Supercharged! How do we Create the Required EV Charging Infrastructure?

By Martin Flusberg
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Image Courtesy of BlackBerry Blogs

How Adequate is the Current EV Charging Infrastructure in the US?

Electric Vehicle (EV) sales in the US in Q2-23 were approximately 300,000, a 50% increase over Q2-2022. Cox Automotive projects that total EV sales in 2023 will exceed 1 million. That will bring the total number of EVs up to just over 3 million – which is a little more than 1% of light vehicles on the road in the US[1]. Projections are that sales will continue to grow.

According to J.D. Power, worries about public chargers – their availability and reliability - are the number one reason why would-be EV buyers are reluctant to move forward. It even outranks concerns about the high price of most EVs. CNBC reported in April 2023 that nearly 80% of the nation's public felt that a lack of public charging infrastructure deterred them from buying an EV. Even people who can install an EV charger at home have "range anxiety" when thinking about the issue of taking long trips.

[1] For this article, I am generally using the term EV to refer to Battery Electric Vehicles, often referred to as BEV. This does not include Plug-in Hybrid Vehicles (PHEV) that run on both gasoline and electricity – which have a much lower electric range and whose owners typically do not have to worry about where to charge. According to J.D. Power there were approximately 860,000 PHEVs in the US at the end of 2022, or about 40% as many as BEVs. Unfortunately, many articles on EVs do not differentiate; hence there are often discrepancies in the numbers of Electric Vehicles being reported.

Back in 2021, both the Economist and Forbes, along with a number of major other periodicals, wrote articles suggesting that the lack of EV chargers could limit the sales of EVs.

Articles like this have continued to appear into 2023. For example, in March 2023 the energy service company ENERGY5 published a piece entitled "Not Enough Charging Stations for Electric Cars: What are the Consequences?".

There have also been a number of consumer surveys that have highlighted problems with the existing EV infrastructure. For example, a recent study conducted by the Social Science Research Network (SSRN) reported that only 72.5% of chargers in the San Fransisco area were functional, despite claims of 95-98% uptime from charging station providers. Problems identified included cables too short to reach the cars' charge ports, broken connectors, unresponsive screens for use in payment, and payment system failures.

A survey done by McKinsey concluded that the customer experience with public charging is often unsatisfying. Respondents mentioned the speed, cost, and availability of charging locations as the main issues. They also noted that it is sometimes difficult to find chargers - mobile apps for locating chargers on a charging network generally exclude competitors' chargers. Payment is sometimes difficult to perform, and pricing varies considerably—from pricing by the minute or kilowatt-hour to different rates for members - which makes it difficult to know which network offers a better value. And different charging networks operate differently – and there is no real customer service to help.

A very recent piece on NPR chronicled a 4-day electric vehicle road trip during which the reporter accompanied Secretary of Energy Jennifer Granholm. Granholm's group of EVs — including a Cadillac Lyriq, a Ford F-150, and a Chevy Bolt - had to deal with a number of EV charging issues.

For example, when looking for fast chargers in Grovetown Georgia, Secretary Granholm's advance team realized there weren't going to be enough ports. One of the station's four chargers was broken, and others were occupied. So, an Energy Department staffer parked a non-electric vehicle in front of an available charger as a way to reserve that spot. Which so upset an EV driver that needed to charge that she called the police – who reported that they couldn't do anything because it's not illegal for a non-EV to claim an EV charging spot in Georgia. (Some parts of the country do issue fines for this).

Unfortunately, incidents such as these do not appear to be uncommon; EV drivers across the country continue to encounter broken chargers and non-electric vehicles blocking some chargers – an act that has gotten the name of "ICEing" (Internal Combustion Engine-ing)[2]. And there are many instances where EV owners monopolize charging stations by leaving their cars in place for hours after charging, or charge to 100 percent no matter how many others are waiting.

The US government has called for 50% of all vehicles purchased in the US by 2030 to be EVs. To support this goal, the Bipartisan Infrastructure Law (BIL) passed in 2021 provides $7.5 billion to develop the country's EV-charging infrastructure. The goal is to install 500,000 public chargers nationwide by 2030.

Before getting into a discussion of whether it will be possible to have enough EV chargers available to serve the expected number of EVs, let's start with a look at the current EV charging network.

[2] Tesla has actually introduced a pop-up floor block in China to keep non-Teslas from parking at their charging stations; the Tesla app lowers the device.

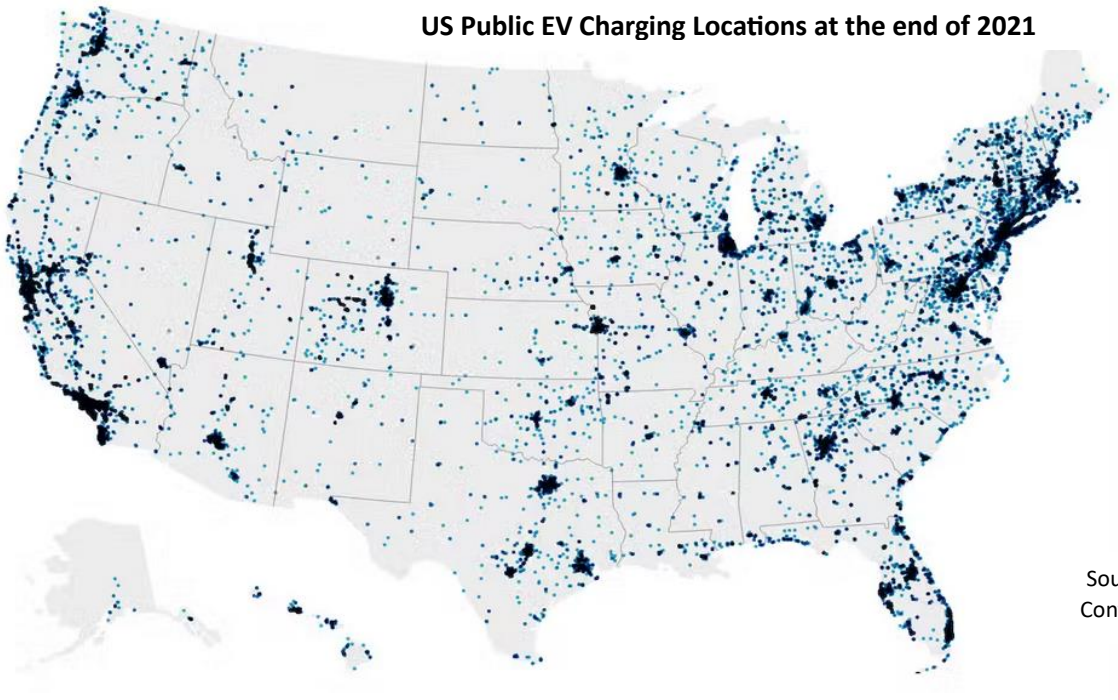
How Many Public Chargers are There in the US – and who Operates Them?

