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# Electric Vehicle Sales and the Charging Infrastructure Required Through 2035

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# EXECUTIVE SUMMARY

Since the Edison Electric Institute's (EEI's) last electric vehicle (EV) forecast in 2022, the EV market has accelerated rapidly. The first major milestone of one million cumulative EV sales was achieved in 2018, more than eight years after the introduction of the first mass market EVs in late 2010. Nearly three years later, the next milestone of two million in cumulative sales was achieved in mid-2021. In 2023, sales set another milestone with more than 1.4 million EVs sold in a single year, bringing the cumulative sales total to nearly 4.8 million.

Customers continue to purchase EVs in record numbers, and electric companies are working with stakeholders to make the transition to EVs seamless for all drivers. Automakers are continuing to respond to customer demand by developing more EV models, including both plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), that increasingly are cost-competitive with their internal combustion engine (ICE) counterparts.

The Infrastructure Investment and Jobs Act (IIJA) is critical to the continued acceleration of EVs. IIJA is the largest investment in infrastructure since the New Deal, and it contains several provisions for electric transportation including up to $7.5 billion in funding for EV charging infrastructure, $5 billion for electric school buses, and $5.6 billion for electric transit buses. A lack of charging infrastructure often is cited as a primary barrier to EVs becoming more widely adopted. The funding from IIJA allocates unprecedented EV charging investment to many areas of the country, which is fundamental to the growth of the market. Alongside this public investment, automakers and third-party charging providers are rushing to install charging infrastructure to meet demand and capture market share.

Unlike conventional vehicles, which typically refuel only at gas stations, EVs may charge at many different locations, including at home, at work, or in public spaces. Today, customers have access to various types of charging equipment, which often are referred to as a charging station or a charging port.

For the purposes of this paper, a charging station refers to a site with one or more chargers and a charging port is a plug on that charger that delivers electricity into a vehicle battery. A charger may have more than one port, and charging equipment comes in a variety of types and configurations, but generally is categorized by power level.

The data provided in this paper forecasts through 2035 and details new insights into the anticipated wave of EV sales and the infrastructure needed to support that projected growth.

This consensus forecast is based on four independent forecasts and concludes that:

- The **stock of EVs** (i.e., the number of EVs on U.S. roads) is projected to reach **78.5 million in 2035**, up from 4.5 million at the end of 2023 (see Figure 1). This is more than 26 percent of the nearly 300 million total vehicles (cars and light trucks) expected to be on U.S. roads in 2035.
- **Annual sales of EVs will be nearly 12.2 million in 2035**, reaching nearly 72 percent of annual total light-duty vehicle sales in 2035 (see Figure 2). In 2030, annual EV sales are projected to reach 7.7 million and account for nearly 46 percent of total light-duty vehicle sales. This is more than a 2 million increase in annual EV sales compared to projections in EEI's 2022 forecast.

The availability of EV charging infrastructure also is fundamental to the growth of EVs.

Based on the EEI forecast, we estimate that:

- **More than 42.2 million charge ports will be needed** to support the projected 78.5 million EVs that will be on U.S. roads in 2035. This includes Level 2 (L2) chargers at homes, workplaces, and in public as well as DC fast chargers (DCFC).
- Approximately **325,000 DCDCFC ports will be needed** to support the level of EVs projected to be on the road in 2035.

DCFC stations are key to reducing range anxiety for EV travel and to providing fast, convenient charging for individuals who lack access to dedicated parking that can be equipped with a charger. America's electric companies are making significant investments to expand access to EV charging, including investing more than $5.3 billion in charging infrastructure and other EV programs.

**Figure 1. EEI Forecast of EV Stock: 78.5 Million EVs on U.S. Roads in 2035**

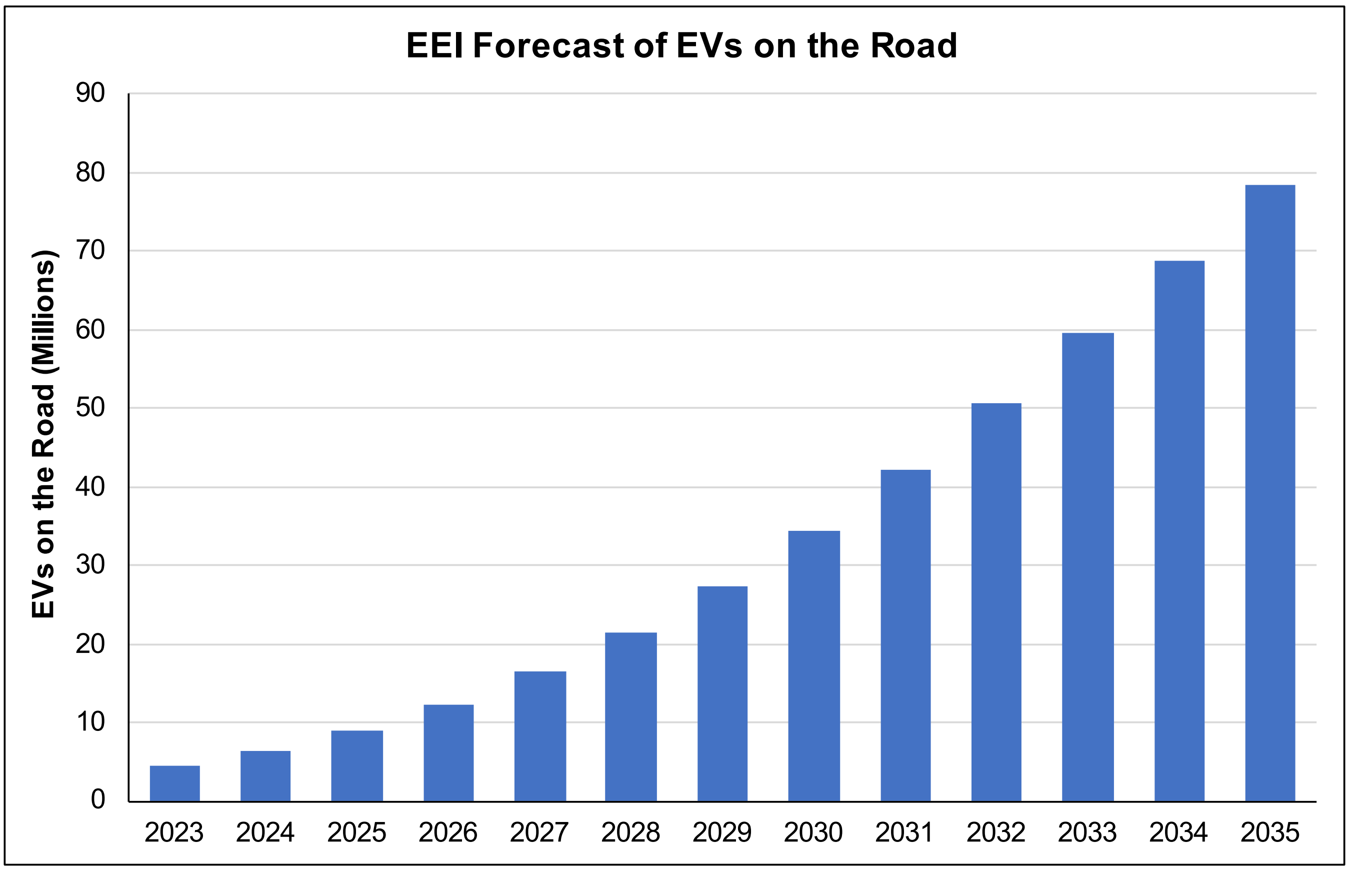
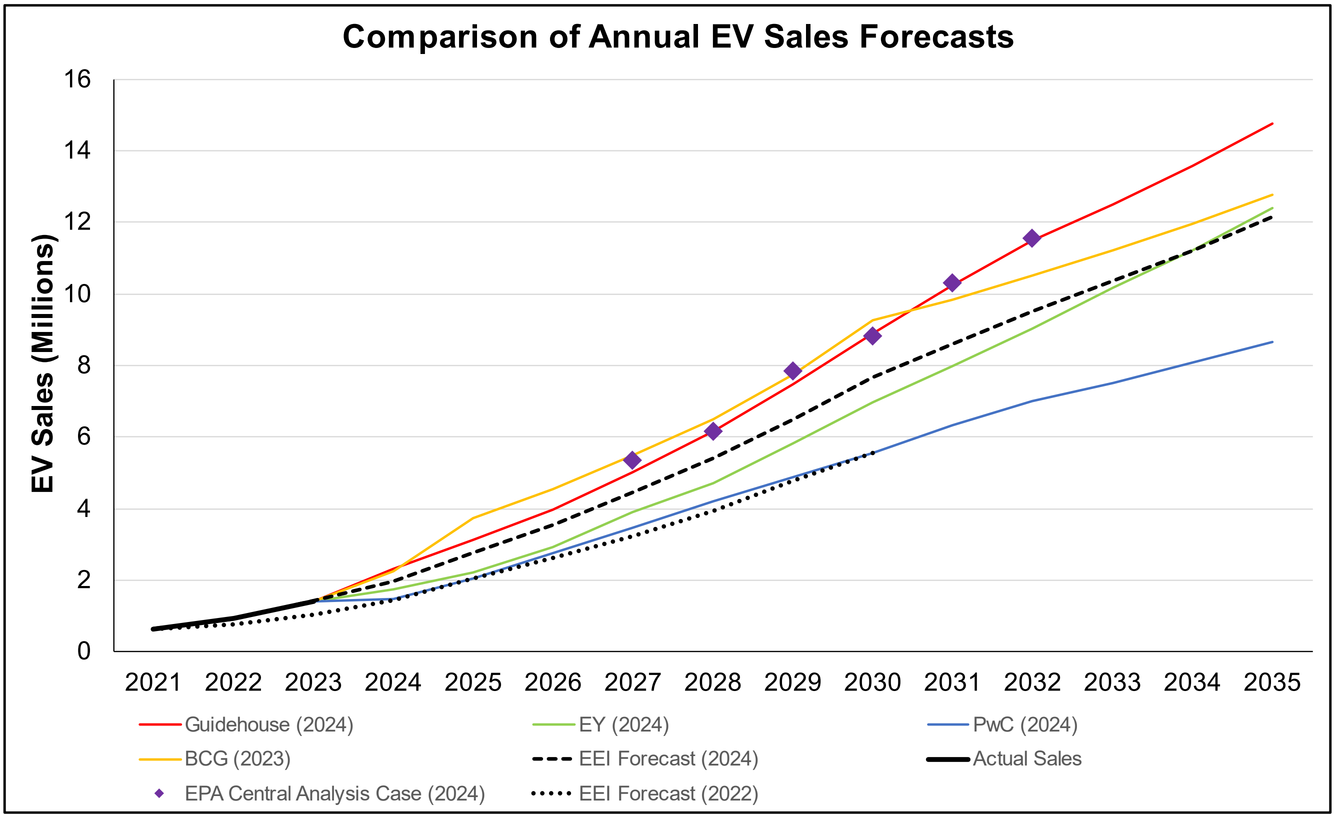


