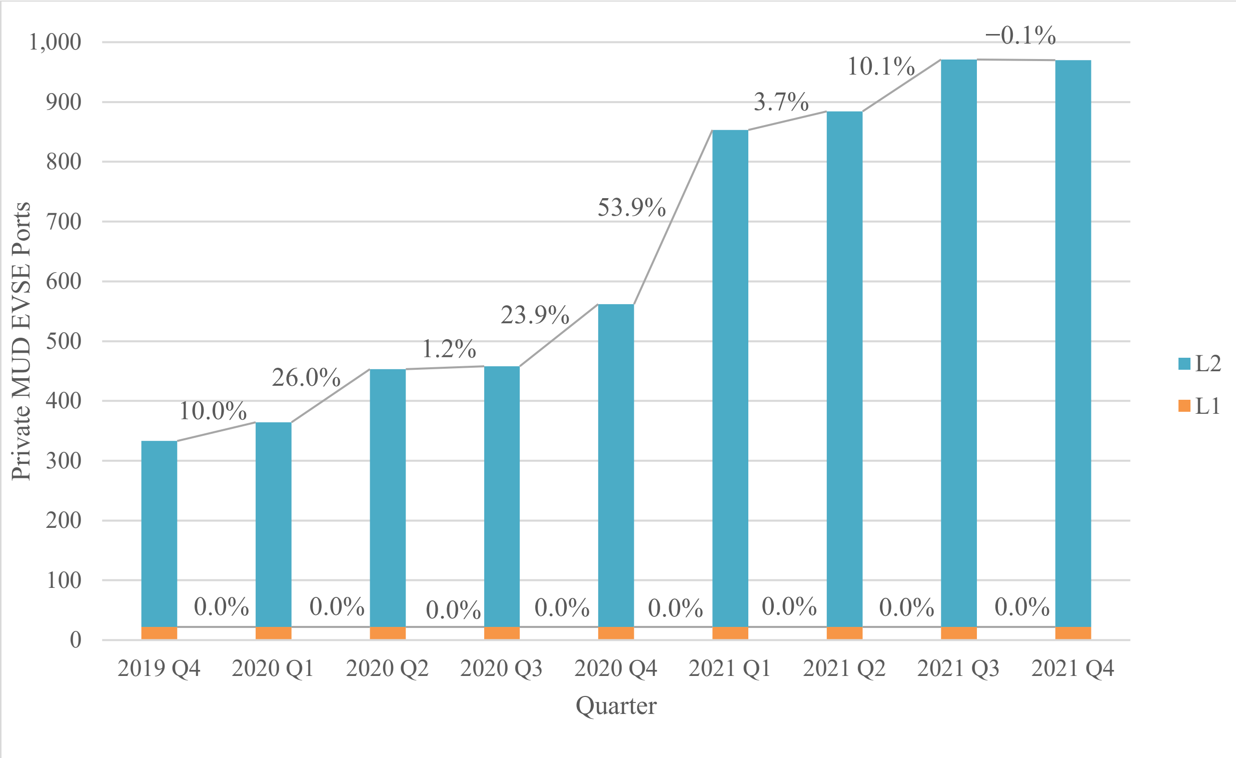

Figure 15. Quarterly growth of private multifamily building EVSE ports by charging level

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 on the Federal Highway Administration weight class (i.e., light-duty [LD], medium-duty [MD], or heavy-duty [HD] vehicles). As of Q4, the team has collected this information for 86.2% of private EVSE ports, of which 46.7% 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 16 shows the breakdown of these EVSE ports by fleet type and charging level. The fleet type indicates the largest vehicle type that uses the station as of Q4 based on the types of vehicles in the fleet, though smaller 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 (Figure 16). Additionally, the majority of fleet charging EVSE ports are Level 2 (Figure 16).

