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Assessment of U.S. electric vehicle charging needs and announced deployments through 2032

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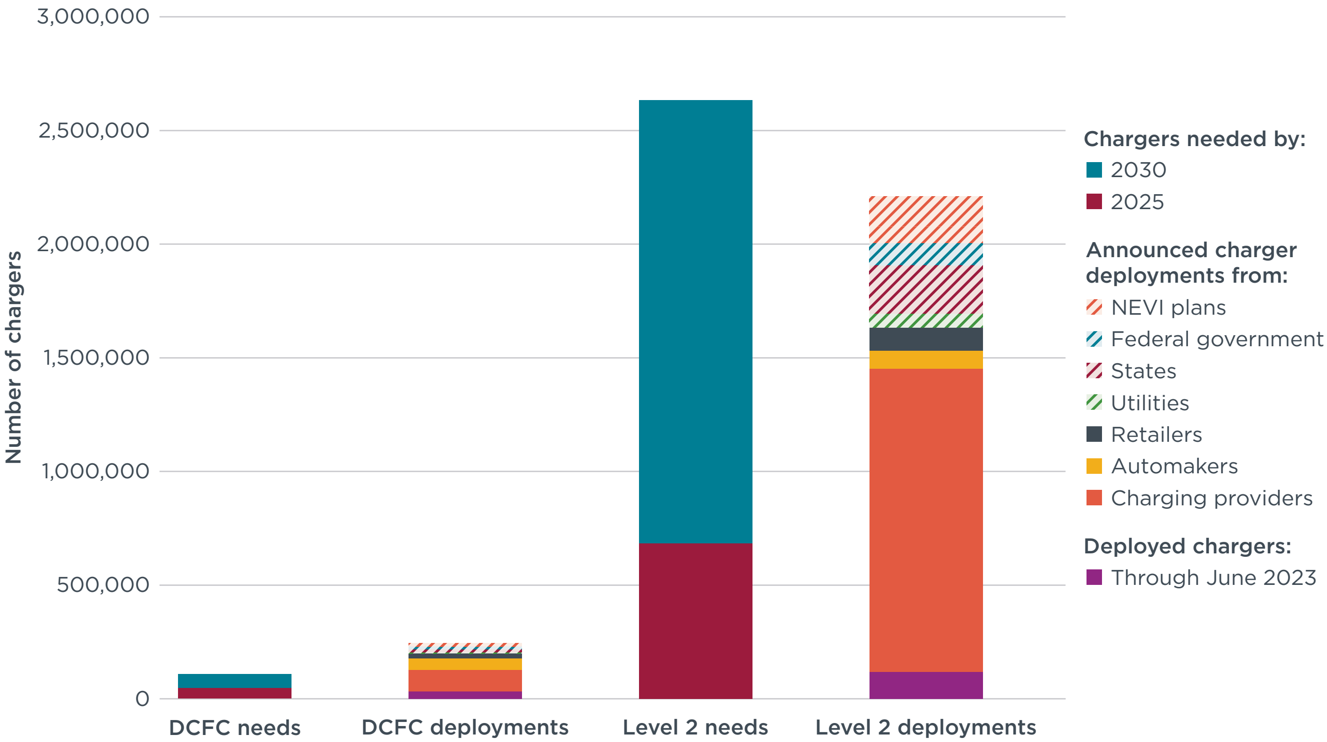
EXECUTIVE SUMMARY

New policies and proposed regulations in the United States aim to accelerate the transition to clean electric vehicles. The Inflation Reduction Act of 2022 allocates billions of dollars to climate and clean energy investments, including offering greatly expanded tax credits and incentives for zero-emission vehicles and their refueling infrastructure. In April 2023, the U.S. Environmental Protection Agency released its proposed rule for multi-pollutant emissions standards to be phased in over model years 2027 through 2032 for light-duty and medium-duty vehicles (U.S. Environmental Protection Agency, 2023). By the agency's estimates, the proposal is projected to lead to a new light-duty battery-electric vehicle (BEV) sales share of 67% in 2032 (Multi-Pollutant Emissions Standards, 2023). To meet the energy demands of a growing electric vehicle fleet, charging infrastructure deployment must keep pace. This paper analyzes the growth of U.S. light-duty BEV sales and the associated home, workplace, and public charging needs through 2032. We compare those charging needs with a detailed examination of more than 160 announcements—made by federal and state governments, charging infrastructure providers, automakers, retail companies, utilities, and other stakeholders—regarding charging deployments and investments in charging infrastructure.

Figure ES1 summarizes the key findings of this work. The figure shows our findings of how many public and workplace chargers will be needed by 2030 and compares this with the number of chargers that could be deployed by 2030, based on announcements by private and public stakeholders. This comparison shows that the number of public DC fast chargers (DCFCs) could exceed the need in 2030. For public and workplace Level 2 chargers, the announced deployments sum up to 62%–84% of the 2030 needs. The solid bars in Figure ES1 represent announcements by charging providers, automakers, and retailers. The hatched bars represent announcements of potential additional deployments by federal, state, and utility stakeholders. These are considered potential additional deployments because it is unclear whether these announcements may overlap with the announcements by private stakeholders.

Figure ES1

Non-home EV chargers needed by 2030 compared with announced deployments



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Our analysis leads us to three high-level conclusions:

Continued EV market growth requires continued charging deployment. Based on the U.S. Environmental Protection Agency's proposed multi-pollutant standards and our underlying analysis, there could be 55 million BEVs on the road in 2032. This BEV fleet will require about 3.7 million Level 2 chargers at workplace and public locations, 136,000 public DC fast chargers, and 40.1 million chargers at single-family and multifamily homes. Our estimate that approximately 3.8 million publicly accessible non-home chargers are needed by 2032 means that the number of public and workplace chargers deployed will need to increase by about 27% compounded annually from 2024. That's less than the 40% compounded annual rate of public and workplace charger growth between 2017 and 2022.

Millions of new chargers have been announced. Private and public stakeholders have announced plans to deploy millions of chargers by 2030. Our analysis of announcements by charging providers, automakers, and retailers shows that a total of 164,000 new DC fast chargers and 1.5 million new Level 2 chargers could be deployed at public locations and workplaces by 2030. About 20% of these chargers are included in announcements that provide explicit numbers on the types of chargers to be deployed. The other chargers come from nonspecific announcements that provide important information, such as the amount of money to be invested or the overall number of chargers to be deployed, but do not provide breakdowns by charger type. Additional announcements by the federal government, states, and utilities could lead to additional deployments of 47,000 DC fast chargers and 579,000 Level 2 chargers, although it is unclear whether these may overlap with announced deployments by private stakeholders.

Charging announcements cover a substantial share of the chargers needed by 2030. Existing and announced charging deployments by charging providers, automakers, and retailers cover about 182% of the needed public DC fast chargers and about 62% of the needed public and workplace Level 2 chargers in 2030. This amount of charging would provide about 39.2 GW of electrical capacity, which represents 96% of the non-home BEV charging capacity needed in 2030. Analysis of potential additional chargers from the federal government, states, and utilities, shows that the number of public and workplace chargers in 2030 could increase to more than 244,000 DC fast chargers and 2.2 million Level 2 chargers, which would represent about 225% of the needed DC fast chargers and 84% of needed Level 2 chargers. This amount of charging would provide about 47.2 GW of electrical capacity, which represents 115% of non-home BEV charging capacity needed in 2030.

These findings indicate that planned charging deployment in the United States is already on track to keep pace with charging needs by 2030. More announcements of additional charger installations are likely in the years ahead. If stakeholders fall short of their announced commitments, more chargers will continue to be needed.

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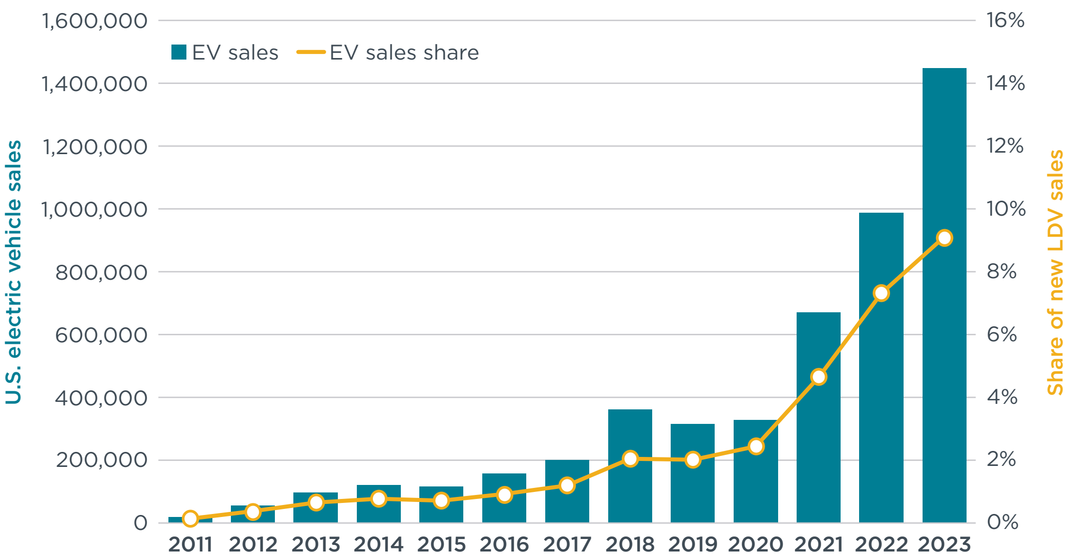
INTRODUCTION AND BACKGROUND

The transition to zero-emission vehicles in the United States continues to accelerate. In 2023, electric vehicles (EVs), which include plug-in hybrid electric vehicles and battery-electric vehicles (BEVs), accounted for about 9.1% of new light-duty vehicle (LDV) sales across the United States (EV-Volumes, 2024). Figure 1 depicts this acceleration of U.S. EV uptake, which has increased significantly from about 2.5% of new LDV sales in 2020 to about 4.5% in 2021, more than 7% in 2022, and about 9.1% in 2023. Over this same time frame, annual U.S. EV sales increased from about 330,000 in 2020 to about 650,000 in 2021, nearly 1 million in 2022, and about 1.4 million in 2023.