The most comprehensive list of the EV charging networks I could find was prepared by the EV analytics firm EVAdoption. The table below shows what they reported as of the end of 2021[3]. Charging station location "density" is highlighted in the map immediately below the table.

US Public EV Charging Infrastructure at the end of 2021

Network	Level 1 Loc.	Level 1 Ports	Level 2 Loc.	Level 2 Ports	Level 3 Loc.	Level 3 Ports	Total Loc.	Total Ports
ChargePoint Network	152	157	14,155	47,114	1,147	1,675	**15,454**	**48,946**
Tesla			4,436	14,677	1,246	12,580	**5,682**	**27,257**
SemaConnect Network			1,908	5,802			**1,908**	**5,802**
Blink Network			1,340	3,158	76	154	**1,416**	**3,312**
Electrify America			134	152	717	3,112	**851**	**3,264**
EV Connect			686	2,774	61	183	**747**	**2,957**
Greenlots			821	2,309	279	477	**1,100**	**2,786**
Volta			913	2,199	18	19	**931**	**2,218**
EVGo Network			295	464	849	1,711	**1,144**	**2,175**
Other	356	1,023	5,563	12,890	832	1,765	**6,751**	**15,678**
TOTALS	**508**	**1,180**	**30,251**	**91,539**	**5,225**	**21,676**	**35,984**	**114,395**

US Public EV Charging Locations at the end of 2021



Source: The Conversation

[3] Greenlots was acquired by Dutch Shell in 2019 and renamed Shell Recharge in 2023. Electrify America, established by Volkswagen in 2016 as part of VW's efforts to offset emissions in the wake of the diesel engine emissions scandal, still operates as Electrify America. SemaConnect Network has been acquired by Blink Network. The "Other" category in the table includes approximately 5,900 locations and 12,400 charge ports that are not operated by charging networks but have been installed by municipalities for public use, by parking lots/garages for customer use, and by others.

As is evident from the table, ChargePoint is by far the largest provider of public charging in the US, accounting for more than 40% of all charge ports (the vast majority of which were Level 2 chargers) in the US in 2021. ChargePoint continues to grow and by mid-2023 had close to 20,000 charging locations. Tesla is by far the leader in Level 3 charging, accounting for about 58% of all supercharger locations. By mid-2023 Tesla had increased its fleet to approximately 1,900 locations and 19,000 Level 3 ports.

DOE estimates that there was a total of 140,000 public charging points by the end of 2022. By the end of 2023 we can expect to see around 170,000 public charge ports across the US spread out across about 53,000 locations.

It is also pretty obvious, as would be expected, that EV chargers are more abundant in the major cities – particularly along the coasts. (Interestingly, Hawaii has the 2nd highest number of EV chargers per capita in a state - 15.4 per 1,000 people - after California's 27.6 per 1,000 people).

Before delving into the numbers - or locations - any further, it is extremely important to elaborate on what the levels of charging are. To start, consider the following table.

Level	Power	Power Output	Charge Rate/Hour
Level 1	120V AC	1 - 1.8 kW	3 - 6 Miles
Level 2	240V AC	3 - 22 kW	10-70 Miles
Level 3	400V DC	60 - 350 kW	200-1,200 Miles

As you can see, Level 1 chargers can use a standard home outlet and only generate 3 – 6 miles of range per hour while charging. That is why there are so few public Level 1 charging points. However, overnight a Level 1 charger might provide 36 – 72 miles of charge, so a home charger will work fine for someone with a typical commute – or someone with a hybrid plug-in vehicle.

Level 2 chargers are not only the most common public chargers, but they are also represent the vast majority of private chargers. They require a 240V line such as those typically used for an electric dryer in a home. They cost more to purchase – and more to install since the installer often needs to run a 240V line out to a garage for a home charger - but they charge much more quickly than Level 1 chargers. Virtually all Level 2 chargers can fully charge an EV overnight. They can also deliver a reasonable amount of range for an EV that stops to charge for an hour for lunch at a restaurant, for example.

Level 3 chargers – often referred to as Direct Current Fast Chargers (DCFC) – clearly provide a significantly longer range – and have been becoming more and more powerful over the past few years. Tesla has confirmed that they have successfully built a Level 3 charger that can deliver up to 350kW and deliver close to the maximum range shown above. These chargers are not yet available but are expected to be by the end of the year. ABB has also developed a Level 3 charger that delivers 350kW of power.

But while Level 2 chargers can cost as little as $1,000 to install if not less, Level 3 chargers typically cost tens of thousands of dollars – in some cases in excess of $100,000. Hence the fact that fast chargers represent only about 25% of all charge ports in the US.

Until very recently the majority of Level 3 chargers – those part of the Tesla Supercharging Network – were only available to Tesla drivers. Tesla uses a different protocol than all other electric vehicles[4]. Tesla provides adaptors to allow Tesla cars to use the standard employed by all other electric vehicles in the US and therefore Teslas can charge anywhere. While Tesla has been talking about possibly opening up their network to other car models for a while, that did not happen until this year.

In order to qualify for a slice of the $7.5 billion earmarked for EV charging network expansion in the BIL, Tesla announced in early 2023 that they will open up at least 7,500 chargers from its network to non-Tesla vehicles by the end of 2024. Of these, at least 3,500 will be existing and new fast 250-kW (soon to be 350kW) Superchargers along highways; the rest will be Level 2 chargers located at businesses such as hotels and restaurants. At this point only a handful of stations are available, although more are being added on a regular basis. Autos that have been testing these chargers include the Lucid Air, Kia EV6 and Mercedes-Benz EQE. (Tesla has reported that they will be charging non-Tesla vehicles more than they charge Tesla owners for charging).