**Figure 2. EEI Annual EV Sales Forecast: Nearly 12.2 Million Annual EV Sales in 2035**



# Electric Vehicle Forecast

## Approach

Consistent with EEI's 2022 analysis, we developed a consensus forecast of EV sales projections from 2023 to 2035 based on four independent forecasts:

- Guidehouse – Guidehouse Insights: PEV Sales by Region, World Markets (Q1 2024).[1]
- Boston Consulting Group (BCG) – A Tale of Two Tomorrows in EV Sales (September 2023).[2]
- PwC – Electric Vehicle Charging Market Growth through 2040 (May 2024).[3]
- EY – Mobility Lens Forecaster (May 2024).[4]

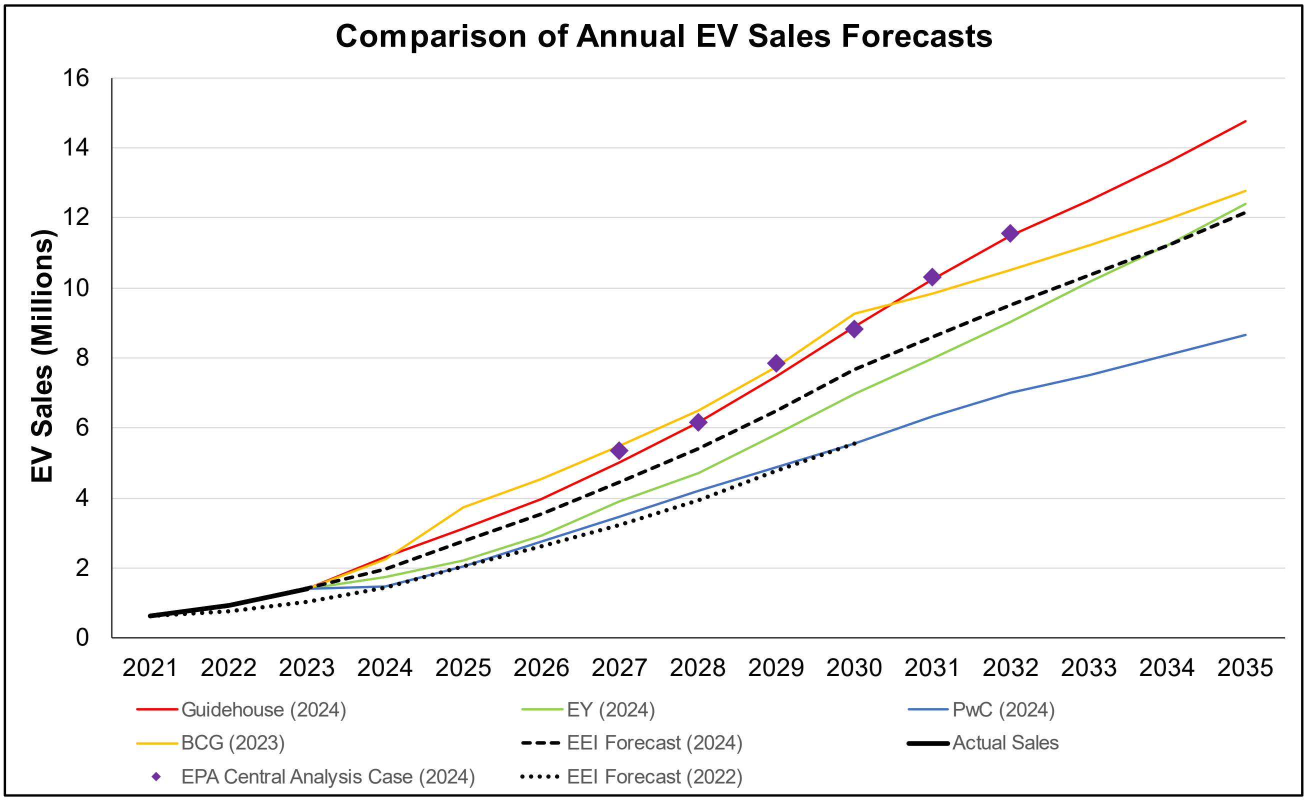
These forecasts were selected because they include three key factors: customer preference models that determine interest in EVs; declining battery costs that influence EV cost competitiveness with ICE vehicles and manufacturer profitability; and fuel efficiency standards and environmental regulations. In cases where forecasts reported EV sales in terms of percent of total U.S. auto sales, EEI applied that percentage to estimated total auto sales for that year to determine an EV sales figure. The 2023 forecast from BCG did not report sales figures for all years and missing data was estimated based on the relative increase in sales from previous BCG forecasts.

The forecasts provided by each of the sources listed above were the most up-to-date available, but due to the rapidly evolving market and regulatory landscape, forecasts may not reflect the most recent developments as of the publication date. The potential impact of policy on the EV market is discussed further below.

EEI forecasts nearly 12.2 million annual EV sales in 2035, which results in more than 78 million total EVs on U.S. roads in 2035 (see Figure 3 for annual EV sales).

1. Guidehouse. Market Data: EV Geographic Forecast – North America. https://guidehouseinsights.com/reports/market-data-ev-geographic-forecast-north-america.
2. A Tale of Two Tomorrows in EV Sales. Boston Consulting Group. https://www.bcg.com/publications/2023/exploring-divergent-futures-of-ev-sales
3. PwC. U.S. Electric Vehicle Charging Market Growth. https://www.pwc.com/us/en/industries/industrial-products/library/electric-vehicle-charging-market-growth.html
4. Mobility Lens Suite. EY. May 2024. https://www.ey.com/en_us/industries/automotive/mobility-lens-suite

**Figure 3. EEI Annual EV Sales Forecast Compared to Selected Forecasts: 12.2 Million in Annual Sales in 2035**




## Policy, Market, and Technology Factors to Consider

Two of the key considerations for the rapid development of the EV market are the evolving policy landscape in the United States and continued technological advancement. Since EEI's forecast in 2022, there have been significant new developments in both federal and state policy aimed at advancing transportation electrification. In terms of technological advancement, we continue to see the manufacturing of less expensive batteries with higher storage capacity. New investments in emerging technologies such as solid-state batteries are particularly promising.

