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Electric Vehicle Supply Equipment (EVSE) in the United States

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Abstract

Electric vehicle (EV) chargers are a complement to EV sales, as they are needed to charge EVs. EV chargers are offered in three levels, each level uses more power and charges an EV faster than the previous one. Most at-home chargers are Level 1 or Level 2. Public chargers are primarily Level 2 or Level 3. While early EVs had a variety of EV connectors, most manufacturers now use the SAE Combo connector, with Tesla being the exception. Many public chargers are "networked" so that they can be easily searchable, adjust prices based on the cost of power, and be updated or repaired remotely. The federal government and state governments offer a range of incentives to encourage the purchase of EV chargers, particularly public chargers, because they believe EV chargers are key infrastructure supporting increased EV sales. Many different types of companies participate in the EV charger supply chain, which has a few key areas: design, production, installation, management, and maintenance of a network. Some companies participate in all five areas, while others just participate in one or two. Most of those that participate in all five are startups, while established companies have tended to focus in areas where they already have competitive advantages. For example, gas companies have focused on installation and management of stations because they already have a network of gas stations. Similarly, electrical product manufacturers design and manufacture chargers. Public EV charger availability has increased rapidly in the United States with one public charger for every 18.5 EVs, but with EV sales expected to increase significantly in the next few years, EV charger availability will have to continue its rapid growth to keep pace. Trade data is difficult to parse, as EV chargers are in a highly aggregated statistical code. U.S. imports of that statistical code have increased significantly since 2017, possibly due to increased imports of chargers.

U.S. International Trade Commission

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Introduction

Electric Vehicle (EV)[1] sales are expected to quadruple from 2021 to 2025 (EV sales totaled 231,000 in 2020). Considering that there were only 1.1 million EVs on U.S. roads in 2020, this increase will lead to a dramatic increase in vehicles on the road and thus demand for charging infrastructure.[2] In the United States 80 percent of EV owners use a charger at home or work to regularly re-charge their EVs.[3] However, as more drivers use their EV as their primary vehicle, they will need to be able to charge that vehicle outside of the home for longer trips, and it would be reasonable to expect comparable growth in EV charging stations as EV sales.[4] EV charging outside of the home is a highly competitive space, with many different types of U.S.-headquartered and foreign companies employing different business models to service that need, and few (if any) entrenched participants.

This working paper describes the current EV Supply Equipment (EVSE) landscape in the U.S. market. The first section describes the main features of EV chargers including their voltage levels, connectors, internet connection capability, and tax incentives for EV charging stations. The next section explains how and where EVSE companies compete. The following section describes the rapid growth of EV charger availability in the United States, companies that compete in the U.S. EVSE market, and how competition in the market is evolving. The final section analyzes available data on U.S. production and trade.

Product Description and Uses

EVSE, more commonly known as EV chargers, are used to recharge EVs and plug-in hybrid electric vehicles (PHEV) by supplying electric energy.[5] An EV charger pulls an electrical current from either an outlet or the grid it is hardwired to and delivers that electricity to a charging port in the vehicle. Key EVSE components include the charger, the vehicle connector, and the network connection.

EV Chargers

The three types of EV chargers available are, Level 1, Level 2, and Level 3 chargers (also known as Direct Current Fast Chargers, DC Fast Charging, or DCFC).[6] The differences between the 3 levels are in charging speed, cost and required infrastructure. Higher level chargers are capable of delivering more power to the vehicle at once, speeding up the charging process (figure 1). The five main factors that affect the time it takes to charge an EV are the size of battery, state of battery (empty vs. full), max charging rate of vehicle, max charging rate of the charging station, and environmental factors (e.g., temperature).[7]

[1] Note: In this paper the term electric vehicle or "EV" is used for battery electric vehicles, not including hybrids whether they have plugs or not. Though plug-in hybrids may also use the chargers discussed in this paper.
[2] IEA, "Global Data Explorer," April 29, 2021.
[3] Electrify America, "National ZEV Investment Plan: Cycle 2," February 4, 2019.
[4] IEA, Global EV Outlook 2021, April 2021.
[5] Mr. Electric, "What is EVSE?" (accessed October 2021).
[6] Moloughney, "What are The Different Levels of EV Charging," October 4, 2021.
[7] Pod Point, "How Long Does It Take to Charge an Electric Car?" November 11, 2021.

Figure 1 Different levels of charging stations

Source: Seong, "Level 1 vs. Level 2 vs. Level 3 Charging Explained," September 29, 2021.