Ford, GM, Honda, Nissan Mercedes, Polestar, Rivian, and Volvo announced this summer that their vehicles will be able to use Tesla's Superchargers starting in 2024.

Tesla Charge Port CCS1 Charge Port

Currently non-Tesla autos require an adaptor to use the Tesla chargers, but several auto manufacturers, including Mercedes, have indicated that they will support Tesla chargers directly by 2025.

Part of this move to adopt the Tesla standard stems from the performance of the charging networks. JD Powers has reported that, on a 1,000-point scale, Tesla's Supercharger network received a score of 734, vs. an average for all other providers of 558.

Reliability is no doubt the major factor in that satisfaction. Only 3.9 percent of Tesla Supercharger users reported not being able to charge when they reached a station; by comparison, the users of other charging networks were unable to charge 21.6 percent of time.

[4] The non-Tesla standard used on the US is called CCS1. Some Nissan models still use the Japanese CHAdeMO standard, but they are converting all their models to CCS1.

EV Charging Station in Pasadena CA that has 20 Tritium and 24 Tesla fast chargers

J.D. Power has also noted that Tesla benefits from controlling both the charging stations and the vehicles that use them, enabling Tesla to test – and control - the compatibility between the vehicle hardware and software and the Supercharger hardware and software. But access to the much more reliable Tesla network – which is monitored and managed by Tesla in a way that other charging networks are not – should still make a real difference for non-Tesla drivers.

Are There Enough Chargers Now?

Thus far the discussion here has focused on *public* chargers, that are available to any EV drivers (subject to the Tesla charger restrictions discussed above). But the vast majority of chargers in the US today are *private* chargers, and the vast majority of these are home charging stations. There are also private chargers in a small number of apartment complexes for use by renters, and in office buildings for use by employees. Multiple organizations with fleets of trucks are also building out private charging networks for their fleets (more on that later). There are a small number of other private charging stations as well.

According to J.D. Power, about 85% of current EV owners have a home charger and do the vast majority of their charging at home. (As an EV owner with a home charger I can confirm that the last time I used a public charger was in June). Home charger owners typically only use public chargers for long trips. (Home charging is less expensive since unlike most public charging there is no mark-up on the utility's rate and on the charger's capital cost – which has already been paid).

It has been estimated that perhaps 1% of renters currently have access to a private EV charger at their apartment buildings and while there are few estimates of how many EV owners have access to a private charger at work the number is probably not very high at this time.

So, assuming that 85% of current EV owners rely on their home chargers for most charging, that would imply around 450,000 EVs currently rely on public chargers. And this is probably a slightly high number since some of these will have access to private chargers at their apartment building or office, as noted

above, and some homeowners without a home charger will simply plug into an 120V or 240V outlet at home.

If 450,000 EVs have access to 170,000 charging ports, that's an average of 2.65 EVs per charge point – ignoring for the moment the failure rates we have been seeing among non-Tesla chargers. How does that compare with gasoline vehicles?

There are currently about 260 million cars and light duty trucks registered in the US, and around 1,450,000 gasoline pumps at 160,000 gas stations. That's a total of 182 cars per gas pump. Or 68 times as many gas-powered cars per pump as EVs per charge point

So why do we think we have an EV charging shortage?

All kidding aside, this is not an apples-to-apples comparison. EVs have much shorter ranges than gasoline powered cars and therefore need to "fill-up" more frequently. Gas cars take about 8 minutes to add several hundred miles of range; even at most Level 3 fast chargers an EV would need a half hour to add 100 miles. At most Level 2 chargers that would take more than 2 hours. So clearly, we need a lot more charge ports per EV than gas pumps per gas car. But the current numbers do not seem to be that unreasonable.

We will come back to discuss this in more detail after a look at where we are headed, but there are a few reasons for the concern about charging locations today. First of all, as noted earlier, more than 20% of non-Tesla chargers appear to be non-functional on a regular basis. Level 3 chargers, which charge much more quickly, represent fewer than 20% of all charge ports across the US – and as also noted earlier a good share of EV drivers do not have access to the Tesla Supercharger network which represents almost 60% of all Level 3 charge ports. EV chargers are far from evenly distributed across the US; there are currently relatively few in rural areas, for example. There are a lot in major cities, but in large cities like New York and Chicago there are a lot fewer homeowners, so a lot less than 85% of EV drivers have access to a private home charger in those areas. So, the reality is there are probably areas in the US where there are a sufficient number of EV charging ports – but others where there are not.

The number of chargers will need to grow considerably based on expectations for the growth in EV ownership, so let's take a look at that before addressing things that are being and can be done to deal with the shortage of chargers in some areas.

Where are EVs - and EV Charging Fleets - Headed?