### *Federal and State Policy Drivers*

Policy developments at the federal and state levels that could impact the U.S. EV market between now and 2035 include:

- **Vehicle standards:** The U.S. Environmental Protection Agency (EPA) finalized its companion greenhouse gas regulation in March 2024 that covers model years 2027 through 2032.[5] These standards require increasingly stringent greenhouse gas emissions from vehicles through 2032, which are likely only to be met through the increased production and sales of EVs. However, the standards are less stringent than originally proposed and offer multiple pathways for automakers to achieve compliance including increased production of mild hybrids, which use small batteries that are powered by the vehicle's engine, rather than BEVs or PHEVs. For comparison to the consensus

5. U.S. Environmental Protection Agency. "Final Rule: Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles." July 3, 2024, https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-multi-pollutant-emissions-standards-model

estimate, EPA's central analysis case for EV sales is presented in Figure 3.

The U.S. Department of Transportation (DOT) issues its own standard on fuel economy and, in June 2024, updated the Corporate Average Fuel Economy (CAFE) standards for light-duty vehicles to require an industry-wide fleet average of 50.4 miles-per-gallon in model year 2031.[6]

- **Federal Policy Shifts:** The above regulations from both EPA and DOT were both promulgated under the current Biden administration which has passed numerous laws and regulations, including the IIJA and the Inflation Reduction Act (IRA), which support a nationwide transition to EVs. However, these rules could be altered under a different administration and their effect on the auto market over the long term is uncertain.
- **State Level Policy:** Under the Clean Air Act, California has a waiver to set emissions standards that are more stringent than federal standards. With this authority, California has passed the Advanced Clean Cars II regulations requiring all new vehicles sold in California to be zero-emission by 2035. Other states can adopt these more stringent regulations in place of the federal standard. Eleven states have done so as of this publication. If more states were to follow this standard, total EV sales and growth rate of the EV market could be higher.
- **Tariffs and Buy America Requirements:** In May 2024, the Biden Administration announced substantial new tariffs on Chinese-made EVs and EV components including batteries and critical minerals.[7] These tariffs significantly raise the cost of both batteries and EVs that are manufactured in China. The tariffs aim to foster the development of an EV and battery supply chain within the United States and shield U.S. automakers from potentially anti-competitive trade practices. In addition, the IRA requires that 60 percent of an EV battery must be assembled and manufactured in the United States and 50 percent of the critical minerals must be extracted or processed in the United States for EVs to qualify for tax credits of up to $7,500.[8] These figures are for 2024, but they will increase by 10 percent annually through 2029 for battery assembly and through 2027 for critical minerals.[9] However, the supply chains for EV components, particularly for batteries, are not yet well developed outside of China[10] and could put upward price pressure on American-made EVs in the short term.

The EEI forecast is not driven exclusively by these policies. Customer demand and other market conditions that are driving EV sales will be present even if these policies are weakened. However, the policies stated above could alter the trajectory of EV sales in the near term.

### *Battery Costs Trending Down*

Declining battery costs and are helping to bring down the costs of EVs and accelerate sales. Cost reductions in battery packs enable longer-range EVs, increase cost-competitiveness with ICE vehicles, and result in automobile manufacturers producing a wider variety of EVs across more vehicle segments to better meet customer demand.

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6. U.S. Department of Transportation, National Highway Traffic Safety Administration. "Corporate Average Fuel Economy." June 7, 2024, https://www.nhtsa.gov/laws-regulations/corporate-average-fuel-economy
7. The White House. "FACT SHEET: President Biden Takes Action to Protect American Workers and Businesses from China's Unfair Trade Practices." May 14, 2024, https://www.whitehouse.gov/briefing-room/statements-releases/2024/05/14/fact-sheet-president-biden-takes-action-to-protect-american-workers-and-businesses-from-chinas-unfair-trade-practices/
8. H.R. 5376 - 117th Congress (2021-2022): Inflation Reduction Act of 2022, August 16 2022, https://www.congress.gov/bill/117th-congress/house-bill/5376/text
9. See *Ibid*
10. International Energy Agency. "Global EV Outlook 2024." April 2024, https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-vehicle-batteries

- Between 2013 and 2023, battery pack costs declined by more than 82 percent in real terms. Bloomberg New Energy Finance estimated average battery pack costs in 2023 at $139 per kilowatt-hour (kWh).[11]

Since our most recent forecast in 2022, battery supply chain issues have largely resolved and the temporary increase in battery prices has reversed. Manufacturing costs continue to decline with new advancements in battery design and the price of many raw materials used in battery manufacturing has decreased. In addition to manufacturing advancements, automakers and battery manufacturers are exploring the use of different battery chemistries like lithium-iron-phosphate and sodium-ion batteries, which rely on less expensive minerals.[12] The long-term projections of continued decreases in battery cost have not changed. Experts predict battery costs will continue to drop, reaching approximately $70 per kWh in 2030.[13]

### *Battery Technology Advancements*

Advancement in battery technology is continuing to take place across multiple fronts. In addition to continued refinements in existing battery technology, several companies are demonstrating entirely new battery technologies that are capable of significant increases in energy density at reduced costs. In particular, solid-state battery technology could result in EV batteries that are more stable, lighter, longer lasting, and capable of faster charging compared to current EV batteries.[14] Provided they can be priced competitively with current battery technologies, solid-state batteries would bring a multitude of benefits for EVs including increased range resulting from lighter batteries and decreased charging time, both of which could alleviate range anxiety which remains a top concern for potential EV buyers.[15]

- Volkswagen,[16] Ford,[17] GM,[18] BMW,[19] Toyota[20], and Nissan[21] all have announced significant investments or partnerships with solid-state battery companies, with Nissan planning on launching its first solid-state battery EVs by 2029.

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11. Bloomberg. "Lithium-Ion Battery Pack Prices Hit Record Low of $139/kWh." November 26, 2023, https://about.bnef.com/blog/lithium-ion-battery-pack-prices-hit-record-low-of-139-kwh/
12. International Energy Agency. "Global EV Outlook 2024." April 2024, https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-vehicle-batteries
13. Goldman Sachs, "Lower battery prices are expected to eventually boost EV demand." February 29, 2024, https://www.goldmansachs.com/intelligence/pages/even-as-ev-sales-slow-lower-battery-prices-expect.html
14. Mark Crawford. "Solid-State Batteries Drive the Future of the EV Market." The American Society of Mechanical Engineers, February 2022, https://www.asme.org/topics-resources/content/solid-state-batteries-drive-the-future-of-the-ev-market.
15. AAA. "EV Consumer Sentiment Survey." November 20, 2023, https://newsroom.aaa.com/2023/11/annual-electric-vehicle-sentiment-survey/
16. Volkswagen Group. "PowerCo and QuantumScape Announce Landmark Agreement to Industrialize Solid-State Batteries." July 11, 2024, https://www.volkswagen-group.com/en/press-releases/powerco-and-quantumscape-announce-landmark-agreement-to-industrialize-solid-state-batteries-18494
17. Ford. "Ford Boosts Investment in Solid Power, Aiming to Accelerate Solid-State Vehicle Battery Development for Customers." May 3, 2021, https://media.ford.com/content/fordmedia/fna/us/en/news/2021/05/03/ford-boosts-investment-in-solid-power.html.
18. Rebecca Bellan. "GM partners with startup SolidEnergy Systems to pack more energy in its batteries." TechCrunch. March 11, 2021, https://techcrunch.com/2021/03/11/gm-partners-with-startup-solidenergy-systems-to-pack-more-energy-in-its-batteries/
19. Solid Power. "Solid Power and BMW Deepen Joint Development Partnership." December 21, 2022, https://www.solidpowerbattery.com/investor-relations/investor-news/news-details/2022/Solid-Power-and-BMW-Deepen-Joint-Development-Partnership/default.aspx
20. Aditi Shah. "Toyota to roll out solid-state battery EVs globally in a couple of years." Reuters. January 11, 2024, https://www.reuters.com/business/autos-transportation/toyota-roll-out-solid-state-battery-evs-couple-years-india-executive-says-2024-01-11/
21. Jon Fings. "Nissan plans to launch its first solid-state battery EV by 2028." Engadget. April 8, 2022 https://www.engadget.com/nissan-solid-state-battery-ev-release-date-182025167.html.

### *Fleet Electrification*

The above projections are focused on the light-duty vehicle market but do not necessarily account for increasing rates of fleet electrification. Fleet sales for light-duty vehicles make up approximately 15 percent of annual auto sales, though that figure drops to roughly 7 percent when excluding purchases from auto rental agencies[22].