Level 1 chargers are the most basic chargers, and are relatively inexpensive, but charge the vehicle slowly. Level 1 chargers are usually included when purchasing an EV or PHEV and use the standard 120-volt wall outlet at home to charge. These chargers are a small box or cylinder with a short cord, and a grounded household plug on one end and a longer cord and the connector that plugs into the car on the other. These "trickle" chargers are more useful for those that live in single-family homes and can park their car in the same spot overnight, than those in apartment buildings or condos and do not have access to a permanent parking spot with access to electricity. Level 1 chargers are the slowest when compared to Level 2 and 3 chargers, charging at approximately 3-5 miles of range for every hour it is connected to an EV or PHEV.[8] While there are several factors that impact the charging time, it takes approximately 30 hours to replenish 150 miles of range.[9] This level of charging is usually used as an overnight home charging option due to its speed. It is also useful for PHEVs because they have smaller batteries and have on average an electric range of 15-60 miles.[10]

Level 2

Level 2 chargers are the most common chargers, they charge faster and are costlier than Level 1. Level 2 chargers are found in workplaces, public areas, and individual homes. While sold separately from the vehicle, residential Level 2 chargers are often purchased at the same time and usually require professional installation. Level 2 chargers provide faster charging due to their ability to handle voltages in excess of 200 volts as well as the amount of current supported by Level 2 chargers extending from 12 to 80 amps (compared to Level 1 that are limited to 10–12 amps).[11] Due to the higher charging speed compared to Level 1, they are the most common type found at public charging stations.[12]

Level 2 chargers can be installed in homes without extensive modification, they handle voltages in excess of 200 volts, which households already receive for certain appliances such as central AC or washing machine. A Level 2 charger will charge a typical EV at a rate between 12–60 miles of range per

[8] Moloughney, "What are The Different Levels of EV Charging," October 4, 2021.
[9] Moloughney, "What are The Different Levels of EV Charging," October 4, 2021; Free Wire, "What's the Difference Between EV Charging Levels?" July 1, 2020.
[10] U.S. Department of Energy, "Plug-In Hybrid Electric Vehicles," (accessed October 19, 2021).
[11] Moloughney, "What are The Different Levels of EV Charging," October 4, 2021.
[12] DOE, "Alternative Fuels Data Center," (accessed October 6, 2021).

hour, depending on how much power the charger can supply and how much power the EV can accept. The cost of purchasing and installing a Level 2 charger varies significantly depending on various components, such as the EVSE itself, design and engineering, permitting, and construction.[13] Residential Level 2 chargers are usually cheaper to purchase and install due to being a stand-alone unit and part of the non-networked charging stations.[14]

Level 3

Level 3 chargers, also known as Direct Current Fast Chargers (DC Fast Charging or DCFC), are the fastest way to charge an electric vehicle and due to high installation costs, they are primarily used at public charging stations.[15] The voltage used is also much higher than Level 1 & 2 charging, which is why Level 3 chargers are difficult to install in a single-family residence. Level 3 chargers can recharge an EV at a rate of 3-20 miles of range per minute, charging it to 80 percent or more in approximately half an hour.[16] However, not every EV can charge at this speed, as most EV batteries limit to how fast they can charge to avoid overheating the battery.

Level 3 chargers can be much more expensive and time consuming to install. According to one report, it can take 7–18 months to complete installation of a Level 3 charger, with only one to two months spent on construction of the charger. The rest of the time is going through the permitting and grid upgrade process.[17] DCFCs can cost as little as $20,000 for a 50kW unit to as much as $150,000 for a single 350kW charger.[18]