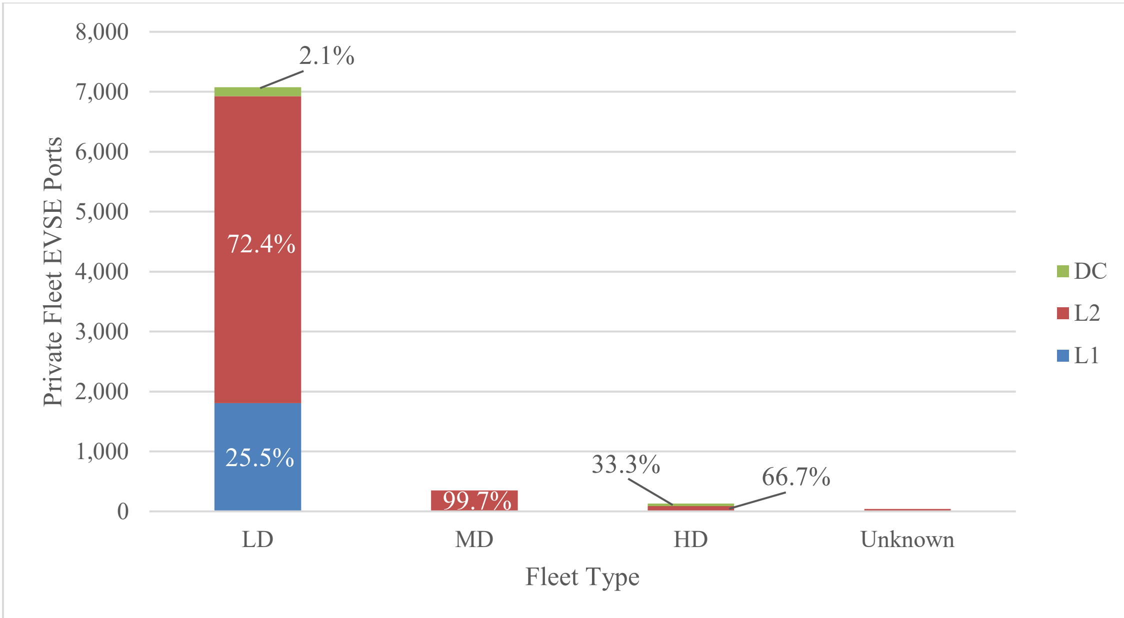

Figure 16. Breakdown of private fleet EVSE ports by fleet type and charging level in Q4

The Station Locator team continues 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

Early in Biden's presidency, his administration set a goal of building a network of 500,000 public EVSE ports in the United States by 2030.[3] The BIL (H.R. 3684), which President Biden signed into law on November 15, 2021, formally established the National Electric Vehicle Infrastructure (NEVI) Formula Program and the Discretionary Grant Program for Charging and Fueling Infrastructure, discussed further in Section 4 (The White House 2022). These programs will provide states with funds to begin to build this network, though will not necessarily fund all the infrastructure required to meet Biden's goal. Although Biden's goal does not differentiate between DC fast and Level 2 EVSE ports and these programs do not dictate how many DC fast versus Level 2 EVSE ports will be funded, the NEVI Formula Program will initially be focused on building out charging infrastructure along the interstate highway system with DC fast EVSE ports and the Discretionary Grant Program is expected to fund both DC fast and Level 2 EVSE ports (Federal Highway Administration 2022). The Biden administration's goal serves as a useful benchmark for where the country's charging infrastructure is headed and what will be required to achieve it. To put this goal into context, the number of public EVSE ports in the

[3] The goal includes installing 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. Further, it is unclear whether this goal means that 500,000 additional EVSE ports will be funded by 2030, or enough EVSE ports will be funded so that the total number of EVSE ports in the United States reaches 500,000 by 2030. This report assumes the later.

Station Locator has grown by an average of 5,077 EVSE ports per quarter since the beginning of 2020. In order to reach 500,000 EVSE ports by 2030, approximately 12,048 public EVSE port installations will be required each quarter for the next 9 years, indicating that installation pace will need to increase significantly. As of Q4, the number of public EVSE port installations is 22.9% of the way towards the goal.