For many use cases, EVs already provide savings over the lifetime of the vehicle compared to ICE vehicles. This cost savings potential, in combination with corporate environmental goals and state regulations, has begun to attract many major fleets to transition to EVs. As EV technology improves and costs continue to decrease, the economics of electrification will drive more commercial fleets to electrify[23], likely at a much faster rate than the broader market.

- **Federal Fleet Electrification:** The federal government fleet is the largest in the United States, comprising more than 650,000 vehicles. The Biden administration announced, via executive order, a goal to make all light-duty vehicles purchased for the federal fleet electric by 2027 with all vehicle purchases electric by 2035.[24] This includes the United States Postal Service, which has plans to deploy at least 66,000 electric delivery vehicles by 2028.[25]

- **Commercial Fleet Electrification:** Early movers in the commercial fleet electrification space have primarily been for last-mile delivery services like Amazon, which already has deployed more than 15,000 electric delivery vans with a total goal of 100,000 by 2030.[26]

- **Ride Hailing Companies:** Uber and Lyft collectively account for 99 percent of the U.S. ride-hailing market and both companies have committed to be zero-emission in the United States in 2030.[27,28,29] Several million drivers provide ride-hailing services for Lyft and Uber, which could account for a substantial increase in EV sales in the near term while also creating increased demand for charging infrastructure.

- **Medium- and Heavy-Duty Electrification:** Although it's outside the scope of this analysis, transportation electrification is not just limited to light-duty vehicles. The largest producers of medium- and heavy-duty vehicles, Daimler Truck North America, Volvo, and Navistar all have committed to electrifying their vehicle offerings. These companies, along with partners from across

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22. Martin Romjue, "2023 Fleet Vehicle Soar Past 2 Million Mark." Automotive Fleet, January 3, 2024, https://www.automotive-fleet.com/10213124/2023-fleet-vehicle-sales-soar-past-2-million-mark
23. Sarah Chauhan, et al. "Why the economics of electrification make this decarbonization transition different." Mckinsey, January 30, 2023, https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/why-the-economics-of-electrification-make-this-decarbonization-transition-different
24. The White House. "FACT SHEET: President Biden Signs Executive Order Catalyzing America's Clean Energy Economy Through Federal Sustainability." December 8, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/08/fact-sheet-president-biden-signs-executive-order-catalyzing-americas-clean-energy-economy-through-federal-sustainability/.
25. USPS. "U.S. Postal Service Unveils First Postal Electric Vehicle Charging Stations and Electric Delivery Vehicles." January 22, 2024, https://about.usps.com/newsroom/national-releases/2024/0122-usps-unveils-first-postal-electric-vehicle-charging-stations-and-electric-delivery-vehicles.htm
26. Amazon. "Everything you need to know about Amazon's electric delivery vans from Rivian." July 10, 2024, https://www.aboutamazon.com/news/transportation/everything-you-need-to-know-about-amazons-electric-delivery-vans-from-rivian
27. Kinshuk Chatterjee. "How Policymakers Can Help Electrify Ride-Hailing Services." Center For Sustainable Energy. April 10, 2024, https://energycenter.org/thought-leadership/blog/how-policymakers-can-help-electrify-ride-hailing-services
28. Uber. "Sustainability." Accessed June 2024, https://www.uber.com/us/en/about/sustainability/?uclick_id=e6da7f2c-77a9-4aa3-947c-22eb87bec76d
29. Tom Vanderbilt. "Inside Lyft's Quest To Get Drivers To Adopt EVs." Lyft. March 27, 2023, https://www.lyft.com/blog/posts/inside-lyfts-quest-to-get-drivers-to-adopt-evs

the fleet and EV charging landscape, recently launched the Powering America's Commercial Transportation (PACT) Coalition, focused on accelerating the deployment of accessible and reliable infrastructure for zero-emission medium- and heavy-duty vehicles.[30] The electrification of these vehicles could add substantial demand for additional public charging infrastructure.

30. PACT Coalition. Accessed July 2024, https://www.pactcoalition.org/

# Charging Infrastructure Needed to Support EV Market

The availability of EV charging infrastructure is fundamental to the growth of EVs. Unlike conventional vehicles, which typically refuel only at gas stations, EVs may charge at many different locations, including home, work, or in public spaces.

Charging equipment is needed to deliver electricity from the energy grid to an EV and comes in a variety of types and configurations. Generally, it is categorized by power level:

- **Level 1 (L1)** chargers use 120-volt, alternating current (AC) power. L1 charging refers to chargers that use conventional electric outlets that a driver may plug into via a charging cord that typically is included with an EV. L1 charging adds approximately 3 to 4 miles of electric range per hour.
- **Level 2 (L2)** chargers use 240-volt, AC power. L2 chargers typically are mounted on a wall or on a pedestal. L2 charging at home typically requires the installation of a 240-volt circuit, the same as would be used for a household clothes dryer. L2 charging adds approximately 10 to 20 miles of electric range per hour of charging. For this analysis, we assume that all workplace and public locations use Level 2 charging.
- **DC Fast Chargers (DCFCs)** convert AC electricity to direct current (DC) and deliver charge to the vehicle at high power, typically anywhere from 50 to 350 kilowatts (kW). DCFCs are intended to add a substantial charge to an EV in a short amount of time (e.g., charging a battery to 80 percent capacity in 15-45 minutes, depending on battery size and charger power level). For this analysis, we assume DCFCs are used only at public DCFC stations at power levels of 150 to 350 kW and are only available for use by BEVs.

An important additional distinction for charging infrastructure is how it is tabulated. In general, there are three ways in which locations that provide EV charging are referred to in this report:

- **Charging Station**: A charging station is a location that hosts charging equipment for use by the public. A charging station is similar to a gas station in that it refers to the piece of land or business where charging equipment is located. Charging stations often have multiple chargers available for use.
- **Charger**: For the purposes of this report, a charger is either wall-mounted or a free-standing charging cabinet capable of charging one or more EVs.
- **Charging Port**: A charging port is a plug on a charger that sends electricity into a vehicle battery. A charger may have more than one port.

Table 1 summarizes the EV charging infrastructure locations, charging equipment type, and available charging time considered in this analysis. This analysis limits consideration to these major categories for simplicity.

**Table 1. EV Charging Equipment by Location**

| Location | Charging Type Considered | Charge Time |
|---|---|---|
| Home (single and multi-family homes) | Level 1, Level 2 | Overnight (approx. 12 hours) |
| Workplaces | Level 2 | Workday (approx. 8 hours) |
| Public Level 2 | Level 2 | Approx. 2+ hours |
| Public DC Fast Charging | DCFC | Approx. 30 minutes |

Home EV charging generally is the most convenient for those who have access to a dedicated parking space with proximity to electricity. Public charging infrastructure is important for EV owners who do not have dedicated home charging. Having charging infrastructure available at workplaces or in public settings provides a convenient charging option for EV owners and increases their confidence in driving electric. Public DC fast charging infrastructure, in particular, is critical for enabling long-distance EV travel and enabling use cases like ride-hailing, which may require multiple quick charging sessions per day.

## Modeling the Charging Infrastructure Needed to Support EV Growth in 2035

EEI used the Department of Energy's Electric Vehicle Infrastructure Toolbox (EVI-X) as well as the National Renewable Energy Laboratory's (NREL's) report, "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure,"[31,32] to estimate the amount of EV chargers needed to support the projected 78.5 million EVs on the road in 2035. The EVI-X modeling suite is a set of tools that are a simplified, publicly accessible version of models developed by NREL to estimate the demand for EV charging infrastructure. The tools estimate the number of charging ports needed within a city or state and along highway corridors to support a given EV population based on vehicle travel patterns as well as EV and charging station characteristics. The tool allows users to adjust key assumptions, such as the mix of BEVs versus PHEVs and the amount of charging done at home.

Since our last analysis in 2022, NREL has made significant upgrades to the EVI-X modeling suite. As the charging needs for daily commutes, highway travel, and ride-hailing differ substantially, NREL has developed and upgraded tools to separately model the charging needs for each distinct type of travel. Our analysis relies on the updated EVI-Pro Lite and EVI-Road trip tools to determine estimates for community charging and highway charging, respectively. The major assumptions used for the analysis are as follows:

- **EV Population:** The EVI-Pro Lite tool does not provide a national calculation option, so the results shown are the sum of the outputs for individual analyses of all 50 states and the District of Columbia. The 78.5 million EVs were allocated to states by applying historic and forecasted EV sales percentages for each state. For EVI-Road Trip, the tool only allows users to forecast EV charging needs based on EV penetration rate to the nearest 5 percent. To accommodate for this limitation, the calculated population of EVs in each state in 2035 was divided by the forecasted total population of vehicles and rounded to the nearest 5 percent.

