BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	R 2024-017
PROPOSED CLEAN CAR AND TRUCK STANDARDS: PROPOSED 35 ILL. ADM. CODE 242	)))	(Rulemaking – Air)

NOTICE OF FILING

TO: Don Brown
Clerk of the Board
Illinois Pollution Control Board
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Chicago, IL 60605

Vanessa Horton
Carlie Leoni
Hearing Officers
Illinois Pollution Control Board
60 E. Van Buren St., Suite 630
Chicago, Illinois 60605

(VIA ELECTRONIC MAIL)

(SEE PERSONS ON ATTACHED SERVICE LIST)

PLEASE TAKE NOTICE that I have today filed with the Office of the Clerk of the Illinois Pollution Control Board, **PRE-FILED ANSWERS OF STEVEN DOUGLAS ON BEHALF OF THE ALLIANCE FOR AUTOMOTIVE INNOVATION**, copies of which are hereby served upon you.

Respectfully submitted,
Alliance for Automotive Innovation

By: /s/ *Melissa S. Brown*
One of Its Attorneys

Dated: March 3, 2025

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CERTIFICATE OF SERVICE

I, the undersigned, on the oath state the following: That I have served the attached **PRE-FILED ANSWERS OF STEVEN DOUGLAS ON BEHALF OF THE ALLIANCE FOR AUTOMOTIVE INNOVATION,** via electronic mail upon:

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That the number of pages in the email transmission is 281.

That the email transmission took place before 4:30 p.m. on March 3, 2025.

Date: March 3, 2025

/s/ *Melissa S. Brown*
Melissa. S. Brown

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

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	)	R 2024-017
PROPOSED CLEAN CAR AND	)	(Rulemaking – Air)
TRUCK STANDARDS: PROPOSED 35 ILL.	)	
ADM. CODE 242	)	

PRE-FILED ANSWERS OF STEVEN DOUGLAS ON BEHALF OF
THE ALLIANCE FOR AUTOMOTIVE INNOVATION

The Alliance for Automotive Innovation (Auto Innovators),[1] by and through counsel, submits the following Pre-Filed Answers in response to Pre-Filed Questions directed to either Steven Douglas or All Witnesses, in accordance with the Hearing Officer Order dated December 6, 2024 and Notice of Hearing dated January 14, 2025.

ILLINOIS POLLUTION CONTROL BOARD

Question Directed to All Witnesses

1. ***On February 6, 2025, Commonwealth Edison (ComEd) announced $100 million in new rebates designed to boost electric vehicle (EV) fleet purchases and charging stations across northern Illinois. The rebate program is discussed in a February 11, 2025, Canary Media article, titled "Illinois' largest utility unveils $100M to spur EV adoption". The Board takes notice of this article, attached hereto as Attachment B, under Section 101.630 of the Board's procedural rules. See 35 Ill. Adm. Code 101.630.***

[1] Auto Innovators represents the full auto industry, including the manufacturers producing most vehicles sold in the U.S., equipment suppliers, battery producers, semiconductor makers, technology companies, and autonomous vehicle developers. Our mission is to work with policymakers to realize a cleaner, safer, and smarter transportation future and to maintain U.S. competitiveness in cutting-edge automotive technology. Representing approximately 5 percent of the country's GDP, responsible for supporting nearly 10 million jobs, and driving $1 trillion in annual economic activity, the automotive industry is the nation's largest manufacturing sector.

As discussed in the Canary Media article, ComEd's program helps meet the mandate for the State's CEJA [Climate and Equitable Jobs Act], which calls for 1 million EVs on the roads by 2030. Of the $100 million, $53 million is available for business and public-sector EV fleet purchases, $38 million is designed to upgrade infrastructure for non-residential charger installations, and nearly $9 million is intended for residential charging stations. This money is in addition to $87 million announced last year for similar incentives.

Participants have noted the shortfall of money and infrastructure needed to make 100% zero-emission vehicle (ZEV) sales by 2050 a reality. However, as the ComEd announcement purports, there are non-governmental entities that are already contributing toward the needed infrastructure and financing. Is it Participants' position that market forces and other rebate and incentive programs would not contribute significantly to the ZEV mandate requirements of the proposed rule? If so, why?

Pre-filed Answer: Whether funded by taxpayers, ratepayers, or non-government organizations, charger and vehicle rebates and other incentive or education programs help expand the EV market, and we wholeheartedly support these programs. We believe that addressing the need for infrastructure and incentives must involve all stakeholders – from builders to charger manufacturers, to automakers, to utilities, to every level of government, and beyond. However, a single program like the ComEd program is unlikely to significantly change the ZEV market in Illinois. For example, despite the $87 million ComEd announced last year, the Illinois ZEV market shrank in 2024 rather than expanding. The article mentions that since launching the $87 million program last year, it funded 200 new *and pre-owned* EV fleet vehicles. Compare the 200 new and pre-owned EVs in the ComEd program to the 240,977 new ZEVs needed in the first year of implementation (i.e., toward which pre-owned ZEVs do not count).[2]

Programs like this are needed. Just like the $100s of billions the automobile industry has invested in developing vehicles, batteries, control systems, and production and assembly facilities are needed. However, the ACC II ZEV mandate requirements are still unachievable in Illinois.

Questions Directed to Steven Douglas

10. ***In your summary of US vehicle emission regulations, you mention the requirement that if states adopt California's standards, they must be identical, and automakers must be given at least two years of lead time. In your opinion, under section 177 of the Clean Air Act, can states adopt California vehicle emission standards for different model years than those used in the California standards?***

Pre-filed Answer: Yes, provided they meet the two-year lead time, states can adopt the California vehicle emission standards for different model years. For example, Colorado, New Mexico, and Delaware begin implementation in 2027 model year (MY) and then revert to the federal regulations (or sunset the California regulations) after 2032 MY. However, regardless of when a state decides to join ACC II, the ZEV requirement and

[2] This assumes new vehicle registrations remain at the 2023 level of 408,436. *See* Illinois Automobile Dealers Association, Economic impact report (2023), attached hereto as **Exhibit A**, and publicly accessible at https://illinoisdealers.com/wp-content/uploads/2024/05/IADA2023EconImpactfullreport8pg.pdf.

flexibilities are those stated in the regulation for that model year (i.e., if a state joins in 2031 MY, the requirements in that state are the ZEV Mandate regulation requirements for 2031 MY, which are 76 percent without flexibilities).

11. ***On page 7 of your testimony, you state that "Illinois residents already have an abundance of EVs to choose from (perhaps even an overabundance) should they desire to purchase one."***

a. ***Please comment on whether you consider the currently available EVs to be affordable alternatives to low or mid-level priced gas-fueled cars and SUVs.***

Pre-filed Answer: Electric vehicles (EVs) have become more affordable in recent years, but cost parity has not yet been achieved with traditional gasoline engines. There are several factors to consider:

1. **Initial Cost**: The MSRP of the lowest priced EVs is significantly higher than the lowest priced gas-fueled cars and SUVs. The lowest-priced EVs, like the Nissan Leaf and Chevrolet Bolt EV, start at around $28,000 to $29,000. In comparison, the lowest-priced gas-fueled cars like the Nissan Versa and Mitsubishi Mirage start at $18,000 to $21,000.

2. **Incentives and Rebates**: The incentives and rebates associated with EVs can substantially reduce the cost. For example, federal tax credits in the U.S. can be up to $7,500, recognizing these federal tax credits could be in jeopardy. State and local rebates can also reduce the cost to the customer.

3. **Fuel Costs**: For customers with home charging (typically, single-family homeowners), EVs generally have lower operating costs compared to gas-fueled vehicles. Home electricity rates are almost always cheaper than gasoline. The same is not necessarily true for customers without access to home charging that must use public direct current fast charging (DCFC), which typically costs about the same or more than gasoline and imposes a significant "inconvenience cost" associated with the time away from home to charge their EV.

4. **Total Cost of Ownership (TCO)**: Consumers typically do not make large purchases based on the 5-year total cost of ownership. They rightfully look at monthly affordability, since financial institutions do not provide loans based on potential money saved over five years. Nevertheless, when considering the TCO, including initial cost, potential incentives/rebates, and fuel costs for customers with home charging, EVs can be competitive with or even cheaper than gas-fueled vehicles.

Thus, for single-family homeowners that can charge at home, EVs can be an affordable alternative to low- and mid-priced gasoline-fueled cars and SUVs with the current federal and state incentives. For customers without access to home charging, the high cost of charging might make EVs more expensive and far less convenient than gasoline-fueled cars and SUVs.

b. ***If not, do you believe a ZEV mandate would accelerate the availability of lower cost EVs?***

<u>Pre-filed Answer</u>: The ZEV mandate is more likely to eliminate many low or mid-level priced gas-fueled cars and SUVs. Historically, the Corporate Average Fuel Economy (CAFE) standards encouraged manufacturers to produce and sell low-cost efficient gas-fueled vehicles to offset more profitable but less efficient larger, more capable, or more luxurious vehicles. However, the ZEV mandate eliminates the incentive to produce low-cost affordable gasoline vehicles, and in fact, does just the opposite by penalizing automakers that produce these vehicles. For example, just two years after the ACC II could be implemented in Illinois (2031 MY), the ZEV mandate requires 76 percent of new vehicles sold to be ZEVs. Every time an automaker sells one gasoline vehicle, whether that vehicle is a low-cost sub-compact car or a high-priced large SUV, it must sell three EVs. Thus, every low and mid-level priced gas-fueled car and SUV sold will carry a "ZEV mandate tax" equal to three EVs. The cost of ZEV compliance (such as through buying ZEV credits) is typically passed onto the customer and that cost is likely to increase as the requirements ramp up.

12. ***On page 8 of your testimony, you state, "Maine and New York adopted California's ZEV mandate decades ago, yet their ZEV sales are not significantly different than Illinois ZEV sales." Please clarify whether the ZEV mandates you are referring to are the same as those being proposed in this rulemaking. If not, please explain for the record what ZEV mandates you are comparing in your statement.***

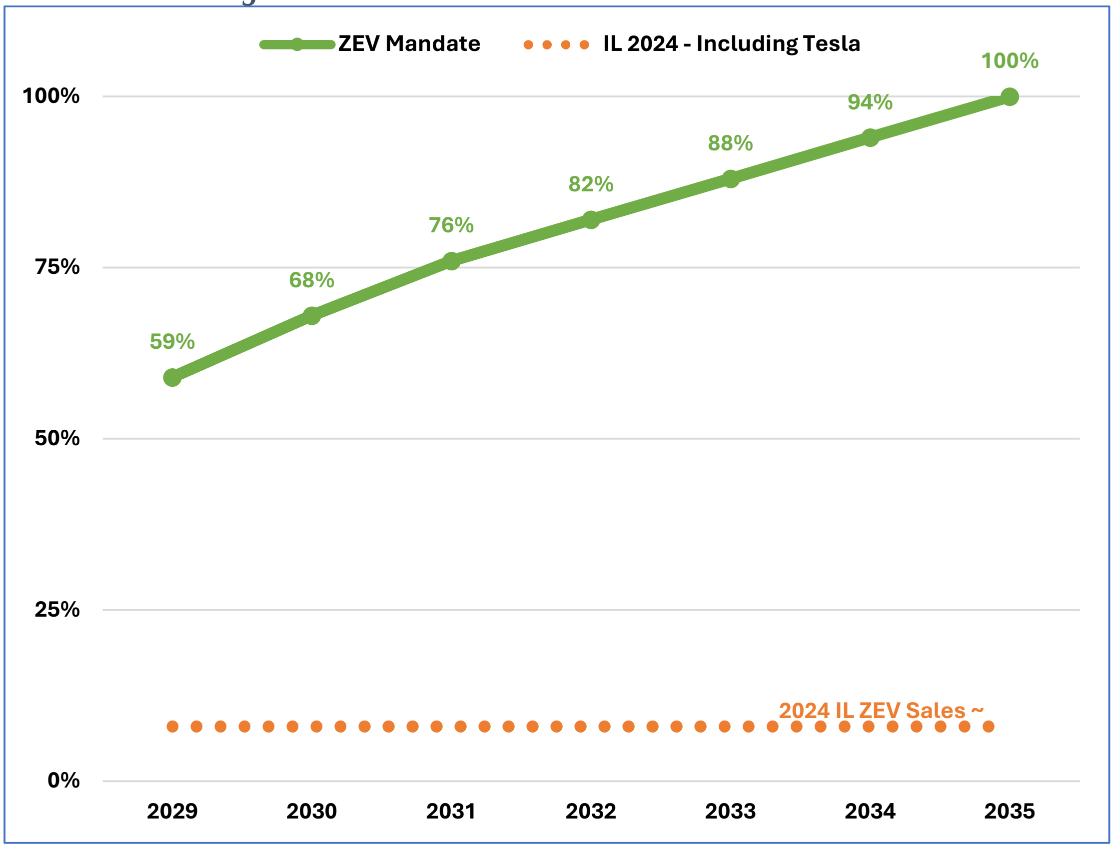
<u>Pre-filed Answer</u>: California adopted the ZEV mandate in 1990. California has modified the ZEV mandate significantly over the past 35 years – first delaying the requirements from 1998 to 2003, then allowing very clean gasoline vehicles to earn ZEV credits, then allowing the ZEV mandate to be met with a few hundred fuel cell electric vehicles (FCEVs) industry-wide, then allowing plug-in hybrid electric vehicles to earn ZEV credits, requiring the ZEVs to be “placed in service” instead of “delivered for sale”, and then reversing this, etc. Among many changes, the most recent modifications (ACC II) to the ZEV mandate replaces the ZEV credit market with ZEV vehicle values, substantially increases the minimum ZEV targets, and adds multiple regulations associated with data standardization, in-use requirements, etc. This is the very beginning of the first year implementing the modifications under ACC II, Maine and New York have had the California ZEV mandate for 25 years or more. However, Maine rejected ACC II in 2023 and will revert to the federal program starting this year with the 2026 MY.

13. ***On page 10 of your testimony, you state that under the Clean Air Act, “other states can adopt California’s regulations so long as they are identical to California’s and automakers are given at least two years of lead time.” Please comment on whether the two-year lead time for automakers can be extended to allow for car and truck sales to reach the proposed ZEV targets. If so, what would be a reasonable timeline for Illinois?***

Pre-filed Answer: The lead time is a minimum, so a state could start the regulations at any time beyond the two full model years. For example, a state could adopt the regulations this year and begin implementation in 2030, 2032, or 2037 model year. However, the ZEV regulations must be identical to those of the year in which the regulations are adopted. So, for example, if a state begins implementing ACC II starting in 2031MY, it must require 76 percent of new vehicles to be ZEVs in the 2031MY. Section 177 of the Clean Air Act (CAA) would prohibit a state from starting in 2031MY with a sales standard applicable to another year, such as the 2026 MY 35 percent California ZEV requirement.

A reasonable timeline for Illinois would need to be determined later. The rapid increase in the ZEV mandate requirements through 2035 MY and the current low ZEV market share in Illinois (see **Figure 1** below) make it impossible to predict an appropriate starting point for Illinois. Of course, the ZEV mandate stays 100 percent after 2035, so it is possible that in 2031 or 2033, Illinois could determine an appropriate time where adopting the California ZEV mandate would push the ZEV market without significantly disrupting the entire vehicle market. However, at this point, it is impossible to know how the Illinois ZEV market will grow over the coming years and when its market will approach the requirements in the ACC II ZEV mandate.

Figure 1 : ZEV Mandate vs. 2024 ZEV Sales in Illinois



14. ***On page 16 of your testimony, Figure 4 excludes Tesla sales from the Illinois ZEV market. On page 7 of your testimony, you mention that EV-only manufacturers like Tesla do not sell their cars through the traditional dealership model.***

a. ***How do non-dealership sales from EV-only manufacturers affect the amount of EV sales needed from conventional dealerships to meet the proposed ZEV sales targets under the proposed rule?***

<u>Pre-filed Answer</u>: The non-dealership sales from EV-only manufacturers do not affect the amount of EV sales needed from conventional dealerships. EV-only manufacturers must meet the same ZEV mandate as traditional automakers. For example, in 2029MY, Tesla and Rivian must use 59 percent of their ZEV vehicle values to meet the ZEV mandate. They can then bank, sell, or trade the remaining ZEV vehicle values (41% in 2029MY, 32% in 2030MY, 24% in 2031MY, etc.).

However, because only a small number of manufacturers representing a small portion of the overall vehicle market are selling more ZEVs than required under the ZEV mandate, the availability of such credits is small compared to the broader market needs. For example, Tesla had a market share of about 3% of total light vehicle sales in Illinois in 2024. Given increasing ZEV requirements and assuming stable market share, the availability of credits for purchase is both limited and shrinking.

California (and federal EPA, for that matter) regulations apply to automakers regardless of whether the vehicles are sold through conventional dealerships or directly by the automaker. The regulations do not apply to dealerships, beyond the fact that dealers must sell and service vehicles meeting the California requirements including the specific quota of ZEVs.

b. ***Please comment on whether the proposed rule should account for the sale of EVs that occur outside of conventional dealerships.***

Pre-filed Answer: No changes would be needed in this area.

15. ***On page 10 of your testimony, you note that "there are currently two sets of vehicle emissions standards: a federal program, overseen by EPA (Tier 3 and Tier 4), and a California program (ACC I and ACC II) overseen by CARB."***

a. ***Please comment on whether implementation of the proposed CARB emissions standards in Illinois would conflict with USEPA's rules.***

Pre-filed Answer: If the Board adopts CARB emission standards, those standards will not conflict with the USEPA's rules. Instead, the CARB emission standards replace the USEPA rules. It is worth noting that EPA fleet average requirements for GHG and NMOG+NOx are 50-state requirements, meaning that Illinois' vehicles would still be counted in the U.S. EPA fleet average for compliance with the federal rules. As noted in my Pre-Filed Testimony, "The EPA fleet average standards (both GHG and criteria) apply in all 50 states. Consequently, the total 50-State GHG emissions are unchanged by states adopting California's requirements."[3]

b. ***Please comment on whether any federal action taken since the Board opened this docket has any effect on the Board's authority to adopt the CARB rule or on the economic reasonableness or technical feasibility of doing so.***

Pre-filed Answer: I am not aware of any final federal action or even any draft regulatory proposals currently. However, initial actions by the new Administration have delayed or otherwise constrained distribution of funds for electric vehicle charging infrastructure for some states. I recommend that the Board ask other state agencies about whether, or to what extent, these actions impact Illinois.

[3] Pre-Filed Testimony of Steven Douglas in Opposition of Rule Proponents' Regulatory Proposal, PCB R 24-17, at 10 (January 21, 2025).

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

Questions for Steven Douglas

1. ***In your testimony, you state, in part, "Meeting the most-likely ZEV mandate scenario with all flexibilities and automakers purchasing credits from Tesla and other EV-only automakers still requires a 620 percent increase from 2024CY ZEV sales (see Figure 13)." R24-17, Pre-Filed Testimony of Steven Douglas in Opposition of Rule Proponents' Regulatory Proposal, January 21, 2025, at 36.***

What is the current average price of a ZEV credit if a manufacturer needs to purchase credits?

Pre-filed Answer: The ZEV credits are traded through confidential business contracts between automakers. The price of credits is unknown to anyone beyond the contracting companies. Someone could speculate the price per ZEV credit (or "ZEV Vehicle Value" starting in 2026MY) is proportional to the non-compliance penalty, which is up to $50,000 per vehicle in Illinois if the rules are adopted, or about $25,000 per vehicle in California. However, this is purely speculative and ignores many other factors that would be involved, such as the available supply and demand of credits.

2. ***At the first hearing in this rulemaking, Rule Proponents' witness testified:***

So, I think it's important to clarify that [the ACC II rules] will not limit the sale of plug-in hybrid electric vehicles. It will just limit the amount that they can be counted towards compliance. So, if manufacturers are seeing profit in that market, they can sell as many as they like. But only 20 percent of the total sales can be attributed to credits

> ***coming from plug-in hybrid EVs. So, no, there is necessarily no limitation on how many they can sell, or the Board would not be limiting how many plug-in hybrid EVs they can sell. [Transcript of December 2, 2024, Hearing at 169:6-15.]***

In your testimony, you state, "Proponents of ACC II have claimed the policy is somehow technologically neutral and will not limit the market to only EVs. While there is a very limited option to sell advanced, long-range plug-in hybrid electric vehicles (PHEVs), of which no current PHEVs can comply, this policy will ultimately ban combustion engine vehicles and even advanced hybrids (about 92 percent of the vehicles currently being purchased in Illinois)." [R24-17, Pre-Filed Testimony of Steven Douglas in Opposition of Rule Proponents' Regulatory Proposal, January 21, 2025, at 5.]

Please elaborate on how the ACC II rules could, in practice, limit the sale of plug-in hybrid electric vehicles.

Pre-filed Answer: Please note the comment states the regulation will ultimately ban combustion engine vehicles and even advanced hybrids. Speaking specifically to plug-in hybrid electric vehicles (PHEVs), the ACC II rules specifically require that no less than 80% of all new vehicles must be BEVs in 2035 MY. Thus, in 2035, no more than 20 percent of new vehicles sold could be PHEVs. The following table shows the maximum portion of PHEVs if automakers stopped selling conventional combustion or hybrid electric vehicles - which make up 92 percent of the vehicles purchased in Illinois last year. However, no current PHEVs meet the ACC II PHEV requirements defined in 1962.4(e) to fulfill any portion of the ZEV requirement.

Table 1: Maximum PHEVs

MY	ZEV Mandate	Max PHEV*
2029	59%	53%
2030	68%	46%
2031	76%	39%
2032	82%	34%
2033	88%	30%
2034	94%	25%
2035	100%	20%

**Assumes automakers stop selling all other gasoline vehicles*

3. ***Do you agree with Rule Proponent Natural Resources Defense Council's previous statement that plug-in hybrid electric vehicles "have the potential to improve air quality and to substantially contribute to meeting . . . long term GHG reduction goals of 80% below 1990 levels by 2050"? [See Environmental Assessment of Plug-In Hybrid Electric Vehicles Volume 1: Nationwide Greenhouse Gas Emission (July 2007), available at https://www.energy.gov/sites/prod/files/oeprod/DocumentsandMedia/EPRI-NRDC_PHEV_GHG_report.pdf, at PDF page 14 (last accessed Feb. 17, 2025).]***

Pre-filed Answer: Yes.

<u>RULE PROPONENTS</u>

<u>Pre-Filed Questions to Steven Douglas</u>

1. ***Please refer to page 4 of your testimony, stating "The Auto Innovators respectfully recommends the Illinois Pollution Control Board (IPCB) not adopt California's ACC II regulations."***

a. ***Please confirm that your testimony and analysis only address the ACC II rule and not the proposed ACT or Low NOx rules. For any answer other than an unqualified confirmation, please provide a full explanation.***

<u>Pre-filed Answer</u>: The testimony takes no position on ACT or Low NOx rules.

b. Do you oppose the ACC II rule in its entirety, or only the portion of the rule requiring manufacturers to meet annual ZEV sales requirements?

<u>Pre-filed Answer</u>: We oppose the ZEV mandate portion of the ACC II rule.

2. ***Please provide, in native format with all formulas intact, all workpapers, calculations, sources, and analyses that support all Figures and numerical values provided in your testimony.***

<u>Pre-filed Answer</u>: The spreadsheet used to calculate all figures and numerical values provided in Steven Douglas' pre-filed testimony is being provided in native format (Excel) via email, as **<u>Exhibit B</u>**, to those on the service list for this rulemaking.

3. ***Please state whether you were compensated to prepare and offer your testimony in this proceeding. If yes, please state the amount of the compensation and identify the party that has or is offering payment to you in exchange for your testimony.***

Pre-filed Answer: I have been retained as a consultant for the Alliance for Automotive Innovation since November 2023. I received no additional compensation for this testimony.

4. ***Please refer to page 4 of your testimony, stating "The ACC II ZEV mandate will quickly eliminate new vehicle choices for Illinois families, farmers, and businesses."***

> **a.** ***Do you dispute that the proposed ACC II rule imposes compliance obligations only on vehicle manufacturers, and not on consumers? If you do, please provide a full explanation.***
>
> **Pre-filed Answer**: Henry Ford once said, "Any customer can have a car painted any color that he wants so long as it is black." There was no obligation for customers to buy a black vehicle, but they could not buy anything else.
>
> Likewise, the ACC II rule ultimately says, "Any customer can have any vehicle technology she or he wants, so long as it's a ZEV." There is no obligation for customers to purchase ZEVs, but they cannot buy anything else, starting in 2035, and their options are limited as soon as the ACC II regulation is implemented.
>
> Suggesting that customers have the choice to buy any vehicle, while prohibiting manufacturers from selling anything but ZEVs, is illogical.
>
> Can a customer buy a new non-ZEV in 2035? No. Why? The ZEV mandate prohibits a manufacturer from selling a non-ZEV in 2035. Can all customers buy

new non-ZEVs in 2029 under these rules? No. The ACC II regulations require that 59 out of 100 new vehicles sold must be ZEVs.

b. ***Do you dispute that the proposed ACC II rule applies only to new vehicles, and does not affect customers' choice regarding used vehicle purchases? If you do, please provide a full explanation.***

Pre-filed Answer: The rules only apply to new vehicles. However, the availability of new vehicles clearly impacts the availability – and cost – of used vehicles.

c. ***How is your statement that the "ACC II ZEV mandate will quickly eliminate new vehicle choices for Illinois families, farmers, and businesses" consistent with your statements that "our members have invested hundreds of billions of dollars to provide a range of great EV choices" (p. 5), that "[a]utomakers are offering a wide range of EV styles and types to meet diverse consumer needs" (p. 7), and that "[t]his extensive variety ensures that there is an EV for nearly every consumer segment" (p. 7)?***

Pre-filed Answer: Two things can be true at the same time, and in this case, the multiple statements noted are true. The ZEV mandate is a quota system where an automaker must sell a specific and increasing number of EVs for every gasoline vehicle it sells. Consequently, if we assume ZEV sales increase 20 percent every year starting this year, automakers will need to eliminate more than 80 percent of gasoline vehicle sales to comply with the 59 percent mandate in the first year of implementation. Despite the expanded BEV and PHEV offerings that automakers have invested in and that are available for customers today, customers are not choosing the technology in nearly sufficient volume. This could be due to many factors such as availability of home charging, availability and reliability of public charging infrastructure, cost of technology, perceived obsolescence of technology, necessity to haul heavy goods, tow, or travel long distances, fleet purchasing conditions, repair concerns, etc.

5. ***Please refer to page 7 of your testimony, describing "concerns that if a state does not adopt California's ZEV mandate, automakers may limit the availability of EV models most in demand in those states" as "unfounded" and page 8, Figure 1 of your testimony, comparing ZEV market share in Illinois, Washington, New York, and Maine.***

a. ***Do you agree that ACC II requires a significantly greater level of ZEV deployment than ACC I, which, as you state at page 15 of your testimony, allows vehicles to generate up to 4 ZEV credits per vehicle? If you disagree, please provide a full explanation.***

Pre-filed Answer: Yes, the ACC II ZEV mandate bans the sale of new conventional hybrid vehicles and traditional gasoline vehicles by 2035 and severely restricts their sales as soon as the regulations are implemented.

b. ***Do you agree that if ACC II requires a significantly greater level of ZEV deployment than ACC I, manufacturers are more likely to have fewer excess ZEVs that are not required for compliance in Section 177 states and that can be delivered to non-Section 177 states? If you disagree, please provide a full explanation.***

Pre-filed Answer: To my knowledge, any customer in any state can purchase any new ZEV. I believe this will continue in the future. The ZEV mandate ultimately bans the manufacturer from delivering non-ZEVs for sale in a state in 2035 and severely restricts the sale of new non-ZEVs as soon as the regulations are implemented.

c. ***Do you agree that no state has yet had an opportunity to implement the ACC II rule's ZEV requirements, which apply to model year 2026 (calendar year 2025) at the earliest and for which U.S. EPA only recently issued a waiver of preemption permitting California and other adopting states to enforce the rule? If you disagree, please provide a full explanation.***

Pre-filed Answer: We are now in calendar year 2025. As the question suggests, model year 2026 can start as early as January 2, 2025, and many model year changeovers occur roughly mid-year. Thus, California and the states that follow California have just started implementing ACC II.

d. ***Did the Alliance for Automotive Innovation oppose adoption of ACC II in Washington, New York, and/or Maine? Please provide all documentation of the Alliance's participation in each of those states' proceedings.***

Pre-filed Answer: Maine (like Connecticut, Virginia, Minnesota, and Nevada) chose not to adopt ACC II.