EV Connectors

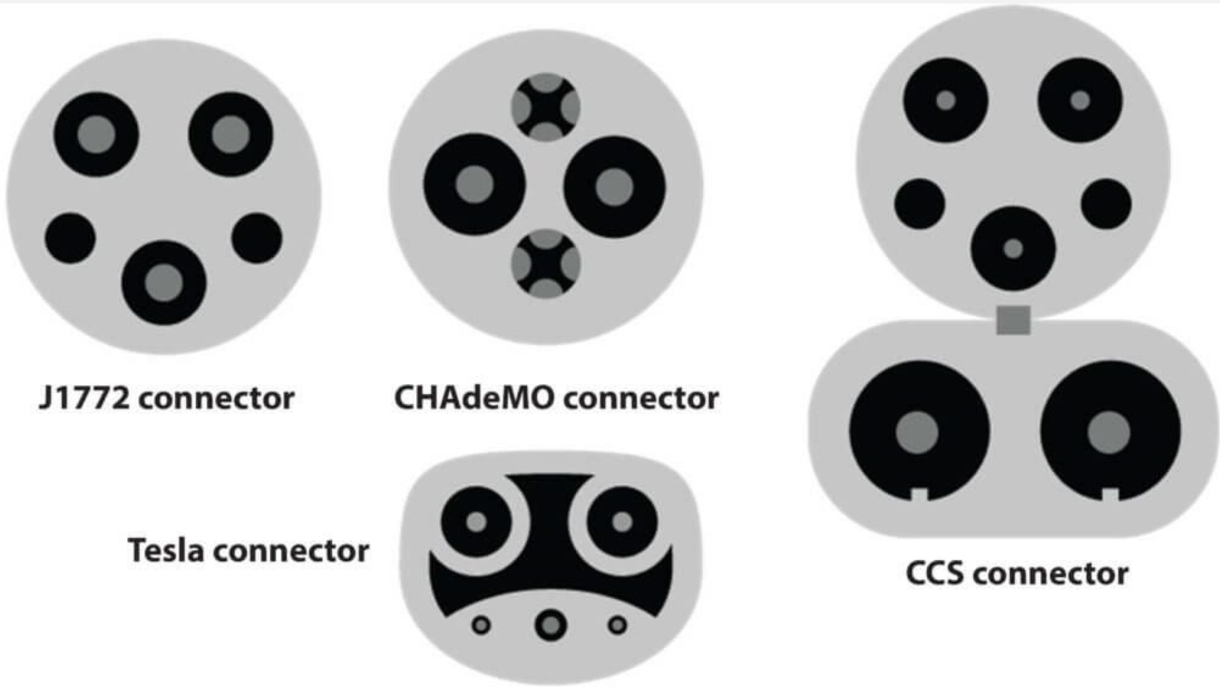
A charging plug is the connector that you insert into the charging socket of an electric vehicle.[19] There are several kinds of connectors available for the different levels of chargers. Thus electric vehicles need either a connector that is the same as its socket, or one that will be compatible through an adaptor. While manufacturers in each region tend to use a common connector, Tesla has tended to be the outlier. The discussion below looks at the different connectors available in North America and highlights which vehicles are compatible using adaptors.

In North America, the most common connector is the J1772 (figure 2).[20] All U.S. electric vehicles can charge using this plug, with only Tesla requiring an adapter. However, the J1772 only provides Level 1 and 2 charging and has been adopted by the Society of Automotive Engineers as the standard plug for

[13] Networked vs. Non-Networked Section will touch on pricing ranges. Oreizi, "How Much does it Cost to Install EV Charging Stations?" May 31, 2021.
[14] Section below discusses differences between networked vs non-networked charging stations.
[15] ChargeHub, "2020 Guide on How to Charge Your Electric Car," (accessed October 18, 2021).
[16] Gorzelany, "What it Costs to Charge an Electric Vehicle," (accessed October 18, 2021).
[17] Gordon, "Building an Electric Vehicle Fast Charger," June 2, 2021.
[18] Nelder and Rogers, "Reducing EV Charging Infrastructure Costs," (accessed February 16, 2022).
[19] Charluet and Van Barlingen, "EV Charging Cables and EV Charging Plugs Explained," November 19, 2021.
[20] ChargeHub, "2020 Guide on How to Charge Your Electric Car," (accessed October 18, 2021).

Level 2 charging.[21] Tesla also has a unique Level 2 connector compatible only with their vehicles called Tesla High Power Wall Connector (HPWC).[22]

Figure 2 Different types of connectors



Source: Ricks Free Auto Repair Advice, "EV Charging Levels," (accessed February 16, 2022).

For Level 3 charging, the CHAdeMO and SAE Combo (CCS) are the most common connectors. All non-Tesla EVs either have a CCS or a CHAdeMO charging port. However, these two connectors are not interchangeable, CCS to CHAdeMO adaptors and vice versa are not available in the market, hence an EV with one type of port cannot charge using the other. The CHAdeMO connector is from the Japanese EV Fast Charger Association, and CCS is from the European Automobile Association.[23] CCS is quickly becoming the industry standard, as all upcoming U.S. and European EVs will use this connector.[24] The CHAdeMO connector is still used by various EVs, including Nissan, Mitsubishi, Kia, and Honda.[25] Tesla vehicles are also compatible with the CHAdeMO connector using an adaptor and will soon be compatible with CCS with an adaptor.[26] Tesla manufactured another unique connector, different from the Tesla HPWC mentioned above, called Supercharger Tesla that could be used with Level 3 charging stations.[27]

[21] BlinkCharging, "Understanding EV Charging Plugs," (accessed December 27, 2021)
[22] ChargeHub, "2020 Guide on How to Charge Your Electric Car," (accessed October 18, 2021).
[23] Setec Power, "Difference Between CHAdeMO and CCS," (accessed December 27, 2021).
[24] BlinkCharging, "Understanding EV Charging Plugs," (accessed December 27, 2021)
[25] Setec Power, "Difference Between CHAdeMO and CCS," (accessed December 27, 2021).
[26] Cristovao, "Tesla CCS adapter coming to US," November 12, 2021.
[27] ChargeHub, "2020 Guide on How to Charge Your Electric Car," (accessed October 18, 2021).