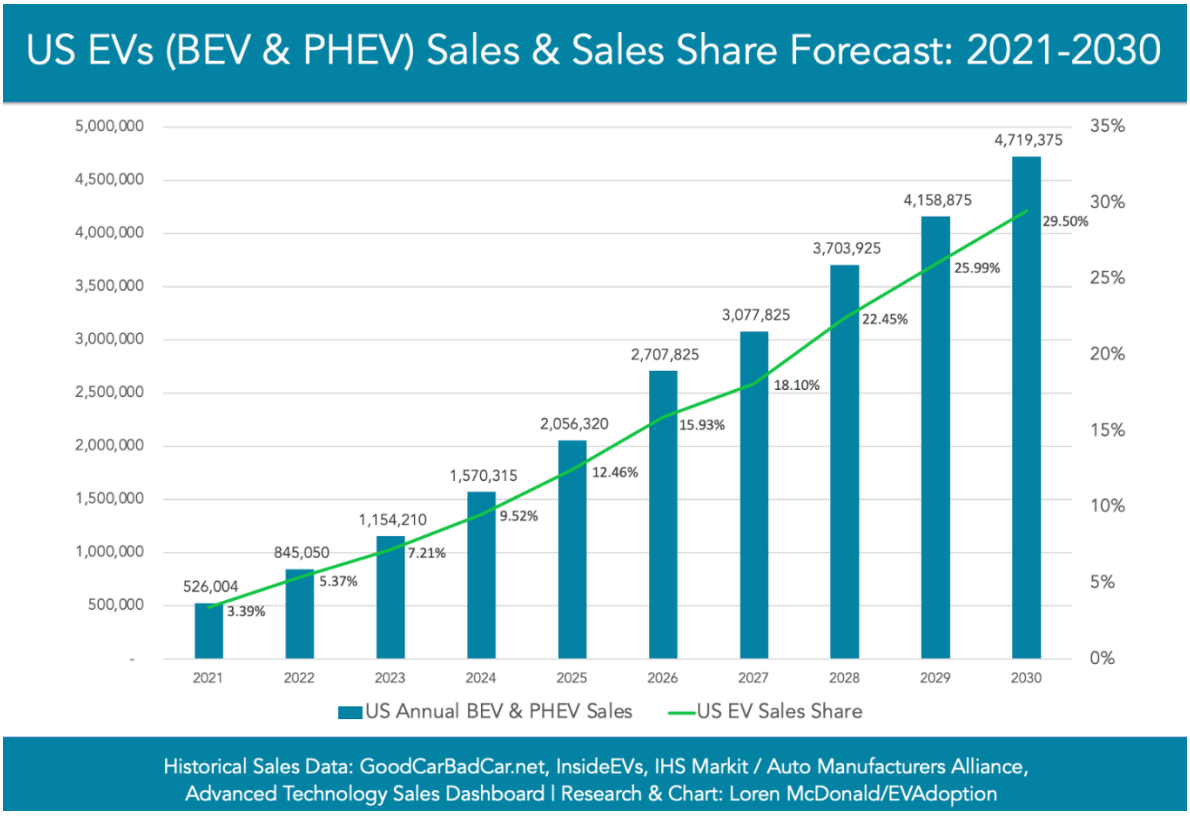
As noted earlier, EV sales are rising rapidly and the US now has a goal of having 50% of all cars sold in 2030 be EVs. (14 states have followed California's lead of requiring 100% of light duty vehicles sold in 2035 to be Zero-Emission vehicles (ZEVs), defined as battery-electric or fuel cell-electric/hydrogen). The Inflation Reduction Act (IRA) has already been shown to be jumpstarting EV sales. Hitting the 2030 goal would imply sales of more than 6.5 million EVs in 2030, a pretty significant increase over the numbers for 2023.

Estimates of the number of EVs that would be on the road in 2030 if we hit that goal vary widely but are generally in excess of 30 million – and range as high as 48 million in a report from McKinsey. (Confusion between BEVs and PHEVs may account for some of these discrepancies).

Many forecasters think we will fall short of this goal. For example, Guidehouse Insights forecasts that 33% of the nationwide market will be EVs in 2030 - 27% BEVs and 6% PHEVs.

At the other end of the spectrum, Plug In America, thinks the 2030 goal will actually be exceeded and that we will hit 50% before 2030 and be 70% or higher by 2030. They are projecting that Tesla's alone will sell 20 million vehicles per year in 2030.

Below is a year-by-year forecast of EV sales from EVAdoption:



The number of EVs will obviously impact the number of chargers required, so one would expect wide diversity in the number of chargers being projected. But there also appear to be issues with how people are looking at that as well.

For example, there appears to be confusion in some reports between EV charging stations, EV charge ports, gas stations, and gas pumps. A May 2023 report from Jerry Insurance was entitled "Number of U.S. EV Charging Ports will Soon Surpass Gas Stations". They stated that there were approximately 108,000 public EV charging ports in the U.S., compared to an estimated 110,000-150,000 gas stations, which implied that there are 21 EVs per public charging port and 2,500 gas-powered cars per gas station. Aside from the accuracy of these numbers (at the end of 2022 there were approximately 2 million EVs and 140,000 public charging points, or about 14.3 EVs per charge point, and 260 million lightweight gas vehicles and 160,000 gas stations, or 1,625 per gas station), the point is that they are comparing apples

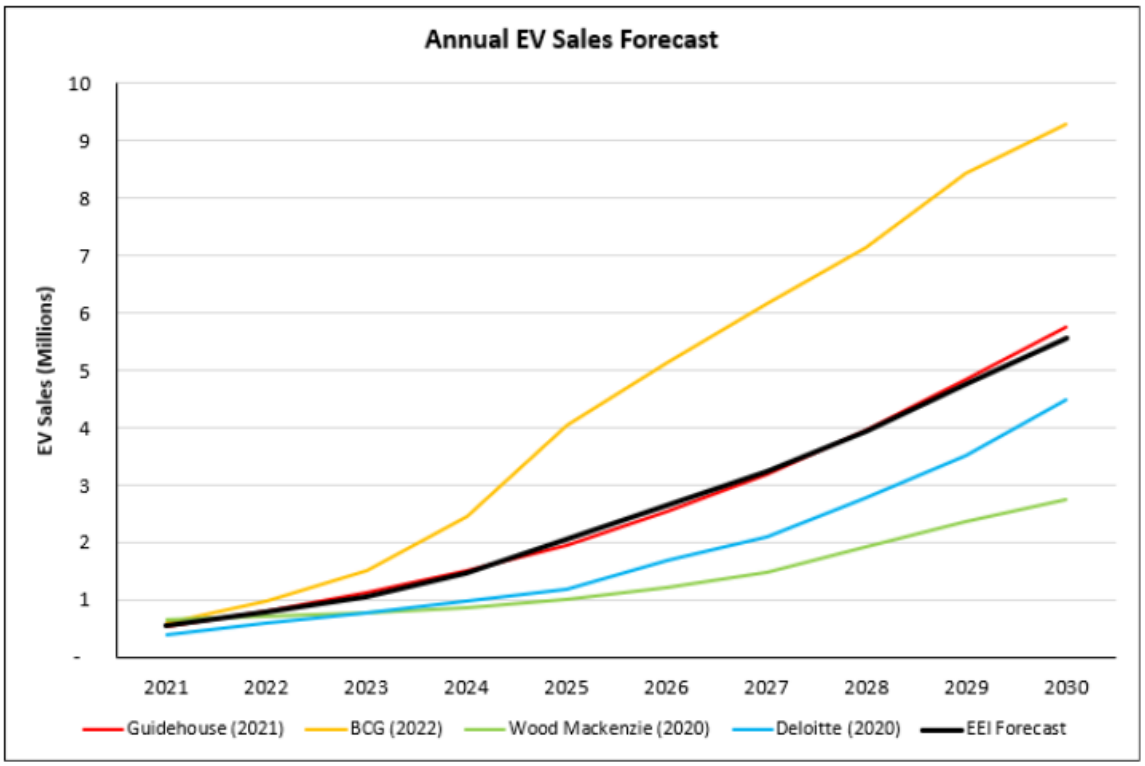
to oranges – or charge ports with gas stations rather than with gas pumps. As noted earlier, when you look at the number of pumps, which was about 1.45 million, gas cars per gas pump amounted to about 182. Still a big difference for EVs, but not the factor of more than 100 that they claimed.