Figure 1

Annual U.S. light-duty electric vehicles sales and sales shares, 2011 through 2023



Source: EV-Volumes (2024)

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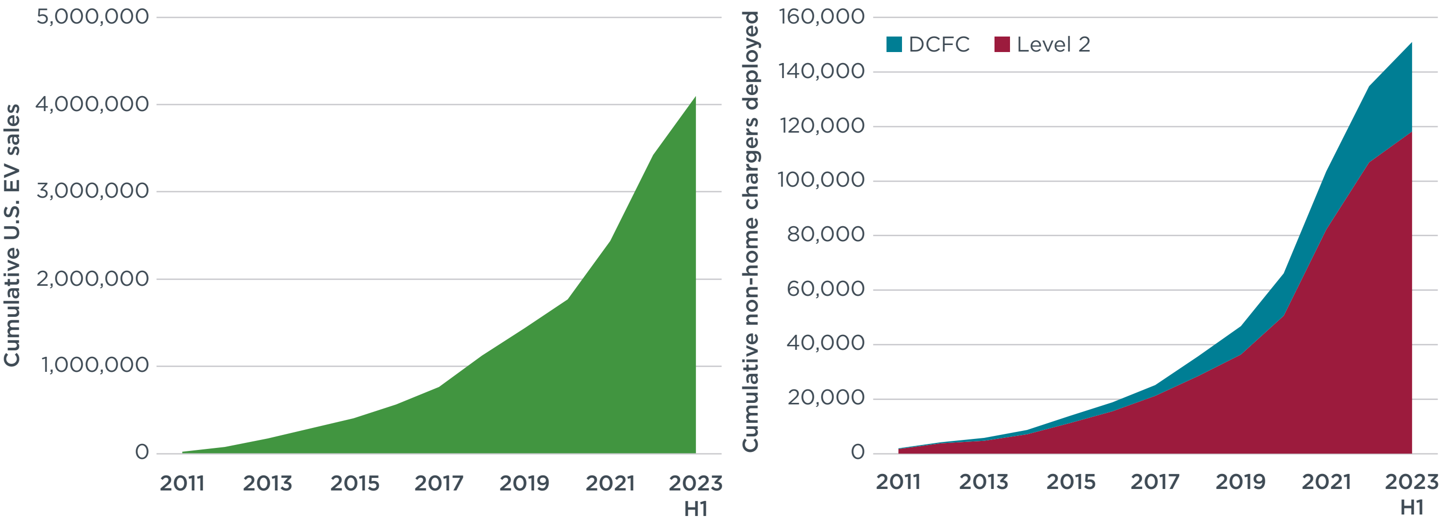
Electric vehicle market growth and charging infrastructure deployment occur in unison. Figure 2 shows cumulative EV sales and the cumulative number of non-home chargers (public chargers and publicly accessible workplace chargers) deployed in the United States through June 2023, based on data from EV-Volumes (2024) for sales and the U.S. Department of Energy's Alternative Fuels Data Center (n.d.-c) for chargers. More than 4 million light-duty EVs have been sold in the United States from 2011 through June 2023. The number of non-home chargers has grown from about 66,000 in 2020 to about 151,000 in June 2023, which indicates an acceleration in the growth of charging infrastructure. The June 2023 total includes about 118,000 Level 2 chargers (up from about 51,000 in 2020), 1,100 of which are workplace chargers, and about 33,000 DC fast chargers (up from about 16,000 in 2020), 30 of which are workplace chargers. The Alternative Fuels Data Center (AFDC) dataset identifies these workplace chargers as being available to the public as well as to employees.

Figure 2

Cumulative U.S. EV sales and deployment of non-home chargers, 2011 through June 2023



Sources: EV data from EV-Volumes (2024); charging infrastructure data from Alternative Fuels Data Center (n.d.-c)

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The AFDC charger counts include approximately 7,000 temporarily unavailable chargers. These are chargers that typically would be accessible to drivers but were categorized as unavailable at the time of downloading the dataset, perhaps due to charger maintenance. Charger reliability has been a well-documented issue (Rajon Bernard, 2023). To address this, the U.S. Department of Transportation awarded $150 million in grants in 2022 and 2023 to repair and replace broken and faulty chargers (Federal Highway Administration, 2024).

In April 2023, the U.S. Environmental Protection Agency (EPA) released its proposed rule for multi-pollutant emissions standards for model year 2027 and later light-duty and medium-duty vehicles. The standards are phased in over model years 2027 through 2032 (U.S. Environmental Protection Agency, 2023). This rule would deliver deep emission reductions. By the agency's own estimates, this rule could lead to a new light-duty BEV sales share of 67% in 2032 (Multi-Pollutant Emissions Standards, 2023). Given these regulatory developments, EV charging infrastructure deployment must accelerate to meet the changing needs of a growing U.S. light-duty EV fleet.

Several studies have assessed the demand for electricity and the number of chargers needed to support the expected numbers of EVs on U.S. roads in the coming years, but few have comparatively examined whether announced charger deployments to date will meet this demand. This paper analyzes whether there is a gap between the expected demand for EV charging infrastructure and the anticipated supply. To undertake this analysis, we first model the expected growth of the U.S. light-duty BEV fleet and associated charging needs through 2032, assuming that the EPA's proposed rule is implemented. We then research and compile information about planned deployments of charging infrastructure during the same time period. This information is based on public announcements made by a range of government and private entities about charging investments and deployments.

ASSESSMENT OF CHARGING INFRASTRUCTURE NEEDS THROUGH 2032

This section describes the methodology used to quantify the number and type of chargers needed in the United States through 2032. Later in the paper, the results of this analysis are compared with announced charging infrastructure investments.

METHODOLOGY

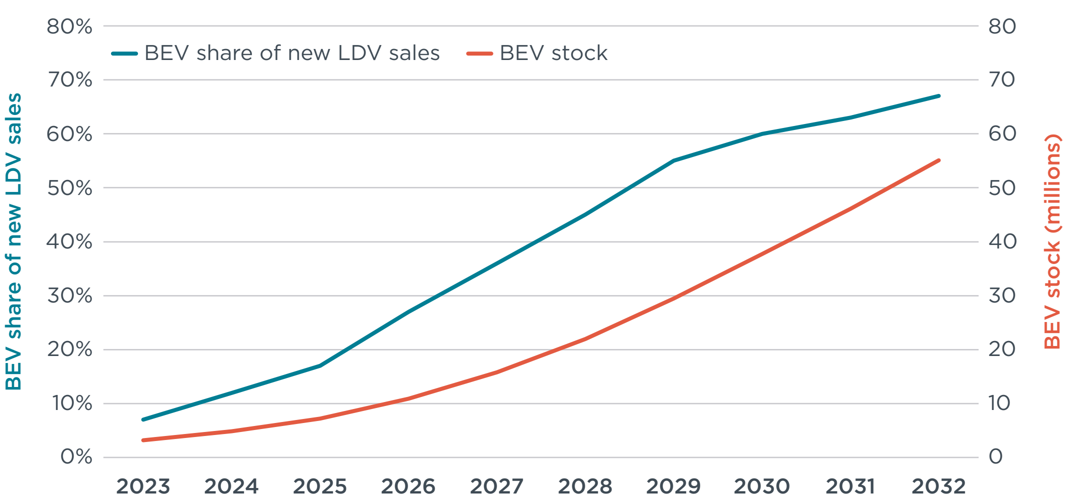
Our methodology to quantify charging infrastructure needs is separated into two steps. The first step defines the fleet transition scenario as the BEV market share increases nationwide, using the International Council on Clean Transportation's (ICCT) Roadmap Model (International Council on Clean Transportation, 2023a). In this model, we assume characteristics for BEVs in the U.S. passenger vehicle fleet which include, for example, annual travel patterns, market adoption curves, and technical specifications. The second step uses ICCT's EV CHARGE model to estimate charging needs based on the energy demand from the number of BEVs estimated in the first step, as well as assumptions on charger technical specifications and BEV drivers' charging behavior (ICCT, 2023b). Our inputs, assumptions, and results for each step are described below.

Fleet transition scenario

Figure 3 illustrates the assumed evolution of the U.S. BEV market from 2023 through 2032, based on the Roadmap model and applied in this analysis. The top line depicts the BEV share of new vehicle sales by year. The lower line depicts BEV stock—or the total number of BEVs in use—by year. The BEV market evolution shown in Figure 3 aligns with the annual projected light-duty BEV market penetrations in EPA's proposed multi-pollutant standards for model year 2027 and beyond (U.S. EPA, 2023). The proposal estimates that 67% of new LDV sales will be BEVs by 2032. We estimate that this BEV sales share would result in an estimated stock of 55 million BEVs in 2032, which would represent about 25% of all registered LDVs in that year.

Figure 3

Assumed BEV share of light-duty vehicles sales and total light-duty BEV stock, 2023 through 2032



Source: U.S. EPA, 2023, for sales share estimates

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To determine the energy demand of this BEV fleet, we estimate the fleet age-weighted average of annual vehicle miles traveled (VMT) and energy efficiency. EPA's MOVES3 model provides survival rates for LDVs by age (U.S. EPA, 2021). We apply these rates to historical light-duty BEV sales counts and to projected light-duty BEV counts from the Roadmap model to determine the age distribution of the BEV fleet in each year of the analysis. EPA's MOVES3 model also provides assumptions for annual VMT of light-duty cars and trucks by age based on NHTSA survey data (U.S. EPA, 2021). Average survival rates and annual VMT are assumed to be identical for BEVs and combustion vehicles. These data are applied to our BEV stock projections to determine the age-weighted VMT of the light-duty BEV fleet in each year of the analysis. Finally, we apply data on projected BEV efficiency by model year and vehicle class from ICCT's EV cost analysis to determine the age-weighted efficiency of the BEV fleet in each year of the analysis (Slowik et al., 2022). The mileage and efficiency of the fleet are then multiplied to determine the charging energy demand of the fleet.

Modeling of charging needs

This updated analysis of U.S. LDV charging needs follows the modeling methodology outlined in Rajon Bernard et al. (2023) for ICCT's EV CHARGE model (ICCT, 2023b). The analysis applies data specific to the U.S. charging market based on Bauer et al. (2021) with some important updates. Namely, we peg many of our assumptions to the BEV stock share of the LDV market rather than to specific years. Charging dynamics and light-duty EV fleet characteristics in this analysis—such as utilization, home, and workplace charging access, and the share of BEVs that are used for commuting or that reside in various housing types—are linked to the size and growth of the EV market. This analysis of charging needs is focused on passenger vehicles and does not assess charging needs for fleet vehicles such as light commercial vehicles, ride-hailing vehicles, or medium-duty vehicles. Similarly, our compilation of charging deployment announcements does not include announcements related to light commercial vehicles, ride-hailing vehicles, or medium-duty vehicles.

Light-duty EV charging infrastructure is classified into three main types: Level 1, Level 2, and direct current (DC) fast charging. Level 1 and Level 2 chargers use slower alternating current (AC). Level 1 chargers provide 1 to 2 kW of power and up 5 miles per hour of charge. This type of charger typically is used only at homes via a standard 120V household outlet. Level 2 chargers provide 3 to 19 kW of AC power and up to 50 miles per hour of charge, depending on the current rating of the charger and the accepted current rating of the EV. DC fast chargers (DCFCs) can offer 50 kW to 350 kW of power, allowing for a much faster charge that provides well over 100 miles per hour of charge.