Networked vs. Non-networked Charging Stations

EV charging stations are divided into two categories, networked charging stations and non-networked charging stations (also known as stand-alone units). Networked charging stations are connected remotely, via the internet, to a wider network and are part of an infrastructure system of connected chargers. Networked chargers can use dynamic charging that changes based on the cost of power or other factors, are searchable for users of that network, and can provide real-time information both for users (e.g., whether the charger is currently in-use), and for maintenance purposes. Non-networked chargers on the other hand are stand-alone units that are not part of the online infrastructure system of connected chargers.[28]

While both categories power electric vehicles with the required energy to run, there are differences in the initial costs, ongoing costs, accessibility, and maintenance.[29] The discussion below will highlight why networked charging stations are used primarily for commercial purposes and non-networked charging stations are the ones usually found at residential homes and workplaces.

For Level 2 chargers, non-networked stations are the less expensive option due to not having an integrated technology that allows them to connect to the EVSE network. A stand-alone unit (non-networked) may cost a few hundred to a few thousand dollars ($750–$1,500) to purchase with no annual fees.[30] Networked charging stations are more expensive to purchase as they have an integrated technology that allows them to connect to the EVSE network. Depending on the technology and manufacturer, a Level 2 EV charger which connects to an EVSE network costs about a few thousand dollars ($1,500-$4,000) per charging port plus annual networking fees. Installation of the wiring required for both is the same and varies depending on the site and the charging level, ranging from $2,200 to $4,500.[31]

Since networked stations are connected to a larger network infrastructure, they tend to have several uses. For example, because networked stations have access to internet systems, they have the ability to charge a dynamic fee for the electricity consumed. Thus, public chargers tend to be networked. They also store the station's usage data, such as the number of charges per day/time, time of use, electricity consumed per charge and so on. The stored data can then be used to understand the station's use, revenue, and electricity costs. The detailed report is provided by the EVSE network provider, which the station's owner pays networking fees for as mentioned above.

By contrast, non-networked stations can only offer energy at a fixed price using an attached credit card reader. Another major difference is that non-networked stations are unable to monitor usage and are

[28] Blink, "Networked vs. Non—Networked Chargers for Hosts," (accessed October 18, 2021); ChargeHub, "2020 Guide on How to Charge Your Electric Car," (accessed October 18, 2021).
[29] Blink, "Networked vs. Non—Networked Chargers for Hosts," (accessed October 18, 2021).
[30] Blink, "Networked vs. Non—Networked Chargers for Hosts," (accessed October 18, 2021).
[31] A 2015 report from the Department of Energy says some Level 1 installations may have no installation costs, while the most expensive installation costs are DCFC stations, where installation can cost as much as $51,000. U.S. DOE, "Costs Associated With Non-Residential Electric Vehicle Supply Equipment," November 2015; Oreizi, "How Much does it Cost to Install EV Charging Stations?" May 31, 2021.

only able to see the total electricity consumed by unit in a given period of time.[32] Most chargers in single-family homes do not need these features, and are thus non-networked.

Networked stations are easier for drivers to find and owners to maintain than non-networked chargers. Unlike networked stations, non-networked stations must be manually added online resources to appear on EVSE charging maps. Drivers may also have a hard time finding non-networked charging stations. Owners of networked stations can also control who has access to the charger, how long it can be used, which hours it operates, and have the ability to remotely start and stop the charger.[33] With networked stations, maintenance is often simple as they can be remotely fixed without the need of a physical presence of a technician. Most EV charging station providers have a Network Operations Center that remotely monitors, and fixes hosts' chargers if a software problem occurs. Because non-networked stations are not connected to the internet/network, any repair will require the physical presence of a technician. This could cost hundreds to thousands of dollars every time a station needs a repair.[34]