Auto Innovators comments to Maine noted, "The challenge of reaching the CARB ACC II mandate of 43% in 2027 to 82% EV market share by 2032, requires Maine to address several hurdles to consumer acceptance. In Maine, EV sales must increase more than seven-fold in four model years. These are staggering required sales increases for a new technology that relies heavily on customer acceptance and market readiness."[4] On March 20, 2024, the Maine Board of Environmental Protection voted 4-2 to reject a proposal to implement the ACC II regulations and directed staff to terminate further rulemaking on ACC II.[5]

New York and Washington adopted ACC II on a very abbreviated timeline. In fact, New York used emergency rulemaking. The ACC II regulations were approved by California on November 30, 2022, Washington adopted ACC II within 18 days and New York within 29 days. Auto Innovators commented to the state of Washington that they face significant challenges to adopting ACC II due to lack of infrastructure, vehicle and other incentives.[6]

It is worth comparing the circumstances in late-2022 and 2023 with those we find ourselves in today. During those years, the EV market was climbing rapidly, the Infrastructure Investment and Jobs Act (IIJA, 2021) and the Inflation Reduction Act (IRA, 2022) had recently passed promising billions in funding for EV charging infrastructure, EV incentives or tax credits, and billions more for EV manufacturing and battery production. Today, however, the EV market has stalled nationwide (and in virtually every state) and the funding associated with IIJA and the IRA incentives are either paused or threatened.

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[4] Miller. T (2023, August 17). *Comments on the state of Maine Chapter 127A draft rule* [letter]. Alliance for Automotive Innovation, attached hereto as **Exhibit C**.
[5] Maine Department of Environmental Protection, 2024 BEP Legislative Report at 8-9 (2024), attached hereto as **Exhibit D** and publicly accessible at https://www.maine.gov/dep/bep/legislative-reports/2024%20BEP%20Legislative%20Report.pdf.
[6] Miller, T. (2022, October 19). *Comments to the State of Washington on Chapter 173-423-WAC- Clean Vehicles Program*. Alliance for Automotive Innovation, attached hereto as **Exhibit E**.

e. ***Do you dispute that ERM's analysis assumes Illinois will receive a proportional share of the clean vehicles deployed to meet federal emission standards? If you do, please provide a full explanation.***

<u>Pre-filed Answer</u>: ERM's analysis appears to assume that Illinois will receive a proportional share of ZEVs deployed to meet the Federal EPA regulations (i.e., 43% ZEV in 2029MY, 66% in 2032), based on Proponents Statement of Reasons, Exhibit 4, at 144 under the "beginning with MY 2029 baseline" scenario.

f. ***Do you dispute ERM's finding that adopting the proposed ACC II rule in Illinois will increase EV sales in Illinois, compared to a baseline where Illinois receives a proportional share of the clean vehicles deployed to meet federal emission standards (i.e., a baseline where automakers do not "limit the availability of EV models most in demand" in Illinois)? If you do, please provide a full explanation.***

<u>Pre-filed Answer</u>: The ACC II ZEV mandate is a quota system that requires the manufacturer to sell a specific number of ZEVs for every non-ZEV sold. It is true that the ACC II ZEV mandate requires a higher percentage of ZEVs than the federal EPA regulations. While the higher percentage ZEV requirement might be met with higher ZEV sales, it might also be met by selling fewer hybrid and gas-powered vehicles. The latter option might be a more reasonable option given the extremely high and ever-increasing ZEV mandate sales requirements, combined with lackluster consumer demand for EVs.

6. ***Please refer to page 9 of your testimony, stating "If Illinois wishes to accelerate its EV market, it should follow Colorado's lead."***

a. ***Are you aware that Colorado adopted the Advanced Clean Cars I standards in 2019, and in 2023 adopted the Advanced Clean Trucks and Low NOx rules, and the Advanced Clean Cars II rule through model year 2032?***

Pre-filed Answer: Yes.

b. ***Did the Alliance for Automotive Innovation oppose adoption of ACC II in Colorado or California? Please provide all documentation of the Alliance's participation in each of those states' proceedings.***

Pre-filed Answer: All Auto Innovators comments on California's ACC II regulations ("45-Day") and on the "15-Day changes" to those regulations can be found at the California Air Resources Board website at https://www.arb.ca.gov/lispub/comm/iframe_bccommlog.php?listname=accii2022.

Auto Innovators did not oppose the ACC II regulations in California. However, it noted, "[a]utomakers will work to meet the standards CARB ultimately adopts, but the proposed requirements will be *extremely challenging* even in California. These standards may not be achievable in all the states that currently follow California's program." (emphasis added). After these comments, ZEV sales have plateaued across the country and the funding for incentives and infrastructure in the IIJA and IRA is either paused or threatened as noted above in response to 5.d.

We supported Colorado's transformation to electrification without specifically supporting its adoption of the ACC II program and continue working with them to support EVs through infrastructure and incentives.[7]

At the same time, the auto industry, has worked with the state legislatures, agencies, the governors and policy makers throughout the U.S. to expedite charging infrastructure deployment, offer state-based incentives, and identify additional financial and non-financial incentives to expand the ZEV market. A whole government approach is necessary to build a growing, vibrant, and robust ZEV market.

c. ***Does Alliance for Automotive Innovation presently support implementation of ACC II in Colorado for MYs 2027–2032?***

Pre-filed Answer: Colorado has adopted ACC II, so the meaning of the question is unclear. Nonetheless, we support and applaud the work of the Colorado legislature, governor, and the governor's administration to build out Colorado's infrastructure, provide substantial and sustained incentives, vehicle rebates, and education throughout the state. These efforts resulted in their ZEV market share outpacing California in Q4 2024.

d. ***Does the Alliance for Automotive Innovation presently support implementation of ACC II in California for MYs 2026–2035?***

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[7] Miller, T. (2023, October 1). *Comments to the State of Colorado on Regulation 20, Advanced Clean Cars II* [Letter]. Alliance for Automotive Innovation, attached hereto as **Exhibit F**.

Pre-filed Answer: Again, California adopted ACC II, so the meaning of the question is unclear. We support and applaud the work by California to build out the infrastructure, provide substantial and sustained incentives, vehicle rebates, building codes to ensure infrastructure at businesses, and in single- and multi-family homes, and education throughout the state. Of note, Auto Innovators supports these actions regardless of whether a state has or has not adopted the ZEV mandate.

Nonetheless, ZEV sales have plateaued over the past year leading to concern with ZEV compliance in California and even more so in states that have adopted the California ZEV mandate.

7. ***Please refer to page 10 of your testimony, stating "EPA projects that compliance with their newly adopted GHG standards will result in 50 percent ZEVs in 2030MY and 72 percent in 2032MY nationwide."***

a. ***Are you aware that the current Trump Administration has indicated it intends to rescind and replace EPA's current multi-pollutant tailpipe emission standards?***

Pre-filed Answer: I am not aware of any specific comments where the current Trump Administration has indicated it intends to specifically rescind and replace EPA standards at this time. President Trump's Executive Orders have generally provided broad direction to the agencies regarding administration priorities without naming specific actions to take, and to the best of my knowledge, the EPA Administrator has not directed EPA staff to revise any specific regulation at this time. Any regulatory changes will be subject to notice and comment rulemaking during which the proponents and stakeholders can provide comments and recommendations.

b. ***Are you aware that in 2020, the first Trump Administration rescinded the Obama Administration's EPA GHG tailpipe emission standards and enacted weaker standards?***

Pre-filed Answer: Yes.

8. ***Please refer to page 12 of your testimony, stating "the total 50-State GHG emissions are unchanged by states adopting California's ACC II requirements."***

a. ***Do you dispute that adopting the proposed ACC II rule in Illinois will reduce Illinois' GHG emissions, as indicated by ERM's analysis? If you do, please provide a full explanation.***

Pre-filed Answer: Yes. GHG emissions are controlled by a fleet average. California's GHG regulation was adopted in 2012 and has not been updated since, and the current (2026MY) California fleet average is less stringent than the current (2026MY) federal EPA fleet average, which was adopted in December 2021.

b. ***Do you dispute that a reduction in Illinois' GHG emissions would help achieve Illinois' state-specific decarbonization targets, including Governor Pritzker's commitment to meeting the Paris Agreement target of net zero emissions by 2050? If you do, please provide a full explanation.***

Pre-filed Answer: See the response to 8.a. above.

c. ***Do you dispute that enacting policies to reduce GHG emissions in Illinois will help maintain and strengthen Illinois' position as a leader on decarbonization policy? If you do, please provide a full explanation.***

<u>Pre-filed Answer</u>: See the response to 8.a. above.

d. ***Do you dispute that adopting the proposed ACC II rule in Illinois will increase EV sales in Illinois, as indicated by ERM's analysis? If you do, please provide a full explanation.***

<u>Pre-filed Answer</u>: Yes. If an automaker stopped selling all gasoline cars tomorrow, they would be at 100% ZEV without selling any additional ZEVs. As noted in 5.f. above, the ACC II ZEV mandate is a quota system that requires the manufacturer to sell a specific number of ZEVs for every non-ZEV sold. Adopting the proposed ACC II rule will require a *higher percentage of ZEVs* than the federal EPA regulations. That higher percentage can be met by selling more EVs, or by selling fewer hybrid and gas-powered vehicles, or a combination of both.

e. ***Do you dispute that the increasing EV sales in Illinois will help achieve the statutory target of achieving one million EVs on Illinois' roads by 2030? If you do, please provide a full explanation.***

<u>Pre-filed Answer</u>: This appears to be a math or maybe a logic question. It's certainly true that selling more EVs results in more EVs. However, improving customer acceptance of EVs by addressing costs, refueling concerns and other roadblocks is better than a percentage-based mandate that would eliminate consumer choice.

f. ***Do you dispute that states' adoption of ZEV standards has contributed to technological and market developments that have improved the availability, quality,***

and cost competitiveness of ZEVs nationwide? If you do, please provide a full explanation.

<u>Pre-filed Answer</u>: California's adoption of a ZEV mandate certainly contributed to initial technological and market development. However, whether other states' adopting California's program contributed to this is more questionable. Moreover, the path toward today's EVs and EV market was neither smooth, certain, nor inexpensive. The regulations at first focused on battery electric vehicles (BEVs), then when those did not work, on super ultra-low emission gasoline vehicles (SULEVs), then on hydrogen fuel cell electric vehicles (FCEVs), then on plug-in hybrid electric vehicles (PHEVs). Now, the regulation is a combination of FCEVs, BEVs, and PHEVs.

The more important question is whether a mandate in Illinois will result in greater availability and sales of such vehicles. The similarity of EV sales rates in some states that have adopted the ZEV mandate compared to states that have not, suggests the ZEV mandate is not the primary driver of the EV success in a state.

9. ***Please refer to pages 14–15 of your testimony, stating "Assuming ICE vehicles meet the same NMOG+NOx emission levels federally as in California, the EPA program requires automakers to produce 50% BEVs by 2032MY."***

a. ***Do you agree that if ICE vehicles meet the same NMOG+NOx emission levels federally as in states that adopt ACC II, and ACC II requires more than 50% of new vehicle sales to be ZEVs in a given model year, then ACC II will reduce***

tailpipe NMOG+NOx emissions relative to the federal standards in that model year? If you disagree, please provide a full explanation.

Pre-filed Answer: Yes, as ZEV sales increase, and assuming the fleet meets the same NMOG+NOx fleet average under ACC II, new vehicle fleet emissions for that model year will decline. However, fleet turnover (replacing older, higher polluting vehicles, especially poorly maintained ones) is much more important than just the new vehicle NMOG+NOx emissions. To the extent the ZEV mandate reduces fleet turnover because of lack of availability or higher prices, total fleet emissions (including both the new vehicles and the used vehicle) could be higher rather than lower.

b. Do you agree that ACC II requires more than 50% of new vehicle sales to be ZEVs in MY 2029 and beyond? If you disagree, please provide a full explanation.

Pre-filed Answer: Yes.

10. ***Please refer to page 14 of your testimony, stating "EPA's criteria emission program . . . is more stringent than California's, so adopting California will not result in any criteria emission benefits."***

a. Do you dispute that a ZEV produces zero tailpipe criteria emissions? If you do, please provide a full explanation.

Pre-filed Answer: No, BEVs and FCEVs produce zero tailpipe criteria emissions.

b. ***Do you dispute that as ACC II requires more new vehicles to be ZEVs, fleetwide criteria emissions from new vehicles will decrease if criteria emission standards for ICE vehicles are held constant? If you do, please provide a full explanation.***

Pre-filed Answer: No, the emissions from the new vehicle fleet will be lower, but as noted in 9.a. above the total fleet emissions could be higher to the extent drivers keep their older, higher-polluting cars longer.

c. ***Do you dispute that ERM's analysis of the proposed ACC II rule accounted for the new EPA standards in its baseline? If you do, please provide a full explanation.***

Pre-filed Answer: We do not dispute that the Statement of Reasons referenced in this question[8] states that ERM's analysis of the proposed ACC II rule accounted for the new EPA standards in its baseline.

d. ***Do you dispute ERM's finding that compared to the new EPA standards, adopting ACC II will reduce Illinois' 2050 light-duty vehicle NOx emissions by up to 82% and its PM2.5 emissions by up to 80%?21 If you do, please provide a full explanation.***

Pre-filed Answer: Yes, the ERM analysis appears to ignore the NMOG+NOx fleet averaging, banking, and trading at a national level, the movement of used vehicles into the state, and the potential for Illinois drivers to keep older higher-emitting cars longer. See the response to 9.a. above.

11. ***Please refer to pages 19–24 of your testimony regarding manufacturers' expected use of the ACC II rule's flexibilities, and specifically Figures 5 and 6.***

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[8] *See* Statement of Reasons, PCB R 24-17 at 12–13 & n.16, 34–35.

a. ***Does your testimony address or account for manufacturers' ability to carry forward a credit deficit for up to three years. For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: Yes, the testimony recognizes carry forward. However, carry-forward is not a compliance mechanism. The provision simply moves the deficit problem to later years, compounding the problem by assuming ZEV sales will increase substantially more than required in subsequent years. This is the equivalent of getting a new credit card to pay off the debt from another credit card. This does not solve the problem – it only exacerbates it. The solution to credit card debt is to dramatically cut back spending – or, in the case of the ZEV mandate, dramatically reduce the sales of non-ZEVs.

b. ***Do you agree that if manufacturers decide to make limited use of the available ACC II compliance flexibilities, it is because they have determined that another compliance pathway is more attractive? If you do not agree, please provide a full explanation.***

Pre-filed Answer: There are currently no "attractive" compliance pathways. Credits and flexibilities are capped and are of limited use when a state such as Illinois is currently so far away from the level of ZEV sales required under the ZEV mandate. The most likely pathway is to severely restrict the sale of gasoline vehicles to meet the ZEV mandate quotas.

c. ***Do you dispute that ERM's analysis of the "ACC II Flex" scenario does not assume that manufacturers will use the maximum amount of all available***

compliance flexibilities, but instead is "based on projections provided by Shulock Consulting [to provide] a reasonable midpoint estimate of ZEV placements"? If you do, please provide a full explanation.

Pre-filed Answer: We could not locate the referenced "projections provided by Shulock Consulting." Regardless of whether the ERM estimates are set at the maximum theoretical level or some other midpoint deemed "reasonable" by Shulock Consulting, they are vastly higher than will ever be used. For example, in 2029MY, the ERM analysis (Rule Proponents Statement of Reasons at 144) seems to assume that flexibilities will reduce the 59% requirement by 20% without explaining which flexibilities will be used and to what extent.

d. ***Do you dispute ERM's finding that under the "ACC II Flex" scenario, implementing ACC II rule starting in MY2029 will produce $50 million in cumulative net societal benefits including $40 million in ZEV owner savings by 2029, and that these net benefits will grow to $74.6 billion including $54.6 billion in ZEV owner savings by 2050? If you do, please provide a full explanation.***

Pre-filed Answer: I do not have the expertise to determine societal and owner benefits. I will note that low-income communities, without access to reliable, convenient, low-cost home charging, are likely to be left behind and paying for at least a portion of these societal and owner benefits.

e. ***Do you dispute that ERM's analysis of the "ACC II Full" scenario assumes that manufacturers do not use any of the compliance flexibilities available through the ACC II rule? If you do, please provide a full explanation.***

Pre-filed Answer: This seems to be the very definition of the ACC II Full scenario, "Illinois adopts California's ACC II regulation and manufacturers do not use any of the compliance flexibilities."[9]

f. ***Do you dispute ERM's finding that under the "ACC II Full + Clean Grid" scenario, implementing the ACC II rule starting in MY2029 will produce $520 million in cumulative net societal benefits including $160 million in ZEV owner savings by 2029, and that these net benefits will grow to $80.2 billion including $57 billion in ZEV owner savings by 2050? If you do, please provide a full explanation.***

Pre-filed Answer: Again, I do not have the expertise to calculate the societal or owner benefits. However, looking at the trend of the last two questions, it seems ERM's model would show the maximum societal and owner benefits by immediately banning hybrid and gasoline cars and trucks.

g. ***Please confirm that the extent to which manufacturers take advantage of the ACC II rule's compliance flexibilities, and the corresponding percentage of ZEV sales, shown for each model year in Figures 5 and 6 of your testimony falls between the "ACC II Flex" and the "ACC II Full" scenarios analyzed by ERM. For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: No, the "ACC II Flex" clearly falls outside of Figures 5 and 6. Note that Figure 6 is simply a detailed table. Figure 5 plots the "Minimum Actual

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[9] *Id*. at 107.

ZEV requirement" and "ZEV Mandate" from the table in Figure 6. Of course, ACC II Full is simply the ZEV mandate without any flexibilities, so it shows greater ZEV requirements than would be expected with some use of flexibilities.

12. ***Please refer to page 20 of your testimony, stating that the use of "converted credits" from ACC I is not available as a compliance flexibility in Illinois.***

a. ***Are you aware that the Rule Proponents are open to including a one-time credit allotment based on manufacturers' ACC I vehicle values?***

Pre-filed Answer: No. We have not received any details on this "one-time allotment." Moreover, the proposed rule begins three years after ACC I sunsets and long after ACC I credits have been converted (and probably used). Adding a "one-time credit allotment based on manufacturers' ACC I vehicle values" does not make sense in this context. Finally, the Rule Proponents seem confident automakers can meet the "ACC II Full" so it is unclear why they would suggest this.

b. ***Please confirm that if such a one-time credit allotment were implemented in Illinois, it would not be the case that a compliance flexibility based on converted ACC I credits "is not available in Illinois." For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: It is an undisputed fact that converted credits are not available in the proposed rule. However, this question seems to ask, "If they were available, would they be available?" Thus, if these were available, it seems they would be available.

13. ***Please refer to page 22 of your testimony, stating that you are not aware of anything in Illinois that is "similar in scope or scale" to California's funding and vetting of community-based clean mobility programs.***

a. ***Are you aware that Section 242.102 of the proposed rule would define "Community-Based Clean Mobility Program" to include programs that serve equity investment eligible communities as defined in Illinois by 20 ILCS 627/45(b)?***

Pre-filed Answer: Yes.

b. ***Are you aware that 20 ILCS 627/45 provides for multiple forms of funding, vetting, and support for equity investment eligible communities, including a requirement that the Illinois Commerce Commission consider whether electric utilities' Beneficial Electrification Plans "ensur[e] there are significant opportunities for residents and businesses in eligible communities to directly participate in and benefit from beneficial electrification programs" and whether the Plans provide "at least a 40% investment of make-ready infrastructure incentives to facilitate the rapid deployment of charging equipment in or serving environmental justice, low-income, and eligible communities"?***

Pre-filed Answer: Yes.

c. ***Are you aware that Illinois has developed multiple resources to vet and support equity investment eligible communities, including an Equity Investment Eligible Community Map28 and an Energy Workforce Equity Portal?***

Pre-filed Answer: Yes, and we applaud the efforts of Illinois in this area. However, none of these programs match California with the programs that have existed for many years, have multi-step vetting processes, and provide $100s of millions of dollars in funding.

14. ***Please refer to Figure 4 on page 16 of your testimony and Figure 13 on page 37 of your testimony.***

a. ***Please confirm that the overall 2024 market share of ZEVs in Illinois is 7.7% as indicated in Figure 13, rather than 4.5% as indicated in Figure 4 (which excludes Tesla's ZEV sales). For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: As noted in Figure 4 of my testimony, the Illinois ZEV market share excluding Tesla is 4.5%. The Illinois ZEV market share including Tesla is 7.7%. However, it is important to understand the sales from manufacturers excluding Tesla, because those manufacturers will need to take market actions to increase ZEV sales, to purchase credits from Tesla, and/or to decrease gas vehicle sales to comply with the mandate. Traditional manufacturers will suffer the penalties if the Illinois ZEV market does not expand dramatically in the next three years, and then continue to expand dramatically in subsequent years.

b. ***Please confirm that your projection for the increase in ZEV sales that manufacturers will collectively need to achieve in Illinois by MY 2029 under ACC II is the approximately 620% increase from 7.7% to 55% reflected in Figure 13,***

rather than the approximately 1,200% increase from 4.5% to 59%. For any answer other than an unqualified confirmation, please provide a full explanation.

Pre-filed Answer: Automakers excluding Tesla must either increase ZEV sales by 1,233 percent over the next three model years (Figure 4) or buy credits from Tesla and other EV-only automakers. In the latter case, all automakers (including Tesla) must collectively increase sales by 620 percent over the next three model years.

15. ***Please refer to page 36 of your testimony, stating "Meeting the most-likely ZEV mandate scenario with all flexibilities and automakers purchasing credits from Tesla and other EV-only automakers still requires a 620 percent increase from 2024CY ZEV sales (see Figure 13). Such an increase has never happened in history."***

a. ***Are you aware that the ZEV market share in Illinois increased sevenfold from 2016 to 2022?***

Pre-filed Answer: Yes. However, a seven-fold increase starting from 0.4 percent over six years does not compare to a 620% increase starting from 7.7 percent over three years. Sales from 2022-2024 increased by only 10% annually (from 6.3 to 7.7 percent). The Illinois ZEV market share decreased in 2024 compared to 2023.

b. ***Are you aware that ZEV sales in Germany increased by over 760% from 3% in 2019 to 26% in 2021?***

Pre-filed Answer: Yes, but 26 percent is still less than half of the 59 percent ACC II ZEV mandate that would exist if Illinois adopts and implements ACC II in 2029MY. The increase in Germany's ZEV market share was largely due to ZEV incentives of around $10,000 per vehicle. In 2024, BEV sales in Germany plummeted by 27 percent when the incentives ended.[10]

c. ***Are you aware that ZEV sales in California doubled from 12.4% in 2021 to 25% in 2023?***

Pre-filed Answer: Yes, but 25 percent is still less than half of the 59 percent ACC II ZEV mandate if Illinois adopts and implements ACC II in 2029MY. Moreover, ZEV sales in California have hit a plateau at that level and did not significantly increase in 2024.[11]

d. ***Do you agree that upfront ZEV costs, the total cost of ZEV ownership, and the range of available ZEV models are key factors that influence the pace of ZEV market share growth?***

Pre-filed Answer: Upfront ZEV costs and the availability of tax credits and incentives are certainly significant factors for growing the market. For example, JD Power[12] found that 64 percent of premium-brand EV owners and almost 50 percent of mass-market EVs said tax credits and other incentives were a primary driver of their decision to buy an EV. Given the range of current ZEV models, expanded ZEV model availability is probably a much less significant factor for ZEV market growth.

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[10] Best Selling Cars. (2025, January 30). *2024 (Full Year) Germany: Best-selling electric cars by brand and model*, attached hereto as **Exhibit G** and publicly accessible at https://www.best-selling-cars.com/germany/2024-full-year-germany-best-selling-electric-cars-by-brand-and-model/.

[11] California Energy Commission. (n.d.). *New ZEV sales*. California Energy Commission, attached hereto as **Exhibit H** and publicly accessible at https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics-collection/new-zev.

[12] JD Power. (2023, February 20). EV sales growth will stagnate in 2025, J.D. Power says. *Automotive News*, attached hereto as **Exhibit I**.

Although not mentioned in the question, infrastructure availability (home and public) and reliability (public) are more critical factors.

e. ***Please confirm that your testimony does not include any comparison of the total cost of ownership between ZEV and ICE vehicles, or any response to ERM's finding that "a ZEV purchased in MY 2028 will save about $20,000 in lifetime vehicle costs compared to a combustion engine vehicle." For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: First, consumers do not make large purchases based on the 5-year total cost of ownership. They look at monthly affordability. Nonetheless, the ERM projection of a customer buying a 2028 MY ZEV saving $20,000 compared to a gas vehicle seems questionable with problematic assumptions. For example, affluent single-family homeowners with home charging will certainly pay significantly less for fuel (electricity vs gasoline), but a low-income resident in a multi-family home without home charging could pay substantially more when compared to an efficient 50 mpg hybrid electric vehicle like the Toyota Camry Hybrid LE or Honda Accord Hybrid (which will be banned in 2035 under ACC II). Moreover, this ignores the value of time and inconvenience for low-income customers without access to home charging.

f. ***Please confirm that your testimony does not include any projections of future trends in the upfront cost of ZEVs, or any response to ERM's finding that "By MY 2030, a ZEV is expected to cost $3,000 less than a gas-powered vehicle, yielding upfront savings even with charger costs added and without purchase incentives."***

For any answer other than an unqualified confirmation, please provide a full explanation.

Pre-filed Answer: No, my testimony did not include any projections of future trends, which could vary considerably based on factors such as tariffs, tax credits, critical mineral supply, etc.

g. ***Please confirm that your testimony does not include any projections of future trends in the number of available ZEV models, or any response to EDF and ERM's projection that by 2025 the number of ZEV models will increase to 197. For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: As of Q3, 2024, there were 125 EV models available including 71 BEVs, 51 PHEVs, and 3 FCEVs. BEVs include 19 cars, 40 utility vehicles, 6 pickup trucks, and 6 vans. PHEVs include 20 cars, 30 utility vehicles, and 1 van. Finally, FCEV models include 1 car and 2 utility vehicles (including one that is a plug-in FCEV).[13] It is possible that manufacturers will introduce 72 new ZEV models by the end of the year, but this seems unlikely. Nonetheless, as noted in response to 15.d, given the range of current ZEV models, additional model availability will probably have minimal impact on ZEV market growth.

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[13] Autos Innovate. (2024). *Get connected: EV quarterly report 2024 Q3*, attached hereto as **Exhibit J** and publicly accessible at https://www.autosinnovate.org/posts/papers-reports/Get%20Connected%20EV%20Quarterly%20Report%202024%20Q3.pdf.

16. ***Please refer to page 25 of your testimony, stating that if ZEV market share grows by 20% every year starting in 2025, automakers would need to eliminate 84% of gasoline vehicle sales in 2029 to comply with ACC II.***

a. ***What is the basis for your assumption that ZEV sales will grow by 20% per year starting in 2025?***

Pre-filed Answer: A 20 percent year-over-year sales growth seemed reasonable given the current market trends. Moreover, 20 percent per year is twice the 10 percent per year mentioned by the Rule Proponents Pre-Filed Answers at 90,

> "*Sales need to increase by about 10 percent per year between 2025 and 2029* in order to reach compliance in MY 2029 for ACC II. *Meanwhile there was a 51% increase in EV registrations from Feb. 2023 to Feb. 2024* according to the Illinois Secretary of State, which was the first year that IRA credits (without the point of sale) were available." (emphasis added)

b. ***How is this assumption consistent with research indicating that technology adoption tends to follow exponential "S-curves," rather than linear trajectories?***

Pre-filed Answer: The exponential "S-curve" adoption is typically for products that offer a new benefit or vastly better experience. For example, telephones allowed people to communicate in real time over vast distances, a dramatic improvement over the telegraph. The more people that had a telephone, the more valuable it became. Over the 80 years between 1900 and 1980, penetration of telephones grew from 10 to 90 percent of U.S. homes.