The EV CHARGE model takes the BEV fleet outputs from the Roadmap model and groups vehicles into several different cohorts. These cohorts are defined by drivers' access to types of charging infrastructure and on assumptions of the amount of energy supplied by each charging type, both based on surveys about BEV drivers' charging behavior (ICCT, 2023b). The types of chargers assessed include home, workplace, public Level 2, and public DC fast chargers. Home chargers are located at private residences, either at single-family homes or multifamily homes such as apartment buildings. Workplace chargers are located at workplaces and are intended for employees who commute to work. Public Level 2 and public DC fast chargers are in a variety of locations and are publicly accessible or accessible via a membership subscription. We consider several use cases for public chargers, which include overnight, destination, and en-route chargers. Public overnight chargers are Level 2 chargers located in residential locations to serve EV drivers without home charging; they are used the most frequently as a substitute for a private home charger. Public en-route chargers are DC fast chargers located alongside highways and are used to support long-distance trips. Public destination chargers are either Level 2 or DC fast chargers in any public location other than highways or residential areas.

Access to home and workplace charging—or the lack of it—is a significant factor affecting charging behavior and points to the need for public charging infrastructure. Vehicles spend long periods parked at home or work, which allows time for slower, cheaper, and more convenient charging. Among early EV adopters, about 70%–80% of charging occurs at home or work (Fuels Institute, 2021). Home charging access is closely related to housing type. Single-family homes are more likely to have off-street parking and the easiest access to charging (Pierce & Slowik, 2022). We follow the trajectory in Bauer et al. (2021) to estimate that 88% of BEV drivers in 2023 live in single-family homes and 12% live in multifamily homes or other housing types. As the BEV market expands, we expect the housing patterns of BEV drivers to approach the national housing patterns of all LDV owners, so that 82% of BEV drivers will live in single-family homes by 2029 while 18% live in multifamily homes or other housing types. Similarly, workplace charging access is related to whether BEVs are used for commuting. We again follow the trajectory from Bauer et al. (2021) to estimate that 76% of BEVs are used for commuting in 2023. The percentage of BEVs used for commuting will converge toward the nationwide average for all vehicles so that 56% of BEVs will be commuter cars in 2029.

As the EV market expands, more drivers without access to home charging will increase the demand for workplace, public Level 2, and public DC fast charging. As such, we expect the percentage of EV drivers with home charging access to gradually decline in the near term across all housing types. We estimate that 90% of BEV drivers who live in single-family homes have home charging access in 2023, declining to 82% in 2032. Likewise, we estimate that 55% of BEV drivers who live in multifamily homes have access to home charging in 2023, but 44% have access in 2032. These estimates are based on a study on home charging access by the National Renewable Energy Laboratory (Ge et al., 2021). In contrast, workplace charging is expected to increase as the EV market expands. We estimate the percentage of BEV drivers with workplace charging access to increase from 35% in 2023 to 55% in 2032 (Bauer et al., 2021). For BEV drivers with workplace or home charging access, we estimate that at least 70% and up to 90% of their energy demand will be met at either or both locations, with the rest coming from public Level 2 or public DC fast charging.

Increased demand for non-home charging also means increased utilization of non-home chargers. Utilization is defined as the amount of time per day a charger is actively in use and supplying energy. Following the approach in Bauer et al. (2021), we apply a logarithmic relationship to our new BEV stock share projections to estimate charger utilization during the period of this analysis for public Level 2, public DC fast, and workplace chargers. Table 1 provides an overview of the charger types and their characteristics which is applied in this analysis. The final column shows the daily utilization assumptions for different charger types by year applied, which generally increase from about 2–5 hours per day in 2025 to about 2–6 hours per day in 2032, depending on the use case (ICCT, 2023b).

Table 1

Overview of light-duty EV charger characteristics applied in this analysis

Charger type	Nominal power output	Potential locations	Estimated electric range per hour of charging	Estimated hours utilized per day
Home	Level 1 1.9 kW	Single-family and multifamily homes	5 miles	5.1 hours (2025) 4.2 hours (2030) 4.1 hours (2032)
Home	Level 2 7.2 kW	Single-family and multifamily homes	20 miles	2.0 hours (2025) 1.7 hours (2030) 1.6 hours (2032)
Public overnight	Level 2 7.2 kW or 14 kW	Residential location	20–40 miles	5.0 hours (2025) 5.6 hours (2030) 5.7 hours (2032)
Public destination	DCFC 50 kW, 150 kW, or 350 kW	Shopping center, hotel, downtown curbside, etc.	180 miles or more	3.0 hours (2025) 4.8 hours (2030) 5.2 hours (2032)
Public destination	Level 2 7.2 kW or 14 kW	Shopping center, hotel, downtown curbside, etc.	20–40 miles	3.0 hours (2025) 4.8 hours (2030) 5.2 hours (2032)
Public en-route	DCFC 150 kW or 350 kW	Highway rest stop, highway charging station	180 miles or more	3.0 hours (2025) 4.8 hours (2030) 5.2 hours (2032)
Workplace	Level 2 7.2 kW or 14 kW	Office, transit hub	20–40 miles	3.8 hours (2025) 4.4 hours (2030) 4.5 hours (2032)

This analysis defines and applies average characteristics for different use cases of public overnight, destination, and en-route chargers. However, in practice EV drivers will use charging infrastructure as needed and there will likely be an overlap in how chargers are used. If average daily charger utilization increases at a slower rate than what we model here, the number of required workplace and public chargers would be higher than our estimate. Conversely, if daily utilization increases more rapidly than what we model, each charger will be able to serve more EVs and the number of required workplace and public chargers would be lower than our estimate.

For DC fast charging, we consider three different nominal power ratings (i.e. charging speeds), depending on the use case: 50 kW, 150 kW, and 350 kW. DC fast charging speeds are known to fluctuate depending on the state of charge of the battery while charging, ambient conditions, and the technical limitations of the vehicle. The average DC fast charger power output during a charging session is therefore often less than the rated power. As battery and charging technology improves and EV drivers better understand their vehicle's capabilities, EVs will achieve average power output that is closer to the nominal rated power of chargers. We consulted new studies on charge acceptance curves (i.e. power output vs. state of charge) and technical specifications from a diverse set of EVs to estimate the average power output or power delivery ratio (i.e. actual power delivered divided by nominal power rating) for each DC fast charger speed analyzed (Hackmann, 2022). Based on this research, we assume a 75% power delivery ratio for a 50-kW charger in 2023, which improves to 86% by 2032; a 65% ratio for a 150-kW charger in 2023, which improves to 76% by 2032; and a 50% ratio for a 350-kW charger in 2023, which improves to 65% by 2032.

For public and workplace Level 2 charging we consider two nominal power ratings: 7.2 kW and 14 kW. Level 2 charging requires converting AC power from the Level 2 charger—via the EV's on-board charger—to DC power to charge the battery. This limits the power entering in the battery pack. As on-board charger technology improves, more vehicles will be able to accept higher power from Level 2 chargers. As such, we assume that workplace and public destination Level 2 chargers have an 80% power delivery ratio in 2023, which improves to 88% by 2032. Public overnight chargers are assumed to have 80% power delivery ratio for all years of the analysis.

As EV technology improves, we also expect that chargers with lower power ratings will become decommissioned over time, to be replaced by higher-rated chargers that better match the vehicle technical specifications of a newer EV fleet. Likewise, we anticipate that in each subsequent year a greater share of newly installed chargers will have higher power ratings. Table 2 shows the share of newly installed chargers by rated power for each charger type in 2023 and 2032; shares increase or decrease linearly between 2023 and 2032. For example, we estimate that 64% of newly installed public destination DC fast chargers in 2023 are rated at 50 kW, 35% are rated at 150 kW, and 1% are rated at 350 kW. By 2032, 33% of newly installed public destination DC fast chargers are rated at 50 kW, 61.5% are rated at 150 kW, and 5.5% are rated at 350 kW.

Table 2
Assumed share of newly installed chargers by type and rated power in 2023 and 2032

Charger type (Level)	Share of newly installed chargers in 2023 (nominal power)	Share of newly installed chargers in 2032 (nominal power)
Workplace (Level 2)	60% (7.2 kW), 40% (14 kW)	46% (7.2 kW), 54% (14 kW)
Public overnight (Level 2)	70% (7.2 kW), 30% (14 kW)	53% (7.2 kW), 47% (14 kW)
Public destination (Level 2)	90% (7.2 kW), 10% (14 kW)	72% (7.2 kW), 28% (14 kW)
Public destination (DCFC)	64% (50 kW), 35% (150 kW), 1% (350 kW)	33% (50 kW), 61.5% (150 kW), 5.5% (350 kW)
Public en-route (DCFC)	55% (150 kW), 45% (350 kW)	41% (150 kW), 59% (350 kW)

We combine the estimations of charger utilization and power to determine the amount of energy supplied by each charger of each type. We then quantify the number of chargers required to meet the estimated charging demand for each charger type in each year of the analysis.

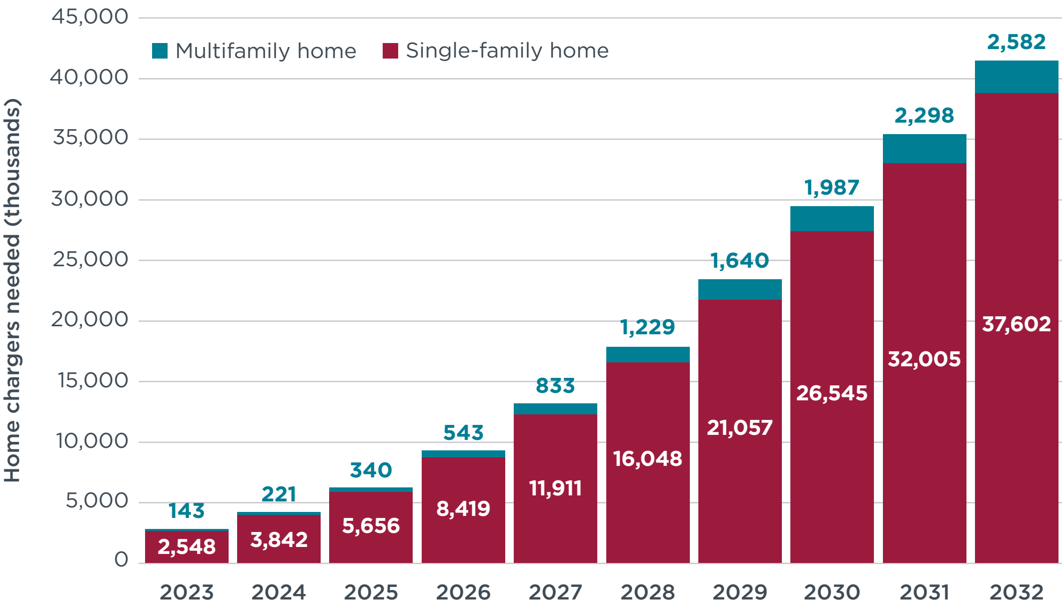
RESULTS

This section summarizes the projected need for home chargers and non-home chargers by year based on our EV CHARGE modeling. Throughout this paper, the term "charger" is synonymous with an EV charging port as defined by the AFDC (n.d.-a): one charger can charge one EV at a time. We are using the term *non-home* to refer collectively to workplace chargers, public Level 2 chargers, and public DC fast chargers. We compare our estimates of projected needs with the results of a previous ICCT analysis of the U.S. charging gap and with other recent assessments of U.S. charging infrastructure needs.