As another issue, some discussions of EV charging requirements do not bother to differentiate between public and private EV chargers. The reality is that the vast majority of EV chargers are, and will continue to be, private chargers - at homes, apartment buildings, and private fleets – and there is no need to worry in the same way about if and how the private chargers will be installed.

As one example of this, a 2022 article by PWC predicts that there will be 27M EVs on the road by 2030, and this will require 35 million EV charge ports – of all types. This sounds like an incredibly high number to reach – if you ignore the fact that the vast majority would be privately installed. (It would also mean there would be more than 1 charge port per EV which sounds unreasonable).

These issues are only some of the reasons that projections of the number of EV chargers that will be required by 2030 vary incredibly widely. For example, according to McKinsey, if half of all vehicles sold are zero-emission vehicles by 2030—in line with federal targets - the US would require just under 1.2 million public EV chargers (specifically 1 million Level 2 and 182,000 Level 3) and 28 million private EV chargers to support their mid-point estimate of 33 million plug-in vehicles on the road. ElekTrek says that there will be 28.3 million EVs on US roads in 2030 and predicts that a total of around 2.13 million Level-2 and 172,000 Level-3 public chargers will be required, in addition to private EV chargers.

The Edison Electric Institute (EEI) projects that we will need just under 13 million total charging ports – including 140,000 Level 3 chargers - to support 26.4 million EVs by 2030. Their forecast of EVs sold in 2030 is about 5.6M – which represents approximately 40% of all light vehicles sold rather than 50%. This forecast of the number of EVs on the road appears to be the mid-point and most common of the forecasts out there, so we will use that for the analysis. Below is a graph prepared by EEI that shows how their forecast compares to several others.



Let's take a dive into the numbers to see what seems to make sense for total chargers. Homeowners represent 60% of all households in the US (and 92% of homes have garages). It seems very reasonable to assume that homeowners will own at least 75% of all EVs on the road – and probably even more. Taking another reasonable estimate – that 80% of homeowners with EVs will buy a charger - down from 85% today - that would imply a little over 15.8M EVs with home chargers, and just under 4M without. (Again this is likely a conservative number since by then there will likely be numerous households with multiple EVs that share a charger and, as noted earlier, other households that simply plug in at home without a charger).

The remaining 25% of EVs would then be owned by renters, and if we assume 15% of them have access to an EV charger at their apartment building or at work, that would mean an additional 990,000 households with access to EV chargers – and 5.6M without.

So that would imply roughly 9.6M cars that do not have access to a private EV charger. How many public charging ports would that require? If we assume that we would want to see 10 times as many charging ports per EV as gas pumps per gas-car, that works out to approximately 527,000 public charge ports.

This is in addition to the roughly 16.8M private chargers at homes and apartment/office buildings estimated above (ignoring the fact that most of the private chargers not at homes will probably be shared, which was not factored into the calculation). This forecast of EV charging ports is way fewer in total than estimated by PWC. Or even McKinsey.

So, the 500,000 public chargers called for by the Infrastructure Act does not sound so crazy - does it?

Building out the EV Charging Infrastructure

There are clearly challenges to building out the EV charging infrastructure to reach the levels suggested here or projected elsewhere, other than the sheer cost of doing so. Permitting issues vary from state to state and often county to county, making the process complicated for the charging providers. Finding the right locations can be tricky as well. While most power grids in the US can supply enough electricity to meet the general demand from EV charging, few can deliver the large amounts of electricity that would be needed if many EVs are charging at Level 3 chargers at the same time. Grid constraints will factor into the task of finding the right charging locations. Despite these challenges, there is significant momentum in the build out of the charging infrastructure in the US.

Public Chargers

Regardless of whether the actual number of public chargers we will have is the 500,000+ calculated above or a bit more than double that as projected by McKinsey, it still represents major growth over what is out there today. Having $7.5 billion in Federal funds from the BIL as well as funds that will result from the IRA is clearly a step in the right direction, but what other factors are at work?

In addition to the continued build-out by the existing EV charger networks, other organizations are getting involved in the process of expanding the EV charging infrastructure.

EV Car Companies

Tesla has committed to continuing to expand their network – which will soon be available for virtually all EVs. As noted earlier, Electrify America - a VW company - also continues to expand its network.

Not to be outdone, seven major automakers announced a plan in July 2023 to nearly double the number of fast chargers in the United States in help address consumers' hesitation to buy electric cars.

The automakers — BMW, General Motors, Honda, Hyundai, Kia, Mercedes-Benz, and Stellantis — will initially invest at least $1 billion in a joint venture to build 30,000 charging ports on major highways and other locations in the US and Canada.