Personal computers offered the ability to use word processors, spreadsheets, databases, and games, which did not previously exist. Adoption grew from 15 to 80 percent between 1990 and 2010.

Smart phones offered a mobile phone, text messaging, internet, cameras, and a small computer leading to adoption growth from 10 to 85 percent between 2010 and 2018.

All these technological transformations happened without mandates.

EVs certainly offer some advantages over gasoline vehicles, but the differences are not that large. Moreover, EVs come with disadvantages (beyond the initial cost) that consumers consider – primarily related to range and charging infrastructure (both at home and on the road).

c. ***Please confirm that if ZEV sales increase faster than the 20% annual increase you have assumed, automakers would not need to eliminate as many gasoline vehicle sales as you have estimated in order to comply with ACC II. For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: It is true that if EV sales increase faster than 20 percent per year, automakers would need to eliminate fewer gasoline vehicle sales than projected. Of course, the inverse is true as well – if EV sales do not increase by at least 20 percent per year, automakers would need to eliminate more gasoline vehicle sales than projected.

17. ***Please refer to page 29 of your testimony, stating that "In Illinois alone, a report from Illinois Answers estimates that $678 million [of public charging investment] is required to support just one million EVs by 2030."***

a. ***Please confirm that the source you cite for this statement (attached to your testimony as Exhibit K) is a news article that states that Illinois is currently "expected to spend more than $230 million in building out its charging infrastructure." For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: Yes, this is correct.

b. ***Please confirm that the source you cite for this statement in turn cites a Chicago Sun Times article for the statement that Illinois' $230 million in planned charging infrastructure investment is "a portion of the estimated $676 million investment needed to support the goal of having 1 million electric vehicles on Illinois roads at the start of the new decade, environmental groups have warned." Specifically, the cited article is: Manny Ramos, Illinois Gearing Up For Significant Investment In EV Charging Network Along Highways, Chicago Sun Times (updated Aug. 10, 2022), https://chicago.suntimes.com/2022/8/10/23298757/illinois-investment-electric-vehicle-charging-network-infrastructure-climate-change-stations. For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: Yes, this is correct.

c. ***Please confirm that the Chicago Sun Times article cited for this statement attributes the $676 million estimate to the Environmental Defense Fund, stating***

that by EDF's estimates, "the state needs to invest $676 million in publicly accessible EV charging stations to support 1 million electric vehicles on the road — about $425 million more than what the state will get from the feds." For any answer other than an unqualified confirmation, please provide a full explanation.

Pre-filed Answer: Yes, this is correct.

d. ***Are you aware that the $676 million infrastructure investment need estimated by EDF in 2022 includes both light- and heavy-duty charging infrastructure?***

Pre-filed Answer: Yes.

e. ***Are you aware that the $676 million investment need estimated by EDF in 2022 represents a total spending amount, rather than the amount of incremental spending needed to increase ZEV deployment from a baseline level to 1 million ZEVs on the road by 2030?***

Pre-filed Answer: Yes.

f. ***Are you aware that the $676 million infrastructure investment need estimated by EDF in 2022 does not account for existing and planned investments, including over $200 million in federal support and additional investments that have been made since 2022?***

Pre-filed Answer: Yes.

g. ***Are you aware that EDF and Atlas Public Policy have published a report finding that Illinois' estimated charging infrastructure needs to implement the Advanced***

Clean Truck rule—which applies to medium- and heavy-duty vehicles—can be met feasibly?

Pre-filed Answer: Yes.

h. ***Please confirm that your testimony does not include any sources or analysis indicating that the $676 million total charging investment need, described in your Exhibit K, is inconsistent with ERM's estimate that the "ACC II Full + Clean Grid" scenario will result in $351 million in cumulative investment in incremental charging infrastructure by 2030.38 For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: I could not locate the ERM estimate of $351 million in the referenced Rule Proponents Statement of Reasons at 150. There is a $352 million under "beginning in MY 2027" scenario, but it is labeled as "Annual Spending on Chargers by Location and Category."

i. ***Are you aware that ERM's estimated investment in incremental charging infrastructure is accounted for in ERM's estimates of the ACC II rule's net social benefits?***

Pre-filed Answer: Yes.

18. ***Please refer to page 29 of your testimony, where you reference the "Illinois Public Utilities Commission (PUC)." Are you referring to the Illinois Commerce Commission (ICC)?***

Pre-filed Answer: Yes, the Illinois Commerce Commission (ICC) is the correct reference.

19. ***Please refer to page 30 of your testimony, stating that "by 2035, more than 42.2 million charge ports will be necessary nationwide to support the 78.5 million EVs expected on U.S. roads."***

a. ***Please confirm that your testimony does not include any sources or analysis indicating that the expected nationwide need for 42.2 million charge ports is inconsistent with ERM's estimate that the "ACC II Full + Clean Grid" scenario will result in 158,378 incremental charge ports in Illinois by 2030. For any answer other than an unqualified confirmation, please provide a full explanation.***

Pre-filed Answer: The Edison Electric Institute (EEI) report[14] forecasts that 42.2 million charge ports will be needed to support the 78.5 million EVs that EEI forecasts will be on the road in 2035. For 2030, the EEI report states that its analysis would produce substantially similar results to that projected in the National Renewable Energy Lab (NREL) report.[15] The 2030 NREL report (at 41-43) shows that Illinois would need 942,200 private L2 ports, 33,000 public L2 ports, and 5,700 public DCFC ports to support 1.1 million BEV and PHEVs (see

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[14] Edison Electric Institute. (October 2024). *Electric Vehicle Sales and the Charging Infrastructure Required through 2035*, attached hereto as **Exhibit K** and publicly accessible at https://www.eei.org/-/media/Project/EEI/Documents/Issues-and-Policy/Electric-Transportation/EV-Forecast-Infrastructure-Report.pdf?la=en&hash=FF7F1A5913E3B48E8F92FA26E2AFB79FDBE0E89C.

[15] Wood, E., Borlaug, B., Moniot, M., Lee, D., Ge, Y., Yang, F., & Liu, Z. (2023). *The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5400-85654, attached hereto as **Exhibit L** and publicly accessible at https://www.nrel.gov/docs/fy23osti/85654.pdf.

Table 2 below). The number of chargers projected in the ERM study (I could not find the 158,378 mentioned in the question) are substantially lower than those projected by NREL. For example, the ERM study (Rule Proponents Statement of Reasons, at 150) shows 152,733 L2 Home chargers whereas NREL projects a need for 893,000 for single-family homes and another 34,600 for multi-family homes.

Table 2: NREL 2030 Illinois Charging Network for 1.1 million ZEVs

Port Type	Port Location	Number of Ports
Private L2	Single-Family	893,000
Private L2	Multifamily	34,600
Private L2	Workplace	14,600
TOTAL Private L2		**942,200**
Public L2	Neighborhood	11,000
Public L2	Office	5,100
Public L2	Retail	6,000
Public L2	Other	10,900
TOTAL Public L2		**33,000**
Public DCFC	DCFC 150kW	2,000
Public DCFC	DCFC 250kW	2,000
Public DCFC	DCFC 350kW	1,700
TOTAL Public DCFC		**5,700**

20. ***Please refer to page 31 of your testimony, stating that "[i]n Illinois, the residential landscape presents its own set of challenges for expanding charging infrastructure."***

a. ***Are you aware that the General Assembly addressed these challenges in the Electric Vehicle Charging Act, effective January 1, 2024, which provides that "a significant portion of parking spaces in new and renovated residential***

developments shall be capable of electric vehicle charging," and that "renters and condominium unit owners shall be able to install charging equipment for electric vehicles under reasonable conditions"?

<u>Pre-filed Answer</u>: Illinois can be rightfully proud of the Electric Vehicle Charging Act. It is probably the most aggressive EV building code law in the nation that should pave the way for EVs in the future. However, over the period of this regulation, it does not address the challenges identified for the following reasons:

1. It applies only to new construction. Housing typically turns over at about 1 to 2 percent annually. In 10 years (2035) when the ZEV mandate requires 100 percent of new vehicles sold to be ZEVs, only 10 to 20 percent of the housing stock will have been built under the act's requirements – 80 to 90 percent of housing stock will not have the EV-capable spaces, EV-Ready spaces, electric panel capacity, or raceways from the electric panel to the parking space required in the EV Charging Act.
2. As I understand the legislation, the requirement for renovations only applies when multi-family housing is converted into an association by a developer. Even then, it does not apply if the developer would be required to excavate an existing parking lot or facility.
3. Affordable multi-family housing requirements are lower and begin two years later than non-affordable housing. For example, rather than requiring 100 percent of parking spaces to be EV-Capable 90 days after the effective date, affordable

housing requires only 40 percent of parking spaces to be EV-capable starting 2 years after the effective date.

4. The provision giving the tenant a right to install an EV charger will probably not be utilized to any significant extent. If a renter wants to buy an EV and install EV charging, the following would be required:
    a. First, they must receive the landlord's consent, including submitting an agreement in writing to comply with safety/building code requirements and reasonable aesthetic provisions on dimensions placement, or external appearance specified by the landlord.
    b. Hire a licensed electrical contractor.
    c. Pull the appropriate permits from the local government (or ensure the electrical contractor does so).
    d. Coordinate the installation with the landlord, electrical contractor, and possibly other tenants.
    e. Obtain insurance naming the landlord as an additional insured party on the policy.
    f. Pay an additional security deposit to cover restoration of the property to its original condition if the tenant removes the charger.
    g. Possibly pay an additional fee for a dedicated parking spot.

    All of these require substantial effort and come at a substantial cost. It is likely that only affluent diehard EV enthusiasts will go through this process for a rental unit.

b. ***Are you aware that Commonwealth Edison's approved Beneficial Education Plan includes a pilot program, scheduled to launch in Q1 2025, that "[d]emonstrate[s] a modular and scalable curbside charging model that practically addresses gaps in vehicle charger access while optimizing cost, efficiency, and grid operation"?42***

<u>Pre-filed Answer</u>: Yes.

21. ***Please refer to page 32 of your testimony, stating that homes that use natural gas for cooking "will likely have limited electric panel capacity making EV charger installation more complicated and significantly more expensive."***

a. ***Please confirm that your testimony does not include any sources or analysis indicating that there is any particular relationship or correlation between cooking fuel and electric panel capacity. For any answer other than an unqualified confirmation, please provide a full explanation.***

<u>Pre-filed Answer</u>: Correct, my testimony does not contain any sources or analysis indicating a direct correlation.

b. ***Are you aware that a range of load management products are available to enable installation of EV chargers while in many cases avoiding the need for electric panel upgrades?43***

<u>Pre-filed Answer</u>: Yes. However, dynamic load management chargers are typically more expensive to buy and more expensive to install since they require a separate power meter in the electric panel.

c. ***Are you aware that Commonwealth Edison's approved Beneficial Education Plan includes a pilot program, scheduled to launch in Q1 2025, that will explore the use of load control technologies to ensure that EV charging equipment does not exceed the available capacity of homes' existing electric panels?44***

Pre-filed Answer: Yes, this seems like load management chargers.

22. ***Please refer to page 33 of your testimony, stating that "[i]nstalling DCFC stations can and usually does require substantial grid upgrades with exceptionally long lead-times."***

a. ***Are you aware that approximately half of Illinois' 1,352 public DCFC charging ports came online in 2023 or later?45***

Pre-filed Answer: I was not.

b. ***Do you agree that this indicates an accelerating pace of DCFC installations in Illinois?***

Pre-filed Answer: This is certainly laudable progress, but installations will need to accelerate. The pace of installations may accelerate with experience, but they also may slow if the stations recently installed represent "low-hanging fruit" (e.g., locations with easy access to high levels of grid power, low-cost property locations, etc.).

23. ***Please refer to page 33 of your testimony, stating that "a plaza with just ten 350 kW ports would require 3.5 MW of power."***

a. ***Are you aware that Commonwealth Edison maintains an EV Load Capacity Map that shows 3 MW or more of estimated EV hosting capacity in most areas of***

Chicago, Aurora, Joliet, Rockford, and Sterling, and other communities, and 501 kW to 3 MW of estimated EV hosting capacity in most other areas of Commonwealth Edison's service area?46

Pre-filed Answer: Yes. First, there is a world of difference between having the load capacity and delivering power (lines, transformers, etc.) to a specific location. Moreover, it is not clear from the map if the "EV Hosting capacity" means it can deliver 3 MW to 1 station or 10,000 stations. Clearly, there must be a limit.

24. ***Please refer to page 38 of your testimony, stating that "since adopting the ZEV mandate 35 years ago, California has focused on developing the ZEV market."***

a. ***Do you agree that manufacturers of ZEVs and charging infrastructure who have received incentives in California now offer their products in states other than California?***

Pre-filed Answer: Yes.

b. ***Do you agree that California's historical investments in developing the ZEV market have contributed to technological improvements that can now be deployed in states outside of California?***

Pre-filed Answer: It is not clear how their historical investments have contributed to technological improvements. Nonetheless, EVs and EVSEs are now offered in all states.

c. ***Do you agree that California's historical investments in developing the ZEV market have contributed to market development strategies that can now be applied in states outside of California?***

Pre-filed Answer: Yes.

d. ***Do you agree that California's historical investments in developing the ZEV market have contributed to techniques for deploying charging infrastructure that can now be applied in states outside of California?***

Pre-filed Answer: This is not necessarily clear. California spent considerable amounts of resources installing inductive chargers that are now obsolete. Nonetheless, experience from California and other states generally improve charging infrastructure deployment and implementation.

e. ***Do you agree that public education efforts in California have contributed to consumer awareness of ZEVs in states other than California?***

Pre-filed Answer: Maybe indirectly. Public education in California is typically focused on California (e.g., PEV Collaborative, Veloz). To the extent other states use material or model programs on California, it can improve consumer awareness.

25. ***Please refer to pages 9 and 38 of your testimony, stating that Colorado achieved a higher level of ZEV market penetration than California in Q3 2024.***

a. ***Please confirm that your testimony does not include any sources or analysis indicating that Colorado's historical level of investment in ZEV market***

development is comparable to California's. For any answer other than an unqualified confirmation, please provide a full explanation.

Pre-filed Answer: Colorado's historic level of investment is very comparable to California. In fact, over the last few years, Colorado's incentives have been substantially higher and available more consistently and to a broader market, than California's.

Dated: March 3, 2025

Respectfully submitted,

Alliance for Automotive Innovation

By: /s/ *Melissa S. Brown*______
One of Its Attorneys

Melissa S. Brown
HEPLERBROOM, LLC
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Melissa.Brown@heplerbroom.com
PH: (217) 528-3674

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
	)	R 2024-017
PROPOSED CLEAN CAR AND	)	(Rulemaking – Air)
TRUCK STANDARDS: PROPOSED 35 ILL.	)	
ADM. CODE 242	)	

STEVEN DOUGLAS' PRE-FILED ANSWERS TO PRE-FILED QUESTIONS

TABLE OF EXHIBITS

Exhibit Number	Exhibit Title
Exhibit A	Illinois Automobile Dealers Association, Economic impact report (2023)
Exhibit B	Spreadsheet used to calculate all figures and numerical values provided in Steven Douglas' pre-filed testimony
Exhibit C	Alliance for Automotive Innovation, T. Miller, *Comments on the state of Maine Chapter 127A draft rule* (2023, August 17)
Exhibit D	Maine Department of Environmental Protection, 2024 BEP Legislative Report (2024)
Exhibit E	Alliance for Automotive Innovation, T. Miller, *Comments to the State of Washington on Chapter 173-423-WAC- Clean Vehicles Program* (2022, October 19)
Exhibit F	Alliance for Automotive Innovation, T. Miller, *Comments to the State of Colorado on Regulation 20, Advanced Clean Cars II* (2023, October 1)
Exhibit G	*2024 (Full Year) Germany: Best-selling electric cars by brand and model*, Best Selling Cars (2025, January 30)
Exhibit H	*New ZEV sales*, California Energy Commission
Exhibit I	*EV sales growth will stagnate in 2025, J.D. Power says*, Automotive News (2023, February 20)
Exhibit J	*Get connected: EV quarterly report 2024 Q3*, Autos Innovate (2024)
Exhibit K	*Electric Vehicle Sales and the Charging Infrastructure Required through 2035*, Edison Electric Institute (October 2024)

Exhibit L	*The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure*. Wood, E., Borlaug, B., Moniot, M., Lee, D., Ge, Y., Yang, F., & Liu, Z., Golden, CO: National Renewable Energy Laboratory. NREL/TP-5400-85654 (2023)

EXHIBIT A

2023 Illinois
Economic Impact Report

Sponsored by:

ILLINOIS AUTOMOBILE DEALERS ASSOCIATION

EXHIBIT A

Employment

2023 Economic Impact Study

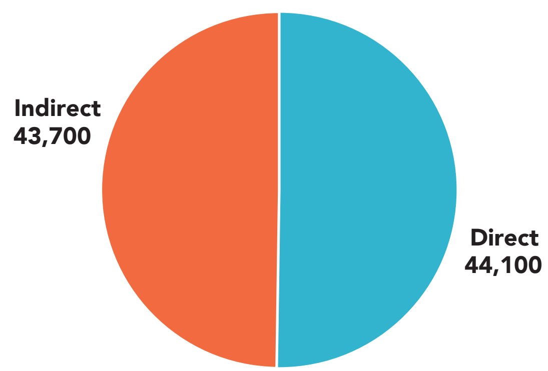
Employment totals for new vehicle retailing industry - 2023
(Direct: at dealerships; Indirect: elsewhere in economy)

Total employment at new car dealerships:
44,100

In 2023, Illinois new vehicle dealerships directly employed a total of 44,100 individuals.

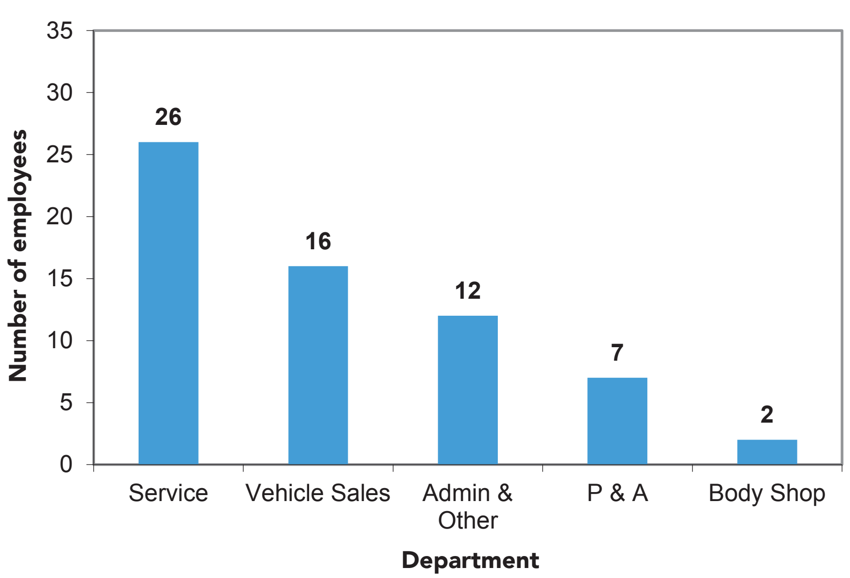
An additional 43,700 individuals were employed due to the indirect impact of dealership operations.

Automobile dealership operations accounted for 15.3% percent of total retail employment in the state. (This included both direct and indirect employment.)



Dealership Contribution to Retail Employment in Illinois - 2023	
Total employment resulting from auto dealerships	87,800
Total retail employment in Illinois	574,700
Dealership percent of state retail employment	**15.3%**

Dealership employment by department



Percentage of Dealership Employment by Department	
Service	41%
Vehicle Sales	26%
Administration & Other	19%
Parts & Accessories	11%
Body Shop	3%

Payroll and Taxes

2023 Economic Impact Study

Employee compensation due to new vehicle retailing industry - 2023

Total compensation at new car dealerships:
$4.04 billion

In 2023, the average Illinois dealership paid $5,180,000 to its employees in salary and compensation and an additional $590,000 in fringe benefits. Including both direct and indirect sources, the new vehicle retailing industry resulted in more than $6.6 billion of total compensation to Illinois residents!

Industry Total	Direct	Indirect	TOTAL
Payroll	$3,626,000,000	$2,320,640,000	$5,946,640,000
Fringe Benefits	$413,000,000	$256,060,000	$669,060,000
TOTAL	**$4,039,000,000**	**$2,576,700,000**	**$6,615,700,000**

Average Dealership Payroll	Direct
Payroll	$5,180,000
Fringe Benefits	$590,000
TOTAL	**$5,770,000**

Tax revenue generation - 2023

Total state and local taxes collected or paid by new car dealerships:
$3.37 billion

In 2023, new franchised automobile dealerships in Illinois collected or paid $3.37 billion in state and local taxes, an average of $4.81 million per dealership.

The industry was responsible for nearly $1 billion in Federal Income and Payroll taxes.

Tax Category	Average Per Dealer	Industry Total
State/Local Sales Taxes collected	$4,290,000	$3,003,000,000
State/Local Payroll Taxes	$270,000	$189,000,000
Real Estate Taxes	$148,000	$103,600,000
Other State/Local Taxes	$102,000	$71,400,000
Illinois Total	**$4,810,000**	**$3,367,000,000**
Federal Payroll Taxes	$1,410,000	$987,000,000

Dealership Sales and Market Trends

Departmental Sales (dollars) - 2023

Total sales by new car dealerships in 2023:

$42.1 billion

Total sales for franchised new vehicle dealerships in Illinois during 2023 exceeded $42 billion. Average dealership sales were $60.1 million, with $29.75 million resulting from new vehicle sales.

Department	Average Per Dealer	Auto Retailing Industry Total
New vehicle	$29,750,000	$20,825,000,000
Used vehicle	$17,430,000	$12,201,000,000
Service and parts	$10,576,000	$7,403,200,000
Other	$2,344,000	$1,640,800,000
Total	**$60,100,000**	**$42,070,000,000**

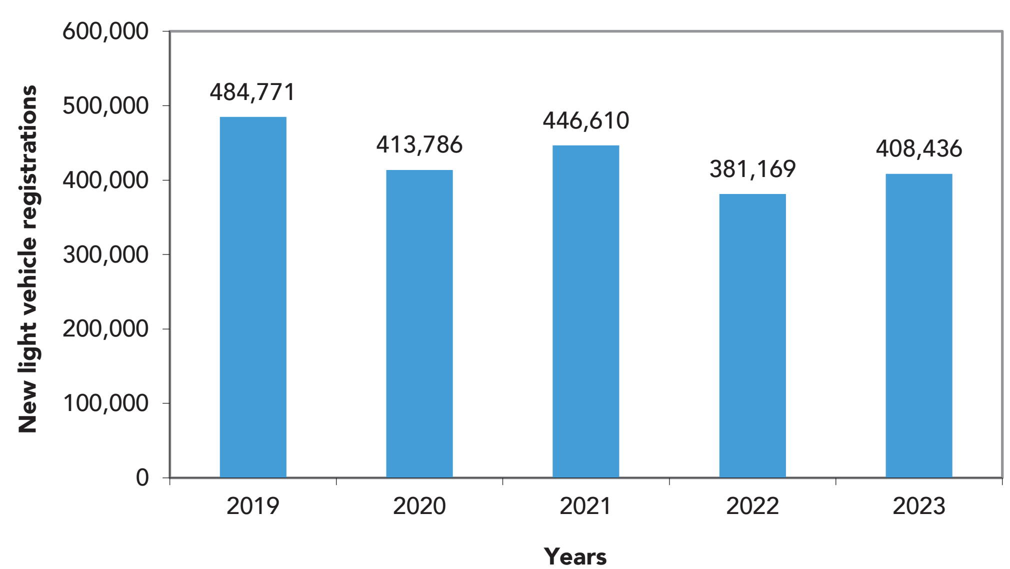
New Retail Car and Light Truck Registrations in Illinois - 2019 thru 2023

New retail registrations in state during 2023:

408,436

As shown on the graph, combined new retail car and light truck registrations in the state declined sharply in 2020 due to the pandemic, improved in 2021, and then fell 14.6% in 2022 as supply chain issues impacted vehicle production. Registrations moved above 400,000 units last year as vehicle inventories recovered.

Data sourced from Experian Automotive.

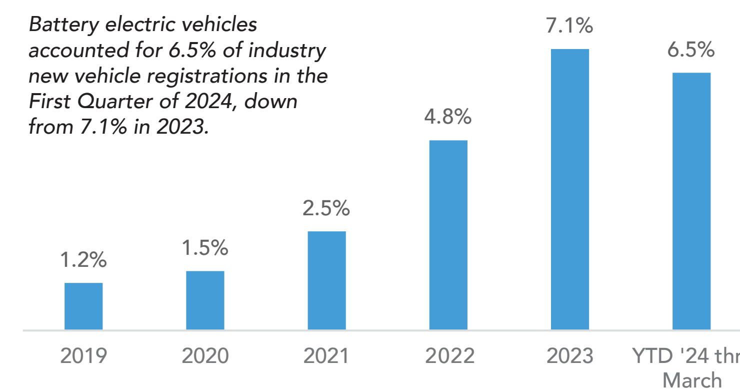


Electric Vehicles

Illinois franchised new vehicle dealerships: Committed to an electric future

Battery electric vehicle (BEV) sales in Illinois increased steadily between 2019 and 2023, before easing in the First Quarter of 2024. Franchised dealerships are accounting for a significantly larger share of the market:

BEV Share of Illinois New Retail Light Vehicle Market

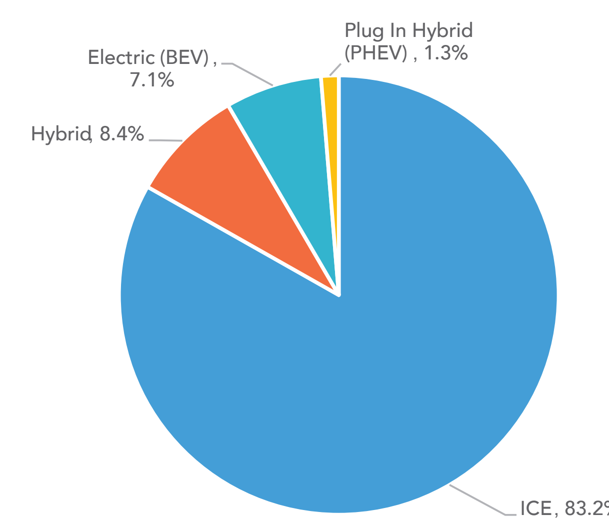


Data sourced from Experian Automotive.

Franchised Dealership Share of State BEV Market in 2019: **11.0%**

Franchised Dealership Share of State BEV Market in 1Q '24: **35.0%**

Market Share for all Powertrain Types - 2023



Data sourced from Experian Automotive.

ICE (internal combustion engine) market share was 83.2% in 2023, down from 96.1% in 2019.

Combined share for BEVs, PHEVs, and hybrids was 16.8% last year, up from just 3.9% in 2019.