Figure 4 shows the estimated number of home chargers needed across the United States from 2023 to 2032, broken down by single-family home and multifamily home chargers. The need at single-family homes increases from about 2.6 million chargers in 2023 to 37.6 million in 2032. At multifamily homes, the need increases from about 140,000 chargers in 2023 to about 2.6 million in 2032. The analysis assumes that the relative number of Level 2 home chargers will increase to meet the increased demand from larger EV batteries or multiple EVs at homes. In 2023, 35% of home chargers at single-family and multifamily homes are Level 1; this share decreases to 17% in 2032. Level 2 chargers make up the remaining 83% of home chargers in 2032.

Figure 4

Projected need for home chargers across the United States, 2023 through 2032



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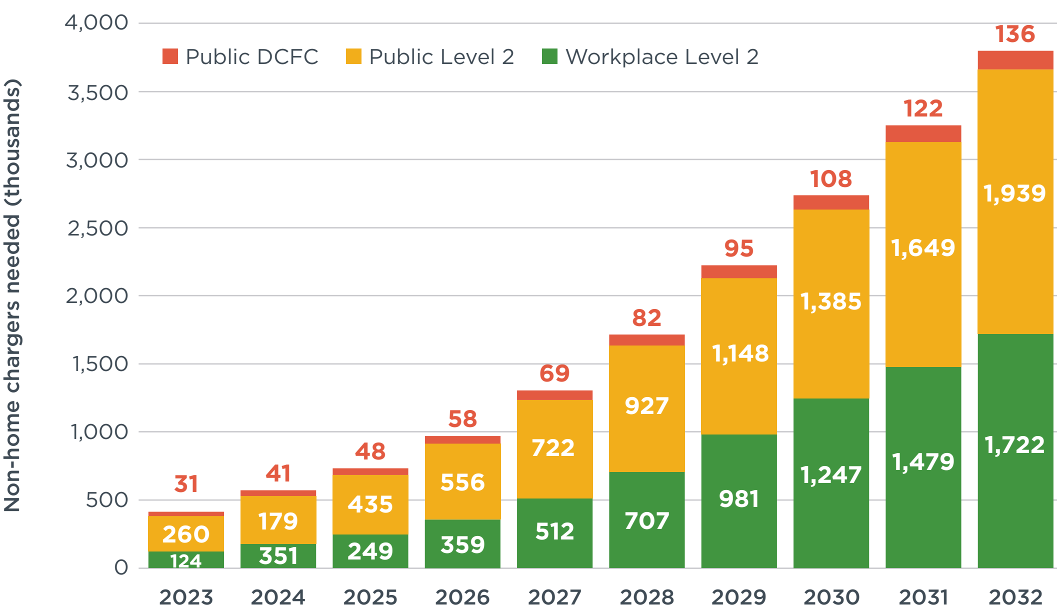
Despite the share of BEV drivers living at multifamily homes growing to almost 20% of the market, less than 10% of home chargers are estimated to be at multifamily homes across all years in the analysis. This assumption reflects the relatively higher costs and challenges of installing home charging at multifamily homes, including capital costs, electrical limitations that require expensive service upgrades, and split incentives between tenants and property managers (Pierce and Bui, in press). These barriers require a variety of policy interventions to ensure that there is equitable home charging access for tenants of single-family and multifamily homes alike. These interventions could include significant incentives to help cover the costs of electrical upgrades and charger installations at multifamily homes as well as regulatory changes that would allow utilities to address necessary grid improvements and to manage charger deployments at multifamily homes (Pierce & Bui, in press). Building codes which require that new buildings are constructed with sufficient electrical capacity and charging infrastructure for all tenants can preempt most of these barriers (Pierce & Bui, in press).

Home charger needs are greater than non-home charging needs, reflecting the preference among EV drivers for home charging due to the convenience and affordability it provides. Nevertheless, as shown in Figure 5, the number of non-home chargers needed increases from about 415,000 chargers in 2023 to 571,000 in 2024, to 2.7 million in 2030, and 3.8 million in 2032. This increase reflects a 27% compounded annual growth rate in public charging infrastructure from 2024 to 2032, which is less than the 40% compounded annual growth rate in public charging infrastructure between 2017 and 2022 (AFDC, n.d.-c). The need for workplace chargers increases from about 124,000 chargers in 2023 to more than 1.7 million in 2032; this increase of almost 14 times is a growth rate of 34% compounded annually. Public Level 2 charger needs increase from about 260,000 in 2023 to more than 1.9 million in 2032, an increase of almost 7.5 times and a growth rate of 25% compounded annually. Public DC fast charger needs increase from about 32,000 in 2023 to about 136,000 in 2032, an increase of more than 4 times and a growth rate of nearly 18% compounded annually.

Figure 5

Summary of U.S. non-home charging needs, 2023 through 2032



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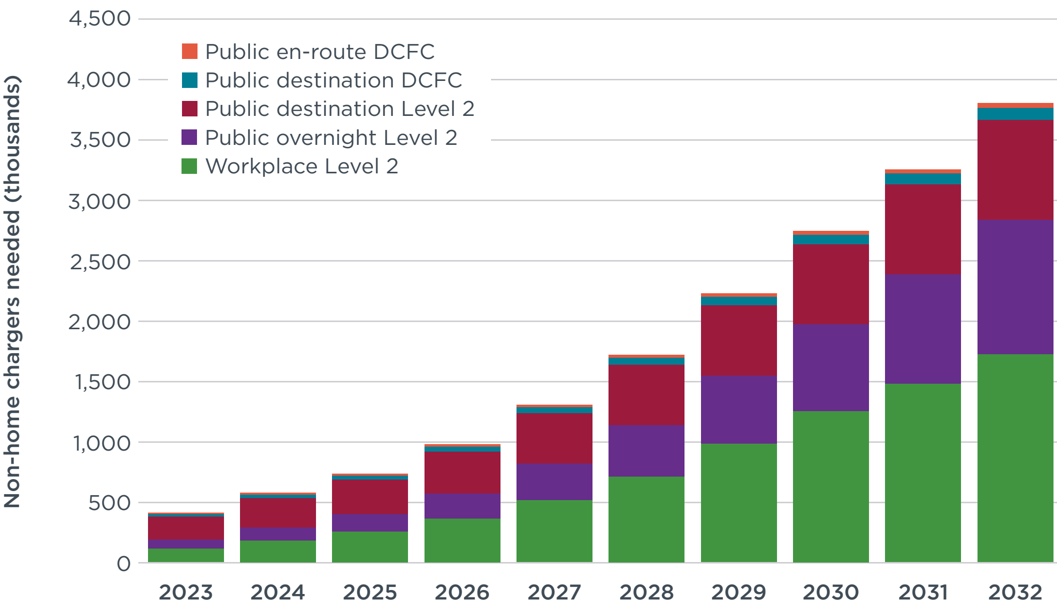
Workplace chargers account for about 45% of non-home Level 2 charger needs and 47% of all non-home charger needs in 2032. This highlights how workplace chargers are convenient for commuting BEV drivers who can use them to charge their vehicle slowly during the workday. Public Level 2 chargers account for 51% of needed non-home chargers; these are largely public overnight chargers, which are also used as a proxy for home charging for BEV drivers without it. DC fast chargers account for less than 4% of the total non-home chargers needed. This reflects the behavioral preference of EV drivers for slower charging, which is often cheaper and more convenient, and the infrequency of long-distance trips made in passenger vehicles. Nevertheless, basic geographic coverage of DC fast charging is necessary to ensure that BEVs can be practical to use for long-distance trips and to assuage concerns of drivers who want to know that they can get a fast charge when needed.

Figure 6 provides a more detailed breakdown of non-home charging needs by five use cases: workplace Level 2 chargers, public overnight Level 2 chargers, public destination

Level 2 chargers, public destination DC fast chargers, and public en-route DC fast chargers. The need for workplace chargers increases from about 124,000 chargers in 2023 to more than 1.7 million in 2032. The need for public overnight Level 2 chargers increases from about 74,000 chargers in 2023 to 1.1 million in 2032. The need for public destination Level 2 chargers increases from about 186,000 in 2023 to almost 830,000 in 2032. The need for public destination DC fast chargers increases from almost 23,000 in 2023 to about 102,000 in 2032, while the need for public en-route DC fast chargers increases from almost 9,000 in 2023 to about 35,000 in 2032.

Figure 6

U.S. non-home charging needs, by type and use case, 2023 through 2032



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Several additional points provide context for the estimated public and workplace charging needs. Public destination chargers represent about 75% of DC fast chargers for each year, while en-route chargers are about 25% of DC fast chargers. This reflects how most DC fast charging usage is assumed to be for typical daily local charging needs as opposed to charging while on long-distance trips. Overnight chargers represent about 39% of the total public Level 2 chargers in 2023, as most BEV drivers can charge at home. However, as the market expands and more BEV drivers do not have home charging access, the percentage of public Level 2 chargers that are primarily overnight chargers increases to 67% in 2032. The remaining public Level 2 chargers are destination chargers, which include chargers at other nonresidential, public destinations where cars may park for a few hours at a time, such as libraries, parks, and shopping malls.

Comparison with previous analyses

This analysis builds on and updates a previous ICCT analysis (Bauer et al. 2021), most significantly by updating the underlying electric vehicle market growth to incorporate EPA's proposed emissions standards (Multi-Pollutant Emissions Standards, 2023). Table 3 compares the results from this study with Bauer et al. (2021), as well as other recent studies on U.S. charging infrastructure needs. EPA's 2023 proposed standards will accelerate BEV adoption compared to previous estimates, with the BEV sales share of light-duty vehicles reaching 60% by 2030, the figure used in this analysis. Bauer et al. estimate a 36% sales share for battery-electric and plug-in hybrid electric vehicles combined in 2030. This accelerated pace of adoption increases the EV fleet size by over 40% from the Bauer et al. estimate, from 26 million to 37.7 million EVs. This corresponds to a similarly significant increase in home charging needs at single-family homes (55% increase) and multifamily homes (100% increase). However, our analysis indicates that the need for workplace chargers and public DC fast chargers is somewhat lower than the Bauer et al. estimate. This is because we estimate a bigger growth in public overnight Level 2 charging, which serves as a proxy for home charging and reduces the need for other non-home charging options.