- **Vehicle Mix:** The EVI-Pro Lite provides users with the option to change the vehicle mix between sedans, C/SUVs, pickups, and vans. The tool updates this vehicle mix based on information for each state and this analysis relied upon the default assumption provided by the tool. The EVI-Pro Lite tool also lets you choose the mix between BEVs, which rely solely on an electric motor powered by

31. U.S. Department of Energy Alternative Fuels Data Center. "Electric Vehicle Infrastructure Toolbox." Accessed June 2024, https://www.afdc.energy.gov/evi-pro-lite
32. Eric Wood, et al. "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure." NREL, June 2023, https://www.nrel.gov/docs/fy23osti/85654.pdf

batteries, and PHEVs which use both an electric motor powered by batteries and an internal combustion engine powered by gasoline. PHEVs have much smaller batteries than BEVs and are typically only able to travel 25-50 miles on electric power before switching to gasoline. PHEVs are also not typically capable of fast charging and can only make use of L1 and L2 charging. For this analysis, we assumed a vehicle mix of 10 percent PHEVs and 90 percent BEVs for our baseline scenario, consistent with the NREL 2030 National Charging Network report. We also explore the effect of higher PHEV penetration and report results for a vehicle mix of 15 percent PHEVs and 85 percent BEVs.

- **Support for PHEVs:** The EVI-Pro Lite tool allows users to select “partial” or “full” support for PHEV drivers. The full support option adds L2 chargers at workplaces and public locations, such that most PHEV trips can be completed on the electric range only, while the partial support option assumes more PHEV trips will be completed using the gasoline range once the electric range is depleted. This analysis chose the partial support option, consistent with research on the number of electric miles driven by PHEVs.[33] This assumption effectively decreases the number of L2 ports compared to the “full support” option.

- **Home Charging:** The EVI-Pro Lite tool allows users to set the percentage of EV drivers who have access to overnight charging at home and begin each day with a full charge. The most recent version of the tool incorporates research on the likelihood of access to home charging and updates the figure for home charging access for each state based on a given EV population.[34] Increased access to home charging would decrease the number of charging ports needed in other locations. For this analysis, we relied upon the default assumption provided by the tool. Though it is not reported in our figures, the tool provides an estimate of homes that will rely only on L1 charging, which is roughly 28 percent of total plugs for single- and multi-family homes.

- **Ride-Hailing Electrification**: Research indicates the travel patterns of ride-hail drivers along with the likelihood of reduced access to overnight home charging result in a much higher reliance on fast charging compared to the average driver.[35] To model the need for charging infrastructure to support ride-hailing electrification, NREL developed the EVI-On Demand tool which estimates charging infrastructure needs at the metropolitan area level. This tool is incorporated into EVI-Pro Lite, but is limited to a select number of larger metro areas in each state. To account for this limitation, this analysis relies upon the figure of DC fast chargers needed to support a 100 percent electrified ride-hailing fleet from the report “The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure.” This assumes that both major transportation network companies, Uber and Lyft, meet their goals of full electrification[36,37] by 2035 instead of 2030 and the population of ride-hail drivers does not substantially change between 2030 and 2035.

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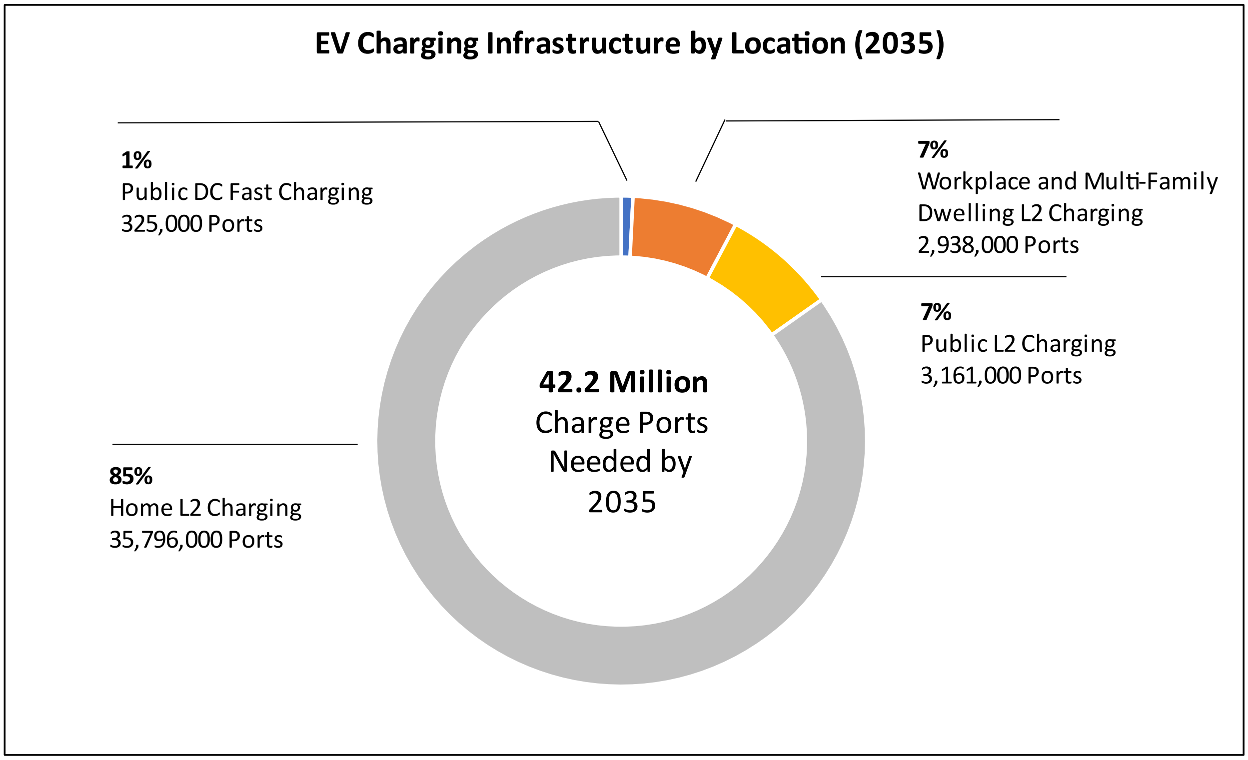
33. Patrick Plotz, et al. “Real World Usage of Plug-In Hybrid Electric Vehicles.” ICCT, September 2020, https://theicct.org/wp-content/uploads/2021/06/PHEV-white-paper-sept2020-0.pdf.
34. Yanbo Ge, et al. “There’s No Place Like Home: Residential Parking, Electrical Access, and Implications for the Future of Electric Vehicle Charging Infrastructure.” NREL, October 2021, https://www.nrel.gov/docs/fy22osti/81065.pdf.
35. Matthew Moniot, et al. “Estimating Fast Charging Infrastructure Requirements to Fully Electrify Ride-Hailing Fleets Across the United States.” *IEEE* Transactions on Transportation Electrification, vol. 8, no. 2, pp. 2177-2190, June 2022 https://ieeexplore.ieee.org/document/9714307
36. Uber. “Sustainability.” Accessed June 2024, https://www.uber.com/us/en/about/sustainability/?uclick_id=e6da7f2c-77a9-4aa3-947c-22eb87bec76d
37. Tom Vanderbilt. “Inside Lyft’s Quest To Get Drivers To Adopt EVs.” Lyft. March 27, 2023, https://www.lyft.com/blog/posts/inside-lyfts-quest-to-get-drivers-to-adopt-evs

## Analysis Results

Based on the EEI forecast, we estimate that approximately 42.2 million charge ports will be needed to support the 78.5 million EVs projected to be on U.S. roads in 2035. This includes 325,000 public DCFC ports, 2.9 million workplace and multi-family dwelling L2 ports, 3.1 million public L2 ports, and 35.8 million home L2 ports. The mix of charge ports by type is shown in Figure 5.

**Figure 4. EV Charging Infrastructure in 2035 Based on EEI Forecast**




## Charging Need in 2030 and the Continuing Buildout to 2035

Much of the literature regarding the need for charging infrastructure in the United States is focused on preparing for the EV population that will be on the road in 2030. Rather than add to the already numerous projections produced by organizations like the International Council for Clean Transportation, S&P Global, Atlas Public Policy, and NREL, our report focuses on the state of the EV charging market in 2035. Moreover, our consensus forecast predicts a total of 34.4 million EVs on the road in 2030, which aligns closely with the figure of 33 million EVs used by NREL in their most recent forecast.[38] Our methodology relies on the same tools that NREL used to derive their forecast and thus would produce a substantially similar result of a need for approximately 182,000 DCFC ports, 1 million public L2 ports, and 1 million workplace and multi-family dwelling L2 ports in 2030.