Dealerships are making large scale investments to prepare for sale and service of electric vehicles:

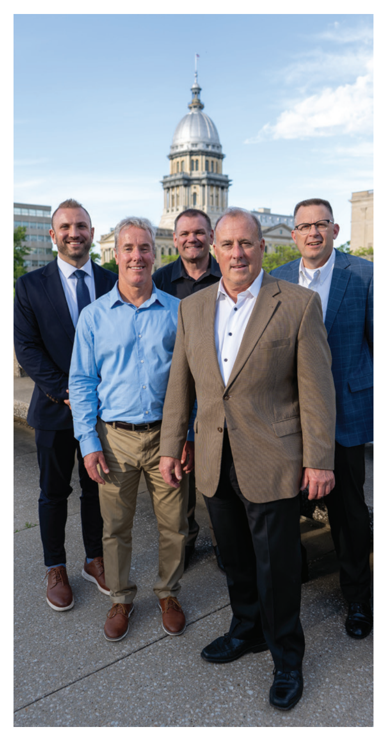
Total estimated dealership expenses between 2022 and 2024 to prepare for the sale and service of electric vehicles: **$171,500,000**

Background and Methodology

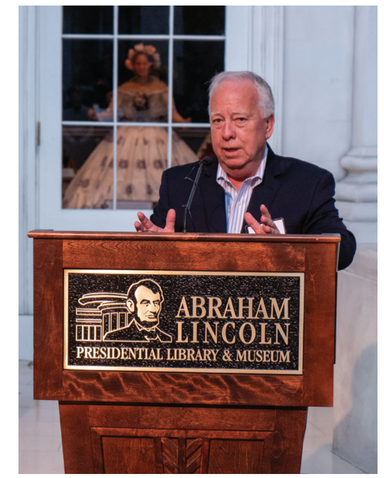
- This report provides an in-depth analysis of the economic impact of Illinois new car and truck dealers on Illinois' economy. It includes estimates of direct and indirect employment, personal income, and tax collections generated by Illinois automotive dealers. Also included is a review of dealership financial statistics and operations.
- Dealership financial data (and other information cited in the report) was collected from a detailed survey sent to all new vehicle automotive retailers in Illinois. Economic impact is separated into two main categories: direct and indirect. Direct impact comprises economic activity at automotive dealerships themselves, such as dealership employment and compensation to employees. Indirect impact occurs away from the dealership and takes into account the extended contribution dealerships and their employees make to the Illinois economy.
- The indirect economic impact of automotive retailers was estimated by Auto Outlook, Inc. Estimates were calculated utilizing regional input-output economic models. Indirect economic estimates in this report are intentionally conservative, and therefore, may underestimate the overall contribution automotive retailers make to the Illinois economy.
- This report was prepared by Auto Outlook, Inc., an independent automotive market analysis firm, sponsored by the IADA. Auto Outlook, Inc. is a regional automotive market analysis firm providing market research services to automotive dealers. Jeffrey Foltz, the President of Auto Outlook, Inc., obtained a master's degree in economics from the University of Delaware and has conducted many research projects analyzing state and regional economies.







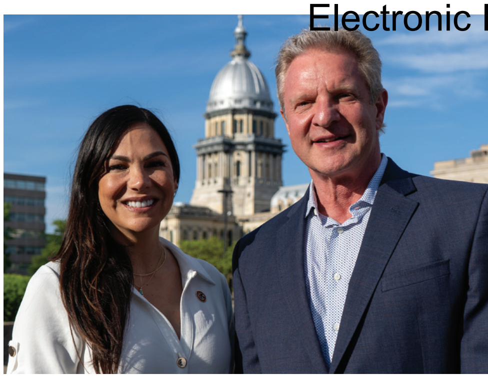












IADA
ILLINOIS AUTOMOBILE DEALERS ASSOCIATION

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EXHIBIT B

Exhibit B is the spreadsheet used to calculate all figures and numerical values provided in Steven Douglas' pre-filed testimony. Exhibit B is being provided in native format (Excel) via email to those on the service list.

EXHIBIT C

ALLIANCE
FOR AUTOMOTIVE
INNOVATION

August 17, 2023

Lynne Cayting Chief Mobile Sources Section
Bureau of Air Quality Department of Environmental Protection
17 State House Station
Augusta, Maine 04333-0017

Subject: Comments on the State of Maine Chapter 127A draft rule

The Alliance for Automotive Innovation[1] (Auto Innovators) appreciates the opportunity to provide comments on Maine's Chapter 127A draft rule that proposes to adopt the California Air Resource Board (CARB) Advanced Clean Cars II (ACC II) regulation. We appreciate the comprehensive approach that Maine has taken towards an electrified future and the progress made from your Maine Won't Wait plan. Through the electric vehicle (EV) rebate incentives, infrastructure planning and a focus on improving consumer awareness, you have been able to realize a market share growth in EV sales that reached nearly 6% through the first quarter of 2023. These plans have set the framework to support increased electrified vehicle transportation in Maine. Our association supports this transformation and are committed to working cooperatively with Maine to ensure vehicles developed, produced, and sold in the state of Maine offer consumers a range of options that are increasingly efficient, clean, and affordable for all. The CARB ACC II regulations are the most aggressive vehicle regulations in history and meeting them will be incredibly challenging even in California, which currently has EV market share of 24%[2], which is four times higher than Maine.

Commitment to Net-Zero Carbon Transportation.

Auto Innovators and its members are committed to achieving a net-zero carbon transportation future for America's cars and light trucks. The auto industry is investing $1.2 trillion globally by 2030[3] to advance vehicle electrification and will increase the number of EV models available from 97 today to around 245 by model year (MY)2026[4]. In August of 2021, Auto Innovators and our members announced support for a goal of achieving 40-50 percent U.S. new light-duty vehicle market share of EVs nationally by 2030, with the right complementary policies in place.

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[1] The Alliance for Automotive Innovation ("Auto Innovators") represents automakers that produce and sell approximately 98% of all the new light-duty cars and trucks sold in the U.S. Auto Innovators is the authoritative and respected voice of the automotive industry.
[2] JD Powers EV Index Report
[3] https://www.reuters.com/technology/exclusive-automakers-double-spending-evs-batteries-12-trillion-by-2030-2022-10-21/
[4] https://www.autonews.com/sales/car-wars-study-2026-60-new-models-will-be-ev-hybrid

1050 K ST, NW | 6th Floor | Washington, DC 20001 | autosinnovate.org

EXHIBIT C

The challenge of reaching the CARB ACCII mandate of 43% in 2027 to 82% EV market share by 2032, requires Maine to address several hurdles to consumer acceptance. In Maine, EV sales must increase more than seven-fold in four model years. These are staggering required sales increases for a new technology that relies heavily on customer acceptance and market readiness. That required seven times sales increase is needed where the average transaction price of EVs is now more than $53,000. Current EV buyers are far more likely to be affluent single-family homeowners with modern electric panels just a few feet from their garage where they will charge their EVs. These buyers do not represent a full cross-section of Maine's new car buyers, and achieving 40, 50, or 82 percent of the new car market will require reaching buyers of more moderate means. It will also require action well beyond automakers' ability to produce lower cost EVs.

While Maine's charging infrastructure has more than doubled since 2018, from 151 charging stations to 431[5] today, to support the prospect of 82% ZEV sales in 2032, our analysis suggests that Maine's public charging capabilities will need to increase from 431 charging ports today to a total of 25,000 to 35,000 charging ports by 2032 to support an EV market share of 82%. That is a substantial commitment and investment by Maine in only nine years.

There is much work to be done to significantly increase EV adoption across the nation. Our shared objectives require collaboration and a sustained commitment to fund and execute supportive programs and policies. The challenge of reaching the CARB ACCII mandate of 43% (2027), 59% (2029), to 82% EV market share by 2032, requires Maine to address several hurdles broader to consumer acceptance. There are many important complementary measures needed for success. Examples include, but are not limited to:

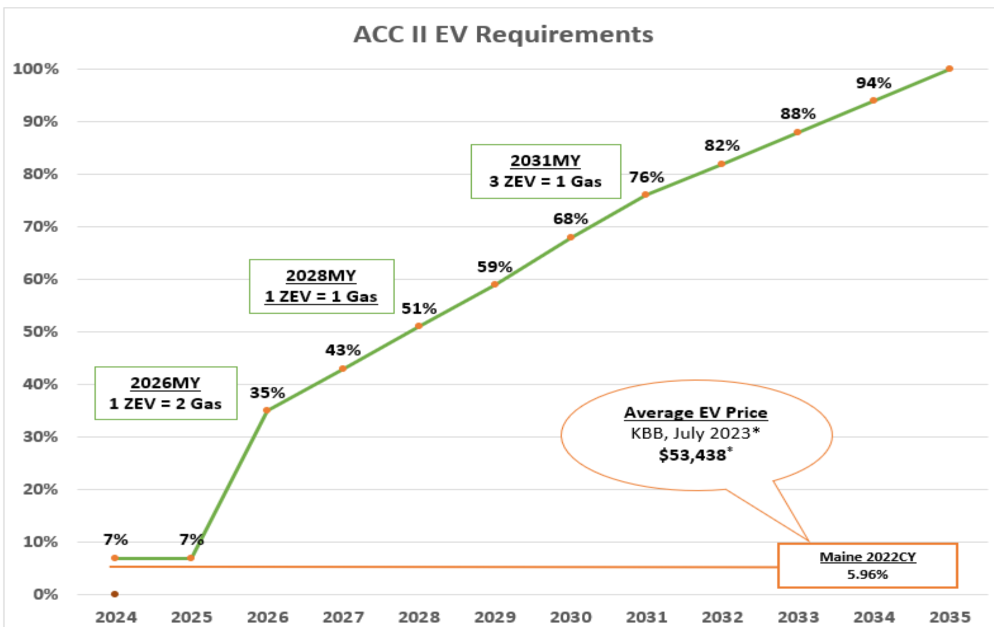
- Increasing funding and duration for current EV incentives.
- Adopting private and state fleet purchase requirements equivalent to or greater than the sales requirements in ACC II
- Deploying convenient, reliable, and affordable access to public EV charging and hydrogen refueling stations, as well as monitoring to ensure reliability not only the charger availability but also the charging power rate delivered at DCFCs.
- Installing 350kW DCFC at airports and major transportation hubs to fuel transportation network company (TNC)s EVs and taxis. Maine should also consider installing H2 fueling stations at locations that would support TNC EVs and taxis.
- Adopting building codes addressing new construction and retrofit requirements for EV-ready residential and commercial parking.

[5] Alternative Fuels Data Center: Electric Vehicle Charging Station Locations (energy.gov)

- Ensuring grid resiliency and utility electric rates that provide low-cost EV charging.

These policies will be critical to the feasibility of meeting future ZEV requirements. Maine must continue to take immediate and substantial action to implement these critical measures to reach its goal.

Current State of Play.
As shown below, the ACC II regulations require very aggressive increases in EV sales starting with MY2027. In Maine, EV sales must increase more than seven-fold in four model years. These are staggering required sales increases for a new technology that relies heavily on customer acceptance and market readiness.



The required seven times sales increase needed where the average transaction price of EVs is now about $53,438[6]. Based on the average transaction price of EVs, EV buyers are far more likely to be affluent single-family homeowners with modern electric panels just a few feet from their garage where they will charge their EVs. These buyers do not represent a full cross-section of Maine's new car buyers, and achieving 40, 50, or 82 percent of the new car market will require reaching buyers of more moderate means. It will also require action well beyond automakers' ability to produce more EVs.

[6] How Much Are Electric Cars? - Kelley Blue Book (kbb.com)

Sustained Consumer EV Purchase Incentive.

Purchase incentives can be a persuasive and effective way to address vehicle affordability and interest customers in purchasing an EV. EVs continue to cost substantially more than a comparable gasoline-fueled vehicle, and so the compounded effect of the federal and state incentives is necessary to equalize purchase costs. We applaud Maine for providing rebates of consumer purchases of EVs and we encourage you to continue to fund these rebates over the coming years.

As you are aware, the recently enacted Inflation Reduction Act (IRA) redefines new clean vehicle credits. Upon being signed into law by President Biden in August 2022, approximately 70% of previously eligible vehicles were unable to qualify for credits due to a North America assembly requirement. Also, starting on January 1, 2023, MSRP and income caps went into effect. And finally, starting with the release of proposed guidance from the U.S. Treasury Department in March 2023, the federal tax credit is split in half with requirements tied to critical minerals ($3,750) and battery components ($3,750). As the battery content requirements increase in future years, the number of electric vehicles that will qualify for the full credit are expected to drop further. Today, roughly eighteen EV models out of 97 that are for sale in the U.S. are eligible for a portion or all of the $7,500 federal EV tax credit. This means Maine's state-funded consumer rebate incentives will become even more critical to the state's goals of greater consumer EV adoption.

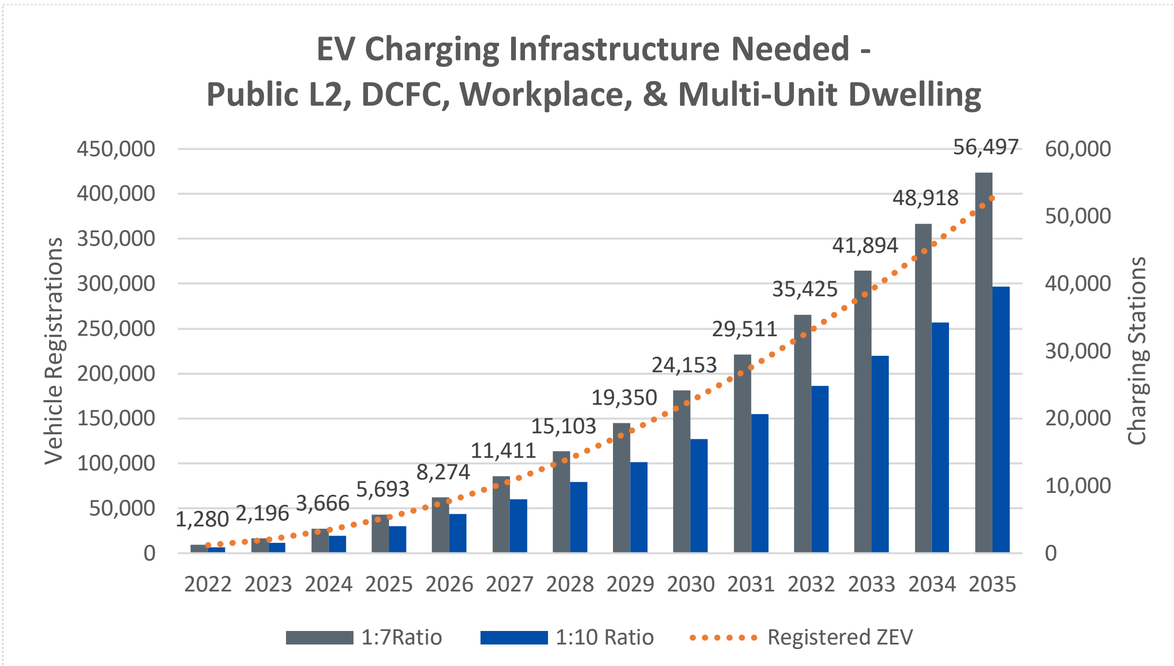
State and Local Fleet Increase.

State and local governments can lead by example by prioritizing adopting EVs (e.g., PHEVs, BEVs, and/or FCEVs) when making fleet purchases. There should be both public and private fleet purchase requirements that match regulatory requirements. This is truly an example of executive leadership and serves to bolster consumer interest in EV purchases. These fleets can also act as an accelerator and because of their utilization compared to EVs used for personal use, should adopt EVs at a faster rate than what the ACC II rule requires of automakers and their customers.

Charging and Hydrogen Refueling Infrastructure.

Reliable and convenient access to charging and hydrogen refueling stations support Maine's customers that buy or lease EVs. Publicly available charging stations not only ease perceived "range anxiety" concerns but also substantially increase consumer awareness of the technology. In addition, hydrogen vehicles may be better suited for some customers, especially those that do not have access to charging at home or the workplace, or those that have a lifestyle that requires short refueling times and a similar refueling process as gasoline.

Currently, Maine has 921 electric vehicle charging ports for 8963 registered electric vehicles in the state[7]. This is a ratio of approximately one charging port for every ten electric vehicles. This is below the CARB recommendation of a 1:7 ratio. In order to support the prospect of 82% ZEV sales in 2032, our analysis suggests that Maine's public charging capabilities will need to increase to a total of 25,000 to 35,000 charging ports by 2032. That is a substantial commitment and investment in only nine years.



Residential and Commercial Building Codes - Retrofit and New Construction Updates Needed.
Numerous studies have shown that retrofitting residential and non-residential charging is five to six times more expensive than installing charging stations during new construction. For existing residential and non-residential buildings, installing infrastructure during any significant renovations, such as parking lot paving, electrical panel upgrades, etc. also substantially reduces costs.

According to a NREL study[8], 88% of EV charging occurs at home, making access to home charging a top priority for customers considering an EV. The converse is also true, lack of access to home charging is a major barrier to EV adoption.

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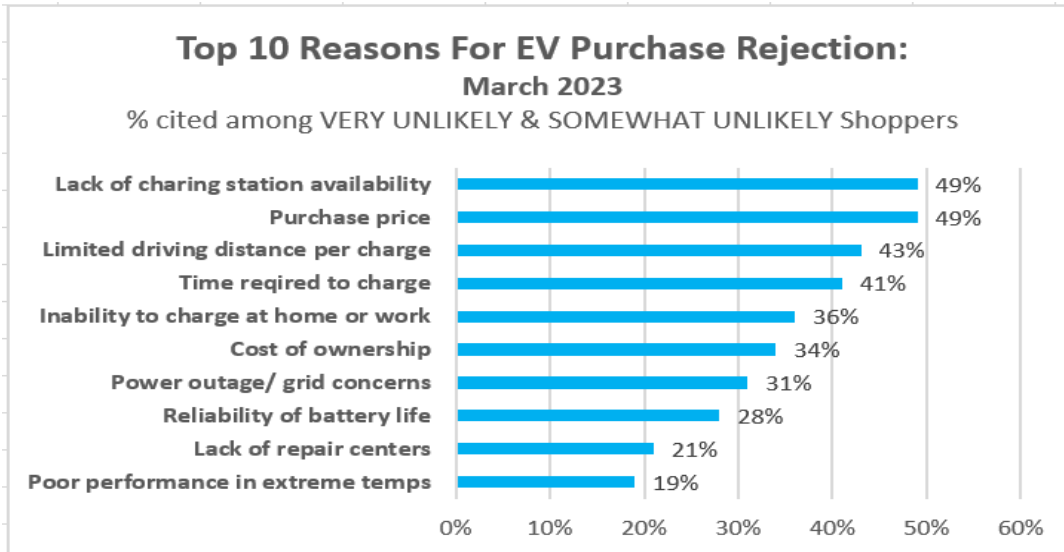
[7] Alternative Fuels Data Center: Electric Vehicle Charging Station Locations (energy.gov)
[8] https://www.nrel.gov/docs/fy17osti/69031.pdf

According to an April 2023 JD Power EV Index report[9], the lack of charging and purchase price are tied for the biggest reasons that is preventing people from buying an EV.



Source: JD Powers

It is important to ensure low- to moderate-income (LMI) and multi-family housing residents have the identical access to low-cost, convenient, and reliable level 2 (L2) home charging that single-family homeowners enjoy. Maine should set targets for residential charging and then monitor and track progress towards meeting those targets. For example, it seems reasonable that in 2030, when ACC II requires 68% of new vehicles to be electric, that 25% of LMI and multi-family housing units have access to level 2 charging at home. There are many important complementary measures needed for wide-scale EV adoption.
Maine should also adopt non-residential building codes that require installation of EV-ready charging capabilities in a significant portion of all new parking at workplace and public locations.

We support building codes that require:

1. Every new unit in a MUD with available parking to have at least one EV-Ready parking space.
2. Each EV-Ready space above provides, at minimum, Low-Power Level 2 (LPL2) (208/240V, 20A) terminating in a receptacle or an electric vehicle supply equipment (EVSE).
3. EV-Ready signage at each parking space.

[9] https://www.jdpower.com/business/resources/ev-divide-grows-us-more-new-vehicle-shoppers-dig-their-heels-internal-combustion

This recommendation for L2 power charging levels should be considered as the bare minimum requirement. Mainstream customer satisfaction may require higher power charging. In fact, this is why the California Air Resources Board (CARB) in adopting regulatory requirement for 100% electric vehicles (EVs), also mandated that every new MY2026 and later EV contain a portable charger capable of charging the vehicle at 5.76 kW (208/240V, 30A).

While building codes that address new construction is a common-sense and lowest-cost first step, it is not nearly enough to support a transition to electrification. For example, new residential construction typically accounts for about 1% of all residential units each year. Thus, new building codes would only provide residential charging in about 15% of the residential units by MY2035. Consequently, Maine should consider public and private programs to support retrofitting of existing homes and MUDs, such as apartments, condos, and townhouses. As noted, retrofits are far more expensive than incorporation of EV-ready infrastructure at the time of new construction, but they will be necessary to support increasing customer adoption of EVs.
In addition, special attention should be given to the infrastructure needs in Maine’s underserved communities to ensure that access to affordable and convenient charging and hydrogen refueling options are made available on an equally aggressive timeline. MUD residents, however, often face the greatest, most costly, and burdensome obstacles to installing residential EV charging. For MUD residents, the additional costs to upgrade the electrical panel, install conduit between the electrical panel and their parking space, and the logistical challenges of securing building owner approval, coordinating the billing with the building owner, and persuading an owner to make a long-term investment on a rental property, make it near impossible to be an EV driver in a MUD.

MUD residents could be forced to charge elsewhere such as DC fast charge stations or public chargers. Charging at home is far cheaper, more reliable, and vastly more convenient. It is unreasonable to expect MUD residents to pay 2 or 3 times as much for charging and spend hours away from home each week fueling their EVs.

Grid Resiliency/Utility Rate Setting Alignment.
A thorough review of Maine’s electric grid to determine the viability of expanded access in both the near- and long-term makes strong practical sense. Public confidence in the resiliency of the grid will only help spur faster EV adoption. Failure to provide consistent electrical service, particularly when the majority of EV charging is done at home, could be devastating for increased EV adoption, both for the light- and heavy-duty vehicle sectors.

Auto Innovators suggests that as part of the review, the state commit to a transparent dialogue with the utility commission and energy companies about making home and public charging affordable and convenient. In addition, an education campaign about the different types of charging systems (L1, L2, DCFC) and suggestions about prime charging times to lessen the load on the grid should be addressed.

Consumer Awareness Programs.

Consumer awareness, understanding, and trust of the technology is essential as we move from 5.96% Maine EV market share to 82% over the next nine years. Raising awareness can happen in many ways, and we encourage the state to explore a variety of options. For example, we've mentioned above that public and workplace chargers and hydrogen stations provide an excellent means of raising consumer awareness. State and local fleet purchases of EVs also substantially raise awareness – particularly if these vehicles are used in high visibility areas such as Department of Transportation (DOT) road crews, police, and fire. Additionally, state-led programs may also be necessary to support the ZEV requirements.

Implementation "Gap Period"

Of course, the Clean Air Act, Section 177 allows a state to adopt California standards but requires the state to adopt such standards at least two years before commencement of such model year. Since the current ZEV and LEV III regulations in ACC I (13 CCR 1962.2 and 1961.2) sunset after 2025MY, and Maine will not adopt ACC II until 2023 or 2024, Maine will have a "gap period" without California regulations. We recommend the following during the gap period before implementation of ACC II (either 2027 or 2028MY) to ensure the smooth path to the state's electrification goals.

- ZEV and NMOG+NOx ACC I credit banks retained and converted as necessary.
- ZEV Sales:
  - Per ACC II, ZEV sales >7% receive banked ACC II Early Compliance Values (ECVs) available two model years prior to implementation (e.g., 2027 implementation, 2025-26MY)
  - ZEV sales < 7% receive credits under ACC I and those credits are then converted per the ACC II regulations.
- EJ Vehicle Values available per ACC II regulation in the following model years
  - Community Clean Mobility – 2024MY
  - Low MSRP – 2026MY+
  - Off-lease EV – 2026MY+
- NMOG+NOx credits earned and banked using ACC I (= Tier 3) avg.
- OEMs continue reporting per ACC I/II.
- OEMs would also report to EPA as required for Tier 3.
- CA GHG regulations (1961.3) are unchanged in ACC II and would continue.

Thank you for the opportunity to provide the auto industry's perspective on a range of policies that Maine must adopt to meet its climate goals. Many of the actions necessary for success must start now, and we stand ready to work with the state and key stakeholders.

Sincerely,

Tom Miller
Senior Director, Energy and Environment
Alliance for Automotive Innovation

EXHIBIT D

STATE OF MAINE
BOARD OF ENVIRONMENTAL PROTECTION

JANET T. MILLS
GOVERNOR

Susan M. Lessard, Chair

William F. Hinkel
Executive Analyst

Ruth Ann Burke
Board Clerk

January 13, 2025

SENT VIA ELECTRONIC MAIL ONLY

Senator Denise Tepler
Representative Victoria Doudera
Joint Standing Committee on Environment and Natural Resources
c/o Legislative Information Office
100 State House Station
Augusta, Maine 04333

Re: Board of Environmental Protection
Report to the First Regular Session of the 132nd Maine State Legislature

Dear Senator Tepler, Representative Doudera, and Committee Members:

Pursuant to 38 M.R.S. § 341-D(7), the Board of Environmental Protection is required to report to the Joint Standing Committee on Environment and Natural Resources by January 15 of the first regular session of the Legislature on the effectiveness of the State's environmental laws and any recommendations for the amending those laws or the laws governing the Board. The enclosed report, which summarizes the Board's responsibilities and activities in calendar year 2024, is respectfully submitted to the First Regular Session of the 132nd Maine State Legislature.

If the Committee would like to discuss this report, I am available to meet with you at your convenience. I can be reached by contacting Board Executive Analyst William Hinkel at 207-314-1458 or bill.hinkel@maine.gov.

Respectfully submitted,

Susan M. Lessard, Chair
Board of Environmental Protection

Enclosure: Board Report 2024

cc: Melanie Loyzim, DEP Commissioner

EXHIBIT D

Report to the Joint Standing Committee on Environment and Natural Resources

Board of Environmental Protection
Summary of Activities in Calendar Year 2024 and Recommendations for Committee Consideration

Contact: William F. Hinkel, Board Executive Analyst
bill.hinkel@maine.gov
(207) 314-1458

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
17 State House Station | Augusta, Maine 04333-0017
www.maine.gov/dep

Board of Environmental Protection
Report to the Joint Standing Committee on Environment and Natural Resources

Summary of Activities in Calendar Year 2024

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Board of Environmental Protection
Report to the Joint Standing Committee on Environment and Natural Resources

Summary of Activities in Calendar Year 2024

I. INTRODUCTION

Maine law requires the Board of Environmental Protection (Board) to report to the joint standing committee having jurisdiction over natural resource matters by January 15 of the first regular session of each Legislature on the effectiveness of the environmental laws of the State and any recommendations for amending those laws or the laws governing the Board. 38 M.R.S. § 341-D(7). Although not required each year, in practice, the Board reports on its activities annually to the Joint Standing Committee on Environment and Natural Resources (Committee). This report is submitted to the First Regular Session of the 132nd Maine State Legislature.

Section II of this report provides an overview of the Board's membership, duties, and responsibilities. Section III summarizes matters considered by the Board in 2024. Section IV summarizes recently settled and pending litigation of orders and decisions issued by the Board.

II. BOARD MEMBERSHIP, DUTIES AND RESPONSIBILITIES

A. Membership. The Board is a seven-member citizen board whose members are appointed by the Governor and approved by the Legislature. 38 M.R.S. § 341-C. The purpose of the Board is to "provide informed, independent and timely decisions on the interpretation, administration and enforcement of the laws relating to environmental protection and to provide for credible, fair and responsible public participation in department decisions." 38 M.R.S. § 341-B.

Board members are appointed for staggered four-year terms, and a member may not serve more than two consecutive four-year terms. The first four-year term for Board member Barbara Vickery expires in December 2025; other Board members terms run through 2026 or later; and one seat on the Board was vacated in March 2024 and is expected to be seated during the First Regular Session of the 132nd Maine Legislature. Susan Lessard was appointed by the Governor to serve as the Board Chair. Board member biographies are provided as Attachment A to this report.

B. Responsibilities. The Board's responsibilities as set forth in 38 M.R.S. § 341-D and § 341-H are summarized below. Proceedings before the Board are governed by the Maine Administrative Procedure Act, the Board's statutes and procedural rules governing the various types of proceedings (e.g., rulemaking, appeal proceedings, adjudicatory hearings, etc.), and by program-specific statutes and rules. Notice of each Board meeting is made in accordance with the Freedom of Access Act, 1 M.R.S. § 406, and all meetings of the Board, which are typically held on the first and third Thursdays of each month, are open to the public. All meetings of the Board are held in-person, unless otherwise specified on the Board meeting notice and agenda. As a convenience, the Board generally provides a live video stream of its meetings for those who wish to watch the proceeding from a remote location. The link for a live stream of each Board meeting is provided on the Board meeting notice and agenda. Audio recordings of each Board meeting are made and an electronic link to the recording is available upon request made to the Board Clerk at clerk.bep@maine.gov. The Board's webpage provides member biographies, meeting materials, information on pending matters of broad public interest, and guidance to facilitate public participation in matters pending before the Board.