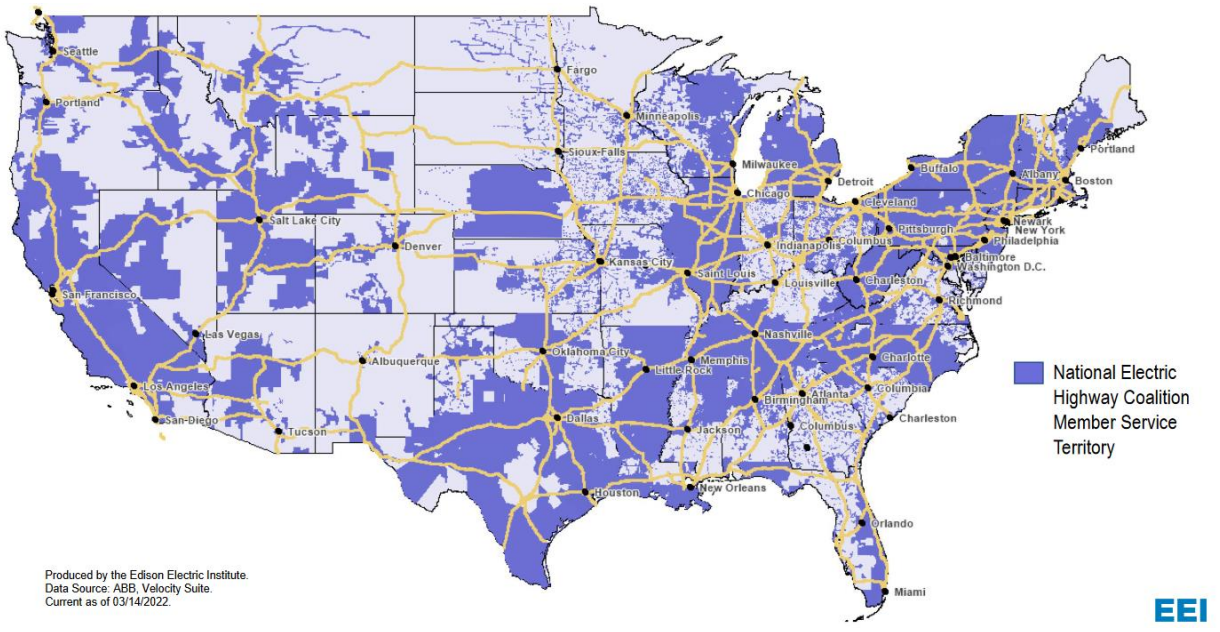
Utilities

Electric utilities are also getting into the game of funding – and in some cases building – EV charging stations. Utilities in many states, including Massachusetts and Connecticut, are also leveraging the Inflation Reduction Act to offer significant rebates for charging station installation – both public and private.

More than 60 U.S. power companies have joined together to build a coast-to-coast fast charging network for electric vehicles along major U.S. travel corridors - with an original goal of making significant progress by the end of 2023 which does not look like it will be met.

The ***National Electric Highway Coalition*** was created by the Edison Electric Institute, combining two existing EV charging groups formed in the Midwest and in Southern and Eastern coastal states - the Electric Highway Coalition and the Midwest Electric Vehicle Charging Infrastructure Collaboration. Members include investor-owned and municipal utilities, as well as rural co-operatives.

Below is a map of the service territories of the utilities that comprise the National Electric Highway Coalition. Limited coverage in many rural areas, but over all there is pretty wide coverage across the US.



Big Box Retailers

Walmart currently has 1,300 EV fast-charging stations at more than 280 U.S. facilities and has announced plans to have thousands more at Walmart and Sam's club locations across the country by 2030.

Image Courtesy of Walmart

Truck Stops

A recent New York Times article notes that truck stops across the country are adding EV chargers – along with amenities like restaurants, expanded restrooms with showers, laundries, and dog parks to accommodate the expanded time electric vehicle drivers need to spend at the stops.

EV Chargers at a Truck Stop. Source: NY Times

The article notes that the 3 largest travel stop operators - Pilot, Loves, and Travel Center of America (recently acquired by BP) - are each adding new locations, EV chargers, and such amenities.

Pilot, which operates more than 870 Pilot and Flying J locations in the US and Canada, has received $9.6 million in fast-charger funding from the state of Ohio and $2.3 million from Pennsylvania and has so far built EV fast-chargers in 17 locations. The company has teamed up with General Motors and EV charging supplier/operator EVgo to build out the infrastructure. This is part of a $1 billion initiative begun in 2022 to remodel 400 of its travel centers and upgrade others. Loves has also budgeted $1B to update half of its 640 travel centers, with plans to pursue state grants and install chargers in many of them. According to the article, the National Association of Truck Stop Operators trade association views this as a logical direction given the growth in electric vehicles.

Private Charging Stations

So far, we have discussed private EV chargers that are being installed by homeowners, apartment building owners, and corporations looking to serve their own employees. But there are also others addressing private chargers

Trucking Fleets

Major truck fleet operators are starting to build out a private EV charging infrastructure.

Amazon has ordered 100,000 electric delivery vans from Rivian and expects to have several thousand on the road this year - and all 100,000 on the road by 2030. Amazon has already added thousands of charging stations at its delivery stations across the country and has committed to continuing to build out the infrastructure to support its planned huge fleet of electric vehicles. In addition to the Rivian order, Amazon has put more than 15 models of electric vehicles on the road across the U.S., the EU, and India, including delivery vehicles, e-cargo bikes, and e-rickshaws.

Amazon is one of a number of major corporations that has joined the ***Corporate Electric Vehicle Alliance***, formed by the nonprofit organization CERES. The Corporate Electric Vehicle Alliance is a collaborative group of companies focused on accelerating the transition to electric vehicles. The Alliance supports companies in making major commitments to fleet electrification and essentially aggregates corporate demand for EVs to expand the business case for building them. To become a member, companies must have a significant U.S. operational presence, operate a minimum of 500 on-road vehicles in the US (that minimum is reduced to 50 if they primarily operate class 5 - 8 medium and heavy-duty vehicles) and have a minimum annual revenue of $100 million.

In addition to Amazon, members of the Alliance include ADT; AT&T; Best Buy; CBRE; Clif Bar; DHL; Element Materials; Ferguson Enterprises; Genentech; Heritage Group; Hertz; Ikea; JLL; Lime Micro-mobility; Lyft; Merchants Fleet; Otis; Schindler Elevators & Escalators; Siemens; States Logistics; T-Mobile; TK Elevator; Uber; United Natural Foods; Verizon; and several utilities.