Our analysis demonstrates that, while much of the focus of the industry is on 2030, the end of this decade is not the finish line for EV charging infrastructure but closer to the start. As of August 2024, approximately 140,000 DCFC and 1.9 million L2 chargers will need to be installed between now and the end of 2030 to meet demand. This pace of EV charging installation would then need to be maintained between 2030 and

38. See *Ibid*

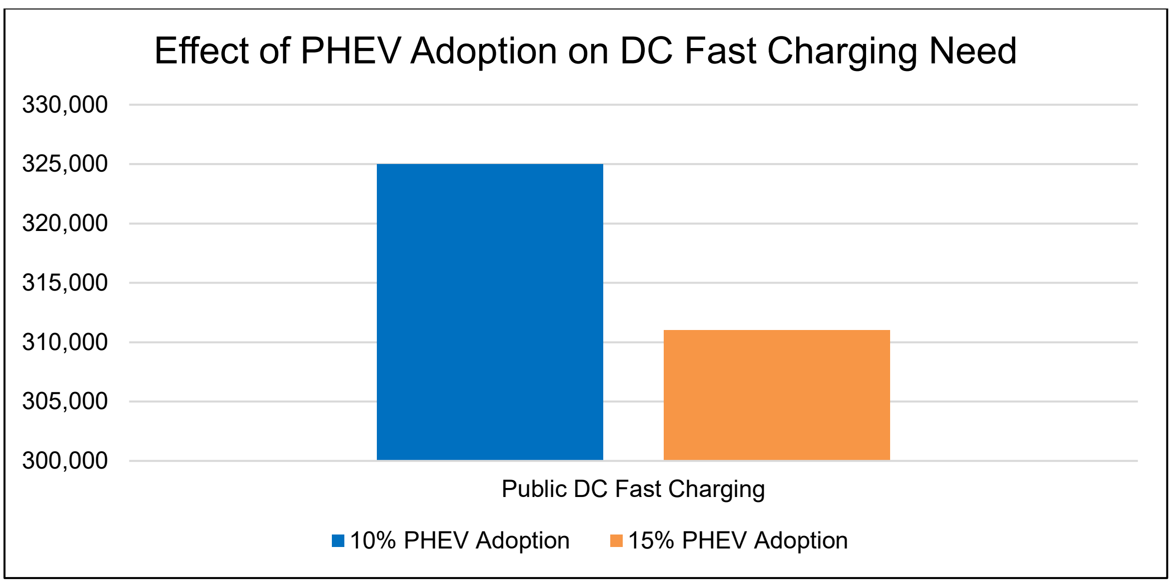
2035, highlighting the critical need to enable the rapid deployment of EV charging infrastructure today to meet the continuing needs of EV drivers through 2035 and beyond.

## Impact of PHEV Adoption

PHEVs currently are typically unable to utilize DC fast charging infrastructure and therefore do not add to the demand for public DCFCs, instead relying exclusively on L1 and L2 charging. In effect, a larger proportion of PHEVs in relation to BEVs reduces the need for DC fast charging infrastructure which, although it only represents roughly one percent of the total need for charging infrastructure, represents the vast majority of total EV charging investment.[39] Costs for L2 equipment and installation usually range in the thousands of dollars, while DC fast charging infrastructure typically costs tens to hundreds of thousands of dollars for each charge port. To assess the effect of PHEV penetration in 2035, our analysis examined the need for charging infrastructure under two scenarios, one with 10 percent PHEV adoption in 2035 and one with 15 percent PHEV adoption.

Under a 15 percent PHEV adoption scenario, DC fast charging infrastructure need is reduced by 4 percent compared to a 10 percent PHEV adoption scenario, a difference of 14,000 ports. While there is not a large absolute difference between the two figures, 14,000 ports is a substantial total in terms of investment. Though firm figures on cost-per-port are difficult to estimate given the site-specific nature of costs for charging infrastructure installation, it would likely represent a decrease of several billion dollars. These savings would be partially offset by an increase in L2 ports, but the net effect would likely be significant cost savings.

**Figure 5. DC Fast Charging Infrastructure Need in 2035**




## Approaches to Deploying EV Charging Infrastructure

The EV market is driven by many dynamics, including customer awareness and acceptance, the types of EVs available and their affordability, and the availability of charging infrastructure. It is well established that the

39. Eric Wood, et al. "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure." NREL, June 2023, https://www.nrel.gov/docs/fy23osti/85654.pdf

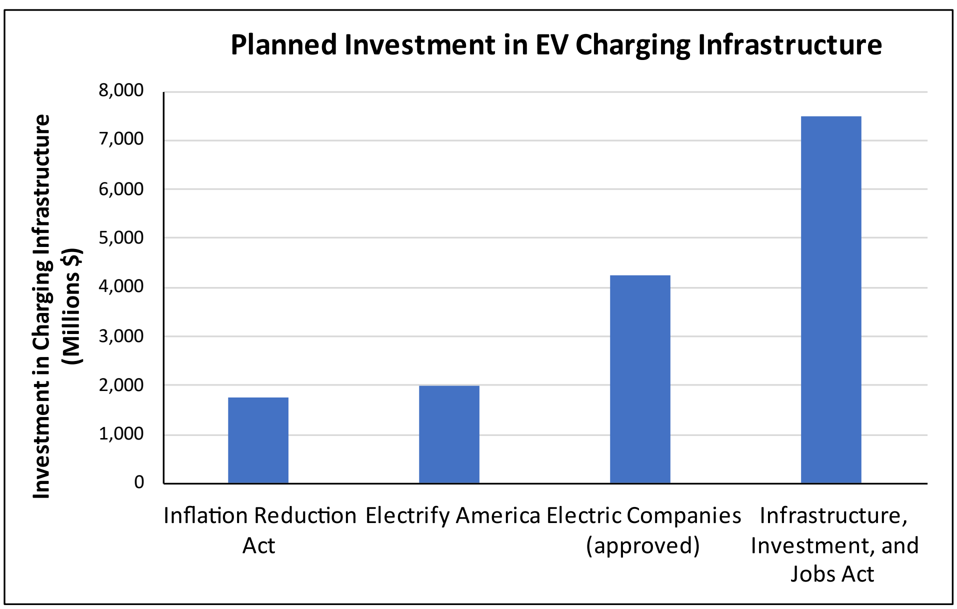
lack of EV charging infrastructure is a primary barrier to EV adoption.[40] The analysis using the EVI-Pro Lite tool in this report estimates the charging infrastructure needed to support a certain level of EVs. In this section, we discuss approaches for deploying EV charging infrastructure.

As of July 2024, approximately 134,000 public L2 charging ports and 44,000 DCFC ports are available in the United States.[41] The precise number of workplace L2 charging ports is unknown. Based on the EVI-Pro Lite tool results, as shown in Figure 4, more than 6 million charge ports in workplaces, multi-family dwellings, and public locations will be needed by 2035. The significant difference between the current availability of charging infrastructure and the expected charging infrastructure needed suggests a growing "infrastructure gap" that must be addressed.

One of the impediments to widespread charging infrastructure availability is the cost. The costs associated with EV charging infrastructure include the equipment itself, ongoing operation and maintenance costs, and the installation costs needed to get power to the charging station. These costs can vary widely, from a few hundred dollars to install a L2 charger at home to tens or hundreds of thousands of dollars to install a DCFC depending on power level.[42] Much of the EV charging infrastructure to date has been paid for by the customer or entity that hosts the charging equipment (the "site host"), whether that is a homeowner, a commercial property owner, or a public entity.

While the EV market is still in its early stages, state and federal funding is driving considerable investments in the deployment of a reliable, nationwide, publicly accessible charging network that enables easy EV travel. As the market has grown, private funding has come to be a leading source of investment as companies compete to provide services for drivers. Some of these funding sources are detailed below in Figure 6.

**Figure 6. Planned Investment in EV Charging Infrastructure**




40. Mare Melania, et al. "Consumer Convenience and the Availability of Retail Stations as a Market Barrier for Alternative Fuel Vehicles" NREL, January 2013, https://www.afdc.energy.gov/uploads/publication/56898.pdf.
41. U.S. Department of Energy Alternative Fuels Data Center. "Alternative Fueling Station Counts by State." Accessed July 2024, http://www.afdc.energy.gov/fuels/stations_counts.html
42. Margeret Smith, et al. "Costs Associated With Non-Residential Electric Vehicle Supply Equipment." U.S. Department of Energy. November 2015, https://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf.