1. Rulemaking. The Board has authority to adopt, amend, or repeal reasonable rules and emergency rules necessary for the interpretation, implementation and enforcement of the laws administered by the Department. The Board also has authority to adopt, amend, and repeal rules as necessary for the conduct of the Department's business.

2. Appeals of Commissioner Licensing and Enforcement Actions. An aggrieved person may appeal to the Board a final license or permit decision of the Commissioner. The Board also hears appeals of emergency orders and unilateral compliance and clean-up orders issued by the Commissioner pursuant to 38 M.R.S. § 347-A(3).

3. Appeals of Ground and Surface Waters Clean-up and Response Fund Claim Decisions. The Ground and Surface Waters Clean-up and Response Fund (Fund) provides for the investigation, mitigation and removal of discharges or threats of discharge of oil from underground and aboveground oil storage tank systems, including the restoration of contaminated water supplies. Costs eligible for coverage by the Fund are expenses that are necessary to clean up discharges of oil to the satisfaction of the Commissioner, are cost-effective and technologically feasible and reliable, effectively mitigate or minimize damages, and provide adequate protection of public health and welfare and the environment. The Department administers Fund coverage claim applications related to discharges of oil from underground storage tank systems while the State Fire Marshal administers Fund coverage claim applications related to discharges of oil from aboveground storage tank systems. The Department (for underground storage tanks) or State Fire Marshal (for aboveground storage tanks) will issue an order that specifies eligibility and deductibles.

   In 2023, the Governor signed into law L.D. 74, *An Act to Update the Responsibilities of the Clean-up and Response Fund Review Board* (P.L. 2023, ch. 61), which shifted responsibility to hear and decide appeals of insurance claim-related decisions of the Commissioner and the State Fire Marshal under 38 M.R.S. § 568-A from the Clean-up and Response Fund Review Board to the Board of Environmental Protection. In 2024, the Board adopted new rules (*see* Chapter 2 in Section III (A)(1) of this report) to govern the processing of such appeals.

4. Decisions on Certain Permit Applications. The Commissioner and the Board are both responsible for reviewing and deciding applications for licenses and permits; however, Maine law specifies certain types of applications that may only be decided by the

Board. In 2024, the Legislature passed L.D. 865, *An Act to Clarify the Roles and Responsibilities of the Board of Environmental Protection* (P.L. 2024, ch. 512 and codified at 38 M.R.S. § 341-D(2)), that amended the Board's responsibilities and duties with respect to the Board's jurisdiction over license applications. The new law amends the criteria for Board jurisdiction over a license or permit application and stipulates the specific categories of license and permit applications over which the Board must assume jurisdiction. The new law establishes that the Board must assume original jurisdiction over the following, and only the following, types of license and permit applications.

- A new mining permit required pursuant to the Maine Metallic Mineral Mining Act, 38 M.R.S. § 490-OO;
- A license for a new solid waste disposal facility required pursuant to the Solid Waste Facility Siting Law, 38 M.R.S. § 1310-N;
- A permit for a new high-impact electric transmission line, as defined in 35-A M.R.S. § 3131(4-A), required pursuant to the Site Location of Development Law, 38 M.R.S. § 483-A;
- A license for a new wastewater discharge required pursuant to the Waste Discharge Licenses Law, 38 M.R.S. § 413, that, as determined by the Department, is expected to use more than 20% of the assimilative capacity of the receiving water;
- A permit for a new offshore wind terminal required pursuant to the Site Location of Development Law, 38 M.R.S. § 483-A; and
- A permit for a new nuclear power plant, as defined in Nuclear Power Generating Facilities Law, 35-A M.S.R. § 4352(9), required pursuant to the Site Location of Development Law, 38 M.R.S. § 483-A.

The Commissioner may not decide any of the application types listed above. The Board may not assume jurisdiction over any other type of license or permit application other than those listed above, unless both the applicant and the Commissioner jointly refer the application to the Board, or Maine statute requires the Board to decide specific application types, such as 38 M.R.S. § 1319-R(3) pertaining to site review of commercial hazardous waste facilities.

The Board may not assume jurisdiction over an application for: an expedited wind energy development project as defined in 35-A M.R.S. § 3451(4); a certification for a smaller-scale wind energy development in organized areas pursuant to 35-A M.R.S. § 3456; a general permit for a general permit for offshore wind energy demonstration project pursuant to 38 M.R.S. § 480-HH; or a general permit for tidal energy demonstration project pursuant to 38 M.R.S. § 636-A.

5. License Modification or Corrective Action. At the request of the Commissioner and after written notice and opportunity for hearing, the Board may modify, in whole or in part, any license, or issue an order prescribing necessary corrective action whenever the Board finds that any of the criteria at 38 M.R.S. § 342(11-B) are met.

6. Administrative Consent Agreements. Any administrative consent agreement to resolve a violation of laws administered by the Department must be approved by the Board to be valid. After negotiating a proposed resolution pursuant to 38 M.R.S. § 347-A(1), the Commissioner may bring a proposed administrative consent agreement to the Board for consideration, and the Board may approve it or reject it with instructions for further consideration or negotiations by the Department.

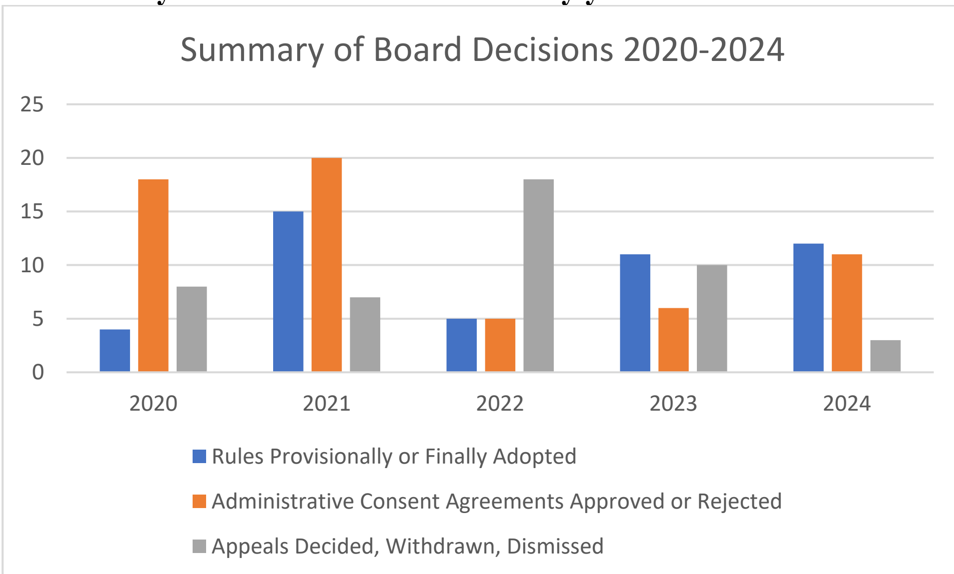
7. Recommendations to the Legislature. The Board is charged with making recommendations to the Legislature regarding the environmental laws of the State and any recommendations for amending those laws or the laws governing the Board.

8. Other Duties. The Board must carry out other duties as required by law. Other duties specified in statute include, among other things, holding hearings on and making recommendations to the classification of waters of the State it deems necessary to the Legislature.

9. Summary of Board Decisions by Year. Figure 1 below summarizes Board decisions on rulemaking actions, administrative consent agreements, and appeals of Commissioner licensing decisions for the period of 2020 through 2024. Matters considered but not

finally decided by the Board (such as rulemaking actions that were initiated but not adopted prior to expiration of the rulemaking action) are excluded from the analysis.

Figure 1. Summary of certain Board decisions by year 2020-2024.



III. SUMMARY OF MATTERS BEFORE THE BOARD IN 2024

A. Rulemaking

The Board acted on 20 rulemaking proposals in calendar year 2024. A summary of the rulemaking actions follows.

1. <u>Chapter 2, *Processing of Applications and Other Administrative Matters*.</u> The Department initiated rulemaking in calendar year 2023 to repeal and replace the existing Chapter 2 rule, *Rule Regarding the Processing of Applications and Other Administrative Matters*. Chapter 2 is the primary rule that governs the administrative procedures of the Department, including the Board, for actions including the processing of license applications, appeals of Commissioner license decisions, license revocations, suspensions, and surrenders, and other administrative matters, such as requests for an advisory ruling. Chapter 2 is a routine technical rule.

The Board held a public hearing on the proposed rule on January 18, 2024, and adopted the rule on September 5, 2024. The rule went into effect on September 15, 2024.

2. Chapter 80, *Reduction of Toxics in Packaging*. The Department initiated rulemaking in calendar year 2023 to amend the existing Chapter 80 rule, which establishes sales prohibitions on the use of specific additives in packaging. The primary purpose of the rulemaking proposal was to update the existing rule Chapter 80 in accordance with changes in the law. In addition, the revised rule establishes a sales prohibition on the use of specific applications of intentionally added PFAS to certain types of food packaging, which is a major substantive component of this rulemaking. The rule amendments relate to food packaging are authorized by 32 M.R.S. § 1737, which requires that the Department adopt rules necessary for the implementation, administration, and enforcement of 32 M.R.S. §§ 1731-1738, Reduction of toxics in packaging.

   The Board held a public hearing on the proposed rule on November 16, 2023. The Board adopted the routine technical sections of the amended rule and provisionally adopted the major substantive section (section 5) of the amended rule on January 18, 2024. The routine technical sections of the rule went into effect on February 6, 20204. The provisionally-adopted section 5 of the amended rule was subsequently approved by the Legislature in Resolve 2024, ch. 147, and was signed by the Governor as Emergency Legislation on March 25, 2024. The Board finally adopted section 5 of the amended Chapter 80 rule on April 18, 2024, and section 5 went into effect on May 25, 2024.

3. Chapter 90, *Products Containing Perfluoroalkyl and Polyfluoroalkyl Substances*. The Department initiated rulemaking in calendar year 2023 to provide guidance on the notification requirements and sales prohibitions for products and product components containing intentionally-added PFAS pursuant to 38 M.R.S. § 1614. Title 38, § 1614 requires manufacturers of products with intentionally-added PFAS to notify the Department of the presence of intentionally-added PFAS in those products beginning

January 1, 2023. The law also prohibits the sale of carpets or rugs, as well as the sale of fabric treatments, that contain intentionally-added PFAS beginning on January 1, 2023. Effective January 1, 2030, any product containing intentionally-added PFAS may not be sold in Maine unless the use of PFAS in the product is specifically designated as a currently unavoidable use by the Department. Chapter 90 is a routine technical rule.

The Board held a hearing on the proposed rule on April 20, 2023. The Department did not recommend that the Board adopt the proposed revisions to Chapter 90 as part of the 2023-2024 rulemaking activity.

On December 19, 2024, the Board considered a new Chapter 90 rulemaking proposal and voted to initiate rulemaking by posting the proposed rule for public comment and a public hearing. Further rulemaking activity on the proposed Chapter 90 is anticipated in 2025.

4. Chapter 111, *Petroleum Liquid Storage Vapor Control*. The Department initiated rulemaking in 2024 to revise Chapter 111, *Petroleum Liquid Storage Vapor Control*, to clarify applicability and to remove the prohibition on tank degassing during certain periods of the year due to the implementation of new control requirements pursuant to Department rule Chapter 170, *Degassing of Petroleum Storage Tanks, Marine Vessels, and Transport Vessels*.

   On November 21, 2024, the Board voted to post the proposed amendments to Chapter 111 rule for public comment and a public hearing. Further rulemaking activity on the proposed amendments to Chapter 111 is anticipated in 2025.

5. Chapter 127-A, *Advanced Clean Cars II Program*. On May 23, 2023, the Department received a citizen petition to initiate rulemaking pursuant to 5 M.R.S. § 8055. The petition was submitted by the Natural Resources Council of Maine and included the certified signatures of more than 150 registered Maine voters. The petition proposed to promulgate a new rule establishing motor vehicle emission standards for new passenger

cars, light-duty trucks, and medium-duty vehicles by incorporating the requirements of the California Advanced Clean Cars II regulations, beginning with the 2027 model year and continuing through the 2032 model year.

The Board held a public hearing on the proposed Chapter 127-A rule on August 17, 2023. On March 20, 2024, the Board voted to not adopt the proposed rule and directed staff to terminate further rulemaking on the proposed Chapter 127-A.

6. Chapter 128, *Advanced Clean Trucks Program*. On May 23, 2023, the Department received a citizen petition to initiate rulemaking pursuant to 5 M.R.S. § 8055. The petition was submitted by the Conservation Law Foundation, the Sierra Club, the Natural Resources Council of Maine, and included the certified signatures of more than 150 registered Maine voters. The petition proposed to adopt California's Advanced Clean Trucks regulation to encourage the sale of electric medium- and heavy-duty vehicles greater than 8,500 pounds GVWR.

   The Board held a public hearing on the proposed Chapter 128 rule on August 17, 2023. On October 24, 2023, the Board held a deliberative session for the purpose of providing staff with direction regarding next steps in the rulemaking process. Following a staff summary of the major comments received on this proposal, a majority of Board members supported taking no further action on the petition. Because the Board neither adopted the proposed rule within 120 days of the final comment deadline nor re-posted the proposal for additional comment, the rulemaking action that commenced on May 23, 2023, expired and the proposed rule was not adopted.

7. Chapter 138, *Reasonably Available Control Technology for Facilities that Emit Nitrogen Oxides (NOx RACT)*. The Department initiated rulemaking in 2024 to revise Chapter 138, *Reasonably Available Control Technology for Facilities that Emit Nitrogen Oxides (NOx RACT)*, to clarify applicability; reevaluate NOx RACT for affected facilities located in the ozone transport region due to promulgation of the 2015 8-hour ozone National Ambient Air Quality Standard; replace blanket exemptions for

periods of startup, shutdown, and malfunction with alternative emission limits; and remove outdated and obsolete requirements.

The Board held a public hearing on the proposed amendments to Chapter 138 on October 17, 2024. Further rulemaking activity on the proposed amendments to Chapter 138 is anticipated in 2025.

8. Chapter 140, *Part 70 Air Emission License Regulation*. The U.S. Environmental Protection Agency requires major stationary sources of air pollutants to obtain operating permits. Maine operates an EPA-approved Operating Permits Program (also known as Part 70 or Title V permitting) pursuant to 40 C.F.R. Part 70. The Department implements this program through Chapter 140. On July 21, 2023, the EPA published a final rule that removed the emergency affirmative defense provisions from 40 C.F.R. Part 70. EPA removed these provisions because they are inconsistent with the EPA's interpretation of the enforcement structure of the Clean Air Act considering prior court decisions from the U.S. Court of Appeals for the D.C. Circuit. The Department initiated rulemaking in 2024 to amend Chapter 140 to align with 40 C.F.R. Part 70.

   The Board held a public hearing on the proposed amendments to Chapter 140 on April 18, 2024, and on June 6, 2024, adopted the amended routine technical rule. The rule went into effect on July 8, 2024

9. Chapter 145, *NOx Control Program*. The Department initiated rulemaking in 2024 to amend Chapter 145, *NOx Control Program*, to clarify applicability and to remove obsolete requirements. When Chapter 145 was adopted in 2001, it applied to affected sources located in areas of the state that were not covered by a waiver of NOx control requirements pursuant to Section 182(f) of the 1990 Clean Air Act (CAA) Amendments. Section 182(f) applies to ozone nonattainment areas and areas within the Ozone Transport Region (OTR). At the time, the entire State of Maine was part of the OTR. The NOx waiver provisions of the CAA recognized that requiring additional NOx emission reductions was not appropriate in certain cases. Chapter 145 acknowledged

this and limited applicability to areas of the state that were not covered by such a waiver. Maine applied for and received a Section 182(f) NOx waiver on several occasions, including a state-wide waiver in 2014.

In February 2020, the State of Maine petitioned EPA to remove the majority of the state from the OTR. EPA granted the State's petition, and the change became effective on March 14, 2022. This petition approval makes the question of a Section 182(f) NOx waiver irrelevant for much of the State, in that it permanently removes portions of the Maine from the OTR.

The Chapter 145 rulemaking action clarifies that the provisions of Chapter 145 apply to affected sources that are located both within the OTR and in a county that has not received a NOx waiver. The affected sources located outside of the current OTR boundaries have consistently been covered by a NOx waiver and considered by the Department not to be subject to Chapter 145. In addition to the applicability clarification, the amended rule removed several provisions for interim standards for which the compliance date has passed.

The Board held a public hearing on the proposed amendments to Chapter 145 on April 18, 2024, and on June 6, 2024, adopted the amended routine technical rule. The rule went into effect on July 8, 2024.

10. Chapter 167, *Tracking and Reporting Gross and Net Annual Greenhouse Gas Emissions*. The Department initiated rulemaking in calendar year 2023 to amend the existing Chapter 167 rule to align with statutory requirements. Title 38, § 576-A(4) requires "By July 1, 2021, the Department shall adopt rules to track and report to the Legislature on gross annual greenhouse gas emissions and net annual greenhouse gas emissions." Chapter 167 was originally adopted in July 2021 to meet this requirement. Chapter 167 establishes methods for the calculation of annual greenhouse gas emissions as required, outlining the methods, data sources, and assumptions used to compile and report these inventories. Methods and data sources used to calculate greenhouse gas

emissions and compile the inventory are regularly updated. The Department proposed updates to Chapter 167 to best align with these recent updates.

These emissions estimates are used to assess Maine's progress toward meeting the gross greenhouse gas reductions in 38 M.R.S. § 576-A(1) and (3). The net emissions estimate will be used to gauge Maine's progress toward the 2045 carbon neutrality goal as stated in 38 M.R.S. § 576-A(2-A). The Department will use these methods to measure progress toward these reductions and toward the goals of the climate action plan described in 38 M.R.S. § 577. Chapter 167 is a routine technical rule.

The Board adopted the amendments to Chapter 167 on January 18, 2024, and the rule went into effect on February 6, 2024.

11. Chapter 200, *Metallic Mineral Exploration, Advanced Exploration and Mining*. The Department initiated rulemaking in 2023 to amend Chapter 200 in response to P.L. 2023, ch. 398, *An Act to Support Extraction of Common Minerals by Amending the Maine Metallic Mineral Mining Act*, which was approved by the Governor on July 7, 2023. The new law allows a person to apply to the Department for exclusion from the requirements of Chapter 200 for the physical extraction, crushing, grinding, sorting, or storage of metallic minerals. Chapter 200 is a major substantive rule pursuant to 38 M.R.S. § 490-NN(B).

    The Board held a public hearing on the proposed amendments to Chapter 200 on January 18, 2024, and on February 28, 2024, provisionally adopted the amended rule. The provisionally-adopted amended rule was subsequently approved by the Legislature in Resolve 2023, ch. 169, and signed by the Governor as Emergency Legislation on April 16, 2024. The Board finally adopted the amended Chapter 200 rule on May 16, 2024, and the rule went into effective on June 22, 2024.

12. Chapter 305, *Natural Resources Protection Act - Permit by Rule Standards*. In 2023, *An Act to Improve Coastal Sand Dune Restoration Projects* (P.L. 2023, ch. 97), was enacted and directed the Department to undertake rulemaking to amend Chapter 305, *Natural Resources Protection Act (NRPA) – Permit By Rule Standards*, to allow for the use of biodegradable stabilization materials in dune restoration projects. Following severe winter storms in 2023, an immediate need to allow for expedited approval of enhanced dune restoration and construction projects through permit by rule (PBR) developed. Pursuant to 5 M.R.S. § 8054 (emergency rulemaking provisions of the Maine Administrative Procedure Act), the Department initiated emergency rulemaking in February 2024 to amend Section 16-A of Chapter 305 pertaining to beach nourishment and dune restoration or construction activities in coastal sand dunes to allow for proposed projects to be approved and constructed through the expedited PBR permitting process. The emergency rulemaking was intended to allow property owners the opportunity to rebuild eroded sand dunes prior to the end of the 2023-24 winter work window, and to more rapidly restore this important line of defense against coastal storms.

    The Board adopted the emergency rule revision on February 1, 2024. Pursuant to 5 M.R.S. § 8054(3), emergency rules are effective for only 90 days. Therefore, the revised Section 16-A provisions expired on May 1, 2024.

13. Chapter 305, *Natural Resources Protection Act - Permit by Rule Standards*. In conjunction with the proposed Chapter 310 revisions described below, the Department initiated routine technical rulemaking in 2024 to amend Chapter 305 in response to increased interest in shoreline stabilization activities requiring a Natural Resources Protection Act permit and to ensure conformity with recently passed legislation. The goals of the proposed rulemaking are to encourage nature-based shoreline stabilization methods using vegetation and biodegradable stabilization materials; place appropriate limits on the use of hardened stabilization structures like riprap and seawalls to ensure project impacts are reasonable and to address cumulative impacts; and to simplify and speed up the permitting process for applicants and the Department. The proposed rule

changes would also implement two laws passed by the 131st Legislature: P.L. 2023, ch. 97, *An Act to Improve Coastal Sand Dune Restoration Projects*, and P.L. 2023, ch. 531, *An Act to Amend the Natural Resources Protection Act to Enhance the State's Ability to Respond to and Prepare for Significant Flood Events and Storm Surge*.

On November 7, 2024, the Board voted to post the proposed Chapter 305 rule for public comment and a public hearing. The Board held a public hearing on the proposed Chapter 305 on December 19, 2024. Further rulemaking activity on the proposed amendments to Chapter 305 is anticipated in 2025.

14. Chapter 310, *Wetlands and Waterbodies Protection*. In conjunction with the proposed Chapter 305 revisions described above, the Department initiated routine technical rulemaking in 2024 to amend Chapter 310 in response to increased interest in shoreline stabilization activities requiring a Natural Resources Protection Act permit and to ensure conformity with recently passed legislation. The goals of the proposed rulemaking are to encourage nature-based shoreline stabilization methods using vegetation and biodegradable stabilization materials; place appropriate limits on the use of hardened stabilization structures like riprap and seawalls to ensure project impacts are reasonable and to address cumulative impacts; and to simplify and speed up the permitting process for applicants and the Department. The proposed rule changes would also implement two laws passed by the 131st Legislature: P.L. 2023, ch. 97, *An Act to Improve Coastal Sand Dune Restoration Projects*, and P.L. 2023, ch. 531, *An Act to Amend the Natural Resources Protection Act to Enhance the State's Ability to Respond to and Prepare for Significant Flood Events and Storm Surge*.

    On November 7, 2024, the Board voted to post the proposed Chapter 310 rule for public comment and a public hearing. The Board held a public hearing on the proposed Chapter 310 on December 19, 2024. Further rulemaking activity on the proposed amendments to Chapter 310 is anticipated in 2025.

15. Chapter 355, *Coastal Sand Dune Rules*. The Department initiated rulemaking in calendar year 2023 to amend the existing Chapter 355 rule to update the Coastal Sand Dune Geology Map reference. Coastal sand dune systems are a protected natural resource under Maine's Natural Resources Protection Act, 38 M.R.S. §§ 480-A–480-JJ. This rulemaking updated the reference to cite the most recent Coastal Sand Dune Maps prepared by the Maine Geological Survey dated 2023. The amendments to Chapter 355 are major substantive pursuant to 38 M.R.S. § 480-AA.

    The Board held a public hearing on the proposed amendments to Chapter 355 on September 21, 2023, and provisionally adopted the rule on November 16, 2023. The provisionally-adopted amended rule was subsequently approved by the Legislature in Resolve 2024, ch. 130, and signed by the Governor as Emergency Legislation on February 29, 2024. The Board finally adopted the amended Chapter 200 rule on April 18, 2024, and the rule went into effective on June 22, 2024.

16. Chapter 375, *No Adverse Environmental Effect Standards of the Site Location of Development Act*. The Department initiated rulemaking in calendar year 2023 to amend its existing Chapter 375 rule to incorporate requirements of L.D. 1881, *An Act Regarding Compensation Fees and Related Conservation Efforts to Protect Soils and Wildlife and Fisheries Habitat from Solar and Wind Energy Development and High-impact Electric Transmission Lines Under the Site Location of Development Laws*, which was signed by the Governor on July 26, 2023 (P.L. 2023, ch. 448).

    The Board held a public hearing on the proposed amendments to Chapter 375 on March 7, 2024, and subsequently scheduled two deliberative sessions to discuss the proposed changes with Department staff. The Board provisionally adopted the proposed amendments to Chapter 375 on December 5, 2024.

17. Chapter 428, *Stewardship Program for Packaging*. The Department initiated rulemaking in calendar year 2023 to adopt a new rule, Chapter 428, in response to P.L. 2021, ch. 455, *An Act To Support and Improve Municipal Recycling Programs and Save*

Taxpayer Money, which was approved by the Governor on July 21, 2021. The law requires the Department to initiate rulemaking to adopt rules necessary for the implementation, administration and enforcement of a stewardship program for packaging pursuant to 38 M.R.S. § 2146. Chapter 428 is a routine technical rule pursuant to 38 M.R.S. § 2146(13).

The Board held a public hearing on the proposed Chapter 428 on March 7, 2024, and subsequently scheduled two deliberative sessions to discuss the proposed changes with Department staff. The Board adopted Chapter 428 on December 5, 2024, and the rule went into effect on December 25, 2024.

18. Chapter 526, *Cooling Water Intake Structures*. The Department initiated rulemaking in calendar year 2023 to adopt a new rule, Chapter 526, which would establish requirements that apply to cooling water intake structures at new and existing facilities that are subject to section 316(b) of the Clean Water Act (33 U.S.C. § 1326(b). These proposed requirements include standards for minimizing adverse environmental impact associated with the use of cooling water intake structures, procedures for establishing appropriate technology requirements at regulated facilities, and monitoring, reporting, and record keeping requirements. Chapter 526 is a routine technical rule.

    The Board held a public hearing on the proposed Chapter 526 on December 7, 2023, and adopted Chapter 526 on February 1, 2024. Chapter 526 will become effective upon the approval of the U.S. Environmental Protection Agency of related parts of the State's application to administer the National Pollutant Discharge Elimination System program of the Federal Clean Water Act, pursuant to 40 CFR part 123. This approval is pending.

19. Chapter 534, *Wastewater Treatment Plant Operator Certifications - Revocation or Suspension*. The Department initiated rulemaking in calendar year 2024 to adopt a new rule, Chapter 534, which sets forth procedures that may be used by the Department to consider revoking or suspending a wastewater treatment plant operator certification. The Department may revoke or suspend wastewater treatment plant operator certifications pursuant to Maine's Sewage Treatment Operators law, 32 M.R.S. § 4175-

A, and Department rule Chapter 531, *Wastewater Treatment Plant Operator Certification*. The purpose of the new Chapter 534 rule is to specify notice requirements and opportunity for a hearing pursuant to the Maine Administrative Procedure Act, 5 M.R.S. §§ 8001-11008. Chapter 534 is a routine technical rule.

The Board adopted Chapter 534 on April 18, 2024, and the rule went into effect on April 30, 2024.

20. Chapter 583, *Nutrient Criteria for Class AA, A, B, and C Fresh Surface Waters*. The Department initiated rulemaking in 2024 to adopt a new rule, Chapter 583, *Nutrient Criteria for Class AA, A, B, and C Fresh Surface Waters*, which would establish ambient water quality criteria for nutrients in most Class AA, A, B and C fresh surface waters of the State and set forth procedures to establish site-specific values for total phosphorus and other nutrients. The proposed criteria integrate numeric concentration values for total phosphorus with values for response indicators such as chlorophyl, algal cover and sewer fungus in a decision framework for determining attainment of the criteria.

    On November 21, 2024, the Board voted to post the proposed Chapter 583 rule for public comment and a public hearing. Further rulemaking activity on the proposed Chapter 583 is anticipated in 2025.

B. Appeals of Commissioner Licensing Decisions

A person who is aggrieved by a licensing decision of the Commissioner may appeal that decision to the Board. Under provisions of 38 M.R.S. § 341-D(4), the Board may affirm the Commissioner's decision, amend the Commissioner's decision, reverse the Commissioner's decision, or remand the matter to the Commissioner for further proceedings. The Board may hold a hearing on any appeal of a Commissioner's licensing decision. In an appeal proceeding, the Board is not bound by the Commissioner's findings of fact or conclusions of law. The Board's decision on appeal may be appealed to Superior Court (or directly to the Law Court in the case of an expedited wind energy development). In an appeal to the Board, the parties may pursue various forms of alternative dispute resolution in an effort to reach a resolution that is satisfactory to all parties.