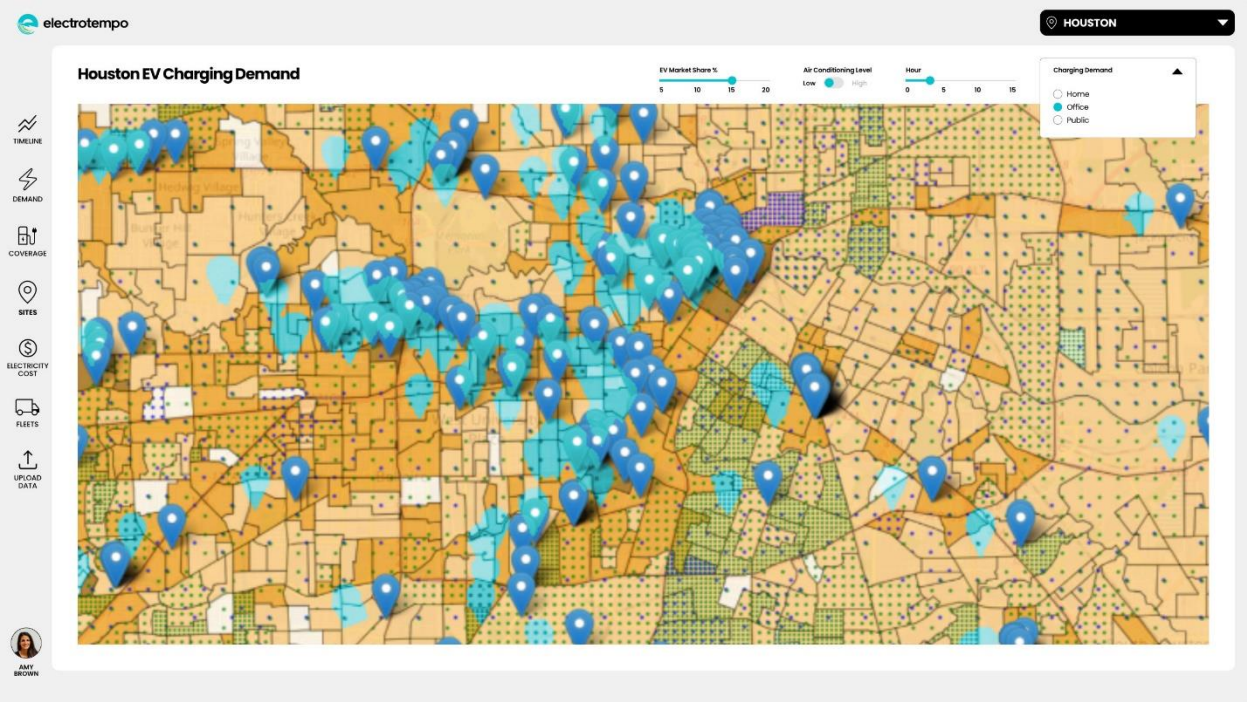
Third Party/Service Companies

In addition to the companies that manufacture EV chargers, there are a number of third party companies that are focused on expanding the EV charging infrastructure.

For example, there are several self-described software companies that are helping multi-family housing and office building owners install, operate, and manage charging networks. Matcha is one such company

that works with both apartment and office complexes to install EV chargers (working with 3rd party equipment manufacturers); manages the applications for utility rebates in states that have them; monitors the performance of the chargers and ensures that problems are quickly resolved; and provides the software that renters or employees can use to schedule their charging and that the building owner uses to bill for charging, based on the length of charge and utility rates at the time of charge. Their involvement makes it much easier for the building owner to install these chargers – which in turn helps building owners attract and retain tenants, as described in this blog post from the company. The company makes money by charging a subscription fee and getting a share of the EV hardware fee and user charging fees. SWTCH is another company that has a similar business model.

ElectroTempo has a very different business model. They work with fleet operators to help find the best locations to install an EV charging infrastructure based on the ability of the grid to support the infrastructure - and with utilities to help them in grid planning to support that growing infrastructure. ElectroTempo refers to their role as: "bridging the information gap between fleets and utilities".



Map of Simulated Houston Area Charging Demand From ElectroTempo Website

Evoke, another company in this general space, describes themselves as offering smart charging, or "an open and scalable cloud platform for electric vehicle (EV) charging, energy management, and grid interaction". They serve apartments and condos, colleges and universities, vehicle fleets, workplaces, and utilities.

And as the final example – of a much larger cohort than listed here - EnTech Solutions helps both EV charging companies and others plan, locate, and install charging stations.

The bottom line is that there are a range of third-party companies helping others install and manage their charging infrastructure.

Other Approaches to Addressing Limitations of the Charging Network Infrastructure

EV Charging In Cities

As noted earlier, the basic math applied earlier to estimate the number of required public chargers does not work in large cities, such as New York and Chicago, where the majority of people live in apartment buildings – generally buildings that do not have their own parking facilities. For example, 70% of Chicago residents live in multi-unit buildings. Therefore, these cities will require a different type of effort in order to enable people to go out and purchase EVs and feel comfortable about being able to find public charging facilities.

There are a number of companies actively trying to address this exact issue. For example, **Stak Mobility** offers, among other things, stacked vertical parking structures designed for dense urban areas that include EV chargers and offer sophisticated mobile software for scheduling and more. Here's a photo of a parking facility in Pittsburgh that was taken from a video on the Stak Mobility Website:

Another start-up – **it's electric** – partners with city property owners to use electricity from the building to power curbside EV chargers for their tenants. it's electric has partnered this past year with the New York City Economic Development Corporation and Hyundai CRADLE to test curbside chargers in New York City. The chargers can be installed at no cost to property owners and can produce $1,000 or more each year in income for the site owners. it's Electric handles all of the required permitting and manages the installation of the chargers.

