Electric Vehicle Charging Infrastructure Trends

The U.S. Department of Energy (DOE) Alternative Fuels Data Center (AFDC) launched in 1991 in light of the Alternative Motor Fuels Act of 1988 and the Clean Air Act Amendments of 1990 (Alternative Fuels Data Center 2021a). Initially, it served as a hard copy resource for alternative fuel performance data, and eventually turned into a internet resource in 1995. From that point forward, the AFDC has evolved emphatically into a robust online resource that gives an expansive scope of data on alternative fuels and high-level transportation innovations, including fuelling and charging station data. In 2017, the National Renewable Energy Laboratory (NREL) partnered with National Resources Canada to expand the data set to incorporate the location of those equivalent 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 presently includes data on public and private non-residential alternative fuelling stations in the United States and Canada and currently tracks ethanol (E85), biodiesel, compressed natural gas (CNG), electric vehicle (EV) charging, hydrogen, liquefied natural gas (LPG), and propane stations. Albeit historical data for all fuel types in the Station Locator are accessible, it is particularly vital to take an in-depth gander at EV charging because of rapidly changing innovation and developing infrastructure. This trend is probably going to go on as the federal government as of late expanded its investment in transportation electrification, original equipment manufacturers (OEMs) twofold down on their electrification responsibilities, more utilities start offering impetuses for EVs and infrastructure, and states and municipalities put forth electrification objectives and mandates. Utilizing Station Locator data, this paper investigates the development of both public and private EV charging infrastructure in the United States for the first calendar quarter (Q1) of 2021.

• Public Charging Trends

Public EV charging alludes to EV charging stations that are accessible to all EV drivers and situated in publicly available areas, like commercial areas or along highway corridors. In Q1, the quantity of public EVSE ports in the Station Locator expanded by 4,566, bringing the complete number of public EVSE (Electric vehicle supply equipment) or charging station ports in the Station Locator to 100,709 and addressing a 4.7% increment since Q4.

By means of Charging Level

Most of public EVSE ports in the Station Locator are Level 2, trailed by DC fast and Level 1. In Q1, Level 2 EVSE ports expanded by the best rate (5.8%), while Level 1 EVSE ports diminished by 2.4%. The abatement in public Level 1 EVSE ports can be ascribed to terminations of ChargePoint stations that were introduced in 2016 or before, however the ChargePoint network developed by and large in Q1, driven by new Level 2 EVSE port establishments.