Table 3

Comparison of results from this study with previous assessments of charging infrastructure needs

Study	Projection year[a]	EV share of LDV sales	EV fleet size	Number of chargers needed					EVs per non-home charger
				Single-family home	Multifamily home	Workplace	Public Level 2	DC fast	
This study	2030	60%[b]	37.7 M[b]	26.5 M	2.0 M	1.2 M	1.4 M	108 K	13.8
Bauer et al. (2021)	2030	36%	26 M	17 M	997 K	1.3 M	883 K	177 K	11
Wood et al. (2023)	2030	50%	33 M	25.7 M	570 K	485 K	1.1 M	182 K	18.6
S&P Global (2023)	2030	40%	28.3 M	—	—	—	2.13 M[d]	172K	12.3
Kampshoff et al. (2022)	2030	50%	48 M	27.5 M[c]	—	757 K	666 K	814 K	25.3
Phadke et al. (2021)	2030	100%	—	50 M[c]	—	1.7 M	3.5 M	600 K	—
U.S. EPA (2023)	2030	60%	—	24.7 M	1.2 M	1 M	200 K	100 K	—
PwC (2022)	2030	—	27 M	21.5 M	6 M	6.6 M	800 K	200 K	3.6
McKenzie et al. (2021)	2030	—	57 M	21.7 M	4.3 M	81 K	163 K	251 K	115

[a] 2030 results are shown here for all studies to allow direct comparison.
[b] Only BEVs are considered in this study; some studies include plug-in hybrid electric vehicles.
[c] Includes single-family and multifamily home chargers.
[d] Includes all public and workplace Level 2 chargers.

The analyses shown in Table 3 vary in their projected charging infrastructure needs, depending on the underlying assumptions in each study. In general, these studies show a need for a substantial increase in charging infrastructure to support the size of the U.S. EV passenger vehicle fleet by 2030. The number of EVs per non-home charger range from 3.6 to 115 across the studies. An alternative metric to assess whether sufficient non-home charging infrastructure has been deployed is to compare the number of EVs with the sum of the maximum power of all installed non-home chargers. Although not shown in Table 3, this study estimates that non-home charging capacity of 1.09 kW per BEV is needed in 2030, when BEVs will represent 17% of the national LDV stock. This meets the recommended levels of charging capacity per vehicle as determined in the ICCT's analysis of the European Union's Alternative Fuel Instructure Regulation (Rajon Bernard et al., 2022). Our comparison of studies in Table 3 highlights how charging projections are sensitive to assumptions on charger utilization, charging behavior, access to home charging, and other factors, as well as the general uncertainty about how the EV charging ecosystem could develop.

SUMMARY OF ANNOUNCED CHARGING INFRASTRUCTURE DEPLOYMENTS

This section assesses whether deployments of new charging infrastructure will match the anticipated demand. For this, we summarize the number of public chargers that various entities have said they plan to deploy across the country over the next several years. Specifically, we compile and catalog data from individual state National Electric Vehicle Infrastructure Formula Program (NEVI) plans, other state and federal transportation grant and incentive programs, and utility proceedings, as well as announcements made by automakers, retailers, and charging network providers.

METHODOLOGY

To perform our accounting of future charging infrastructure deployments, we conducted desk research of announcements, which include explicit information on the numbers and types of chargers to be installed. These announcements come from a variety of stakeholders, including charging network providers, electric utility companies, automakers, retailers, state incentive programs, and federal incentive programs. We collected information on the type of charger (Level 2 or DCFC), the number of stations (i.e., sites where charging would be deployed), the number of ports to be installed, when the installation is expected to begin and end, and the costs associated with the project. We also looked at the remaining funds left to be awarded through ongoing incentive programs to estimate the additional amount of charging infrastructure that could be deployed with these funds.

We focus on publicly accessible non-home charging infrastructure—which includes workplace, public Level 2, and public DC fast chargers—rather than private residential charging. Information on private home charging is less readily available. Of the non-home charger announcements, the number that will be deployed at workplaces is often unclear, as private companies do not typically make announcements about new workplace charging installations. However, there are some cases where incentive programs explicitly allocate funding to workplace charging. Furthermore, the precise delineation between workplace and public charging may not always be clear. For example, a public downtown garage with chargers may largely be used by commuters during the business day but also be used by other people at other times. We expect workplace charging to be largely accessible to the public and therefore do not distinguish between ports at workplaces and public locations.

Estimating chargers from the National Electric Vehicle Infrastructure Formula Program

The NEVI program allocates $5 billion in federal funds for states to build charging stations along interstates and other well-traveled highways. The program requires a 20% non-federal match, so the total funds available for charger deployment will be $6.25 billion. NEVI guidance requires that charging stations have at least four 150 kW DC fast charger ports and be placed every 50 miles along designated Alternative Fuel Corridors to be considered “fully built out” (FHWA, 2023). Once states have fully built out their designated corridors, they can spend any remaining NEVI funds on other public or “community” charging infrastructure.

We examine individual state NEVI plans to determine how many corridor stations and community chargers they anticipate building and how much these would cost. Most states provided estimates for the number of stations needed to achieve fully built out status and the estimated costs to build each station; we use these costs when available. When state plans gave estimates for the number of stations, but did not provide any cost information, we apply a cost of $1.5 million to build a station with four 150 kW chargers, which is a commonly used value in many states' plans. Only a few states (e.g. Texas and West Virginia) made any estimates for the number of community chargers that would be deployed with remaining NEVI funds and how much these would cost. Our summary of the state plans indicates that a total of 8,276 DCFC ports and 25,486 Level 2 ports, worth an estimated $2.1 billion, are expected to be deployed across the country using state NEVI funds and matching non-federal funds. Following these investments, we estimate about $2.9 billion in remaining NEVI and matching funds will be available for discretionary public charging infrastructure investments.

Estimating chargers from announcements with and without explicit charger counts

For explicit announcements of planned non-home charging infrastructure deployment with specific port counts by type (i.e. Level 2 or DCFC), we record the number of chargers and categorized the announcement by the type of stakeholder making the investment. When provided, we also note the cost of the project, and—in the case of ongoing incentive programs—the remaining funds not yet designated for specific projects.

There are also many announcements that did not specify the number of chargers or type of charger to be deployed. Instead, these nonspecific announcements either stated the amount of funds being invested in charging infrastructure or the number of chargers to be deployed, without specifying the type or location of these chargers. From these nonspecific announcements, we found 2.2 million unspecified ports and $6.3 billion dollars in charging investments. We estimate the additional number of chargers, by type, that could be deployed from these unspecified port counts and charging investments using three distinct approaches, described below.

For nonspecific announcements that provided charging investments in dollar amounts, we use two different approaches depending on whether the announcement also provided guidance on the money per charger that would be invested—such as was the case in many state and utility incentive programs—or gave no information beyond the overall dollar amount being invested. For the announcements that provided guidance, we conservatively estimate additional chargers that could be deployed with these investments following the rules of the program. For example, if an incentive program had $2 million in available funding for Level 2 chargers and stipulated that it would award the lesser of 70% of project costs or $4,000 per port, we apply the per port amount to estimate that an additional 500 Level 2 chargers would be installed using the funds from this program.

For unspecified charging investments without guidance on how to allocate funds, such as the remaining funds from the NEVI program, we assume that investments would reflect our projection of charging infrastructure needs in 2032. Effectively, this assumes that charging investments will be spent commensurate with the charging behavioral preferences of EV drivers. We apply conservative, average per charger cost estimates for each charging type from Pierce and Slowik (2023) to the findings of 2032 charger needs to estimate the share of costs, and therefore the share of investments, allocated to each charging type, as shown in Table 4. Based on this, we estimate that 31% of unspecified charging investments will go toward multifamily home charging, 12% towards workplace charging, 20% towards public Level 2 charging, and 37% towards public DC fast charging. Some incentive programs have specific carveouts to deploy chargers at multifamily homes; we include multifamily homes in the allocation of unspecified charging investments only for those programs.

Table 4
Share of chargers and share of costs applied to nonspecific announcements

	Multifamily chargers	Workplace chargers	Public Level 2 chargers	Public DC fast chargers
2032 charger counts	2,581,520	1,722,370	1,938,850	136,270
Share of chargers	**40%**	**27%**	**30%**	**2%**
Per-charger cost	$7,084	$4,231	$6,017	$157,354
Infrastructure investment	$18.3 billion	$7.3 billion	$11.7 billion	$21.4 billion
Share of costs	**31%**	**12%**	**20%**	**37%**

Similarly, for nonspecific announcements with unspecified port counts, we apply the share of chargers shown in Table 4. Thus, 40% of ports will be multifamily-home chargers, 27% will be workplace chargers, 30% will be public Level 2 chargers, and 2% will be public DC fast chargers. For this analysis of public charging deployments, we subtract from our totals the investments and number of ports intended for multifamily homes, as these chargers are not typically accessible to the public. Single-family home charging is also not included in this analysis, as most programs with funding for publicly accessible charging exclude single-family homes. However, there are many rebate and incentive programs, especially from utilities, specifically dedicated to residential charging at both single-family and multifamily homes (Doll, 2023).

RESULTS

Table 5 summarizes the estimated non-home charging deployment from our research of charging announcements and investments. The top row shows the number of publicly accessible chargers deployed through June 2023 according to the AFDC data presented earlier in Figure 2. The subsequent rows show our findings, based on both explicit and nonspecific announcements, organized by stakeholders. Rows are sorted in descending order by the total number of chargers estimated from both explicit and nonspecific announcements combined. Private stakeholders (i.e. charging providers, automakers, and retailers) can apply for incentive and grant funding through many programs. Therefore, we have separated the announcements from states, NEVI plans, the federal government, and utilities because there may be an uncertain amount of overlap with the announcements from private stakeholders.

Table 5

Summary of announced and potential public charging deployments through 2030

	Explicit number of chargers announced		Estimate of chargers from nonspecific announcements		Estimated total charging deployment	
Stakeholder category	**DC fast**	**Level 2**	**DC fast**	**Level 2**	**DC fast**	**Level 2**
Deployed as of June 2023	32,807	118,147	—	—	32,807	118,147
Charging providers	3,492	183,532	90,636	1,149,494	94,128	1,333,026
Automakers	50,122	81,196	0	0	50,122	81,196
Retailers	19,912	0	0	100,000	19,912	100,000
Sum of private stakeholder announcements	73,526	264,728	90,636	1,249,494	164,162	1,514,222
Sum of private stakeholder announcements and chargers deployed through June 2023	106,333	382,875	90,636	1,249,494	196,969	1,632,369
Potential additional chargers						
States	11,282	205,210	278	7,279	11,560	212,489
NEVI plans	8,276	25,486	6,794	182,537	15,070	208,023
Federal government	0	0	13,558	97,483	13,558	97,483
Utilities	6,892	56,365	289	4,399	7,181	60,764
Sum of potential additional announcements	26,450	287,061	20,919	291,698	47,369	578,759
Sum of all chargers	132,783	669,936	111,554	1,541,193	244,337	2,211,129

Charging providers procure, install, and/or manage charging infrastructure; these include, for example, Electrify America, ChargePoint, and Blink. Automakers refers to companies that produce EVs, such as Tesla, Ford, and General Motors. Retailers refers to companies have made deals to purchase chargers from charging providers and install them at their businesses. The NEVI program is highlighted in its own category given that it is the largest single investment in charging infrastructure in the United States, and because there is a lot of specific detail provided in the state plans. The states stakeholder category refers to charging incentive programs managed and funded by state agencies, for example, the California Energy Commission's Clean Transportation program. The federal government stakeholder category refers to federally funded charging incentive programs, such as the Charging and Fueling Infrastructure Grant program. Utilities refer to investor-owned, publicly owned, and cooperative utilities that offer grants and rebates for customers to install charging.