- **Federal Government:** In November 2021, IIJA was signed into law and included significant funding for transportation electrification. The most significant portion of the law related to charging infrastructure is the NEVI formula program, which designates $5 billion for EV charging infrastructure along designated alternative fuel corridors.[43] EEI estimates the NEVI program will support approximately 30,000 DCFC ports at 7,500 sites, based on the average cost per site of approximately $680,000 that have been awarded as of July 2024.[44] This is likely a conservative estimate as it assumes that sites will install only the required minimum of 4 charging ports, though many are installing more. IIJA also includes up to $2.5 billion in funding for the deployment of charging infrastructure in communities and corridors, which could result in an additional 15,000 DCFC ports if that funding was used exclusively for DCFCs, though it will likely be split among L2 ports and stations for other alternative fuels. DOT will distribute these funds to states and local governments with federal oversight and advisory input from the Joint Office of Energy and Transportation.

  Separate from the direct grant funding included in IIJA, the IRA, which was signed into law in August 2022, included multiple new or expanded provisions to support electric transportation. Among these was the re-authorization of the Alternative Fuel Refueling Property Credit (30C), which allows developers of EV charging stations to claim up to a $100,000 tax credit for the installation of EV charging stations. The estimated value of the credit was $1.738 billion.[45]

- **Automakers:** Tesla has built a "Supercharger" network of approximately 26,000 DCFC ports at 2,300 locations in the United States dedicated to its vehicles.[46] However, the Tesla network no longer is exclusive to Tesla vehicles. In 2023, Ford, Audi, BMW, Hyundai, Kia, Volkswagen, Nissan, Honda, Toyota, Rivian, and Stellantis all announced that they will adopt the Tesla charger design known as the North American Charging Standard (NACS), enabling them to charge at Tesla supercharger sites.[47] Electrify America, a subsidiary of Volkswagen established as part of the diesel emissions settlement, is required to spend $2 billion over 10 years (2017-2027) to deploy charging infrastructure and related activities to support the EV market and aims to deploy 10,000 DCFC ports across the United States and Canada through 2025.[48,49] In 2024, BMW, GM, Honda, Hyundai, Kia, Mercedes, Stellantis, and Toyota joined together to launch the Ionna charging network which aims to deploy 30,000 charging ports by the end of 2030.[50]

- **Electric Companies:** Electric companies across the country are gaining state regulatory approval to invest in electric transportation. These investments are primarily in EV charging infrastructure deployment, which may include charging infrastructure for other applications (such as medium- and heavy-duty trucks and buses), as well as other market support activities such as customer education and outreach. As of July 2024, state public utility commissions have approved investments totaling more than $5.3 billion including more than $4.2 billion dedicated to charging infrastructure.

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43. U.S. Department of Transportation Federal Highway Administration. "National Electric Vehicle Infrastructure Formula Program." February 10, 2022, https://www.fhwa.dot.gov/bipartisan-infrastructure-law/nevi_formula_program.cfm.
44. Atlas Public Policy. "State Policy Dashboard." Accessed July 2024, https://www.atlasevhub.com/materials/state-policy-dashboard/
45. Atlas Public Policy, "The Inflation Reduction Act: EV Provisions." Accessed July 2024, https://www.atlasevhub.com/materials/the-inflation-reduction-act-ev-provisions/
46. U.S. Department of Energy Alternative Fuels Data Center, "Alternative Fueling Station Locator." Accessed July, 2024, http://www.AFDC.energy.gov/stations.
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48. Electrify America. "Our Investment Plan." Accessed July 2024, https://www.electrifyamerica.com/our-plan.
49. Electrify America. "Electrify America Announces its "Boost Plan" to More than Double its Current EV Charging Network by End of 2025." July 13, 2021, https://media.electrifyamerica.com/en-us/releases/149.
50. Ionna. "Vision." Accessed July 2024, https://ionna.com/.

- **Third-Party Charging Providers:** Charging providers like EVgo, EV Connect, and Blink are making significant investments in building out private charging networks with the goal of profiting from EV charging. This market has continued to see new entrants and the Alternative Fuels Data Center lists more than 50 companies who now provide charging services. Traditional fuel retailers such as 7-11, Buc-ees, Sheetz, and Circle K also are entering the market for EV charging. As EV adoption increases, the utilization of new and existing charging stations has been steadily increasing and bringing these independent charging providers closer to profitability. The Tesla supercharger network, the largest network of DCFCs in the United States by far, reportedly already is profitable and demonstrates the potential financial viability of the charging business model.[51] Ultimately, the full build-out of charging infrastructure in the United States and abroad likely will be driven by private investment.

- **National Electric Highway Coalition (NEHC):** In December 2021, EEI announced the formation of the NEHC, a collaboration among electric companies that share the common goal of deploying EV fast charging infrastructure along major U.S. travel corridors. Shortly after the formation of the NEHC, the NEVI program was established to fund the creation of a national network of charging stations. Members of the NEHC have been coordinating with state governments to identify sites where chargers can be deployed quickly and cost-effectively. Members of the NEHC also are helping to stretch those federal dollars further via incentive or rebate programs.

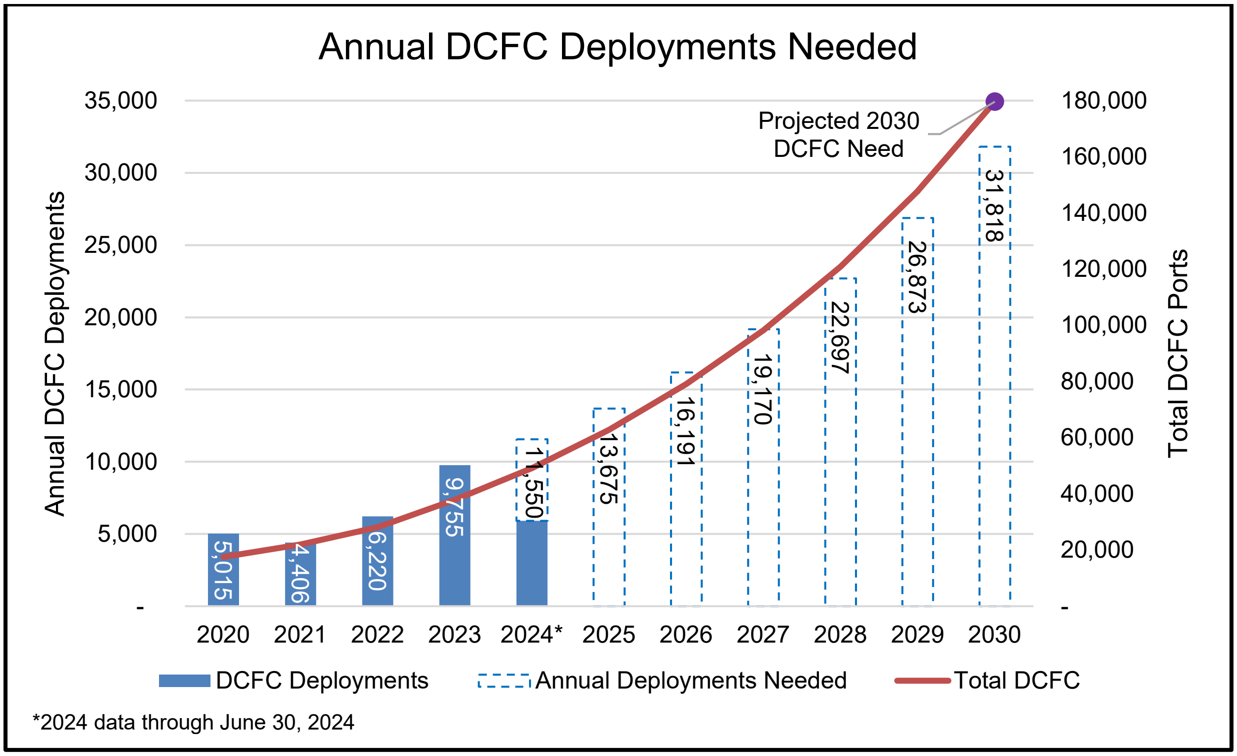
## DC Fast Charging Infrastructure Gap

Investment in all kinds of charging infrastructure, from home charging to high-powered DCFC stations, is necessary to support the number of EVs projected to be on U.S. roads in 2035. While DCFC ports only make up only approximately one percent of the EV charging infrastructure needed to support the projected number of EVs on U.S. roads in 2035, DC fast charging infrastructure is a particular focus for policymakers, third-party charging providers, and electric companies. These chargers are critical parts of the electric transportation ecosystem that allow vehicles to recharge rapidly, reaching 80 percent capacity in as few as 15 minutes depending on the power level of charging station and size of the EV battery. However, while DCFCs provide a faster charge, they are significantly more expensive to install than L2 chargers, often costing hundreds of thousands of dollars per charger.