EV Charging Incentives

As mentioned in the introduction, expanded EVSE infrastructure is important in reducing range anxiety and to support national goals to increase EVs share of vehicle sales. Public chargers are particularly important for EV owners without a dedicated parking spot, and to encourage more drivers to use the EV as their primary (or only) vehicle. To help encourage investment in EV charging infrastructure there is a wide range of federal, state, and local tax credits and other incentives. At the federal level is a tax credit, called the alternative fuel vehicle refueling property credit, of 30 percent of the cost of purchasing and installing an EV charging station.[35] The federal tax credit applies to those who purchased EV charging infrastructure within the years of 2018-2021.[36] The credit is for 30 percent of the cost of the EV charger, up to $1,000 for a residential charger and $30,000 for a commercial one.[37]

If passed, the Build Back Better Act could include even more federal incentives to encourage public charger purchase and installation. The Build Back Better Act version which passed the House on November 23, 2021, but has not yet passed the Senate as of publication of this paper, has set aside $2 billion through 2031 for rebates for publicly available chargers. The rebate is up to 75 percent of covered expenses, with different caps based on level of charger:

- Level 2 (non-networked)- $1,000
- Level 2 (networked)- $4,000

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[32] Blink, "Networked vs. Non—Networked Chargers for Hosts," (accessed October 18, 2021).
[33] Hughes, "Networked EV Charging: The Smart Solution for Business," October 30, 2019; Blink, "Networked vs. Non—Networked Chargers for Hosts," (accessed October 18, 2021).
[34] Blink, "Networked vs. Non—Networked Chargers for Hosts," (accessed October 18, 2021); Beavers, "What Maintenance Do Electric Vehicle Chargers Need?" August 13, 2021.
[35] The U.S. government introduced a tax incentive to encourage the installation of facilities to store or dispense alternative fuels in 1992. That incentive has evolved into a tax credit that also applies to equipment that recharges electric cars. Turbo Tax, "What is Form 8911: Alternative Fuel Vehicle Refueling Property Credit," October 16, 2021.
Clipper Creek, "EVSE Rebates and Tax Credits, by State," (accessed November 17, 2021); IRS, "Instructions for Form 8911" February 2021.
[36] IRS, "Instructions for Form 8911," February 2021.
[37] IRS, "Instructions for Form 8911," February 2021.

- Level 3/DCFC (networked)- $100,000

There are also rebates for replacement equipment, which are half of the size of rebates for new equipment. Also, for multi-port chargers (those with multiple connectors on one charger), the rebate is 75 percent of the original for each additional port.[38]

While they vary by state and area, there are many rebates and tax incentives for purchasing and installing an EV charging station.[39] There are 166 incentives available in 43 states and the District of Columbia. Those incentives include "make-ready" incentives that pay for a share of the grid upgrade cost necessary to connect a Level 2 or Level 3 charger to the grid and discounts on electricity costs, but most are rebates or tax credits for a residential or commercial purchase of an EV charger.[40]

State incentives have a range of eligibility requirements for differing incentives. Some of the states with the most incentives are California and Massachusetts. California, the state with the greatest number of both, EVs (42 percent of EVs nationwide) and electric vehicle charging stations has twenty-nine incentives for EVSEs.[41] While many apply statewide, the majority of the incentives found in California are area specific. Massachusetts on the other hand, the fifth leading state by number of charging stations, has nine different EV charging incentives.[42] Four incentives are grants provided by the state and the remaining five are incentives given by private/utility entities.[43] Most other states also have rebates or incentives given by the state or private/utility entities.[44]

EVSE Areas of Competition

With the number of EVs in the United States, and thus demand for EV chargers increasing, new and existing firms in a number of industries have developed EVSE products and services. Four types of firms compete in EVSE: industrial manufacturers, EV charger startups, EV manufacturers, and energy companies (both utilities and gas companies). EVSE companies have different roles, including designing EV chargers, manufacturing EV chargers, installation of EV chargers, management of an EV charging station, and creating/managing a software network for EV charging stations (table 1). Many existing companies participate in one of these spaces as a natural offshoot of their existing expertise. For example, ABB, Eaton, and Schneider Electric already produce electrical equipment, and have been able to leverage that experience to design and produce EV chargers. Similarly, energy companies such as Shell and BP have a network of gas stations distributed along major traffic throughfares, making natural locations for EV charging stations.[45] EV manufacturers including Tesla and VW have also invested in

[38] U.S. Congress, House, Build Back Better Act of 2021, HR 5376, 177th Cong., 1st sess., introduced in House September 27, 2021.
[39] National Conference of State Legislatures (NCSL), "State Policies Promoting Hybrid and Electric Vehicles," August 20, 2021; Clipper Creek, "EVSE Rebates and Tax Credits, by State," (accessed November 17, 2021).
[40] NC Clean Technology Center, "DSIRE," (accessed October 22, 2021).
[41] Statista, "Leading U.S. States for Private and Public EV Charging Stations," September 28, 2021; DOE, "Alternative Fuels Data Center," December 31, 2020.
[42] Statista, "Leading U.S. States for Private and Public EV Charging Stations," September 28, 2021.
[43] Clipper Creek, "EVSE Rebates and Tax Credits, by State," (accessed November 17, 2021).
[44] NCSL, "State Policies Promoting Hybrid and Electric Vehicles," August 20,2021.
[45] Shell, "Electric Vehicle Charging," (accessed October 21, 2021); BP, "BP Pulse," (accessed October 21, 2021).

charging networks.[46] Meanwhile, a number of startups, such as Chargepoint and Blink, have entered the market, participating in different upstream and downstream areas.