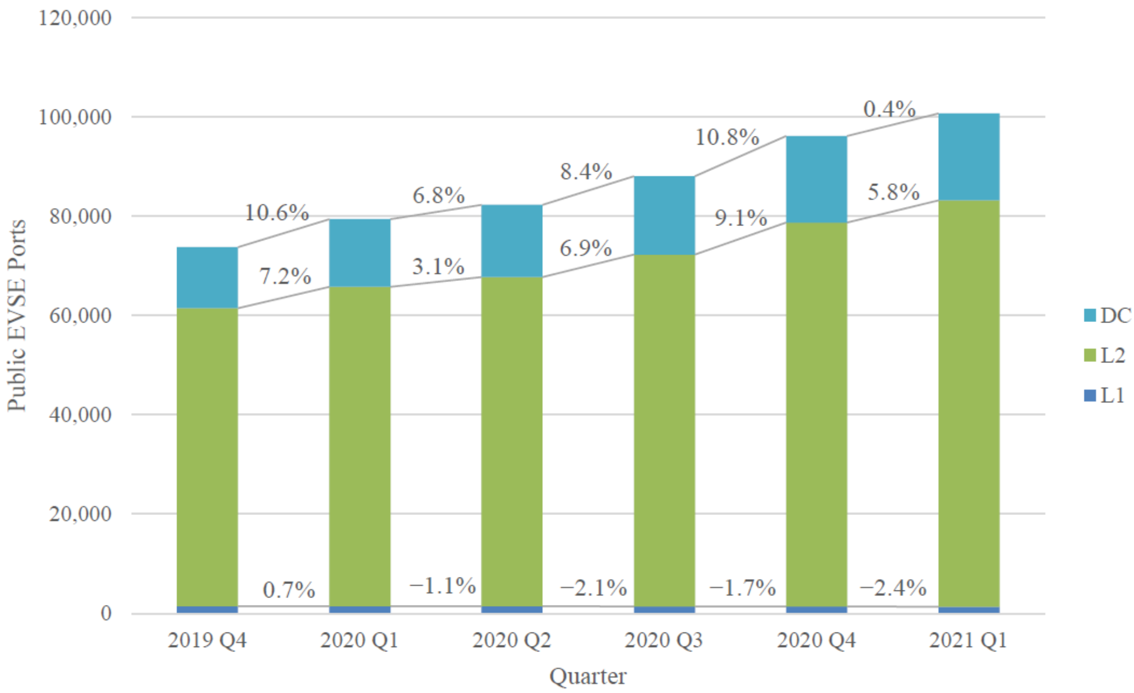

Fig.1. Quarterly growth of public EVSE ports by charging level

The relatively small development in DC fast EVSE ports is because of the 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 quantity of connectors on the port. After the integration, these EVSE ports presently have an EVSE port count of one, reflecting the quantity of vehicles that can charge simultaneously at a port. This brought about a reduction of the DC fast EVSE port count on these two networks.

When contrasted with Level 1 and Level 2 chargers, DC fast chargers have the most powerful output and consequently give the most charge in the least amount of time. DC fast chargers have a standard power output of 50 kW, however DC fast chargers with more elevated levels of power output are accessible. Extreme fast charging infrastructure, which has a power output of 350 kW or more, was presented in 2018. DC fast EVSE ports with such higher powerful levels still stay a minority in the Station Locator. It is vital to bring up that of the 17,508 public DC fast EVSE ports in the Station Locator, power output data are at present just accessible for 39.0%; Figure 2 is in this way based on power output data for 6,821 DC fast EVSE ports. NREL is currently incorporating updated OCPI-based APIs to streamline the assortment of power output data and make an additional complete data set. Furthermore, on the off chance that a DC fast EVSE port has two connectors with various power outputs, just the most extreme power outputs are counted. As displayed in Figure 2, the quantity of EVSE ports with a power output between 51 kW and 299 kW developed by the biggest rate in Q1 (78.3%). In Q1, Chargeway started incorporating power output data in their updates to the Station Locator group, which is the essential driver of this enormous increment. For instance, 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 total number of DC fast EVSE ports with power output data expanded by 5% in Q1, the quantity of EVSE ports with a power output of 50 kW or less diminished by 30.8% (Figure 2). This decline can be basically credited to the integration of ChargePoint's OCPI-based API and the subsequent diminishing in DC fast EVSE port counts, as more than 90% of the DC fast EVSE ports prior to the integration had a power output of 50 kW or less. After the integration, practically 75% of ChargePoint's DC fast EVSE ports have a power output between 51 kW and 299 kW, which reflects new establishments as well as power adjustments for existing stations from 50 kW up to 62.5 kW, 175 kW, and 200 kW. Also, Electrify America briefly adjusts the power output of its DC fast chargers down to 50 kW while maintenance or upgrades were being performed. This added to the abatements seen in Q3 and the increments seen in Q4 and Q1, as the chargers that had been adjusted down to 50 kW were changed back to their original, higher power output (Figure 2). The Station Locator group hopes to keep on seeing changes in DC fast power output data because of these changes.