DCFC stations are key to enabling long-distance EV travel, to increasing driver confidence, and to providing fast, convenient charging for individuals who lack access to dedicated parking. To adequately serve the coming wave of EVs, substantial and sustained investment in the buildout of DCFC stations is necessary. Despite the significant investments detailed in the section above, annual deployments of DCFCs will need to more than double to hit the figures needed by 2030. In 2023, approximately 9,800 DCFCs were installed in the United States. To meet the 2030 target of 182,000 DCFC ports, annual deployments beginning in 2024 would need to be at least 20,000. For the five years between 2030 and 2035, this figure would need to increase to an average of nearly 29,000 per year. While it is unlikely that DCFC deployments will double between 2023 and 2024, the target figure is achievable with an 18 percent year-over-year growth in deployments as shown in Figure 7.

51. EVANNEX. "Tesla Begins Showing Compelling Revenue Outside Its EV Business." *InsideEVs,* April 10, 2023, https://insideevs.com/news/661525/tesla-showing-revenue-outside-electric-car-business/ See also Ryan Fisher, "Tesla Has Built a Charging Business to Be Taken Seriously." *Bloomberg,* April 9, 2024, https://www.bloomberg.com/news/newsletters/2024-04-09/tesla-tsla-charging-network-has-become-a-serious-business

**Figure 7. Annual DCFC Deployments Needed to Meet 2030 Target**




This gap in DCFC ports also could narrow depending on several market factors including the adoption rate for PHEVs, pace of ride-hail electrification, home charging access, and advancement in battery technology. As explored previously, a higher mix of PHEVs will reduce the demand for DCFC, but that figure also will decrease if access to home charging is higher than forecasted. According to modeling from NREL, access to home charging had the greatest effect on the need for DCFC.[52] Advancements in battery technology that allow for longer vehicle ranges or faster charging speed also could reduce the need for DCFC by reducing the reliance on public charging for long road trips or increasing throughput at existing stations.

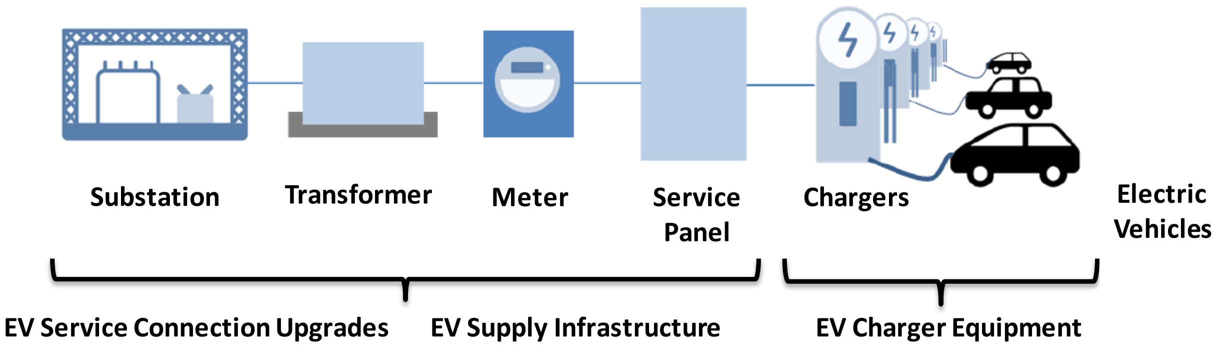
## Electric Company Role

Electric companies are well-positioned to deploy EV charging infrastructure, and the investments they are making in charging infrastructure may take many different forms, including:

- Developing "make-ready" infrastructure, which includes service connection upgrades and new supply infrastructure to bring power to the charging equipment (see Figure 9); the site host is responsible for procuring the actual charging equipment.
- Installing and owning all infrastructure up to, and including, the charging equipment itself. Either the electric company, the site host, or a third-party may operate and maintain charging equipment.
- Offering incentives, typically in the form of rebates, to defray some or all of the cost of the charging equipment and/or the installation costs.

52. Eric Wood, et al. "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure." NREL, June 2023, https://www.nrel.gov/docs/fy23osti/85654.pdf

**Figure 9. Illustration of EV Charging Infrastructure**




In addition, electric company investments can support the smart integration of EV charging load into the distribution grid in different ways, including:

- Offering electric rates that encourage EV charging at specific times of the day (e.g., at off-peak times).
- Requiring charging equipment associated with these programs to be ready for managed charging, such as being capable of receiving demand response signals.
- Helping to educate EV drivers and site hosts about different rate options and connecting them with charging equipment providers.

Studies have shown that increased adoption of EVs, when efficiently added to the energy grid, can provide benefits to all customers. The additional electricity demand from EVs added to the energy grid in a way that more fully utilizes existing infrastructure puts downward pressure on rates for all customers, providing benefits to drivers and non-drivers alike.[53]

## Planning for a Nationwide Buildout

Beyond directly supporting EV charging infrastructure deployment through direct investment, electric companies play a critical role in preparing the grid for the additional electricity demand from EV charging. Although the addition of EV charging does not represent an unprecedented growth in demand in terms of scale, it nonetheless can present hurdles for local upgrades needed to accommodate new electric demand. This is particularly true along highways where large new EV charging stations are needed for highway travelers.

Studies by electric companies such as National Grid and Xcel Energy have shown that, for some electric charging sites, the necessary upgrades to the energy grid should begin as soon as possible to accommodate projected demand in 2030.[54,55] In many cases, this will require a proactive approach to planning for EV

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53. See Synapse Energy, "Electric Vehicles Are Driving Electric Rates Down: June 2019 Update," https://www.synapse-energy.com/sites/default/files/EV-Impacts-June-2019-18-122.pdf ; See also Energy and Environmental Economics, "Cost-Benefit Analysis of Plug-in Electric Vehicle Adoption in the AEP Ohio Service Territory," https://www.ethree.com/wp-content/uploads/2017/10/E3-AEP-EV-Final-Report-4_28.pdf.
54. See National Grid, Electric Highways: Accelerating and Optimizing Fast-Charging Deployment for Carbon-Free Transportation, https://www.nationalgrid.com/document/148616/download
55. See Enterprise Mobility, Electrifying Airport Ecosystems: Act Now to Meet a Growing Demand, https://www.enterprisemobility.com/content/dam/enterpriseholdings/marketing/innovation-in-mobility/vehicle-innovation/airport-electrification-study-full-report-2024.pdf

charging including proactive investment in advance of formal service requests from charging providers. To help plan where these investments should take place, EPRI has launched its EVs2Scale2030 initiative, which brings together critical market stakeholders, including electric companies, fleets, public utility commissions, automakers, NGOs, and government agencies to create innovative new tools for understanding when, where, and how much EV charging will be needed. Enabling the national transition to EVs will take unprecedented coordination among these stakeholders, but will ultimately lead to a well-designed and efficiently deployed EV charging ecosystem and a seamless customer experience.

# CONCLUSION

With more than 78 million EVs anticipated to be on U.S. roads in 2035, the future of transportation increasingly looks to be electric. Customer demand for EVs remains strong and, with an increasing array of options each year and continually improving technology, will continue to grow.

The continued expansion of the U.S. EV market will make coordinated collaboration among all EV charging stakeholders, including policymakers, charging service providers, automakers, and electric companies, critical for ensuring a rapid, efficient buildout of necessary charging infrastructure. Most importantly, the gap in fast charging must be addressed via advanced planning tools and proactive investment in the energy grid.

Electric company participation in the development of EV charging infrastructure supports state-level clean energy and transportation goals, expands customer choice, and helps to ensure that EV owners will be able to charge their cars at home, on the street, at the office, at shopping locations, or along major travel corridors.

Electric transportation is a win-win-win that not only meets customer needs, but also provides economic and environmental benefits for communities across the country.

The **Edison Electric Institute** (EEI) is the association that represents all U.S. investor-owned electric companies. Our members provide electricity for nearly 250 million Americans, and operate in all 50 states and the District of Columbia. As a whole, the electric power industry supports more than 7 million jobs in communities across the United States. In addition to our U.S. members, EEI has more than 70 international electric companies, with operations in more than 90 countries, as International Members, and hundreds of industry suppliers and related organizations as Associate Members.

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