Appeals of Commissioner licensing decisions considered by the Board in 2024 are summarized below.

1. Judith Marsh, Damian Marsh, and Helene Harrower. On October 2, 2023, Seth Holbrook filed with the Board a timely appeal of the August 31, 2023, Order of the Commissioner issued to Judith Marsh, Damian Marsh, and Helene Harrower. That Order approved with conditions the application of Judith Marsh, Damian Marsh, and Helene Harrower for a Natural Resources Protection Act permit and related Water Quality Certification to replace and expand an existing bulkhead and stabilize shoreline at Paul's Marina in Brunswick. The Board voted to deny the appeal and affirm the Commissioner's Order on March 20, 2024.

2. Bill Ham. On November 18, 2024, Richard Hendricks and Nancy Hendricks filed with the Board a timely appeal of the October 21, 2024, Order of the Commissioner issued to Bill Ham. That Order approved with conditions the application for a Natural Resources Protection Act Permit and related Water Quality Certification for the alteration of 13,520 square feet of freshwater wetland habitat to construct a roadway and underground electrical utilities for a nine-lot subdivision on a 58-acre undeveloped parcel of land in Buxton. The appeal proceedings before the Board are ongoing as of the date of this report.

3. LB Ellsworth, LLC. On May 27, 2024, Carl N. Brooks and John Partridge filed with the Board a timely appeal of the May 2, 2024, Order of the Commissioner issued to LB Ellsworth, LLC. That Order approved with conditions the application for a Combined Storm Water Management Law and Natural Resources Protection Act permit and related Water Quality Certification for a proposed new a multi-family housing development in Ellsworth. The Board voted to deny the appeal and affirm the Commissioner's Order on October 17, 2024.

4. Poppy's Redemption Center. On September 4, 2024, Kristin Workman doing business as Four Winds Too filed with the Board a timely appeal of the July 22, 2024, Order of the Commissioner issued to Poppy's Redemption Center in Jay. That Order approved the application of the Licensee for a new redemption center license. The appeal proceedings before the Board are ongoing as of the date of this report.

5. Rumford Falls Hydro LLC. On September 12, 2024, the Maine Council of Trout Unlimited, American Whitewater, Maine Rivers, the Friends of Richardson Lake, Conservation Law Foundation, and American Rivers filed with the Board a timely appeal of the August 16, 2024, Order of the Commissioner issued to Rumford Falls Hydro LLC. That Order approved with conditions the application for Water Quality Certification for the continued operation of the Rumford Falls Hydroelectric Project on the Androscoggin River in Rumford and Mexico. The appeal proceedings before the Board are ongoing as of the date of this report.

C. Appeals of Insurance Claims-related Decisions of the Commissioner and the State Fire Marshal

On May 8, 2023, the Governor signed into law *An Act to Update the Responsibilities of the Clean-up and Response Fund Review* (P.L. 2023, ch. 61). The new law, among other changes, shifted responsibility to hear appeals of insurance claims-related decisions of the Commissioner and the State Fire Marshal made pursuant to 38 M.R.S. § 568-A from the Clean-up and Response Fund Review Board (created pursuant to 38 M.R.S. § 568-B) to the Board of Environmental Protection. A person aggrieved by an insurance claims-related decision of the Commissioner or the State Fire Marshal may be appeal to the Board for review of that decision. Under provisions of 38 M.R.S. § 341-D(4), the Board may affirm the Commissioner's or State Fire Marshal's decision, amend the Commissioner's or State Fire Marshal's decision, reverse the Commissioner's or State Fire Marshal's decision, or remand the matter to the Commissioner or State Fire Marshal for further proceedings.

Appeals of insurance claims-related decisions of the Commissioner or the State Fire Marshal considered by the Board in 2024 are summarized below.

1. Andrea and Doug Alford. On July 30, 2024, the Board received the timely appeal of Andrea and Doug Alford of the Maine Ground and Surface Waters Clean-Up and Response Fund Determination of Eligibility and Assignment of Deductibles Order issued to the Alfords by the Office of the State Fire Marshal on June 10, 2024. The appeal proceedings before the Board are ongoing as of the date of this report.

2. Pepperell, LLC. On May 6, 2024, the Board received the timely appeal of Pepperell, LLC of the Maine Ground and Surface Waters Clean-Up and Response Fund Determination of Eligibility and Assignment of Deductibles Order issued to Pepperell, LLC by the Office of the State Fire Marshal on March 28, 2024. Pepperell, LLC and the State Fire Marshal elected to pursue an alternative dispute resolution to potentially resolve the issues raised in the appeal. On August 2, 2024, the State Fire Marshal provided the Board with a copy of a new decision issued to Pepperell, LLC. That new decision rescinded the Clean-Up and Response Fund Order issued on March 28, 2024. On August 13, 2024, Pepperell, LLC withdrew their appeal of the Clean-Up and Response Fund Order.

D. Appeals of Administrative Orders Issued by the Commissioner

Several program-specific statutes provide for appeals to the Board of a Commissioner's administrative order, such as an order to remediate a site contaminated by oil or hazardous substances. These are unilateral orders through which the Commissioner seeks to correct serious environmental conditions. Due process is afforded through the right of appeal to the Board, and then Superior Court. No appeals of an administrative order were filed with the Board in calendar year 2024.

E. Permit and License Applications

In 2024, the Department did not receive any applications for the types of licenses and permits that the Board must decide. Applications for which the Board must assume original jurisdiction are specified in 38 M.R.S. § 341-D(2) and section II.B.4 of this report.

F. Administrative Consent Agreements

Administrative consent agreements are voluntary, and the terms and conditions of such agreements are the product of a negotiation process between the alleged violator, the Department, and the Office of the Maine Attorney General. The Department calculates civil monetary penalties through the evaluation of the environmental aspects of a case (such as the sensitivity of the environmental resource, size of the affected area, and potential effect to human health), the circumstances in which the alleged violation occurred (such as the alleged violator's knowledge of the laws, the cause of the alleged violation, the alleged violator's response and level of cooperation, and the compliance history of the alleged violator), and whether civil monetary penalty is substantial enough to deter others from similar violations (taking into consideration factors such as whether the alleged violator received a financial gain as a result of the violation, whether the alleged violator has committed either the same or similar violations in past five years, and the alleged violator's ability to pay the penalty). The unique circumstances surrounding the alleged violation(s) results in the calculation of civil penalties that are site- and violator-specific. Maine law authorizes the Department to include supplemental environmental projects – an environmentally beneficial project primarily benefiting public health or the environment that an alleged violator is not otherwise required or likely to perform – as part of an administrative consent agreement. 38 M.R.S. § 349(2-A). Whether or not a supplemental environmental project is included as a component of an administrative consent agreement, mitigation of environmental impacts created by the alleged violation(s) is typically completed during negotiation of the administrative consent agreement or may be established as a binding condition of the administrative consent agreement.

The Board considered 11 administrative consent agreements in 2024, a summary of each is provided below. The Department prepares monthly enforcement reports to satisfy its statutory obligation under 38 M.R.S. § 349(7) that the Department inform the public of certain enforcement resolutions. See the Department's webpage at https://www.maine.gov/dep/enforcement/mcar/index.html.

1. Auto Shine Car Wash, L.L.C. Auto Shine Car Wash, L.L.C. operates a vehicle car wash facility in Windham. In 2019, the Department inspected the facility and determined that Auto Shine had redirected an estimated 900,000 gallons of contaminated car wash wastewater from a holding tank to its stormwater collection system, resulting in the unlicensed discharge of wastewater to ground water in violation of 38 M.R.S. § 413(1), which makes it unlawful to directly or indirectly discharge any pollutant without first obtaining a license from the Department; 38 M.R.S. § 414(5), which makes it unlawful to violate the terms or conditions of a license once issued by the Department; Department rule Chapter 543, *Rules to Control the Subsurface Discharge of Pollutants*, which prohibits unauthorized subsurface wastewater discharges; and Department rule Chapter 691, *Rules for Underground Oil Storage Facilities*, which requires all underground wastewater treatment tank systems that receive or accumulate oil to be registered with the State of Maine.

   To resolve these violations, Auto Shine has redirected its car wash wastewater to an approved holding tank for proper disposal in accordance with Maine laws and rules and paid a civil monetary penalty of $55,869. The Board approved the administrative consent agreement on November 21, 2024.

2. Andrew and Blake Foote. Andrew and Blake Foote own property in Owls Head. On May 17, 2019, Department staff observed that the Footes had altered a freshwater wetland associated with three significant vernal pools for the construction of a residential driveway without first obtaining a permit from the Department. There were no erosion or sedimentation controls in use on the site at the time of the visit. By placing fill and removing vegetation in a freshwater wetland without first obtaining a permit from the Department, the Footes violated the Natural Resources Protection Act, 38 M.R.S. § 480-C. By constructing, or causing to be constructed, an activity that involves filling, displacing or exposing soil or other earthen materials without first taking measures to prevent unreasonable erosion of soils or sediment beyond the project site or into a protected natural resource or ensuring that such measures remain in place

and functional until the site is permanently stabilized, the Footes violated the Erosion and Sedimentation Control law, 38 M.R.S. § 420-C.

To resolve these violations, the Footes restored 532 square feet of altered wetland, obtained after-the-fact approval for 3,528 square feet of permanent wetland impacts within the three significant vernal pools, and paid a civil monetary penalty of $5,000. On April 21, 2023, Department staff determined that restoration of the site was completed to the Department's satisfaction. The Board approved the administrative consent agreement on February 1, 2024.

3. Jeffrey Jordan and Greeley's Garage, Inc. Jeffrey Jordan owns and is president of Greeley's Garage, Inc., a Maine business that operates diesel truck repair and sales facility in Auburn. Jeffrey Jordan and Greeley's Garage, Inc. tampered with the vehicle emission control system of an eight-cylinder diesel truck engine such that the vehicle no longer complies with applicable vehicle emission standards. The Clean Air Act and Maine's motor vehicle emission control system tampering law, 38 M.R.S. § 585-O, prohibit tampering with the emission control system of a motor vehicle. As a result of tampering with the emission control system of the vehicle, the exhaust from the tampered vehicle may contain nitrogen oxides (NOx), particulate matter (PM), and other air pollutants at levels that may be hundreds or thousands of times higher than the applicable air quality standards.

   To resolve these violations, Jeffrey Jordan and Greeley's Garage, Inc. paid a civil monetary penalty of $4,000. The Board approved the administrative consent agreement on March 20, 2024.

4. Maine Drilling and Blasting, Inc. Maine Drilling and Blasting, Inc. is a Maine company that operates a rock drilling, blasting and foundation business with its primary location in Gardiner. S.B. Enterprises, Inc. submitted a Notice of Intent to Comply pursuant to Performance standards for quarries, 38 M.R.S. § 490-Y, to mine at a site in Westbrook. S.B. Enterprises, Inc. hired Maine Drilling and Blasting, Inc. to perform blasting services at the Westbrook quarry.

On June 2, 2020, S.B. Enterprises, Inc. reported to the Department that Maine Drilling and Blasting, Inc. conducted a blast event earlier that day that resulted in flyrock leaving the property and landing on two abutting residential properties. Maine Drilling & Blasting, Inc. immediately took measures to report the incident, meet with the affected abutting property owners, and submitted an incident report and modified extraction plan for future blasting that is intended to prevent flyrock from again leaving the property. Pursuant to 38 M.R.S. § 490-Z(14)(A), Maine Drilling and Blasting, Inc. was required to "use sufficient stemming, matting or natural protective cover to prevent flyrock from leaving property owned or under control of the owner or operator or from entering protected natural resources or natural buffer strips." By failing to use sufficient stemming, matting or natural protective cover to prevent flyrock from leaving property owned or under control of the owner or operator, Maine Drilling and Blasting, Inc. violated 38 M.R.S. § 490-Z(14)(A).

To resolve the violation, Maine Drilling and Blasting, Inc. paid a civil monetary penalty of $8,000. The Board approved the administrative consent agreement on January 18, 2024.

5. <u>MaineHealth doing business as Franklin Memorial Hospital.</u> MaineHealth d/b/a Franklin Memorial Hospital (Franklin Memorial Hospital) is a non-profit corporation that operates a hospital in Farmington. Franklin Memorial Hospital is a hazardous waste generator and subject to the Hazardous Waste, Septage and Solid Waste Management Act, 38 M.R.S. §§ 1301–1319-Y and the Department's Hazardous Waste Management Rules, Chapters 850–858. During a Department inspection, staff determined that Franklin Memorial Hospital failed to: properly label and store hazardous and universal wastes; train all employees and contractors who are responsible for managing the hospital's hazardous waste; conduct required inspections; post required signage; report missing manifest copies; complete its required contingency plan; and other related actions that resulted in violations of the applicable laws and rules.

To resolve the violations, Franklin Memorial Hospital completed corrective actions to achieve compliance with the applicable laws and rules and paid a civil monetary penalty of $20,150. The Board approved the administrative consent agreement on September 5, 2024.

6. STC New England LLC d/b/a Sun Tan City. STC New England LLC d/b/a Sun Tan City (Sun Tan City) operated two Generator Owned Central Accumulation Facility (GOCAF) locations, one in Augusta in the basement of an apartment building, and the second at a storage unit at Capital Area Self Storage. Sun Tan City is subject to the Hazardous Waste, Septage and Solid Waste Management Act, 38 M.R.S. §§ 1301–1319-Y and the Department's *Hazardous Waste Management Rules*, Chapters 850–858. Universal waste lamps were brought from multiple generator locations to these storage locations where numerous universal waste requirements were not followed. Improper storage, labeling and handling of hazardous wastes at Sun Tan City's facilities violated the Hazardous Waste, Septage and Solid Waste Management Act and the Department's Hazardous Waste Management Rules.

   By storing lamps for an excessive amount of time and in improper packaging or loose at the GOCAF in Augusta, extensive lamp breakage occurred, releasing mercury to the environment. The GOCAF was located on the Kennebec River in its floodplain, and there was the potential for mercury contamination of the river via floodwaters. Broken lamps were not immediately contained and were cleaned up improperly by discarding them into an adjacent dumpster. Due to improper employee training combined with the lack of a required spill plan and improper storage, there was an increased risk of health impacts or injury to workers and a higher spill risk.

   To resolve the violations, Sun Tan City has completed corrective actions to achieve compliance with the applicable laws and rules and paid a civil monetary penalty of $39,100. The Board approved the administrative consent agreement on September 5, 2024.

7. T&D Wood Energy LLC and Player Design, Inc. T&D Wood Energy LLC is a Maine company, doing business as Wood and Sons, that operates a wood pellet manufacturing facility in Sanford. Player Design, Inc. is a Maine corporation and operates an engineering and equipment design and supply company in Presque Isle. In 2018, the Department issued an Air Emission License to T&D Wood Energy LLC and Player Design, Inc. for a wood pellet manufacturing facility in Sanford. Department inspections document that, between 2018 and 2023, T&D Wood Energy LLC and Player Design, Inc. failed to operate the pellet manufacturing facility in compliance with its Air Emission License, including the following alleged violations: failure to conduct emission testing within required deadlines; failure to submit emission test result reports within the required time period; failure to construct emissions-related equipment in conformance with licensed specifications; multiple failures of compliance emission tests; failure to operate at or below the dryer inlet temperature standard; failure to maintain records sufficient to demonstrate compliance with Air Emission License requirements; installation and operation of unlicensed equipment; and failure to submit reports outlining facility upsets that resulted in emission exceedances.

   To resolve the violations, T&D Wood Energy LLC and Player Design, Inc. have completed corrective actions to achieve compliance with the applicable laws and rules and paid a civil monetary penalty of $151,550. The Board approved the administrative consent agreement on June 20, 2024.

8. The VW Garage, LLC and Cory Sterling. The VW Garage, LLC is a Maine company, doing business in Westbrook. Cory Sterling is the managing member for The VW Garage, LLC. In 2021, the Department's Division of Response Services was informed by the City of South Portland of complaints of an alleged petroleum-like discharge from a storm drain discharge point on Willard Beach. Numerous residents and beach goers had complained about burning sensations from swimming and strong petroleum odors in the area. Oil sheening was reported to the Department by individuals living in Cape Elizabeth. First responders on scene traced the release back to 491 Cottage Road in South Portland, formerly known as Hill's Service Station, about a half

mile south of the beach. On August 24, 2021, South Portland Fire Department arrived at 491 Cottage Road and observed Cory Sterling and another individual attempting to stop (using sorbent materials) a mixture of oil, water and detergents running across the parking area in front of the former auto repair facility and being released into the storm drain. Cory Sterling indicated he was pressure washing the interior of the garage in anticipation of opening an auto repair business at this location when the oily liquids suddenly backed up and over-flowed a collection pit in the garage bay floor. The Fire Department placed further absorbent materials to contain the release. Response Services arrived on scene at Willard Beach and advised the public to stay out of the water due to the presence of petroleum in the water and on the beach. Response Services' cleanup efforts continued into the evening and over the next several days. This resulted in a beach closure from August 24, 2021, to August 28, 2021. About 3,500 gallons of oily water was removed from the affected storm water system and about 3,000 pounds of oiled debris was recovered from the storm water system and the beach. The Department incurred $54,082.26 total in costs responding to and remediating this spill.

By discharging oil into or upon coastal waters and the beaches and lands adjoining the seacoast of the State, The VW Garage, LLC and Cory Sterling violated 38 M.R.S. § 543, Pollution and corruption of waters and lands of the State prohibited. The VW Garage, LLC, and Cory Sterling's failure to immediately initiate removal of the prohibited oil discharges to the Commissioner's satisfaction violated 38 M.R.S. § 548, Removal of prohibited discharges.

To resolve the violations, The VW Garage, LLC and Cory Sterling reimbursed the Department's expenses of $54,082.26 by payment to the Maine Ground and Surface Waters Clean-up and Response Fund. The Board approved the administrative consent agreement on September 5, 2024.

9. Tower Solar Partners, LLC. On May 24, 2021, the Department issued to Tower Solar Partners, LLC a combined Site Location of Development Law and the Natural Resources Protection Act permit for the construction of a 5.0-megawatt solar energy

development occupying approximately 30.3 acres of land in Embden. On October 14, 2022, Department staff were notified by the Town of Emden Code Enforcement Officer and a neighbor that sediment-laden water was leaving the site boundaries and entering Alder Brook.

On October 18, 2022, Department staff visited the site and observed sediment-laden water entering neighboring properties as well as Alder Brook and the Kennebec River. Approximately 30 acres of the site had been grubbed and graded without adequate stabilization measures and erosion controls were inadequately or improperly installed. On October 19, 2022, Department staff received a complaint and photographs from the Code Enforcement Officer that large amounts of sediment left the site and were tracked onto Kennebec River Road. Department staff contacted Tower Solar Partners, LLC, who confirmed that logging equipment leaving the site tracked sediment onto the road. On October 26, 2022, Department staff received images from the Code Enforcement Officer of sediment leaving the site and entering Alder Brook.

In response to the violations observed by Department staff, Tower Solar Partners, LLC submitted an updated Site-Specific Erosion and Sedimentation Control Plan and implemented a series of corrective measures, including hiring of 3rd party inspector, installing additional sediment basins, expanding perimeter berms and stone check dams, and dedicating a crew to inspect and maintain the erosion and sedimentation controls.

To resolve violations of Tower Solar Partner, LLC's permit and the Erosion and Sedimentation Control Law, Tower Solar Partner, LLC agreed to pay a civil monetary penalty of $148,836. The Board rejected the administrative consent agreement on February 1, 2024, on the basis that the proposed civil penalty is not proportionate to the severity and willfulness of the alleged violations. The Board directed staff to pursue further enforcement proceedings to seek a resolution to the alleged violations.

10. Trombley Industries, Inc. Trombley Industries, Inc. is a Maine corporation that operates a construction business and operated a gravel pit and gravel washing operation in

Limestone. In response to a September 15, 2022, complaint from the United States Fish and Wildlife Service regarding siltation into Greenlaw Brook in the Aroostook National Wildlife Refuge, an investigation by Department staff led to the discovery of a culvert on the Trombley Industries, Inc. property discharging silt laden water from gravel washing to a wetland and subsequently a tributary to Greenlaw Brook approximately three miles upstream of the refuge. The impacted portion of Greenlaw Brook also runs through land owned by the Aroostook Band of Micmac Trust. Upon discovery and in consultation with Department staff, Trombley Industries, Inc. immediately ceased the discharge to the wetland, excavated the silt ponds in the former gravel pit that had been used previously for the wash water, repaired the infrastructure to pipe the wash water to the silt ponds, and re-routed wash water to the silt ponds. Silt discharged by Trombley Industries, Inc. significantly impacted the wetland immediately adjacent to the discharge, the tributary to Greenlaw Brook, and Greenlaw Brook itself. No fish kill was observed, but impact to aquatic life is assumed to have occurred. Subsequent inspection of the wetland, tributary and Greenlaw Brook by Department staff in the summer of 2023 revealed that the impacts had been naturally mitigated. By discharging sediment to a wetland, a tributary to Greenlaw Brook, and Greenlaw Brook without a license, Trombley Industries, Inc. allegedly violated 38 M.R.S. § 413(1), Waste discharge licenses.

To resolve the violations, Trombley Industries, Inc. paid a monetary penalty of $12,000 in the form of a supplemental environmental project to the Friends of the Aroostook National Wildlife Refuge for the purposes of providing signage and other infrastructure for the Mi'kmaq Heritage Corridor Trail. The Board approved the administrative consent agreement on October 17, 2024.

11. Worcester Holdings, LLC. Worcester Holdings, LLC constructed a project known as the Flagpole View Cabins Development in Columbia Falls, which consists of at least 52 rental cabins, a restaurant, parking areas, access roads, a well head, and a water storage tank building without first obtaining a permit from the Department pursuant to the Site Location of Development Law. Worcester Holdings, LLC did not employ appropriate

erosion and sedimentation control devices during construction, as required by the Erosion and Sedimentation Control Law.

To resolve violations of the Site Location of Development Law and Erosion and Sedimentation Control Law, Worcester Holdings, LLC agreed to submit an after-the-fact Site Location of Development Law permit application and pay a civil monetary penalty of $250,000. The Board approved the administrative consent agreement on February 28, 2024.

G. Petitions to Modify a License or Order Corrective Action

The petition process is a mechanism to reopen a final license that was issued by the Department if certain conditions are found to exist. There were no such petitions referred to the Board by the Commissioner in 2024.

H. Recommendations to the Maine Legislature

Another responsibility of the Board is to report to the Legislature on the effectiveness of the environmental laws of the State and any recommendations for amending those laws or the laws governing the Board. 38 M.R.S. § 341-D(7). The Board has identified the following as potentially benefitting from legislative review.

1. The Board recommends that the Legislature consider adjusting upwards the minimum statutory penalty amount for violations of environmental laws and rules in 38 M.R.S. § 349.

2. The Board is charged with adopting and amending rules necessary for the interpretation, implementation and enforcement of any provision of law that the Department is charged with administering and that are necessary for the conduct of the Department's business. 38 M.R.S. § 341-H. The Board recommends that the Legislature carefully consider the extent to which additional significant public policy decisions must be made during

agency rulemaking when the Legislature designates rules as being routine technical or major substantive pursuant to 5 M.R.S. § 8071 with the goal of settling major public policy decisions at the legislative branch level.

3. The Board recommends that the Legislature carefully consider the Clean Water Act and Clean Air Act recusal requirements of 38 M.R.S. § 341-C(8) when evaluating nominees for Board membership with a goal of limited the number of potential conflicts of interest that prevent Board members from participating in matters that come before the Board.

4. The Board encourages the Legislature to support additional staffing resources at the Department to ensure continued fulfillment of the Department's mission to prevent, abate and control the pollution of the air, water and land.

IV. SUMMARY OF PENDING LITIGATION

The following is a summary of recently settled and pending litigation of orders and decisions issued by the Board.

1. *Black Bear Hydro Partners, LLC v BEP, et al.*, Law Court Docket No. KEN-23-491

   This is an appeal filed by Black Bear Hydro Partners, LLC (Black Bear) of a Board Order issued on June 3, 2021. That Board Order denied Black Bear's appeal and affirmed the Commissioner's denial of Black Bear's application for water quality certification for its Ellsworth Hydroelectric Project in Ellsworth. The Kennebec County Superior Court affirmed the Board Order and denied Black Bear's Rule 80C appeal. Black Bear further appealed that Superior Court decision to the Maine Supreme Judicial Court sitting as the Law Court (Law Court). That Law Court appeal was argued in September 2024 and is now awaiting a decision from the Law Court.

2. *EMCI, et al. v BEP, et al.*, Law Court Docket No. KEN-23-348

   This is an appeal filed by Eastern Maine Conservation Initiative (EMCI) and Roque Island Gardner Homestead Corporation (RIGHC) of a Board Order issued on August 4, 2022. That Board Order denied the appeal of Sierra Club of Maine, EMCI, and RIGHC of the Commissioner's Site Location of Development Law and Natural Resources Protection Act permit issued to Kingfish Maine, LLC for a proposed land-based recirculating aquaculture system in Jonesport. The Kennebec County Superior Court affirmed the Board Order and denied EMCI's and RIGHC's Rule 80C appeal. EMCI and RIGHC further appealed that Superior Court decision to the Law Court. That Law Court appeal was argued in April 2024 and is now awaiting a decision from the Law Court.

3. *Mabee, et al. v BEP, et al.*, Business and Consumer Court Docket No. BCD-APP-2024-15

   This is an appeal filed by Jeffrey Mabee and Judith Grace, the Maine Lobstering Union, and David Black, Wayne Canning, and Friends of the Harriet L. Hartley Conservation Area of a Board Order issued on October 19, 2023, on remand from the Business and Consumer Court and the Law Court following its issuance of a decision in a related case, *Mabee, et al. v. Nordic Aquafarms Inc*. 2023 ME 15. This appeal of the Board's Order on Remand was transferred to and is now pending before the Business and Consumer Court in Portland and is consolidated with matter nos. 4 and 5 described below.

4. *Upstream Watch v BEP, et al.*, Business and Consumer Court Docket No. BCD-APP-2024-14

   This is another second appeal, filed by Upstream Watch, of the Board Order issued on October 19, 2023, on remand from the Business and Consumer Court and the Law Court following its issuance of a decision in a related case, *Mabee, et al. v. Nordic*

Aquafarms Inc. 2023 ME 15. This second appeal of the Board's Order on Remand was also transferred to and is now pending before the Business and Consumer Court in Portland, and as noted above, is consolidated with matter nos. 3 and 5.

5. *Mabee, et al. v BEP, et al.*, Business and Consumer Court Docket No. BCD-APP-2024-13

   This is an appeal filed by Jeffrey Mabee and Judith Grace, the Maine Lobstering Union, and David Black, Wayne Canning, and Friends of the Harriet L. Hartley Conservation Area of an August 24, 2022, Board Chair dismissal of an administrative appeal filed with the Board regarding a permit minor revision issued to Nordic Aquafarms Inc. on May 18, 2022, involving its air emission license. This appeal was also transferred to and is now pending before the Business and Consumer Court in Portland and is consolidated with matter nos. 3 and 4 above.

6. *West Forks, et al. v BEP, et al.*, Kennebec County Superior Court Docket No. AUGSC-AP-22-30

   This Rule 80C appeal was filed by West Forks Planation, Town of Caratunk, Kennebec River Anglers, Maine Guide Service, LLC, Hawks Nest Lodge, Edwin Buzzell, Kathy Barkley, Kim Lyman, Noah Hale, Eric Sherman, Matt Wagner, Mike Pilsbury, Mandy Farrar, and Carrie Carpenter (collectively West Forks) of a Board Order issued on July 21, 2022. That Board Order denied the appeals of several parties, Natural Resources Council of Maine, NextEra Energy Resources, LLC, and West Forks, of the DEP Commissioner's May 11, 2020, and December 4, 2020, licensing decisions regarding Central Maine Power and NECEC Transmission LLC's New England Clean Energy Connect (NECEC) project. The Rule 80C appeal had been pending in Kennebec County Superior Court earlier in the year but was dismissed in March 2024 and is no longer active.