Curbside EV charging is much more common in Europe. To the right of the it's electric charger depicted below is a photo I took of a Tesla charging curbside in the city of Knokke in Belgium in 2022 – one of many such chargers that I saw.

it's electric curbside charger in NYC

Curbside charger in Knokke Belgium

Revel, a company better known for its electric mopeds and ride-sharing network, has built the largest public fast charging station in the US featuring 60 charging stalls for EVs. The Maspeth Superhub, built in the Bedford-Stuyvesant neighborhood of Brooklyn, is part of the company's plans to open 136 public charge ports across the metro area. This includes 30 ports in the Bronx, 20 in the Red Hook section of Brooklyn,16 adjacent to the Dime building in South Williamsburg Brooklyn, and several at Pier 36 on the Lower East Side of Manhattan.

All of the above examples represent companies and projects that are still in the early stage of development and by themselves will not solve the EV charging problem in major cities, but they indicate that multiple projects are very much underway to address this issue.

Portable EV Charging

Another development that may play a role is the introduction of portable EV chargers by multiple companies.

Portable chargers - often referred to as Mobile chargers - are intended to offer EV owners a practical and adaptable charging option. Users can recharge their cars in a variety of settings, including homes, offices, and public parking lots. To meet multiple EV models and charging standards, portable chargers frequently come with varying power levels and connector types. They provide an alternative to fixed charging stations and can be used as a fallback in case of emergencies or when conventional charging infrastructure is not easily accessible. Some portable chargers can be purchased by the EV owner; in other cases, they are provided as a service “on demand”

Here's a quick look at the units offered by 3 companies in this space.

- **SparkCharge** - The Roadie Portable is a mobile DC fast charger. SparkCharge also offers a mobile Charging-as-a-Service (CaaS) program which brings the chargers to the vehicle’s location.

- **Zip Charge** -The Go is sold to EV owners. The GoHub is a modular, portable public charging station that can be installed on a footprint the size of a parking space with either a single-sided 5-port charger or double-sided 10-port charger, with the option to power the units via solar panels.

- **Blink** - The Blink mobile charger is built to provide emergency charging for stranded electric vehicles. The gas-powered charger is rated at 32 amps and delivers 0.5 to 1 mile of range per minute. (Blink also has about 66,000 standard charging ports installed across 27 countries).

Additional Developments That Should Make a Difference

- Vehicle range is growing significantly for Electric Vehicles and is expected to continue to do so. That enables the cars to travel much further before they need to be charged. While it will clearly take longer to get a full charge, the longer range should still help in terms of less competition for chargers (It should also reduce range anxiety and help accelerate EV sales).

- Chargers – including both Level 2 and Level 3 – are getting faster and can also be expected to continue to do so – as cars are also modified to enable faster charging. (My first Level 2 home charger purchased more than 11 years ago delivered 20-25 miles per hour of range; the current 4-year-old charger delivers 30 – 40. (A different car accounts for some of the difference).

- More and more charging stations are being installed at hotels, where guests stay overnight, and at restaurants and shopping centers where a user may be staying an hour or more. There are also units being installed at supermarkets where the visit may be shorter but still meaningful in terms of the charging range that can be added. (Interestingly, approximately 82% of gas pumps are currently located at convenience stores, with another 4% located at big-box retailers. In this case, the major motivation is to generate higher revenue for the owner of the fueling facilities).

- As alluded to earlier, companies whose role is to monitor and maintain EV chargers are entering the market. Tesla has demonstrated that it is possible to keep problems to a minimum; with 3rd party help other charger networks should also be able to significantly reduce charger downtime. A term that I have seen used for this is *Reliability as a Service* - where third parties provide regular charging station inspections, perform basic maintenance, and alert operators to additional service needs, for a monthly fee.

- We may also see greater management of the charging infrastructure from entities that lease space to charging network operators, such as retailers and municipalities. While there has been reluctance to play this role, increasing complaints from users about unreliability may force their hands. And the business model deployed with the supplier of the charging stations may allow greater charging revenue to flow to the owners of the space.

- There is finally at least one app – Plug Share - that intends to show all public charging locations across the country, making it much easier for EV users to find convenient locations to charge. This app allows users to comment on their experiences. I expect more apps to follow.

- Finally, while it has been a long time coming, we are beginning to see evidence of 2-way charging, that will enable vehicle-to-grid charging similar to solar-to-grid. This will enable owners of charging stations – including home charger owners - to generate revenue from their investments. While this may introduce scheduling issues for public and shared chargers it should also speed up the roll-out of charging stations. The vast majority of chargers today cannot perform 2-way charging, a handful can, including Fermata Energy, show below.

Bottom Line

There are clearly some challenges with the current EV charging infrastructure. The expected rapid growth of the electric vehicle fleet in the US will only exacerbate the challenges. And, as noted by many observers, the growth of the EV vehicle fleet is inextricably linked with the performance of the EV charging fleet, so there is a bit of a chicken and egg issue. A large number of analysts are predicting that the type of growth needed for EV chargers is going to be extremely hard to achieve.

Despite the challenges, as outlined here there is good reason for optimism. The number of required chargers is probably not as high as many analysts state – assuming we are able to address the performance issues we are currently seeing with the non-Tesla networks. There are considerable federal dollars available from the BIL for building out the infrastructure, along with tax breaks and resulting rebates available as a result of the IRA. And money is also being made available at the state level.

In addition to continued expansion of networks by EV charging providers it appears that EV auto manufacturers will be playing a major role as well. Multiple car companies will be challenging Tesla – but at the same time Tesla is opening up its network to non-Tesla vehicles which will have an extremely positive impact. Utilities, major fleet operators, larger retailers, travel stop operators, and more have begun to build out the charging infrastructure. Third parties have gotten into the act of supporting the installation and operation of both public and private networks. Continued enhancements to charging, battery, and EV technology in general will play a major role in addressing the shortcomings currently being experienced with the charging infrastructure. And utilities are continuing to work on building out their grid infrastructure to support both renewable energy and the growing energy demand of vehicle charging.

It is often forgotten that when gasoline-powered automobiles began to expand all over the US there were hardly enough gas stations to effectively support them – but that has clearly changed. EVs have the added advantage of being able to charge at home or at work and rarely need a public charger if a private one is available. So, while a lot of work is still required to build out an effective EV charging network, there are many signs pointing to the ability to make that readily happen over the coming years.