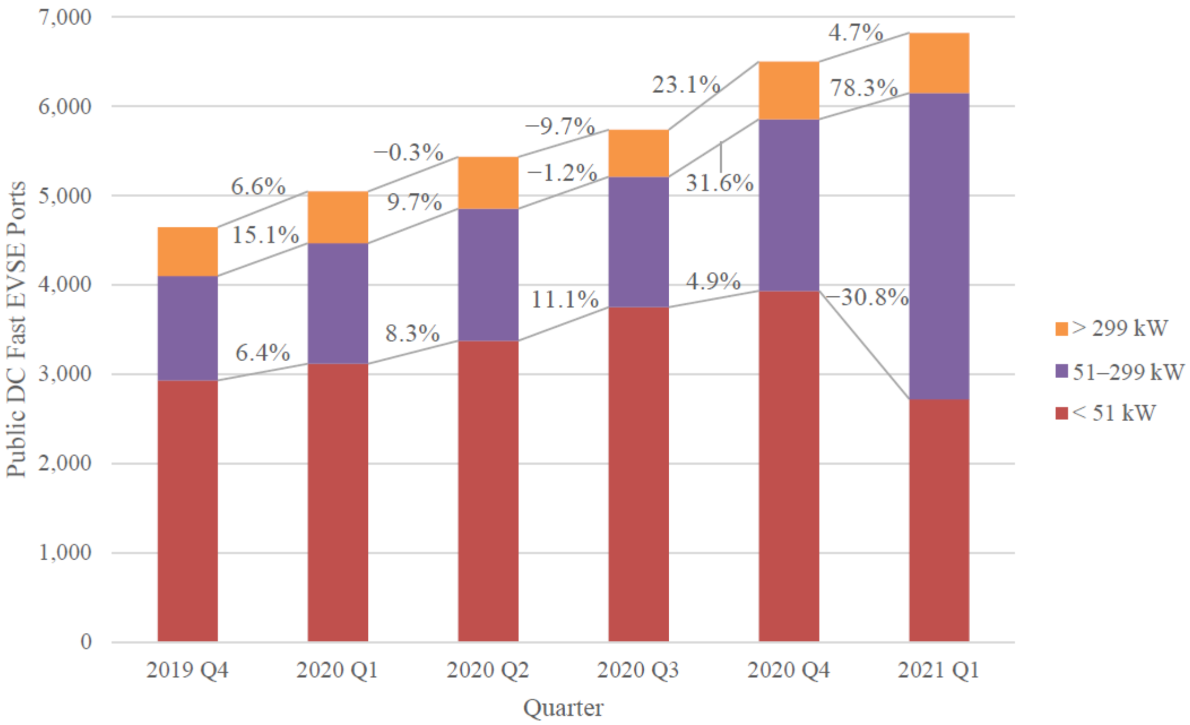

Fig.2. Quarterly growth of public DC fast EVSE ports by power output

There are presently three types of connectors accessible 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 biggest extent of connectors, however CCS connectors developed by the biggest extent (10.2%) (Figure 3).