Table 1 Examples of where different companies participate in EV charging in the United States

Type of Company	Design	Production	Installation	Management	Network
EVSE Startups	X	X	X	X	X
Electrical equipment manufacturers	X	X			
EV manufacturers	X	X	X	X	X
Electric Utilities			X		
Gas companies			X	X	X

Sources: Author generated based on information from company websites.

Even companies competing in the same space have different business models. Take charger production for example. Chargepoint produces and sells a turnkey networked charger to businesses that want to sell power to EV owners while those owners' vehicles are in their lots. Blink sells a similar product but also manages some charger stations, and its network is "open" meaning that non-Blink chargers can use Blink services to sell power. Tesla produces its own chargers and manages a charger network for users of its vehicles, primarily to limit the range anxiety of Tesla owners. Electrical equipment manufacturers such as ABB and Schneider Electric design and produce EV chargers, but are not involved in installation, management, or networking of charging stations. Energy companies such as Shell and BP are investing in charging stations, but are not involved in upstream design and production.

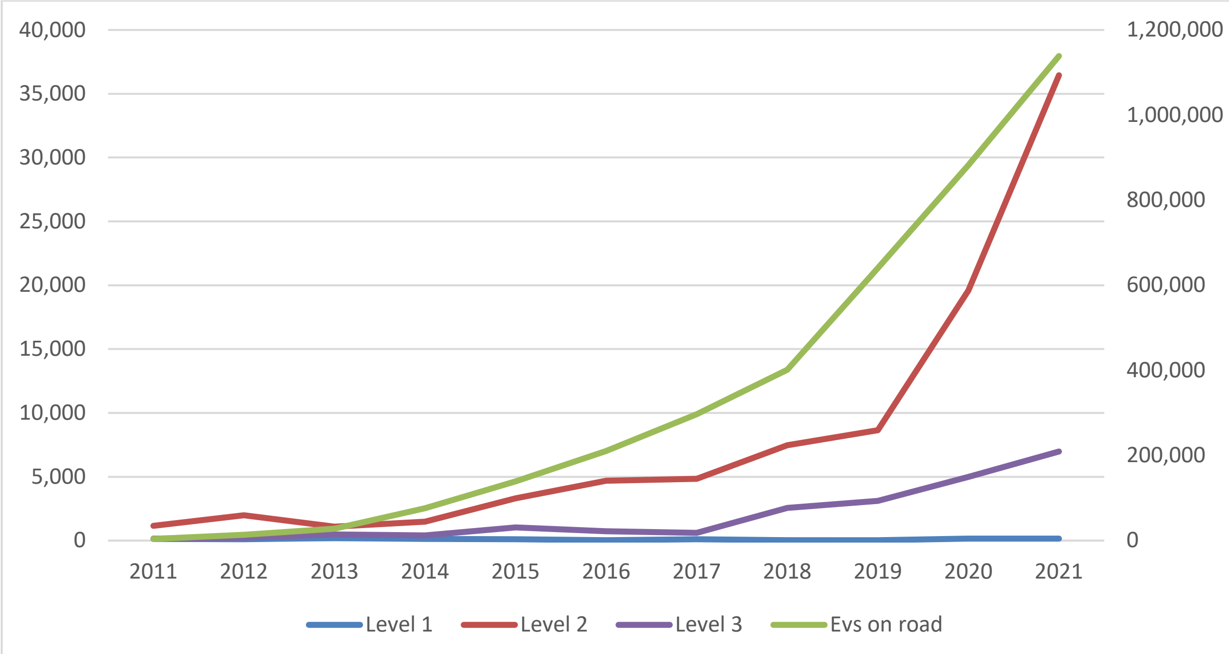
U.S. Market

The U.S. market for EV chargers is closely connected with EV ownership. Many EV owners purchase a charger for use in their home. The United States has one public charger for every 18.5 EVs, but will need to invest significantly in public chargers to keep pace with expected EV sales growth.[47] Reportedly, more than 80 percent of EV charging in the United States is done at home.[48] This may change, however, as the EV sales increase, EV prices drop, and more EV buyers do not have a personal garage or off street parking.[49] Further, with EV range increasing, EV users may be more likely to use an EV as their primary vehicle, and on trips outside of their local area.