Two studies with different EV projection scenarios offer insight into how much public and workplace charging would be required in the United States to support a growing fleet of light-duty EVs. The first study, NREL's 2017 *National Plug-In Electric Vehicle Infrastructure Analysis*, estimates that a total of 27,500 DC fast EVSE ports and 601,000 Level 2 EVSE ports would be required across the United States to support 15 million light-duty EVs by 2030 (Wood et al. 2017). This equates to 1.8 DC fast EVSE ports per 1,000 EVs and 40.1 Level 2 EVSE ports per 1,000 EVs. The second study, Atlas Public Policy's 2021 *U.S. Passenger Vehicle Electrification Infrastructure Assessment*, assumes that 100% of passenger vehicle sales are electric by 2035, which would result in approximately 57.5 million light-duty EVs by 2030 (McKenzie and Nigro 2021). To support these EVs, this study estimates that an additional 252,000 DC fast EVSE ports and 244,000 Level 2 EVSE ports would be required. Using the number of installations as of 2021 Q1 as a baseline, this results in approximately 269,558 DC fast EVSE ports and 335,266 Level 2 EVSE ports by 2030, and equates to 4.7 DC fast EVSE ports per 1,000 EVs and 5.8 Level 2 EVSE ports per 1,000 EVs. For a more detailed discussion of these studies and the different assumptions used to arrive at their respective infrastructure projections, see the 2021 Q3 report (Brown, Schayowitz, and Klotz 2022).

As of Q4, there were 21,732 public and workplace DC fast EVSE ports and 101,213 public and workplace Level 2 EVSE ports available in the United States (Figure 17). Based on NREL's analysis, the number of DC fast and Level 2 EVSE ports installed is 79.0% and 16.8%, respectively, of the way toward meeting projected 2030 infrastructure requirements to support 15 million EVs (Figure 17). Based on Atlas' assessment, the number of DC fast and Level 2 EVSE ports is 8.1% and 30.2%, respectively, of the way toward meeting projected 2030 infrastructure requirements to support 57.5 million EVs (Figure 17). As with previous quarters, it is important to note that 58.0% of public DC fast EVSE ports in the Station Locator are on the Tesla Supercharger network and are therefore only readily accessible to Tesla drivers. Additionally, as of the end of December 2021, over 40% of EVs on the road were Teslas (Experian Information Solutions 2020; Atlas Public Policy 2021).[4] When public Tesla EVSE ports are excluded, the number of DC fast and Level 2 EVSE ports currently installed decreases to 33.3% and 15.0%, respectively, of the way toward meeting NREL's projected infrastructure requirements, and 3.5% and 27.8%, respectively, toward meeting Atlas' projected infrastructure requirements.

[4] This percentage is based on the number of Teslas registered in the United States in 2020, the total number of light-duty EVs registered in the United States in 2020, and 2021 light-duty EV sales data. This figure does not account for Teslas that have been retired in 2021 or total light-duty EVs that have been retired in 2021.