7. *Town of Wiscasset v BEP, et al.*, Lincoln County Superior Court Docket No. WISSC-AP-23-11

This Rule 80C appeal was filed by the Town of Wiscasset of a Board Order issued on October 19, 2023. That Board Order denied the appeal of the Town of Wiscasset of the Commissioner's Order issued to Maine Yankee Atomic Power Company for a tax exemption certification pursuant to 36 M.R.S. §§ 655(1)(N) and 656(1)(E)(2). The Rule 80C appeal had been pending in Lincoln County Superior Court earlier in the year but was remanded to the Board for further remand to the DEP Commissioner for proceedings consistent with P.L. 2024, ch. 588 (emergency, effective Apr. 2, 2024). Those proceedings were not further appealed, and this matter is no longer active.

8. *Conservation Law Foundation, et al. v DEP and BEP*, Cumberland County Superior Court Docket No. PORSC-AP-24-22

This is a Rule 80C appeal and declaratory judgment action filed by the Conservation Law Foundation (CLF), Sierra Club, and Maine Youth Action challenging the Board's alleged failure or refusal to act and adopt proposed rule Chapter 127-A, *Advanced Clean Cars II Program*, addressing certain vehicle emissions standards. On December 26, 2024, the plaintiffs filed a motion for leave to amend their complaint in the Superior Court. The DEP/BEP plan to file a response in opposition, which is due on January 16, 2025.

V. CLOSING

As noted above, this report is submitted in fulfillment of the provisions of 38 M.R.S. § 341-D(7). I would be happy to meet with the Committee and respond to any questions members may have regarding the Board's work or the specific recommendations in this report.

Respectfully submitted,

Susan M. Lessard, Chair
Board of Environmental Protection

Attachment A: Board members' biographical information

ATTACHMENT A

Attachment A: Board of Environmental Protection Members

Susan M. Lessard
Bangor, 2nd Term

Ms. Lessard has 40 years of experience in local government in Maine. She currently serves as Town Manager for the Town of Bucksport, and previously served as the Town Manager for the communities of Hampden, Vinalhaven, Fayette, and Livermore Falls. As such Ms. Lessard has extensive experience in solid waste management issues, municipal financial management, and community development. She is a past president of the Maine Municipal Association and has served on the Municipal Review Committee and the Maine Rural Development Council. Ms. Lessard has received a number of awards for her work including the Governor's Environmental Excellence Award (2002) for development of a collaborative process for municipal review of major landfill expansion projects in Hampden, and the Maine Engineering Excellence Award (1998) and Maine Town and City Manager's Association Leadership Award (1999) for the development of an innovative alternative landfill capping plan for the town of Vinalhaven. Ms. Lessard also received a U.S. Coast Guard Public Service Commendation (1996) for her work on a program to transfer ownership of thirty-five Maine lighthouses from the federal government to municipalities and non-profit organizations across the state. Ms. Lessard resides in Bucksport with her husband Dan. Ms. Lessard was reappointed to the Board by Governor Janet T. Mills in January 2022.

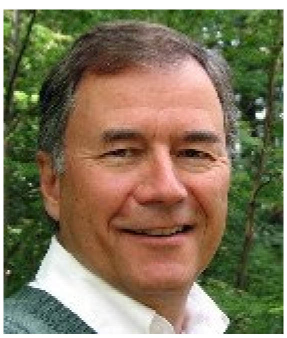
Robert Marvinney
Readfield, 1st Term

Dr. Marvinney is a Licensed Geologist with more than 40 years of experience with geological and environmental issues in Maine. While not a native of the State, he has spent most of his professional career here. He retired in July 2021 from his position as Director of the Bureau of Resource Information and Land Use Planning, and State Geologist, an appointed position that he held for 26 years. Dr. Marvinney's experience with Maine began in the early 1980s while carrying out geological projects in northern Maine for his Master's and Doctorate degrees from Syracuse University. While State Geologist at the Maine Geological Survey, he initiated, carried out, and/or directed many projects that highlight the impact Maine's geology can have on the health and well-being of Maine citizens. Most recently, he co-chaired the Science and Technical Subcommittee of the Maine Climate Council that produced the report, *"Scientific Assessment of Climate Change and Its Effects in Maine,"* that summarizes current impacts and likely future scenarios for climate change in Maine. He has lived in Readfield with his wife Cheryl for more than 34 years and has two grown children. Dr. Marvinney was appointed to the Board by Governor Janet T. Mills in January 2022.

Attachment A: Board of Environmental Protection Members

Barbara Vickery
Richmond, 1st Term

Barbara Vickery is a Conservation Biologist who spent 33 years with The Nature Conservancy, most recently as Director of Conservation Programs. At the Conservancy she was lead scientist, oversaw the stewardship of its preserves and easements, initiated programs in freshwater and marine conservation, and planned land conservation across the state and region. Mrs. Vickery served on numerous state advisory committees, including the Ecological Reserves Science Advisory Committee, the Bureau of Public Lands Integrated Resource Plan, Maine Forest Biodiversity Project Steering Committee, and steering committees of two of MDIFW's State Wildlife Action Plans, which gave her opportunities to work with industry, state agencies and many other environmental organizations. Mrs. Vickery received a B.A. from Harvard in early childhood education and was a teacher for 10 years. She later earned a B.S. in Biology from Bates College and served as Botanist for the State Planning Office Critical Areas Program before joining The Nature Conservancy. Since retirement eight years ago Mrs. Vickery assumed co-managing editor responsibility for Birds of Maine, a major book that her husband was not able to finish before he died. Since the book's publication in 2020, she has become an active volunteer, serving on the Board of the Forest Society of Maine, as Secretary to the Bates Morse Mt. Conservation Area Corporation, and promoting climate adaptation actions in Richmond, where she lives, and Phippsburg where her family owns seasonal homes. Mrs. Vickery was appointed to the Board by Governor Janet T. Mills in January 2022.



Robert S. Duchesne
Hudson, 2nd Term

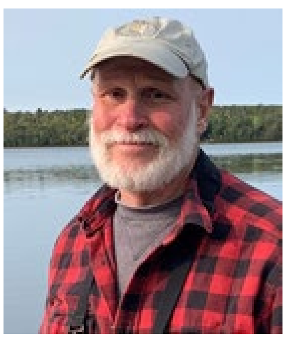
Robert Duchesne is a former state legislator and radio show broadcast host. Mr. Duchesne's radio career spanned more than three decades, during which he served as host of a popular radio show that was broadcast across eastern and central Maine. During his radio career, Mr. Duchesne was active in charity and public service organizations in the Bangor area, including Downeast Big Brothers Big Sisters, Maine Audubon, and the Maine Association of Broadcasters. He also served on several economic and business development boards. In 2005, Mr. Duchesne was elected to the Maine House of Representatives, where he served six non-consecutive terms. While in the Legislature, he chaired both the Environment and Natural Resources Committee and the Inland Fisheries and Wildlife Committee, and started his own guiding business – Maine Birding Trail. Mr. Duchesne shares his birding expertise in a weekly birding column for the Bangor Daily News. Robert Duchesne resides at Pushaw Lake in Hudson with his wife, Sandi. Mr. Duchesne was reappointed to the Board by Governor Janet T. Mills in February 2024.

Electronic Filing: Received, Clerk's Office 03/03/2025

Attachment A: Board of Environmental Protection Members

Robert M. Sanford
Gorham, 2nd Term

Robert Sanford is Professor Emeritus of Environmental Science and Policy at the University of Southern Maine. Mr. Sanford obtained an M.S. and Ph.D. in Environmental Science from the State University of New York College of Environmental Science and Forestry, and an undergraduate degree in Anthropology from SUNY Potsdam. He is the author of numerous books and journal articles on environmental planning and policy, applied archeology, instruction, and civic engagement. Prior to joining the faculty of the University of Southern Maine in 1996, Mr. Sanford served 10 years as an Environmental Board District Coordinator in Vermont. Mr. Sanford has served on numerous advisory committees for state and local government as well as non-profit organizations including the Maine Water Resources Committee, the Maine Farmland Project, and the Friends of the Presumpscot River. Mr. Sanford also served on the Town of Gorham's Municipal Recycling Committee for ten years. He lives in Gorham with his wife and son. Mr. Sanford was reappointed to the Board by Governor Janet T. Mills in February 2024.



Steven Pelletier
Topsham, 2nd Term

Mr. Pelletier is a Certified Wildlife Biologist®, Maine Licensed Forester, and Professional Wetland Scientist with over 40 years of professional natural resource experience. Earlier in his career he served as a Wildlife Biologist with the US Forest Service and as an Environmental Specialist for the Maine Department of Environmental Protection's Land Bureau, was later co-founder/ owner of Woodlot Alternatives, Inc., a Maine-based ecological consulting firm, until its acquisition by Stantec Consulting in 2007. At Stantec he served as Senior Principal and US Ecosystems Discipline Lead specializing in rare species habitats and site and landscape-level resource assessments, also serving as Principal Investigator of two federal offshore migration research projects. Mr. Pelletier also conducted and oversaw a broad variety of diverse projects ranging from highway/ rail transportation to offshore energy development. He has authored numerous publications on a variety of natural resource topics including forest biodiversity, bat migration, vernal pools, and resource mitigation and compensation planning. He has served on a variety of Federal and State advisory committees and stakeholder groups and in 1989, co-founded the ME Association of Wetland Scientists. He currently serves on the Maine Board of Licensure of Foresters and several local community organizations including the Brunswick-Topsham Land Trust Advisory Board, Topsham Conservation Commission, and Topsham Development, Inc. Mr. Pelletier resides in Topsham with his wife Mary. Mr. Pelletier was reappointed to the Board by Governor Janet T. Mills in February 2024.

EXHIBIT E

October 19, 2022

RE: Comments on the State of Washington, Department of Ecology, on Chapter 173-423 WAC – Clean Vehicles Program

The Alliance for Automotive Innovation[1] (Auto Innovators) hereby submits comments on the State of Washington, Department of Ecology (Ecology) on Chapter 173-423 WAC, Clean Vehicles Program. This will expand the adoption of California motor vehicle emission standards to include the Advanced Clean Cars II and the Low NOx Omnibus Rules (which includes the Phase 2 Greenhouse Gas Rules). As written, the regulations could result in zero emission vehicle (ZEV) standards that are more stringent in Washington than they are in California. We support Ecology's proposed adoption of early action credits as part of the ACC I rule, and we also recommend Washington consider proportional credits—i.e., a starting credit banks for each manufacturer proportional to the number of credits in California—to avoid this outcome.

The ACC II regulations are the most aggressive vehicle regulations in history and meeting them will be incredibly challenging even in California, which not only has 60 percent higher ZEV sales than Washington, but also has large credit banks that manufacturers can draw on in the early years. While Washington has consistently had the second highest sales in the U.S., its ZEV sales are still far behind California's.

When California developed ACC II, it assumed manufacturers would use the existing credit banks in California to meet the standards in the early years (model years 2026-2030). However, those credit banks simply do not exist in Washington. While we appreciate the early credit provisions that were contained in ACC I for 2023 model year (MY), these are not likely to result in equivalent stringency between Washington and California. For example, for the 2026MY requirements of 35 percent ZEVs, a manufacturer could comply in California by selling 30 percent ZEVs in MY2026 and using historical banked credits for the remaining 5 percent. Without equivalent credit banks in Washington that manufacturer would need to sell more ZEVs in Washington (i.e., 31-35 percent) to comply.

[1] The Alliance for Automotive Innovation ("Auto Innovators") represents automakers that produce and sell approximately 98% of all the new light-duty cars and trucks sold in the U.S. Auto Innovators is the authoritative and respected voice of the automotive industry. Auto Innovators is focused on creating a safe and transformative path for sustainable industry growth by engaging directly in regulatory and policy matters impacting the light-duty vehicle market across the country. Auto Innovators' members include motor vehicle manufacturers, original equipment suppliers, technology, mobility, and other automotive-related companies and trade associations

EXHIBIT E

Thus, we request that Ecology include proportional credits in MY2025 to ensure the standards in Washington are not more stringent than California's ZEV standards.

Commitment to Net-Zero Carbon Transportation.

Auto Innovators and its members are committed to achieving a net-zero carbon transportation future for America's cars and light trucks. The auto industry is investing over $515 billion globally over the next decade to advance vehicle electrification and will increase the number of EV models available from 83 today to around 130 by MY2026. Additionally, with necessary conditions in place, Auto Innovators and our members support a goal of achieving 40-50% U.S. new light-duty vehicle market share of EVs nationally by 2030, with supportive investments and complementary policies.

There is much work to be done to significantly increase EV adoption across the nation, let alone achieve ACC II requirements for MY2035. Our shared objectives require collaboration and a sustained commitment to fund and execute supportive programs and policies.

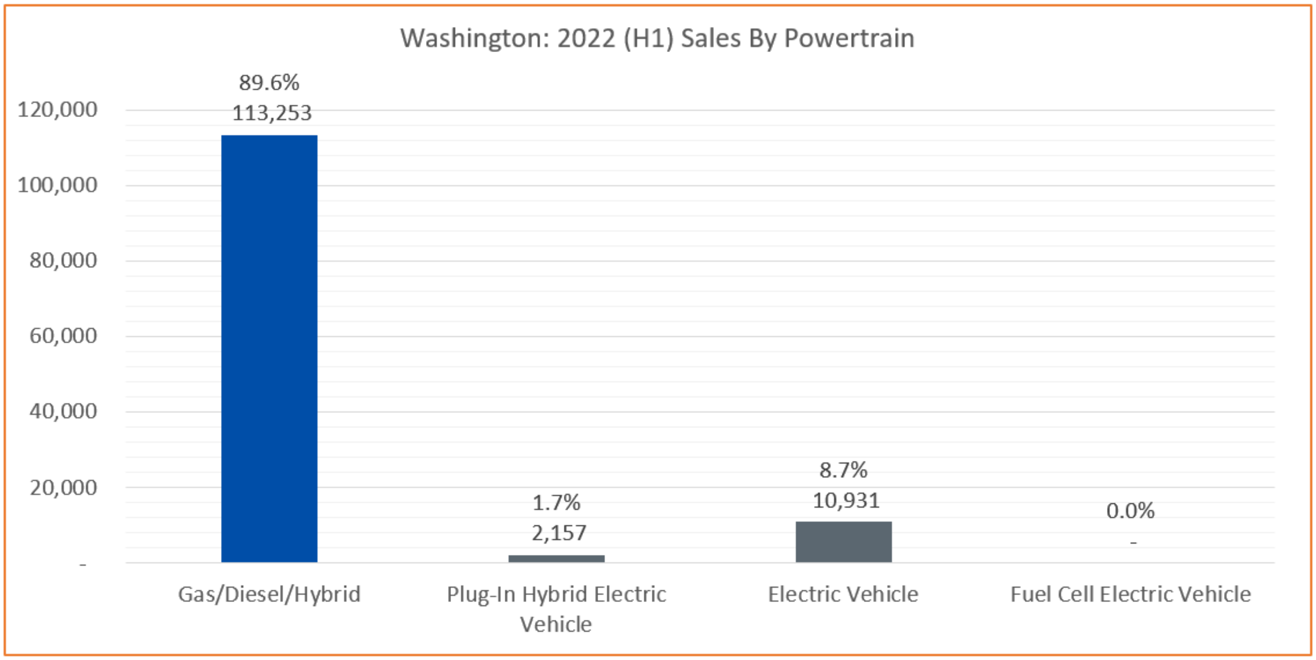
The challenge of reaching a 100 percent EV market by MY2035 requires Washington address several hurdles to consumer acceptance. There are many important complementary measures needed for success. Examples include, but are not limited to:

- Ensuring low- to moderate-income (LMI) and multi-family housing residents have the identical access to low-cost, convenient, and reliable level 2 (L2) home charging that single-family homeowners enjoy.
- Adopting state fleet requirements equivalent to or greater than the requirements in ACC II
- Deploying convenient and affordable access to public EV charging and hydrogen refueling stations.
- Adopting building codes addressing new construction and retrofit requirements for EV-ready residential and commercial parking.
- Ensuring grid resiliency and utility electric rates that provide low-cost EV charging.
- Adopting and funding sustained and comprehensive state-level point-of-sale EV rebates
- Finalizing state action on low carbon fuel standard (LCFS).

These policies will be critical to the feasibility of meeting ZEV requirements. To facilitate Ecology's review of the feasibility of meeting the ZEV sales requirements under ACC II, the following includes relevant EV data points for your state. Washington must take immediate and substantial action to implement these critical measures to reach its goal.

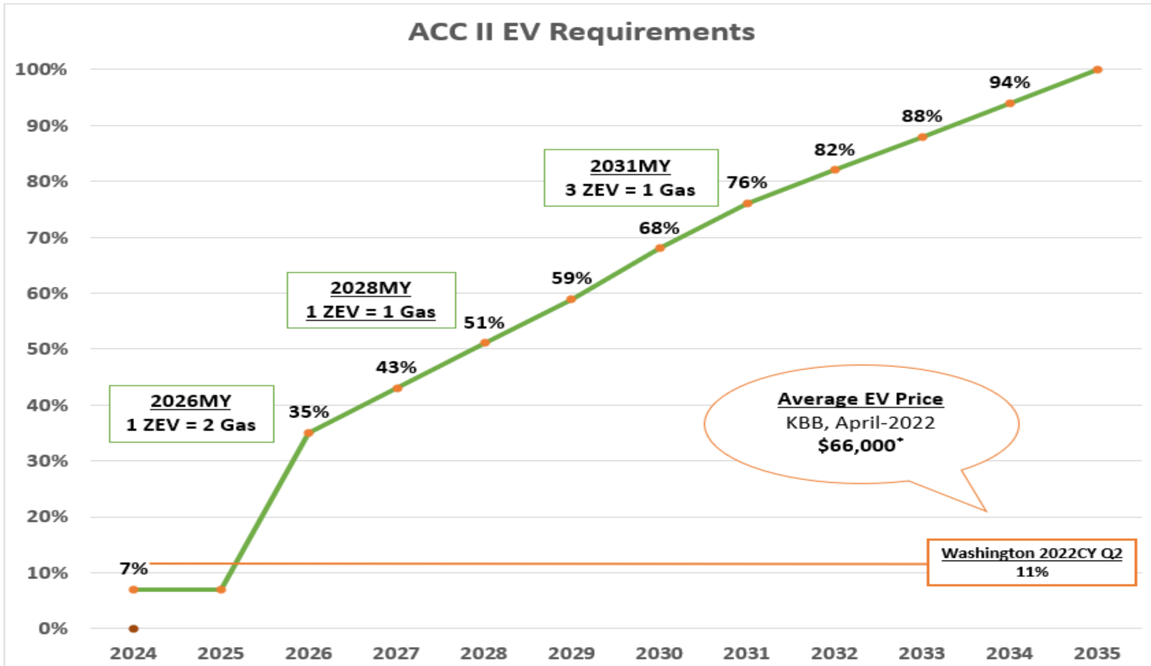
Current State-of Play.

In Washington, EVs comprise 10.4% new vehicle sales in 2022 (H1)[2]



As shown below, the ACC II regulations require very aggressive increases in EV sales starting with MY2026. In Washington, EV sales must increase three-fold in about three model years. These are staggering required sales increases for a new technology that relies heavily on customer acceptance and market readiness.

[2] Compiled by Alliance for Automotive Innovation with data provided by S&P Global Mobility, sales figures represent new vehicle registrations between January 1, 2022 – June 30, 20212.



*See Kelly Blue Book: [Average New Vehicle Price Sets Record, But Don't Panic - Kelley Blue Book (kbb.com)]

The required three-fold sales increase needed is based on 2022 EV sales where the average transaction price of EVs is now about $66,000. Based on the average transaction price of EVs, EV buyers are far more likely to be affluent single-family homeowners with modern electric panels just a few feet from their garage where they will charge their EVs. These buyers do not represent a full cross-section of Washington's new car buyers, and achieving 30, 50, or 70 percent of the new car market will require reaching buyers of more moderate means. It will also require action well beyond automakers' ability to produce more EVs.

State and Local Fleet Increase.

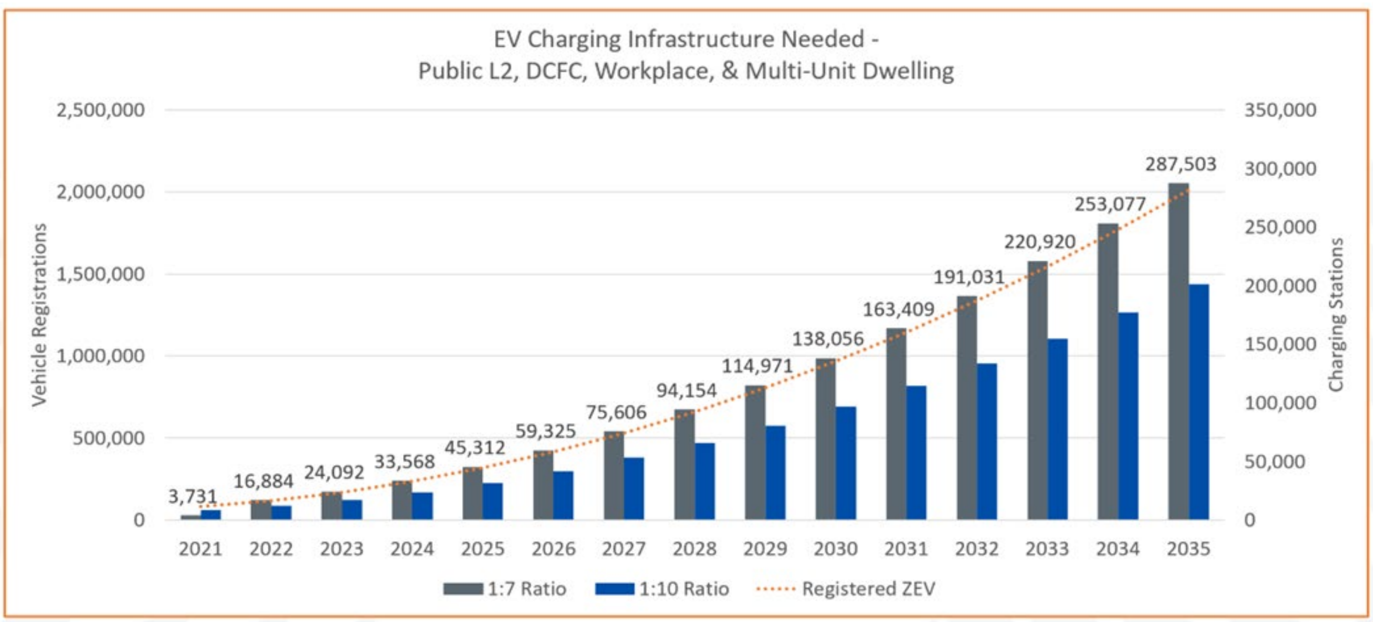
State and local governments can lead by example by prioritizing adopting EVs (e.g., PHEVs, BEVs, and/or FCEVs) when making fleet purchases. This is truly an example of executive leadership and serves to bolster consumer interest in EV purchases. These fleets can also act as an accelerator and should adopt EVs at a faster rate than what the ACC II rule requires of automakers and their customers.

Charging and Hydrogen Refueling Infrastructure.

Reliable and convenient access to charging and hydrogen refueling stations support Washington customers that buy or lease EVs. Publicly available charging stations not only ease perceived "range anxiety" concerns but also substantially increase consumer awareness of the technology. We know that hydrogen vehicles are better suited for some customers, especially those that do not have access to charging at home or the workplace, or those that have a lifestyle that requires short refueling times and a similar refueling process as gasoline. Here is a snapshot of Washington's current EV charging/hydrogen refueling infrastructure[3]:

- Number of non-proprietary L2 public charging outlets: 2,870 (at 1381 stations)
- Non-proprietary DC fast charger outlets: 428 (at 197 stations)
- Hydrogen stations: 0

To support the prospect of 100 percent EV-only sales in MY2035, Washington's charging capabilities will need to increase 7,606% within the next 13 years to be in line with the California infrastructure assessment of the required ratio of seven EVs to charger port. Even at a one-to-ten ratio, charging outlets will need to increase by nearly 5,294%[4]. The chart below depicts the substantial increase needed in Washington's public and MUD charging infrastructure through 2035.



Residential and Commercial Building Codes - Retrofit and New Construction Updates Needed.

According to the 2017 NREL study, 88 percent of EV charging occurs at home, making access to home charging a top priority for customers considering an EV. As a result, the converse is also true, lack of access to home charging is a major barrier to EV adoption. As a first and most cost-effective step, Washington should immediately adopt residential building codes to require EV-ready charging capabilities in 100

[3] Charging information from U.S. Department of Energy Alternative Fuels Data Center, as of 6/30/2022.

[4] Department of Energy, Alternative Fuels Data Center, https://afdc.energy.gov, Accessed 6/10/22

percent of parking spots in new multi-unit dwellings (MUDs) and single- family homes[5]. Washington should also adopt non-residential building codes that require installation of EV-ready charging capabilities in a significant portion of all new parking at workplace and public locations. Numerous studies have shown retrofitting residential and non-residential parking is five to six times more expensive than installing charging stations during new construction[5]. Moreover, the building codes should also include requirements to install the same infrastructure during any significant renovations, such as parking lot paving, electrical panel upgrades, etc.

We recommend the State of Washington to adopt codes in the intervening code cycle that require:

1. Every new unit in a multi-family housing development with available parking to have at least one EV-Ready parking space.
2. Each EV-Ready space above provides, at minimum, Low-Power Level 2 (LPL2) (208/240V, 20A) terminating in a receptacle or an electric vehicle supply equipment (EVSE).
3. Prioritizing access to the lowest-possible electricity cost for charging.
4. EV-Ready signage at each parking space.

This recommendation for L2 power charging levels should be considered as the bare minimum requirement. Mainstream customer satisfaction may require higher power charging. In fact, this is presumably why the California Air Resources Board (CARB) in adopting regulatory requirement for 100 percent electric vehicles (EVs), also mandated that every new MY2026 and later EV contain a portable charger capable of charging the vehicle at 5.76 kW (208/240V, 30A).

While building codes that address new construction is a common-sense and lowest-cost first step, it is not nearly enough to support Washington's goal to adopt regulations that require 100 percent EVs by MY2035. For example, new residential construction typically accounts for about one percent of all residential units each year. Thus, new building codes would only provide residential charging in about 15 percent of the residential units by MY2035 – the year Washington will require 100 percent EVs. Consequently, Washington must adopt public and private programs to support retrofitting of existing homes and MUDs, such as apartments, condos, and townhouses. As noted, retrofits are far more expensive than incorporation of EV-ready infrastructure at the time of new construction, but they will be necessary to support increasing customer adoption of EVs.

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[5] *Nrel.Gov*, 2022, https://www.nrel.gov/docs/fy17osti/69031.pdf.

In addition, special attention should be given to the infrastructure needs in Washington's underserved communities to ensure that access to affordable and convenient charging and hydrogen refueling options are made available on an equally aggressive timeline. MUD residents, however, often face the greatest, most costly, and burdensome obstacles to installing residential EV charging. For MUD residents, the additional costs to upgrade the electrical panel, install conduit between the electrical panel and their parking space, and the logistical challenges of securing building owner approval, coordinating the billing with the building owner, and persuading an owner to make a long-term investment on a rental property, make it near impossible to be an EV driver in a MUD.

Every study conducted by national labs and the California Energy Commission reports customers charge at home 80-90 percent of the time[6]. Nonetheless, some suggest that while those in single family homes can charge at home, MUD residents should be forced charge elsewhere such as DC fast charge stations or public chargers. We do not agree. Charging at home is far cheaper, more reliable, and vastly more convenient. It is unreasonable to expect MUD residents to pay 2 or 3 times as much for charging and spend hours away from home each week fueling their EVs.

Grid Resiliency/Utility Rate Setting Alignment.

A thorough review of Washinton's electric grid to determine the viability of expanded access in both the near- and long-term makes strong practical sense. Public confidence in the resiliency of the grid will only help spur faster EV adoption. Failure to provide consistent service, particularly when the majority of EV charging is done at home, could be devastating for increased EV adoption, both for the light- and heavy-duty vehicle sectors.

Auto Innovators suggests that as part of the review, the state commit to a transparent dialogue with the utility commission and energy companies about making home and public charging affordable and convenient. In addition, an education campaign about the different types of charging systems (L1, L2, DCFC) and suggestions about prime charging times to lessen the load on the grid should be addressed.