Based on the quantifiable, explicit announcements from charging providers, automakers, and retailers, a total of about 74,000 new DCFC ports and about 265,000 new Level 2 ports could be deployed by 2030. In addition, we estimate approximately 91,000 additional DCFC ports and about 1.25 million additional Level 2 ports could be installed based on nonspecific announcements from these same groups of stakeholders. By combining these private stakeholder announcements, we estimate about 164,000 new DC fast chargers and 1.5 million new Level 2 chargers could be installed by 2030, with 20% coming from explicit announcements and 80% from nonspecific announcements. When also accounting for chargers already deployed through June 2023, we estimate about 197,000 DC fast chargers and more than 1.6 million Level 2 chargers could be installed in the United States by 2030.

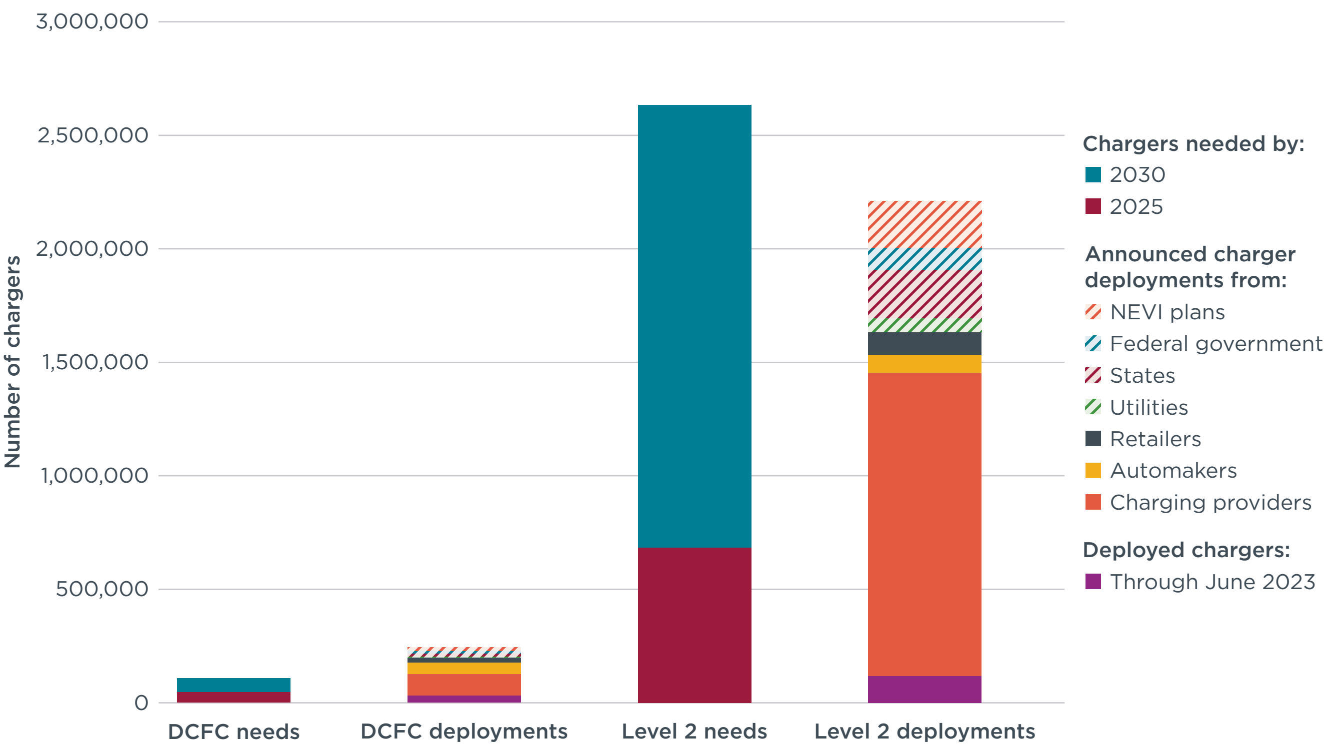
Depending on how many potential additional chargers are deployed—based on the announcements from states, NEVI plans, the federal government, and utilities—there could be an even greater number of publicly accessible, non-home chargers. Explicit charging announcements from these stakeholders include more than 26,000 DC fast chargers and about 287,000 Level 2 chargers. We estimate the nonspecific announcements from these stakeholders could provide about 21,000 DC fast chargers and about 292,000 Level 2 chargers. Altogether we estimate about 47,000 potential additional DC fast chargers and 579,000 potential additional Level 2 charges. If all these potential additional chargers are deployed—along with the announced chargers from charging providers, automakers, and retailers—there could be up to 244,000 DC fast and 2.2 million Level 2 non-home chargers installed by 2030. Full details on the collected announcements and estimated chargers are shown in Table A1 in the appendix.

COMPARISON OF CHARGING NEEDS WITH ANNOUNCED DEPLOYMENTS

Figure 7 shows the key results of this work by comparing the non-home charging infrastructure needs from our modeling (Figure 5) with the announced non-home charging infrastructure deployment from our desk research (Table 5). The two stacked bars representing infrastructure needs show that around 108,000 DC fast chargers and 2.6 million Level 2 chargers will be needed in 2030. The other two stacked bars represent current and announced charger deployments. The purple sections at the bottom show the number of chargers installed in the United States through June 2023. The solid-colored portions of the stacked bars indicate the number of chargers that could be deployed by 2030 based on announcements from private charging stakeholders. The hatched portions of the bars indicate the potential additional chargers included in NEVI plans, and federal, state, and utility stakeholder announcements.

Figure 7

Non-home EV chargers needed by 2030 compared with announced deployments



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Based on existing chargers as of June 2023 and announced charging deployments by 2030, the deployment of public DC fast charging looks to outpace the needs for DC fast charging. With about 197,000 DCFC ports announced or already deployed, this would meet 182% of DC fast charging needs in 2030. On the other hand, the announced and existing deployments of non-home Level 2 chargers supply most, but not all, of the Level 2 charging needs. With an estimated 1.6 million non-home Level 2 ports, either deployed as of 2023 or announced, this would meet 62% of the need for public Level 2 charging in the United States in 2030.

The hatched portions of the bar chart indicate potential additional chargers from NEVI plans, and federal, state, and utility stakeholders. The approximately 47,000 DC fast and 579,000 Level 2 chargers estimated from these government and utility announcements are from incentive funding that private charging stakeholders can apply for to install chargers. Because there is uncertainty as to how much overlap there may be with announcements from private stakeholders, we conservatively assume that all these chargers may be already accounted for. However, if these announcements do lead to additional charging beyond what private stakeholders have targeted, we could see over 244,000 DC fast and 2.2 million Level 2 non-home chargers deployed by 2030. This would supply 225% of the DC fast chargers and 84% of the Level 2 chargers needed.

Public and workplace charging deployment in the United States appears to be on track to meet the charging infrastructure needs of a fast-growing passenger EV fleet. Additional charger investments and announcements are likely in the years ahead. If, however, stakeholders fall short of their announced charging commitments, more chargers will be needed.

Our analysis of charging announcements is conservative in several ways. For example, we did not account for charging announcements from local or city municipalities, and we did not include charging announcements from more than two dozen pending utility transportation electrification plans (Atlas Public Policy, 2023). We also did not consider chargers that could be deployed with money from the Alternative Fuel Infrastructure Tax Credit, which provides tax credits for charging installations in rural and low-income communities (AFDC, n.d.-b). Workplace charging deployments are not typically publicized, which limits the number of announcements we could find. Nevertheless, workplaces will likely continue to deploy charging as an attractive benefit for employees (Charge@Work, n.d.). Additional charging deployment from these sources would continue to fill potential gaps.

This analysis of charging needs is based on assumptions of EV drivers' charging behavior and the energy demand for each charging type. Changes in charging behavior could mean that drivers may meet their charging needs using different chargers than what is modeled here. EV drivers may also adjust their charging behavior to fit the charging network that develops. Our modeling shows a deficit in the number of announced Level 2 chargers as of mid-2023 compared to the estimated need by 2030. Even in the unlikely event that no additional Level 2 charging deployments are announced by 2030, the surplus of announced DC fast chargers could fill this gap and meet the demand for non-home charging in 2030.

We considered the overall electrical capacity of non-home charging, irrespective of type, to determine whether the announced capacity was sufficient to meet the expected charging demand. From our EV CHARGE modeling, we found that BEV demand for non-home charging would total 41 GW of capacity in 2030. We tallied the capacity from charging announcements and made conservative assumptions about capacity from announcements where the rated power of chargers was not specified. We found that the announced non-home charging deployment would provide at least 39.2 GW of capacity, or 96% of the needed capacity, even excluding potential additional chargers from government and utility announcements. When including the potential additional chargers, we find that non-home chargers would provide 47.2 GW of power, which represents 115% of the needed capacity.

Few announcements of charging deployment go beyond 2030. As the EV market continues to grow in the next decade, the need for charging infrastructure will also expand. Specifically, we find that an additional 28,000 DCFC chargers and an additional 1 million Level 2 chargers are needed from 2030 through 2032. This gap could be filled by further announcements and by utility and private-sector investments.

DISCUSSION

As with any analysis of future charging needs, our results depend on several key assumptions. Limitations and uncertainties about these assumptions could lead to relatively more or less charging than quantified here. This section discusses some of the key uncertainties for the analysis and the implications on the results should the market develop differently than modeled here.

The underlying fleet transition scenario is based on the BEV sales share of light-duty passenger vehicles increasing from 7% in 2023 to 67% by 2032. This is aligned with the projection from EPA's proposed greenhouse gas standards. This increase in new BEV sales shares corresponds to a BEV sales increase from about 2.4 million BEVs in 2025, to about 8.6 million in 2030, and about 9.7 million in 2032. However, automakers can choose from many cost-effective technology options to meet EPA's proposed greenhouse gas requirements, such as advanced internal combustion engine vehicles and plug-in hybrid electric vehicles. If automakers sell more vehicles with advanced combustion and plug-in hybrid technology, fewer BEVs would be needed to comply with the standards and the demand for public charging infrastructure would be less than what's modeled in this analysis.