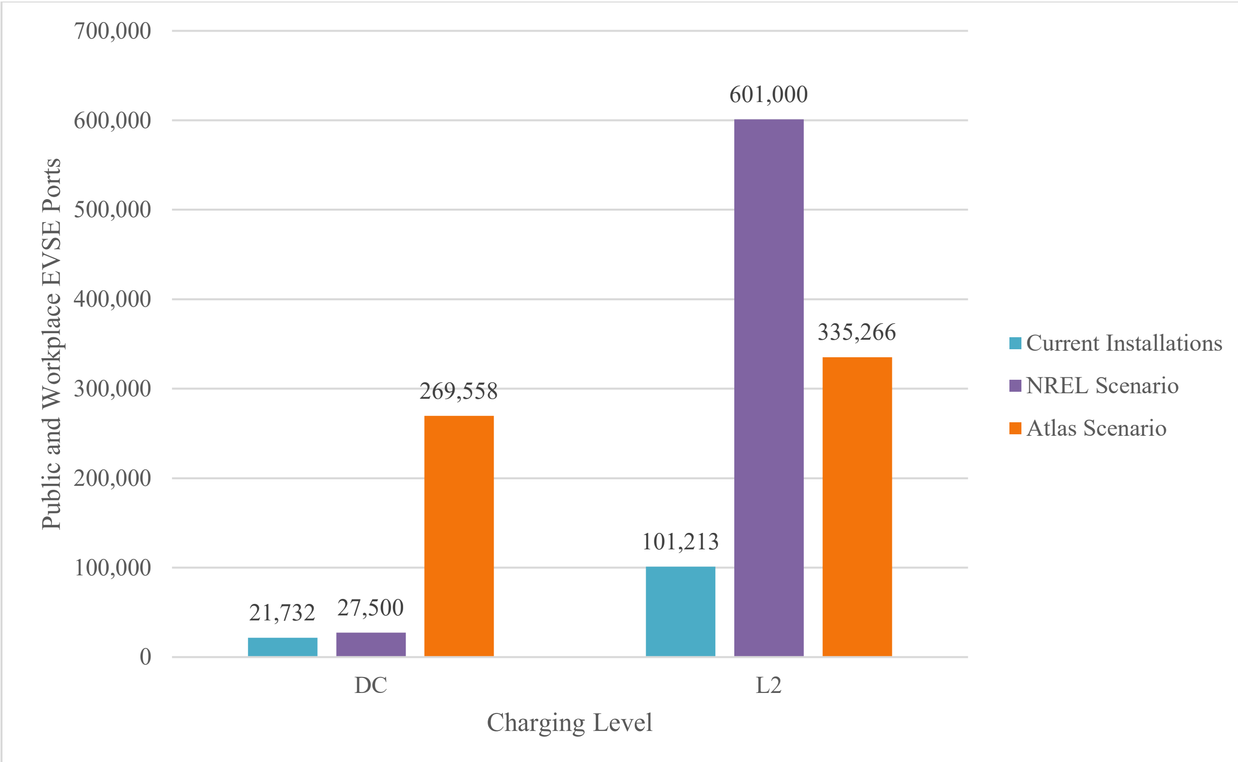

Figure 17. Current availability of public and workplace charging versus two scenarios of 2030 infrastructure requirements in the United States

There were approximately 2.1 million EVs on the road in the United States in Q4 (Experian Information Solutions 2020; Zhou 2021).[5] The ratios of DC fast and Level 2 public and workplace EVSE ports per 1,000 EVs in Q4 were 10.0 and 46.7, respectively (Table 4). These ratios decrease to 4.2 and 41.5, respectively, when Tesla EVSE ports are excluded. Using NREL and Atlas' estimated ratios of the number of DC fast and Level 2 EVSE ports per 1,000 EVs as a proxy for how much infrastructure is sufficient to meet charging needs in 2030, Table 4 suggests that, as of Q4, public and workplace DC fast and Level 2 EVSE ports are keeping up with current charging needs in terms of the amount of infrastructure currently available. However, this comparison does not speak to whether the geographic distribution of EVSE ports matches where there is charging demand. Additionally, it is notable that roughly 14.4% of the 15 million light-duty EVs in NREL's analysis and 3.8% of the 57.5 million light-duty EVs in Atlas' assessment were on the road as of Q4 despite the rapid growth of the EV market in 2021. As the number of EVs on the road continues to grow, these ratios will decrease unless the pace of infrastructure growth is able to keep up.

[5] The number of EVs as of the end of Q4 is based on 2020 EV registration data and 2021 light-duty EV sales data. The 2.1 million figure does not account for vehicles that have been retired in 2021 and may slightly overestimate the number of EVs on the road.

Table 4. Current Public and Workplace EVSE per 1,000 EVs Versus Two Scenarios of 2030 Infrastructure Requirements in the United States

Port Level	EVSE per 1,000 EVs in 2021 Q4	NREL – EVSE per 1,000 EVs needed in 2030 to support 15 million EVs	Atlas – EVSE per 1,000 EVs needed in 2030 to support 57.5 million EVs
DC Fast	10.0	1.8	4.7
Level 2	46.7	40.1	5.8

4 Developments That Could Impact Future Quarters

Perhaps the most significant Q4 development for EV charging infrastructure was the signing into law of the BIL on November 15, 2021. The BIL includes $7.5 billion for EV charging infrastructure, $5 billion of which will be available to states through the NEVI Formula Program and $2.5 billion of which will be available through the Discretionary Grant Program for Charging and Fueling Infrastructure (The White House 2022). The NEVI Formula Program requires that each state develop a plan to strategically deploy public EV charging infrastructure in their state, with funding initially directed to designated Alternative Fuel Corridors (Federal Highway Administration 2022).[6] The infrastructure installed as a result of this funding is intended to build a national network of EV charging stations to support long-distance EV travel and encourage EV adoption. The Discretionary Grant Program is aimed at funding public infrastructure development in rural areas, low- and moderate-income communities, and communities with either low ratios of private parking or high ratios of multifamily buildings, as well as infrastructure development along designated Alternative Fuel Corridors (The White House 2022). The intention of this grant program is to increase access to charging in communities with limited access to home charging.