As EV sales increase, so do publicly available chargers. According to data from the U.S. Department of Energy's Alternative Fuels Data center, available ports at Level 2 and Level 3 EV charging stations have grown rapidly since 2010 (figure 3). Level 2 and DC fast charger ports more than doubled from 2019 to 2021.[50] Stations have 2.43 ports on average, many only have one, but some have dozens of ports and a few have several hundred.[51]

[46] Tesla, "Supercharger," (accessed November 10, 2021); Electrify America, "National ZEV Investment Plan: Cycle 2," February 4, 2019.
[47] Muller, "Biden Wants 500,000 EV Charging Stations," August 6, 2021.
[48] Electrify America, "National ZEV Investment Plan: Cycle 2," February 4, 2019.
[49] *Economist*, "A Lack of Chargers," December 11, 2021.
[50] Author calculations using data from U.S. Department of Energy, "Alternative Fuels Data Center," (accessed October 6, 2021).
[51] Author calculations using data from U.S. Department of Energy, "Alternative Fuels Data Center," (accessed October 6, 2021).

Figure 3 Available EV charging ports (left axis) and EVs on road per year (right axis) in United States



Source: Author calculations using data from U.S. Department of Energy, "Alternative Fuels Data Center," (accessed October 6, 2021); IEA, "Global EV Data Explorer," April 21, 2021.

More than 80 percent of public EV chargers are a part of a charger network, the two largest networks are Chargepoint and Tesla (table 2). Chargepoint has the most ports, and the most Level 2 ports, while Tesla has the most Level 3 ports. Chargepoint's network is open to all vehicles with J1722 plugs (for a fee), while Tesla's "supercharger network" is for Tesla vehicle owners only, and was built to incentivize purchase of those vehicles, which have made up the majority of EV sales.

Table 2 EV charging ports by network in United States (2021)

Network	Level 1 Ports	Level 2 Ports	DCFC Ports	Total Ports
ChargePoint	279	46,885	1,670	48,834
Tesla	0	16,872	12,433	29,305
SemaCharge	0	5,696	0	5,696
Blink	0	3,191	182	3,373
Other networks	42	15,285	7,126	22,453
All networked ports	321	87,929	21,411	109,661

Author calculations using data from U.S. Department of Energy, "Alternative Fuels Data Center," (accessed October 6, 2021).
Note: The Alternative Fuels Data Center lists an additional 13,118 chargers that are not associated with any network.

Production and Trade

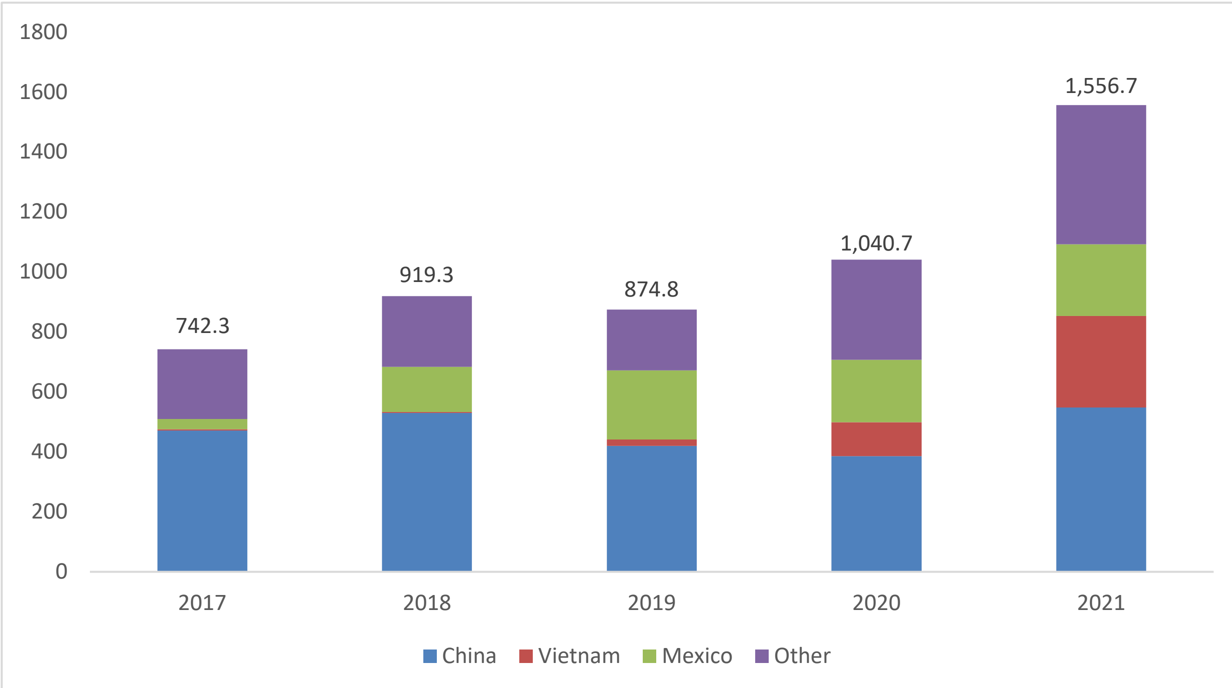
EV production and trade data are not readily available for most manufacturers and are often aggregated with other products. Production appears to have increased, but it's difficult to say how many are produced, or even who the largest producers are. For industrial equipment manufacturers, EV chargers make up a relatively small share of their business and are not broken out in their annual reports. For example, ABB reported that it has produced over 400,000 chargers since 2010 with more than 20,000 of those being DC fast chargers, but does not break down annual production in its reports.[52] EV charger startups have data that is difficult to compare as well. Chargepoint claims 30,000 charging locations worldwide, but has not released annual production numbers.[53] Blink did not report its number of charging locations, but reported annual revenues, which increased from $3.3 million in 2016 to $6.2 million in 2020, with product sales increasing from $1.1 million to $4.4 million (Blink also earns revenue from charging stations it owns and operates, as well as network fees and credits).[54]