This analysis is national in scope. Within the United States, the EV market has grown and developed at different paces in different states (Alliance for Automotive Innovation, n.d.). Led by California, several states are moving ahead with EV adoption faster than others by adopting Advanced Clean Cars II regulations to achieve a 100% zero-emission vehicles sales share (which includes BEVs, plug-in hybrid electric vehicles, and fuel-cell electric vehicles) by 2035 (California Air Resources Board, 2022; Ceres, 2023; Hutchinson, 2023). This means that charging needs will vary from region to region and from state to state, and more detailed regional, state, and local charging infrastructure planning will be required to ensure geographic coverage and capacity.

Public charging needs are also highly dependent on the amount of utilization charging infrastructure receives. Our assessment of charging needs is based on public charging utilization rates of around 3 hours per day (about 13% of the time) in 2023, which increase to about 6 hours per day (about 25%) in 2032, as shown in Table 1. If chargers are used relatively more or less than these values, then the number of chargers needed would decrease or increase, respectively. Actions that can increase utilization include siting chargers in more densely populated or high-traffic areas, ensuring chargers are listed on charging and navigation tools such as PlugShare and Google Maps, installing clear signage and lighting, and using price signals like dynamic pricing and idle fees (Chargelab, 2023). For example, in the city of Monterey, California, city garages charge a $0.50 per minute idle fee to encourage people to vacate charging locations when charging is complete, thereby increasing charger availability and the opportunity for increased utilization (City of Monterey, n.d.). Anecdotal evidence suggests this policy has minimized the time spent plugged in while not charging (City and County of San Francisco, 2023). Utilization is likewise fundamental to the business case and profitability of charging locations. In countries with high levels of EV adoption, such as the Netherlands, increased utilization has led to earlier breakeven time for charging infrastructure projects (ICF & Cenex 2024). If utilization, and thus the business case improves, more private companies might pursue deployment of more charging than announced through 2023.

Home charging access is another key factor that affects public charging needs. With policy support to increase home charging access, public charging needs and overall charging network costs can be reduced from what is modeled here (Pierce & Slowik, 2023). Removing barriers to charging at multifamily homes is particularly crucial to guarantee equitable access to convenient, low-cost charging as the market expands. For example, home charging access for renters and low- and middle-income EV drivers may be hindered by insufficient grid capacity and the lack of ordinances requiring EV-readiness at multifamily homes. ICCT, in conjunction with the International ZEV Alliance, has engaged with multifamily home stakeholders across multiple EV markets to understand and identify technological and policy solutions that can help overcome these barriers (Tankou et al., 2023). Resources are also available that share best practices to improve permitting and planning processes, zoning, and building codes to make EV charging deployment more streamlined and equitable (Gilliland & Graff, 2023). If governments adopt policies to support widespread home charging access, the overall demand for public charging, and the need for greater public investments in charging infrastructure, would be reduced.

Medium- and heavy-duty electric vehicle charging needs are not in the scope of this analysis. However, there are a few limited funding sources for charging of medium- and heavy-duty electric vehicles, including the Diesel Emissions Reduction Act program, the Federal Transit Administration's Grants for Buses and Bus Facilities program, and the State Energy Program (U.S. Department of Transportation, 2023). States can also use remaining NEVI funds and apply for other federal funds, such as from the Charging and Fueling Infrastructure Grant Program, to deploy any type of charging. If states use these funds to deploy charging types that are incompatible with LDVs, then the number of announced chargers would be slightly lower than quantified here. For example, if 50% of the dollars from NEVI and federal funds (included in this paper's nonspecific announcement category) went exclusively to medium- and heavy-duty vehicle charging, the number of announced potential additional chargers quantified here would be reduced by about 11,000 DC fast chargers and about 125,000 Level 2 chargers. This means that our findings of needs versus announcements when including potential charges would decrease from 225% to 215% for DCFC and from 84% to 79% for Level 2 chargers. This would have a minimal effect on charging access for LDVs.

CONCLUDING REFLECTIONS

This paper analyzes critical questions about how much charging infrastructure is needed to support the transition to higher BEV sales. The paper also assesses whether charging deployments that have already been announced by charging providers, government entities, automakers, retailers, and utilities are sufficient to meet this need. Our analysis leads us to the following key conclusions:

Continued EV market growth requires continued charging deployment. Based on the EPA's proposed multi-pollutant standards, BEVs are projected to represent 67% of new U.S. light-duty vehicles sales in 2032, which could lead to 55 million EVs being on the road in that year. We estimate this burgeoning BEV fleet will require about 3.7 million Level 2 chargers at public locations and workplaces, 136,000 public DC fast chargers, and 40.1 million chargers at single-family and multifamily homes in 2032. Compared to the number of chargers installed as of June 2023, this represents a 31-times increase in publicly accessible Level 2 chargers and a 4-times increase in public DC fast chargers.

Millions of new publicly accessible EV chargers have been announced. According to public announcements, charging providers, automakers, and retailers could install 164,000 new DC fast chargers and 1.5 million new Level 2 chargers at public locations and workplaces through 2030. The totals are based partly on announcements that provide explicit details about the number and type of chargers to be deployed (approximately 74,000 DC fast chargers and about 265,000 Level 2 chargers). From announcements that provided total investments or charger numbers, without specifying the type of chargers, we estimate an additional 91,000 DCFC and 1.25 million Level 2 chargers could be deployed. We also find that charging announcements from the federal government, states, and utilities could potentially supply up to an additional 47,000 DC fast chargers and 579,000 Level 2 chargers, respectively, although it is unclear whether these announcements may overlap with announcements from private stakeholders.

Announced deployments make up a substantial share of non-home chargers needed by 2030. Existing chargers as of June 2023 and announced charging deployments by charging providers, automakers, and retailers sum up to around 197,000 DC fast chargers and 1.6 million Level 2 chargers at public locations and workplaces by 2030. This announced deployment would provide 182% of the needed public DC fast chargers and about 62% of the needed public and workplace Level 2 chargers in 2030. This amount of charging is estimated to provide 39.2 GW of capacity, or 96% of the needed electrical capacity modeled. If EV drivers change their behavior to adapt to a network with more DC fast chargers, the total charging deployment announced as of mid-2023 could potentially satisfy nearly all non-home charging needs. With potential additional chargers from announcements by the federal government, states, and utilities, the public charging network in 2030 could consist of about 244,000 DC fast chargers and 2.2 million Level 2 chargers, which would supply 225% of needed DC fast chargers and 84% of needed Level 2 chargers. With these additional chargers, total deployed capacity could reach 47.2 GW, which is 115% of the needed electrical capacity. Nevertheless, more charging deployments will likely be announced before 2030 which could address the need for both publicly accessible Level 2 and DC fast charging in 2030.

At this time, announcements about charging deployments only go through 2030. More charging will be needed in 2032 as the BEV fleet grows in accordance with the

EPA's proposed greenhouse gas standards. Future research could monitor both actual deployments and announcements of future deployments to assess the projected growth of EV charging infrastructure beyond 2030. This paper assesses nationwide charging needs, and further research is needed to determine the geographical distribution of charging deployment as EV adoption trends vary across regions in the United States. Questions also remain for how to deploy charging infrastructure in the most cost-effective way. Public charging needs are highly dependent on home charging access. An expansion of home charging access—particularly for residents of multifamily housing and for low- and middle-income drivers—may reduce the overall need for public EV charging infrastructure and ensure equitable access to low-cost charging.

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APPENDIX

Table A1 summarizes the 162 charging announcements identified in this study and catalogs the announcements by stakeholder, charger type, number of ports, and estimated costs when data are available. A link to each announcement is provided in the far-right column.

Table A1

List of explicit and nonspecific announcements of charging deployments

Description	Stakeholder	Charger type	Number of DCFC ports	Number of Level 2 ports	Cost	Remaining funds	Source
Mercedes-Benz/ChargePoint/MN8	Automaker	DCFC	2,500		$1.0B		1, 2
Seven automakers	Automaker	DCFC	30,000				1
Tesla/Hilton	Automaker	Level 2		20,000			1
GM/Flying J	Automaker	DCFC	2,000				1
GM Dealer Community Charging Program	Automaker	Level 2		40,000			1
GM/EVgo	Automaker	DCFC	2,250				1
Ford Model e program	Automaker	Mixed	10,206	11,346			1, 2
Electrify America/TravelCenters of America	Retailer	DCFC	1,000				1
PG&E/Ecology Action	Utility	Level 2		4,000			1
Francis Energy	Charging provider	DCFC	50,000				1
Revel/New York City	Charging provider	DCFC	100				1
7-Eleven	Retailer	DCFC	44				1
Blink Charging/Royal Farms	Retailer	DCFC	60				1
TeraWatt Infrastructure (Inglewood)	Charging provider	DCFC	26				1
Enel X Way (North America expansion)	Charging provider	Mixed	40,000	1,113,289			1
Charge@Work	Retail	Level 2		100,000			1
Washington EV Charging program	State	Mixed	200	2,000	$64.0M		1
Evgo/GSPP/CALeVIP 2.0	Charging provider	DCFC	100		$6.6M		1
Electrify America/Rocky Mountain Power	Charging provider	DCFC	80				1
Francis Energy/Illinois	Charging provider	DCFC					1
Hertz Electrifies/Houston	Retailer	DCFC	50				1
Hertz Electrifies/Atlanta	Retailer	DCFC	8				1
Hertz Electrifies/Orlando	Retailer	DCFC	50				1
Rove	Charging provider	DCFC	800				1
California Clean Transportation program	State	Mixed	8,600	180,000			1, 2, 3
EVPassport Inc/Viejas tribe/Maada'oozh	Charging provider	Mixed	16	412	$20.0M		1