As discussed in Section 3, funding for these programs will not be made available to states until at least Q4 2022, and resulting installations are not likely to start coming online until the end of the year or later. In the meantime, the National Electric Highway Coalition, a new collaboration of electric utilities formed in December 2021, has committed to filling EV charging gaps along major highway corridors in their service territories by 2023 (Edison Electric Institute 2021). The National Electric Highway Coalition merges the former Electric Highway Coalition and the former Midwest EV Charging Collaboration and comprises 53 members, including 51 investor-owned electric companies, one electric cooperative, and the Tennessee Valley Authority. Collectively, the coalition serves almost 120 million customers in the United States, or just over one-third of the U.S. population. With increasing investment from utilities and new funding available to states, infrastructure development along highways is likely to rapidly increase over the coming years.

Outside of highway corridor infrastructure development, General Motors announced a new program that will install 40,000 public Level 2 charging stations in communities across the United States and Canada, including those that are underserved and have limited charging access (GM 2021). These stations will be available to all drivers and will be installed at workplaces, multifamily buildings, colleges and universities, and other publicly accessible locations. This

[6] For background on the Federal Highway Administration's Alternative Fuel Corridors, see the 2021 Q1 report (Brown, Schayowitz, and Klotz 2021).

effort is part of General Motors' recent announcement that they will invest $750 million in public charging infrastructure development.

Finally, the Station Locator data collection and management processes will continue to impact future EVSE port 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 2020). 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. For example, a charging location with one EVSE port and two connectors was previously counted twice but is now only counted once using the OCPI protocol's counting logic. As of Q4, 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, NREL is continuously working with EVSPs to add new APIs to the Station Locator and is currently working with EV Connect and Rivian to integrate their APIs. Finally, the Station Locator team is making a concerted effort to collect power data for all DC fast EVSE ports to support Round 6 of the Alternative Fuel Corridors nominations and may add new fields to the Station Locator to support other BIL funding initiatives. This new information will continue to make the Station Locator as useful as possible to stakeholders and allow for additional analysis for these reports.

5 Conclusion

This report examines the growth of EV infrastructure in the 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 Q4 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 and national targets.

As of the end of Q4, Level 2 chargers accounted for the majority of both public and private EVSE ports in the Station Locator (80.0% and 86.8%, respectively). Overall, there was a 4.3% increase in the number of EVSE ports in the Station Locator. Although Level 2 EVSE ports contributed to the majority of that growth in absolute terms, public DC fast EVSE grew by the largest percentage (8.8%) when compared with public Level 1 and Level 2 EVSE port growth. California continues to lead the country in terms of the total number of public EVSE ports available (35,520), though public charging infrastructure grew by the largest percentage in the Mid-Atlantic region in Q4 (7.6%).

Based on NREL's 2017 analysis that estimated the number of public and workplace chargers required to support a scenario in which there are 15 million EVs on the road by 2030, the number of DC fast and Level 2 EVSE ports as of Q4 is 79.0% and 16.8%, respectively, of the way toward meeting projected 2030 needs (Wood et al. 2017). However, the majority (58.0%) of public DC fast EVSE ports in the Station Locator are on the Tesla network and are therefore only readily accessible to Tesla drivers. When Tesla EVSE ports are removed, this decreases to 33.3% and 15.0%, respectively. Based on Atlas' 2021 assessment that estimated the number of public and workplace chargers required in a scenario in which 100% of passenger vehicle sales are electric by 2035, the number of Level 2 and DC fast EVSE ports as of Q4 is 8.1% and 30.2%, respectively, of the way toward meeting projected 2030 needs (McKenzie and Nigro 2021). This decreases to 3.5% and 27.8%, respectively, when Tesla EVSE ports are removed.