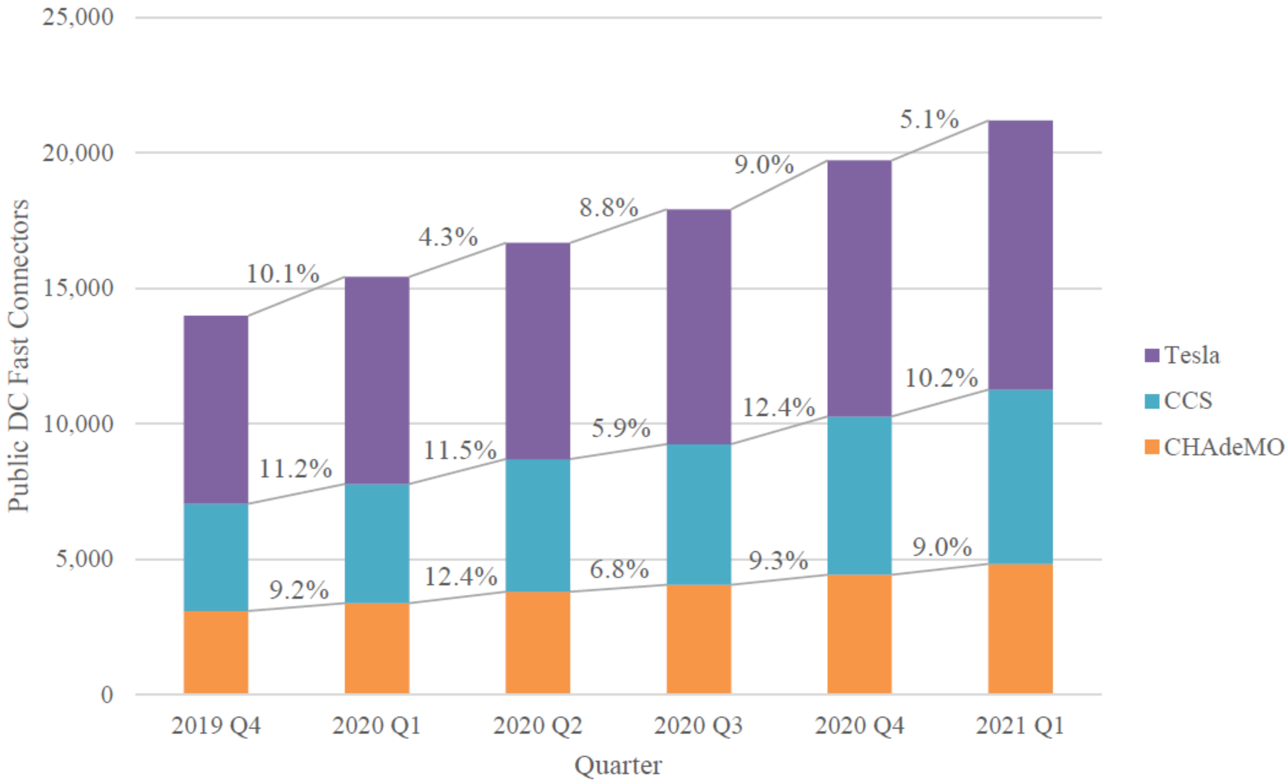

Fig.3. Quarterly growth of public DC fast connectors by type

- **Private Charging Trends**

Private EV charging alludes to EV charging stations that are accessible just to specific drivers for specific purposes, for example, charging for transit fleets or employee-only charging at work environments. Albeit the Station Locator group proactively searches out new station openings to incorporate, the launch of private workplace chargers may not really be shared publicly. The Station Locator group accordingly depends on Clean Cities alliances, industry partners, and Station Locator users to share this data. Because of the challenge in gathering these data, the quantity of private, non-residential charging stations in the Station Locator is somewhat underrepresented; however, the Station Locator group is consistently attempting to further develop the data assortment in these regions.

In Q1, the quantity of private EVSE ports in the Station Locator expanded by 3,514, carrying the complete number to 18,269 and addressing a 23.8% expansion since Q4, the biggest percent development in private EVSE ports seen to date. This development is driven by the Station Locator's yearly update of federally claimed EV charging stations, as well as a huge update of multifamily housing EVSE ports from EV Connect. The accompanying segments separate the development of private EVSE ports by level, as well as by three specific types: workplace, multifamily building, and fleet charging.

By means of Charging Level

Most of private EVSE ports in the Station Locator are Level 2. Despite the fact that DC fast and Level 1 EVSE ports developed by a huge rate in Q1 (75.3% and 64.6%), respectively Level 2 EVSE ports encountered the biggest outright development with the expansion of 2,610 EVSE ports (Figure 4). The enormous expansion in private stations in Q1 is essentially ascribed to an update of federally owned EV charging stations from NREL's Federal Fleets group.