Description	Stakeholder	Charger type	Number of DCFC ports	Number of Level 2 ports	Cost	Remaining funds	Source
EVPassport	Charging provider	Mixed	1,000	10,000	$200.0M		1
itselectric	Charging provider	Level 2		100			1
Smart Charge America	Charging provider	Level 2		140,000			1
Sacramento International Airport	Charging provider	DCFC	30				1
Walmart/Sam's Club	Retail	DCFC	18,700				1
Revel/New York City/Red Hook	Charging provider	DCFC	20				1
Efficiency Maine Phase IV (1&2)	State	DCFC	31	4			1
New Jersey Turnpike Authority	State	DCFC	240				1
New York Power Authority/ NYCDOT	State	DCFC	50				1
SWTCH/White House	Charging provider	Level 2		20,000			1
Evolve NY	State	DCFC	662				1, 2
EV Make-Ready program	Utility	Mixed	5,964	38,569	$1.1B		1, 2, 3
itselectric/Mid-Hudson Valley	Charging provider	L2	250				1
Alabama/ADECA	State	DCFC	18				1, 2
Entergy Arkansas	Utility	DCFC	48		$8.4M		1
Xcel Energy/Colorado	Utility	DCFC	460				1, 2
Connecticut DEEP/VW settlement funds	State	Mixed	40	545	$6.0M		1
Titan Energy Madison, CT	State	Level 2		2			1
Council of the District of Columbia	State	Level 2		15,000			1, 2
LNG Electric/MD7	Charging provider	Mixed		13,000			1
Illinois EPA/VW Settlement	State	DCFC	348		$12.6M		1
ComEd/Exelon/Millennium Garages	Utility	Level 2		200			1
GOEVIN Indiana/VW Settlement	State	DCFC	61				1
Iowa VW settlement	State	Mixed	24	48			1
Ohio-Kentucky-Indiana (OKI)	State	Mixed	12	44			1
Delaware/VW settlement	State	DCFC	29				1
Charge Ready 2.0	State	Level 2		1,905		$11.0M	1
New York Municipal ZEV Infrastructure Grant program	State	Mixed	28	454	$8.3M		1
New Jersey Board of Public Utilities	State	Mixed	39	78	$12.7M		1
New Jersey It Pay$ to Plug In	State	Level 2		1,217		$10.0M	1
Texas VW Settlement	State	Mixed	171	4,049	$31.1M		1
Florida VW Settlement	State	DCFC	66				1

Description	Stakeholder	Charger type	Number of DCFC ports	Number of Level 2 ports	Cost	Remaining funds	Source
Colorado VW Settlement thru September 2023	State	Mixed	38	95			1
Colorado VW Settlement (Charge Ahead Colorado current round)	State	Mixed	37	179		$3.0M	1
Arkansas VW Settlement L2 program	State	Level 2		62		$364.8K	1, 2
Arkansas VW Settlement DCFC program	State	DCFC	9			$1.5M	1, 2
Alabama VW Settlement	State	DCFC	12				1
Massachusetts VW Settlement/ EVIP	State	Mixed	15	284			1
Michigan VW Settlement (Charge Up Michigan)	State	DCFC	49				1
Minnesota VW Settlement	State	Mixed	42	42			1, 2
Mississippi VW Settlement	State	Mixed	12	12			1, 2
Missouri VW Settlement/ MDNR	State	DCFC	18		$5.6M		1, 2
Montana VW Settlement	State	Mixed	11	10			1, 2
Oklahoma VW Settlement	State	DCFC					1
Washington VW Settlement/ Charge Where You Are	State	DCFC		352	$3.5M		1
Washington VW Settlement/ Corridor DCFC	State	Level 2	14				1, 2
Utah VW Settlement	State	DCFC	4	78		$1.3M	1
South Dakota/VW Settlement	State	Level 2	3	53		$1.0M	1, 2
Tennessee VW Settlement	State	DCFC	59	51	$5.2M	$977.6K	1
Pennsylvania VW Settlement/ Driving PA Forward	State	Mixed		750			1, 2
North Carolina VW Settlement	State	DCFC	122	528			1, 2, 3, 4, 5, 6, 7, 8, 9, 10
New Mexico VW Settlement	State	Level 2	23	12			1
West Virginia VW Settlement	State	DCFC		58		$606.6K	1
Kentucky VW Settlement DCFC program	State	DCFC	29			$4.6M	1
Kentucky VW Settlement L2 program	State	DCFC		146		$1.5M	1
Maryland EVSE rebate program	State	DCFC		200		$1.0M	1
Massachusetts Utilities Make Ready programs	Utility	DCFC	400	13,310			1, 2
Minnesota Carbon Reduction program	State	Mixed		19			1
UPPCO EV pilot rebate	Utility	Level 2	11			$750.0K	1, 2
DTE Energy EV pilot rebate	Utility	Mixed	117	1,394		$13.0M	1, 2
Consumers Energy EV pilot rebate	Utility	DCFC	64	536		$10.0M	1, 2
Indiana Michigan Power EV pilot rebate	Utility	DCFC	15	72		$675.0K	1, 2
Alpena Power Company EV pilot rebate	Utility	DCFC	7			$500.0K	1, 2

Description	Stakeholder	Charger type	Number of DCFC ports	Number of Level 2 ports	Cost	Remaining funds	Source
Ameren Missouri charging Station incentive	Utility	DCFC	47	112		$1.5M	1
Montana planned stations	Charging provider	DCFC	42	20			1
New Hampshire planned stations	Charging provider	DCFC	28				1
New Hampshire VW Settlement	State	DCFC	23		$4.5M		1
New Mexico ARPA/Capital Outlay	State	Mixed	108				1
Minnesota VW Settlement	State	Mixed	4	79		$1.5M	1
AES Ohio EV rebate	Utility	Mixed	20	286	$2.2M		1, 2
Oregon DOT Community Charging Rebate	State	Level 2		882	$3.8M		1
Oregon DOT EV charging programs	State	Level 2	83	1,521		$29.0M	1
Pennsylvania planned stations	State	DCFC	48				1
Rivian Adventure/ Waypoint network	Automaker	DCFC	3,166	9,850			1, 2
Rocky Mountain Power	Utility	DCFC	88	1,532		$5.0M	1
Vermont Community Chargers workplace program	State	DCFC		160		$1.8M	1, 2
Vermont Community Chargers public attraction program	State	DCFC	36	72		$1.8M	1, 2
Washington ZEVIP 2023-2025	State	DCFC	128		$30.2M		1, 2
Washington DES 2023-2025	State	Level 2?	45	830		$11.3M	1
Charging and Fueling Infrastructure Community Program	Federal	DCFC	4,461	81,975		$1.6B	1
Charging and Fueling Infrastructure Corridor Program	Federal	Mixed	9,930			$1.6B	1
Francis Energy/SK Signet	Charging provider	L2	1,000				1
Remaining NEVI funds	NEVI	DCFC	8,352	153,499		$2.9B	
BP/Tesla	Charging provider	DCFC	636			$100.0M	1
Alabama NEVI	NEVI	DCFC	184		$69.0M	$30.1M	1
Alaska NEVI (update)	NEVI	DCFC	36		$15.0M	$50.5M	1, 2
Arizona NEVI (update)	NEVI	DCFC	96		$41.0M	$54.6M	1
Arkansas NEVI (update)	NEVI	DCFC	60		$24.4M	$43.2M	1, 2
California NEVI (update)	NEVI	DCFC	291		$45.8M	$433.8M	1
Colorado NEVI: DCFC Charging Plaza program	NEVI	DCFC	188		$21.3M	$49.4M	1, 2
Connecticut NEVI	NEVI	DCFC	44		$16.5M	$49.1M	1
Delaware NEVI	NEVI	DCFC	29		$11.5M	$10.6M	1, 2
District of Columbia NEVI	NEVI	DCFC				$20.8M	1
Florida	NEVI	DCFC	60		$22.5M	$225.1M	1, 2
Georgia	NEVI	DCFC	20		$7.5M	$161.2M	1, 2
Hawaii	NEVI	DCFC	48		$18.0M	$4.1M	1, 2

Description	Stakeholder	Charger type	Number of DCFC ports	Number of Level 2 ports	Cost	Remaining funds	Source
Idaho NEVI (update)	NEVI	DCFC	8		$3.0M	$34.4M	1
Illinois NEVI (update)	NEVI	DCFC	230		$39.7M	$146.1M	1
Indiana NEVI (update)	NEVI	DCFC	176		$66.0M	$58.5M	1
Iowa NEVI (update	NEVI	DCFC	64		$16.0M	$48.2M	1
Kansas NEVI RFPs	NEVI	DCFC	24		$17.5M		1, 2
Kansas NEVI	NEVI	DCFC	40		$15.0M	$16.9M	1
Kentucky NEVI (update)	NEVI	DCFC	148		$44.4M	$42.5M	1, 2
Louisiana NEVI	NEVI	DCFC	300		$87.6M		1
Maine NEVI (update)	NEVI	DCFC	68		$17.5M	$6.7M	1, 2
Maryland NEVI (update)	NEVI	DCFC	160		$36.1M	$39.5M	1
Massachusetts NEVI	NEVI	DCFC	92		$71.3M		1
Michigan NEVI	NEVI	DCFC	127		$45.0M	$92.6M	1
Minnesota NEVI (update)	NEVI	DCFC	72		$16.2M	$69.0M	1
Missouri NEVI	NEVI	DCFC	48		$10.5M	$108.3M	1
Mississippi NEVI (update)	NEVI	DCFC	104		$39.0M	$24.2M	1
Montana NEVI (update)	NEVI	DCFC	164		$36.1M	$17.5M	1
Nebraska NEVI	NEVI	DCFC	28		$7.0M	$30.8M	1
Nevada NEVI	NEVI	Mixed	24	4	$5.4M	$42.0M	1
New Hampshire NEVI (update)	NEVI	DCFC	51		$17.2M	$4.4M	1
New Jersey	NEVI	DCFC	72		$27.0M	$103.5M	1, 2
New Mexico NEVI (update)	NEVI	DCFC	172		$43.0M	$5.0M	1
New York NEVI	NEVI	DCFC	92		$34.5M	$184.8M	1
North Carolina NEVI	NEVI	DCFC	132		$39.6M	$96.7M	1
North Dakota NEVI (update)	NEVI	DCFC	72		$16.2M	$16.2M	1
Ohio NEVI (update)	NEVI	DCFC	238		$54.0M	$121.1M	1
Oklahoma NEVI (update)	NEVI	DCFC	112		$28.0M	$54.9M	1
Oregon NEVI	NEVI	DCFC	260		$52.0M	$13.3M	1
Pennsylvania NEVI Round 1	NEVI	DCFC	224		$43.5M		1, 2
Pennsylvania NEVI (update)	NEVI	DCFC	72		$28.0M	$142.9M	1
Rhode Island NEVI Phase 1	NEVI	DCFC	4		$4.8M		1, 2
Rhode Island NEVI	NEVI	DCFC	8		$23.8M		1
South Carolina NEVI	NEVI	DCFC	64		$16.0M	$54.0M	1
South Dakota NEVI (update)	NEVI	DCFC	52		$15.6M	$21.2M	1, 2
Tennessee NEVI (update)	NEVI	DCFC	128		$60.8M	$49.6M	1
Texas NEVI (update)	NEVI	Mixed	2596	25150	$484.7M	$25.0M	1
Utah NEVI (update)	NEVI	DCFC	60		$27.0M	$18.4M	1
Vermont NEVI (update)	NEVI	DCFC	96		$26.5M		1
Virginia NEVI	NEVI	DCFC	106		$40.5M	$92.5M	1
Washington	NEVI	DCFC					1
West Virginia NEVI (update)	NEVI	Mixed	476	332	$46.9M	$10.2M	1
Wisconsin NEVI (update)	NEVI	DCFC	256		$96.0M	$2.3M	1
Wyoming NEVI	NEVI	DCFC				$33.5M	1, 2

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