When comparing the current rate of deployment of public charging infrastructure with the Biden administration's goal of installing 500,000 EVSE ports in the United States by 2030, it is clear that the pace of installations will need to significantly increase. Since the start of 2020, an average of 5,077 public EVSE ports have been installed each quarter. To meet the Biden administration's goal by 2030, approximately 12,048 public EVSE port installations will be required each quarter for the next 9 years.

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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Appendix

Table A-1. Q4 Growth of EVSE Ports per 100 EVs by State

State	EVSE Ports per 100 EVs in 2021 Q3	EVSE ports per 100 EVs in 2021 Q4	Growth of EVSE ports per 100 EVs in Q4
AK	16.7	18.4	9.9%
AL	81.8	86.0	5.2%
AR	47.2	50.3	6.6%
AZ	147.5	163.3	10.7%
CA	2544.2	2640.9	3.8%
CO	233.4	246.4	5.6%
CT	80.0	82.0	2.5%
DC	27.3	27.9	2.2%
DE	8.7	9.5	9.2%
FL	181.3	189.1	4.3%
GA	118.5	119.5	0.8%
HI	21.7	22.1	1.9%
IA	13.1	13.9	5.9%
ID	6.5	6.5	0.8%
IL	50.1	53.1	6.0%
IN	18.4	19.7	7.1%
KS	19.9	20.1	0.8%
KY	8.4	10.6	26.0%
LA	7.0	7.0	0.0%
MA	83.1	92.3	11.1%
MD	54.4	58.5	7.6%
ME	10.4	11.4	10.1%
MI	29.7	30.3	2.2%
MN	16.6	17.1	3.0%
MO	17.0	17.6	3.1%
MS	2.3	2.3	0.7%
MT	1.7	1.7	2.0%
NC	18.6	19.7	6.1%
ND	1.0	1.0	0.7%
NE	2.3	2.4	4.3%
NH	2.0	2.2	8.9%
NJ	9.8	10.3	5.0%

State	EVSE Ports per 100 EVs in 2021 Q3	EVSE ports per 100 EVs in 2021 Q4	Growth of EVSE ports per 100 EVs in Q4
NM	2.3	2.4	3.3%
NV	5.3	5.5	5.2%
NY	27.2	28.5	4.6%
OH	7.1	7.8	10.7%
OK	3.3	3.4	3.0%
OR	7.0	7.1	1.0%
PA	7.7	8.0	4.1%
RI	1.6	1.6	3.9%
SC	2.2	2.3	3.4%
SD	0.4	0.4	5.4%
TN	3.8	3.8	0.9%
TX	12.6	13.3	5.6%
UT	4.4	4.8	9.4%
VA	5.8	6.3	9.1%
VT	1.3	1.3	3.4%
WA	5.5	5.6	2.4%
WI	1.2	1.3	3.3%
WV	0.3	0.3	3.4%
WY	0.0	0.0	1.2%

Table A-2. Registered Light-Duty EVs by State, 2020 (Experian Information Solutions 2020)

State	Registered EVs
AK	1,323
AL	4,944
AR	2,457
AZ	39,953
CA	690,801
CO	35,473
CT	15,284
DC	3,986
DE	3,459
FL	80,566
GA	32,919
HI	13,880
IA	4,868
ID	4,003
IL	38,951
IN	12,304
KS	5,566
KY	4,734
LA	3,114
MA	36,590
MD	29,827
ME	4,688
MI	23,088
MN	17,040
MO	12,005
MS	1,435
MT	1,523
NC	25,439
ND	484
NE	3,115
NH	5,166
NJ	43,191
NM	4,518
NV	15,228

State	Registered EVs
NY	65,179
OH	24,010
OK	5,181
OR	34,677
PA	30,330
RI	3,166
SC	7,391
SD	872
TN	12,072
TX	72,612
UT	16,456
VA	31,710
VT	4,493
WA	68,926
WI	12,228
WV	1,345
WY	587
Total	1,613,157