Trade data is similarly difficult to track because EV battery chargers are classified under HTS statistical reporting number that contains a number of electrical converters, and not just EVSE equipment.[55] U.S. imports for this statistical reporting number rose from over $630 million in 2016 to over $1 billion in 2020 (figure 4). China continued to be the top source in 2021, but its share of U.S. imports declined from 63 percent in 2017 to 35 percent in 2021. EV chargers were included in the USTR's third enumeration ("Tranche 3") of products originating in China that became subject to an additional 10 percent ad valorem Section 301 duties, effective September 24, 2018. The duties were increased to 25 percent ad valorem, effective May 10, 2019, and remain in effect.[56] Effective August 12, 2020, exclusions have been granted some chargers.[57] These additional tariffs may have contributed to the decline in the share of imports coming from China. Mexico and Vietnam's share of imports increased significantly during this same period, possibly indicating the opening of new production there.

U.S. exports under this statistical code were primarily to Canada, which received 65 percent of U.S. exports in 2020. U.S. exports remained relatively stable (between $400 and $500 million) during this period.[58] Authors could not find evidence of EV charger manufacturing in the United States, and this is a highly aggregated statistical reporting number, thus such level trade may indicate that U.S. exports do not include EV chargers, but instead include other kinds of static converters.

[52] ABB Group, 2020 Annual Report, February 26, 2021, 17.
[53] Chargepoint, "ChargePoint Now Offers 30,000 Places to Charge an Electric Vehicle," unknown.
[54] Blink, 10-k 2020, March 31, 2021.
[55] HTS Statistical Reporting Number 8504.40.9550 "Electrical transformers, static converters…and inductors; parts thereof: Static converters: Other: Rectifiers and rectifying apparatus: Other."
[56] 83 FR 47974, September 21, 2018; and 84 FR 20459, May 9, 2019. See also U.S. notes 20(e) and 20(f), subchapter III of chapter 99 of the HTSUS.
[57] See U.S. note 92 to subchapter III of HTS chapter 99. *HTSUS (2020) Revision 16, USITC publication 5095*, July 2020, p. 99-III-171.
[58] USITC Dataweb (Domestic Exports HTS statistical reporting number 8504.40.9550) accessed February 16, 2022.

Figure 4 U.S. imports of static converters (including EV chargers), 2016–20 ($ million)



Source: USITC Dataweb (General Imports HTS statistical reporting number 8504.40.9550) accessed February 16, 2022.

Conclusion

The EVSE industry is relatively new and features a large number of companies competing with different business models. As EV sales increase, this competition will grow. With increased competition, hopefully better data will come. This is an industry that features opportunities for many different companies, and the winner or winners are far from clear. It seems likely that the leading EVSE networks of the future will be open to EVs from most (if not all) brands because that is the path to having the largest market, but whether it will be a startup, an established energy company, or one of the other current participants in the market is unclear.

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