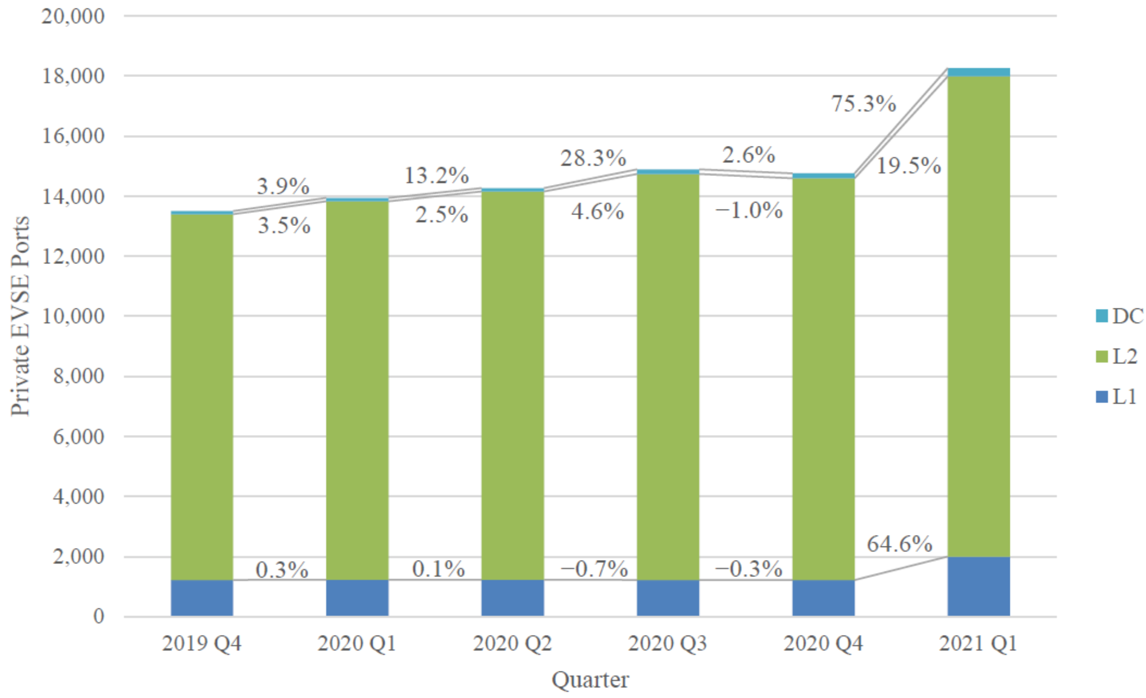

Fig.4. Quarterly growth of private EVSE ports by charging level

Charging in Workplace

Workplace EV charging infrastructure incorporates charging stations that are private and assigned for employee utilization only. Most of private workplace EVSE ports in the Station Locator are Level 2 (Figure 5), since employees utilize workplace chargers while they are parked at work for an extended period, and consequently don't necessarily require rapid charging.

As of the finish of Q1, there were 9,894 workplace EVSE ports in the Station Locator. As displayed in Figure 5, the quantity of Level 1 EVSE ports developed by the best rate (35.5%) at workplaces in Q1. DC fast EVSE ports likewise expanded by an enormous rate (19.0%), however this just addresses an increment of 8 EVSE ports. The enormous increment seen across all charging levels in Q1 is because of the yearly update of federally claimed EV charging stations that the Station Locator group gets once per year from NREL's Federal Fleets group, which brought about the addition of 408 workplace EVSE ports situated at federal buildings.

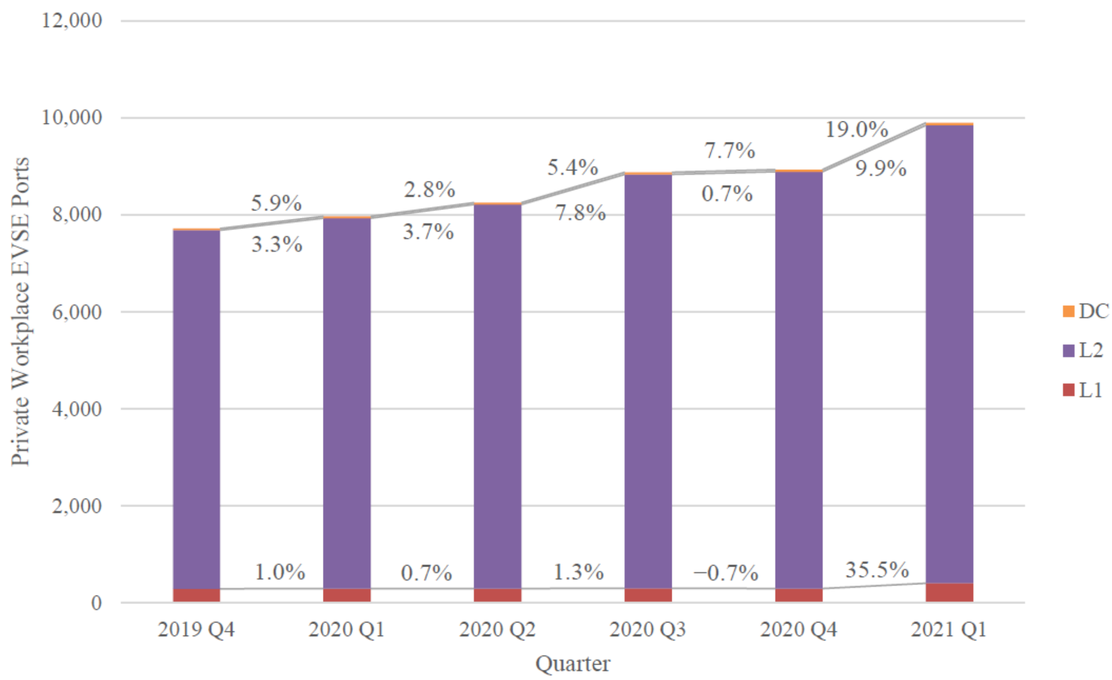

Fig.5. Quarterly growth of private workplace EVSE ports by charging level