[6] For example, see: (2) Crisostomo, Noel, Wendell Krell, Jeffrey Lu, and Raja Ramesh. January 2021. Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment: Analyzing Charging Needs to Support Zero-Emission Vehicles in 2030. California Energy Commission. Publication Number: CEC-600-2021-001. (2) Eric Wood, Clément Rames, Matteo Muratori, Sesha Raghavan, and Marc Melaina, September 2017, National Plug-In Electric Vehicle Infrastructure Analysis, National Renewable Energy Laboratory

Sustained Consumer EV Purchase Incentive.

Purchase incentives can be a persuasive and effective way to address vehicle affordability and interest customers in purchasing an EV. EVs continue to cost substantially more than a comparable gasoline-fueled vehicle, and so the compounded effect of the federal and state incentives is necessary to equalize purchase costs. We applaud the governor and House of Representatives for approving new funding this year for consumer purchases of EVs. However, funding for consumer purchase incentives will need to be significantly increased to meet the requirements of ACC II.

As you are aware, the recently enacted Inflation Reduction Act (IRA) establishes new clean vehicle credits. Eligible battery-powered electric vehicles must meet critical mineral and battery component content and other requirements to qualify for credits of up to $7,500 per vehicle. Unfortunately, with these new requirements about 70% of electric vehicles do not meet that standard and are immediately disqualified from the tax credit. In January 2023, when the provisions in the IRA become fully effective, the number of zero electric vehicles that will qualify for the credit are expected to drop further. This means Washington's state-funded consumer purchase incentives will become all the more critical to the state's goals of greater consumer EV adoption.

Consumer Awareness Programs.

Consumer awareness, understanding, and trust of the technology is essential as we move from 11 percent Washington EV sales to 100 percent in the next 13 years. Raising awareness can happen in many ways, and we encourage the state to explore a variety of options. For example, we've mentioned above that public and workplace chargers and hydrogen stations provide an excellent means of raising consumer awareness. State and local fleet purchases of EVs also substantially raise awareness – particularly if these vehicles are used in high visibility areas such as Department of Transportation (DOT) road crews, police, and fire. Additionally, state-led programs may also be necessary to support the ZEV requirements.

Expected Federal Activity.

While Ecology considers a range of state policies, it should be aware of activity at the federal level which will likely overlap with state considerations. Section 1 of President Biden's EO 14037 set a nationwide goal that "50 percent of all new passenger cars and light trucks sold in 2030 be zero-emission vehicles, including battery electric, plug-in hybrid electric, or fuel cell electric vehicles."

In December 2021, U.S. EPA adopted the most aggressive GHG emission reduction standards in history for MY2023-26 model years. In fact, those standards are even more stringent than the California standards in MY2026. Auto Innovators and our members supported EPA's proposed GHG standards and the appropriate and necessary flexibilities that encourage a higher production of EVs. We noted that policy actions are needed today to help grow EV sales significantly through model year 2026 and beyond. When litigation was brought against this rule, we intervened in support of EPA.

In April, the National Highway Traffic Safety Administration (NHTSA) followed EPA in adopting the most aggressive increase in fuel economy standards in history for MY2024-2026. However, to fulfill President Biden's EO of 50 percent ZEVs by 2030, both U.S. EPA and NHTSA are currently working on regulations for MY2027 and beyond. We expect draft regulations from both agencies within the next 6 to 8 months and final regulations by March of 2024. We continue to work cooperatively and constructively with EPA, NHTSA, California, Washington, and other stakeholders to reach our common goal of electrified transportation.

Thank you for the opportunity to provide the auto industry's perspective on a range of policies that Washington must adopt to meet its climate goals. As a reminder, it is essential that Washington adopt ACCII by December 31, 2022, to allow for a start date in 2027. Many of the actions necessary for success must start now, and we stand ready to work with the state and key stakeholders.

Sincerely,

Thomas Miller
Senior Director, Energy and Environment
Alliance for Automotive Innovation

EXHIBIT F

ALLIANCE FOR AUTOMOTIVE INNOVATION

October 1, 2023

Colorado Energy Office
1600 Broadway, Suite 1960
Denver, CO 80202

Subject: Comments to the State of Colorado on Regulation 20, Advanced Clean Cars II

The Alliance for Automotive Innovation[1] (Auto Innovators) appreciates the opportunity to provide comment to the state of Colorado on Regulation 20, which will adopt California Air Resource Board (CARB) Advanced Clean Cars II (ACCII). We applaud the comprehensive approach that Colorado has taken toward an electrified future, and your continued building on the progress made from Colorado's EV Plan 2020. Through the strong incentives, infrastructure planning, and a focus on improving consumer awareness in your plan, Colorado has been able to realize very strong market share growth (10.26%)[2] in EV sales. These plans have set the framework for personal transportation in Colorado. We continue to support this transformation and are committed to working cooperatively with Colorado to ensure vehicles developed, produced, and sold in the state of Colorado are efficient, clean, and affordable for all.

There is much work to be done to significantly increase EV adoption across the nation, including Colorado. Our shared objectives require collaboration and a sustained commitment to fund and execute supportive programs and policies. The challenge of reaching the CARB ACC II mandate of 43 percent (2027), 51 percent (2028), to 82 percent electric vehicle market share by 2032, requires Colorado to address several hurdles to consumer acceptance. There are many important complementary measures needed for success. Examples include, but are not limited to:

- Continue funding sustained and comprehensive state-level point of sales EV rebates and tax incentives.
- Ensure low- to moderate-income (LMI) and multi-family housing residents have the identical access to low-cost, convenient, and reliable level 2 (L2) home charging that single-family homeowners enjoy.
- Adopt private and state fleet purchase requirements equivalent to or greater than the sales requirements in ACC II.
- Deploy convenient, reliable, and affordable access to public EV charging and hydrogen refueling stations for light-duty, medium-duty, and heavy-duty vehicles, as well as monitoring to ensure reliability of not only the charger availability but also the charging power rate delivered at DCFCs.
- Install 350kW DCFC and hydrogen fueling stations at airports and major transportation hubs to fuel transportation network company EVs and taxis.
- Ensure grid resiliency and utility electric rates that provide low-cost EV charging.
- Adopt residential and commercial building codes addressing new construction and retrofit requirements for EV-ready residential and commercial parking.

Specifically, we recommend Colorado adopt building codes in the intervening code cycle that require:

1. Every new unit in a multi-family housing development with available parking to have at least one EV-Ready parking space.
2. Each EV-Ready space above provides, at minimum, Low-Power Level 2 (LPL2) (208/240V, 20A) terminating in a receptacle or an electric vehicle supply equipment (EVSE).
3. Prioritizing access to the lowest-possible electricity cost for charging.

---

[1] From the manufacturers producing most vehicles sold in the U.S. to autonomous vehicle innovators to equipment suppliers, battery producers and semiconductor makers – Alliance for Automotive Innovation represents the full auto industry, a sector supporting 10 million American jobs and five percent of the economy. Active in Washington, D.C. and all 50 states, the association is committed to a cleaner, safer and smarter personal transportation future. www.autosinnovate.org.
[2] Alliance for Automotive Innovation (2023 Q2) electric-vehicle-sales-dashboard (autosinnovate.org).

4. EV-Ready signage at each parking space.

This recommendation for L2 power charging levels should be considered the bare minimum requirement. Mainstream customer satisfaction may require higher power charging. In addition, special attention should be given to the infrastructure needs in Colorado's underserved communities to ensure that access to affordable and convenient charging and hydrogen refueling options are made available on an equally aggressive timeline. MUD residents often face the greatest, most costly, and burdensome obstacles to installing residential EV charging.

Addressing the "Gap Year"
The Clean Air Act's Section 177 allows a state to adopt California standards but requires the state to adopt such standards at least two years before commencement of the first regulated model year. Since the current ZEV and LEV III regulations in ACC I (13 CCR §§ 1962.2 and 1961.2) sunset after 2025MY, and Colorado will adopt ACC II in 2023, Colorado will have a "gap year" without California regulations. We recommend the following during the gap period before implementation of ACC II (MY2027) to ensure the smooth path to the state's electrification goals.

- ZEV and NMOG+NOx ACC I credit banks retained and converted as necessary.
- ZEV Sales:
    - Per ACC II, ZEV sales >7% receive banked ACC II Early Compliance Values (ECVs) available two model years prior to implementation (e.g., 2027 implementation, 2025-26MY).
- NMOG+NOx credits earned and banked using ACC I (= Tier 3) avg.
- OEMs continue reporting per ACC I/II.
- OEMs would also report to EPA as required for Tier 3.

These policies will be critical to the feasibility of meeting future ZEV requirements.

Thank you for the opportunity to provide the auto industry's perspective on a range of policies that Colorado must adopt to meet its climate goals. Many of the actions necessary for success must start now, and we stand ready to continue to work with the state and key stakeholders.

Sincerely,

Tom Miller
Senior Director, Energy and Environment
Alliance for Automotive Innovation

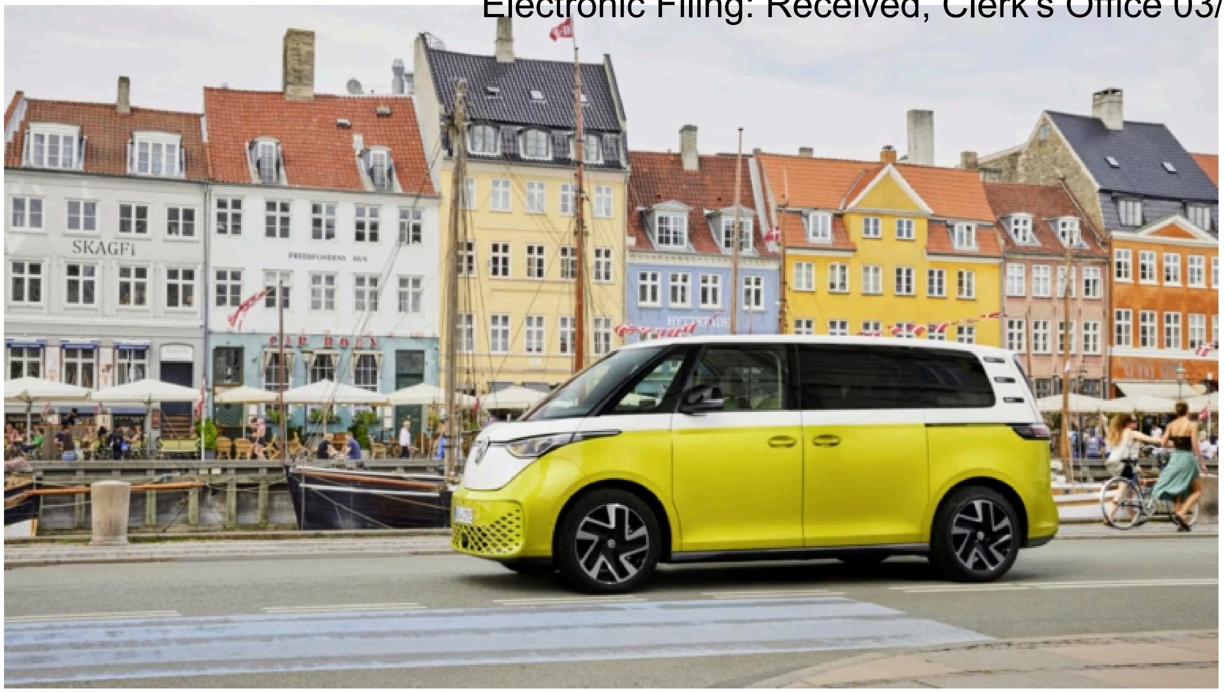
EXHIBIT G

2024 (Full Year) Germany: Best-Selling Electric Cars by Brand and Model

January 8, 2025 by Henk Bekker

In full-year 2024, Volkswagen was again the largest electric car brand in Germany and the Tesla Model Y was the best-selling battery-electric vehicle model (BEV).

EXHIBIT G



VW ID Buzz – © Volkswagen AG

2024 (January to December 2024): Battery-electric car sales in Germany contracted by 27.4% to only 380,609 electric cars for a market share of only 13.5% compared to 18.4% in 2023. Volkswagen was again the largest electric car brand in Germany in 2024 but BMW sold more electric cars than Tesla. The Tesla Model Y was Germany's favorite battery-electric car but volumes were sharply down.

USA

Latest Posts

2024 (Full Year) Global: Nissan Worldwide Car Sales by Region and Model

2024 (Full Year) Global: Mazda Worldwide Car Sales by Region and Model

2024 (Full Year) Global: Lexus Worldwide Car Sales by Region and Model

2024 (Full Year) Global: Toyota Worldwide Car Sales by Region and Model

2024 (Full Year) Europe: Car Sales and European Market Analysis

Statistics by Year

2025

2024

2023

In 2024, the total German new car market was only 2,817,331 vehicles strong. The best-selling car brand in Germany was again Volkswagen with the VW Golf the top-selling car model. Volkswagen was the top electric car brand and the Tesla Model Y was the best-selling battery-electric car model in Germany.

Latest German Car Sales Statistics: 2024: Market Overview, Brands, Models, Electric Cars; 2023-2007.

New Electric Car Sales in Germany in 2024 (Full Year)

–	2024	2023	2022	2021	2020	2019	2018
Total German Car Market	2,817,331	2,844,609	2,651,357	2,622,132	2,917,678	3,607,258	3,435,778
All Electric Cars Sold	380,609	524,219	470,559	355,961	194,163	63,281	36,062
% Share Electric Cars	13.5%	18.4%	17.7%	13.6%	6.65%	1.75%	1.05%

In 2024, new battery-electric passenger vehicle registrations in Germany contracted by 27.4% to only 380,609 electric cars for a market share of only 13.5% compared to 18.4% in 2023 and 17.7% in 2022.

Electric car sales were at the lowest volume in Germany since 2021 while BEV sales had the lowest market share of new passenger vehicle registrations since 2020.

2022
2021
2020
2019
2018
2017
2016
2015
2014
2013
2012
2011
2010
2009
2008
2007

The total German new car market contracted by 1% in 2024 but the sales of electric cars were hindered not only by high prices and economic problems but also continued political uncertainty. The German government was forced to unexpectedly end electric car subsidies in December 2023 and German buyers had been hoping for a resumption of some measures in 2024. Following the collapse of the federal government at the end of 2024, now certainty will be established prior to elections at the end of February 2025.

The UK overtook Germany as the largest market for battery-electric cars in Europe in 2024, if only by 1361 cars.

Best-Selling Electric Car Brands in Germany in 2024

The 20 best-selling electric car brands in Germany in the full-year 2024 according to the KBA were:

	BRAND	BEV SALES 2024	% MS	ALL SALES 2024
	TOTAL MARKET	380,609	100.0	2,817,331
1	VOLKSWAGEN	62,108	16.3	536,888
2	BMW	42,066	11.1	232,886

3	TESLA	37,574	9.9	37,574
4	MERCEDES-BENZ	33,991	8.9	257,888
5	SKODA	25,308	6.6	205,593
6	AUDI	21,831	5.7	202,317
7	SEAT	18,248	4.8	152,334
8	HYUNDAI	16,952	4.5	96,365
9	MG	14,370	3.8	20,977
10	VOLVO	13,535	3.6	62,326
11	SMART	12,463	3.3	12,463
12	KIA	11,837	3.1	68,656
13	MINI	9,225	2.4	32,571
14	FIAT	8,474	2.2	57,561
15	OPEL	7,633	2.0	147,833
16	PORSCHE	7,254	1.9	36,097
17	RENAULT	5,797	1.5	54,349
18	FORD	5,538	1.5	99,554
19	DACIA	3,655	1.0	71,424
20	PEUGEOT	3,349	0.9	67,454

NOTE: *MS indicates the brand's share of the total battery-electric vehicle market in Germany.

In 2024, Volkswagen was again the best-selling electric car brand in Germany despite sales contracting from 70,628 BEVs in 2023 to only 62,108 in 2024. BMW increased electric car sales by around 2,000 BEVs to move BMW ahead of Tesla.

Tesla slipped from second to only the third best-selling electric car brand in Germany in 2024. Sales were down 41% from a year ago. Mercedes-Benz was again fourth while Skoda moved up from eighth.

Best-Selling Electric Car Models in Germany in 2024

The 20 best-selling electric car models in Germany in the full-year 2024 according to the KBA were:

	BRAND	MODEL	BEV SALES 2024	% MS	TOTAL SALES 2024
	TOTAL MARKET	–	380,609	100.0	2,817,331
1	TESLA	MODEL Y	29,896	79.6	29,896
2	SKODA	ENYAQ	25,262	99.8	25,263
3	VW	ID.4, ID.5	21,611	34.8	21,611
4	VW	ID.3	20,101	32.4	20,101
5	SEAT	BORN	16,640	91.2	16,640

6	VW	ID.7	14,554	23.4	14,554
7	AUDI	Q4	12,871	59.0	12,871
8	BMW	X1	12,640	30.0	37,154
9	MG	4	12,004	83.5	12,004
10	MERCEDES-BENZ	GLA	11,476	33.8	24,924
11	BMW	4ER	10,368	24.6	21,971
12	MINI	MINI	9,225	100.0	32,571
13	VOLVO	EX30	8,777	64.8	8,777
14	MERCEDES-BENZ	E-KLASSE	8,742	25.7	33,726
15	BMW	5ER	7,849	18.7	26,669
16	MERCEDES-BENZ	GLB	7,810	23.0	15,495
17	HYUNDAI	IONIQ5	7,638	45.1	7,638
18	FIAT	500	7,615	89.9	20,618
19	SMART	1	7,282	58.4	7,282
20	TESLA	MODEL 3	7,012	18.7	7,012

*%MS indicates the percentage of the model in total electric car sales of the brand in Germany in 2024

The Tesla Model Y was again the top-selling electric car model in Germany in 2024 but sales were sharply down from the 45,818 achieved in 2023 and even 35,426 in 2022. Tesla had some supply and production issues in 2024 but the model is also less competitive with new electric car models entering the market. In 2023, the Model Y was the tenth most popular car model overall in Germany but slipped to 20th in 2024.

The Skoda Enyaq and VW ID4 swapped rank positions while the ID3 moved up to fourth from fifth. Sales volumes of both VW models were lower with VW brand clearly struggling in the German new car market. However, six of the best-selling electric car models in Germany were made by the larger Volkswagen Group.

More German Car Sales Statistics for 2024

- → Latest German Car Sales Statistics
- 2025 (Outlook) Germany: Car Sales, Production, and Market Forecasts
- 2024: German New Car Market Overview
- 2024: Best-Selling Car Brands in Germany
- 2024: Top 50 Car Models in Germany
- 2024: Best-Selling Electric Car Brands and Models in Germany

Latest German Car Sales Statistics: 2024: Market Overview, Brands, Models, Electric Cars; 2023-2007.

About the author:
Henk Bekker

Henk Bekker is a freelance writer with over 20 years of experience in online writing. His best-selling cars website has been reporting car sales statistics since 2008 with classic car auction prices focusing on the most expensive automobiles sold at public auctions in the past decade. He also owns the travel websites European-Traveler.com and Lake Geneva Switzerland. Henk holds an MBA from Edinburgh Business School and an MSc in Finance from the University of London.

Electric, Germany

2024

< 2024 (Full Year) Germany: Best-Selling Car Models

> 2024 (Full Year) USA: Mercedes-Benz US Car Sales by Model

Home » Germany » 2024 (Full Year) Germany: Best-Selling Electric Cars by Brand and Model

EXHIBIT H

New ZEV Sales in California

Note: CEC Staff have updated the methodology to determine the sale of a new vehicle in the DMV source data for 2021 and onward. More information is below in the "Additional Information about the Data" section.

Next Update: April 30, 2025.

Zero Emission Vehicles (ZEV) sales are updated quarterly by conducting specialized analysis of DMV data. Dashboard is best viewed from a computer. Visit full page layout of dashboard, download data, or return to the dashboard collection page.

EXHIBIT H

Other Dashboards in this Collection:

New ZEV Sales | Light-Duty Vehicle Population | Medium- & Heavy-Duty Vehicle Population | EV Chargers | Hydrogen Stations | School Buses | School Bus Chargers | MDHD ZEV Station Development in California

LIGHT-DUTY ZEV

CUMULATIVE SALES

Sales through 2024

2,213,296

BEV	PHEV	FCEV
1,655,001	540,123	18,172

ANNUAL SALES

YTD Sales in 2024

443,374

BEV	PHEV	FCEV
378,910	63,864	600

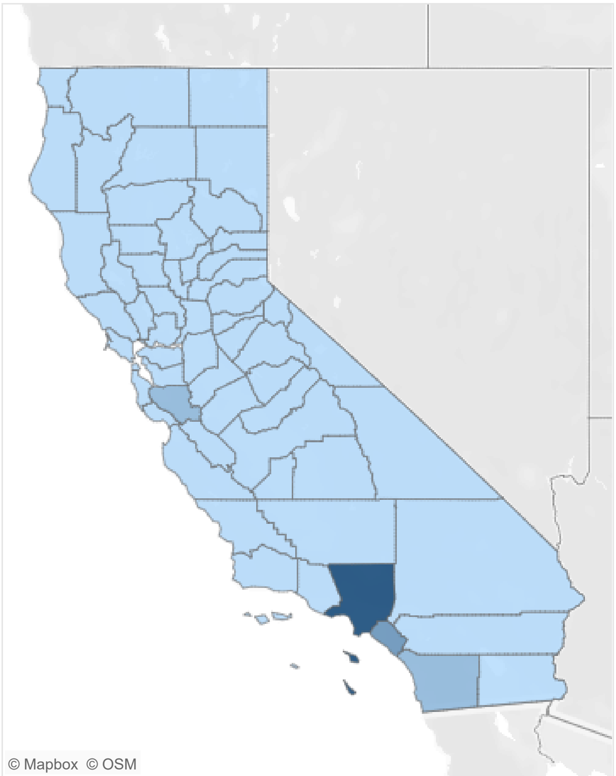
TOTAL LIGHT-DUTY

ANNUAL SALES

Sales in 2024

Q4 Sales	YTD Sales
431,392	1,752,030

Q4 ZEV Share	YTD ZEV Share
25.1%	25.3%



Number of Vehicles

6 — 128,321

Fuel Type	Range	Number of New ZEV Sales
BEV	≥ 200 miles	375,795
	< 200 miles	3,115
PHEV		63,864
FCEV		600

Make	Model	Number of New ZEV Sales
Tesla	Model Y	127,567
	Model 3	52,882
	Cybertruck	9,411
	Model X	8,012
	Model S	3,295
Hyundai	IONIQ 5	17,028
	IONIQ 6	4,010
	Kona EV	1,364
	TUCSON PHEV	1,355
	SANTA FE PHEV	243
	NEXO	89
BMW	i4	8,386
	iX	5,660
	i5	2,932
	X5	2,198
	i7	1,304

SELECT FILTERS

Year: 2024

Map Filter: County

County: (All)

Fuel Type: (All)

Make: (All)

Market Share

For additional information about the data and how to cite this visualization, see the dashboard.

Expand All

Definition of Terms

Additional Information about the Data

CONTACT

Please submit questions and comments to mediaoffice@energy.ca.gov.

CONTACT

California Energy Commission
715 P Street
Sacramento, CA 95814

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EXHIBIT I

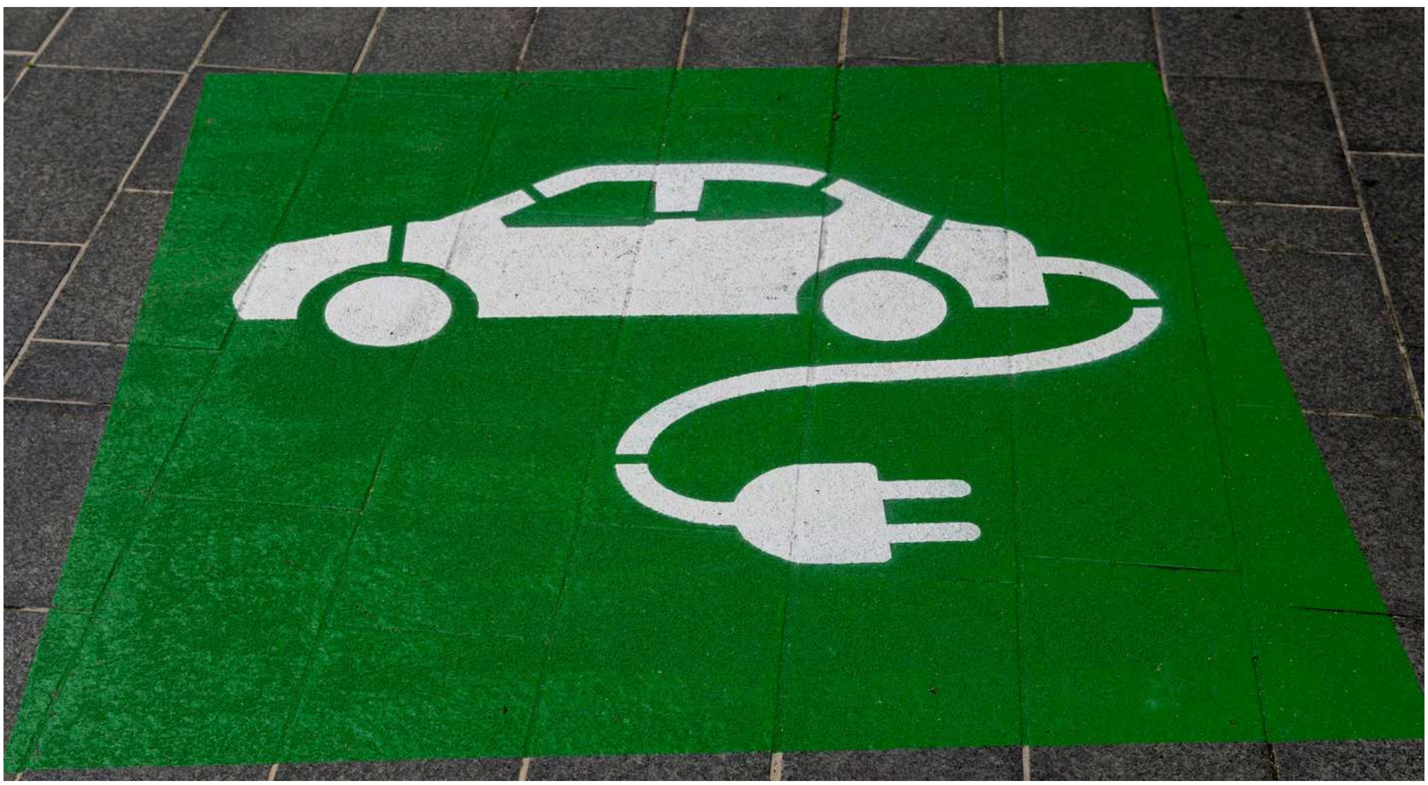
Automotive News

EV

EV sales growth will stagnate in 2025, J.D. Power says

Share

By: **Molly Boigon**
February 11, 2025 01:01 PM



J.D. Power predicts that EVs will remain about 9 percent of the retail market in the U.S. in 2025. (MICHAEL MARAIS/UNSPLASH)

Electric vehicles will retain the same share of U.S. retail sales as last year, the result of tariff and incentive uncertainty, according to projections released Feb. 11 by J.D. Power.

EXHIBIT I

The firm predicts the EV retail share will hold steady from 2024 at 9.1 percent in 2025 with 1.2 million electric vehicles sold.

The findings project real-world impacts from the unpredictability wrought by the new administration of President Donald Trump, which has signaled it will end the $7,500 federal clean vehicle tax credit and impose more tariffs on imports crucial to the automotive industry.

The report also cites continued issues with public charging as an obstacle to wider EV adoption. J.D. Power said the third quarter of 2024 saw the largest quarterly decline in customer satisfaction with EV charging since 2021.

In the longer term, J.D. Power predicts the EV market will reach 26 percent of the retail market by 2030, roughly half of former President Joe Biden's 50 percent target. However, other projections, including those from Recurrent and the International Energy Agency, show EVs reaching 50 percent of U.S. sales by 2030.

Possible changes to incentives may impact EV sales

Trump has indicated he will eliminate the $7,500 individual EV tax credit, which was created by the Inflation Reduction Act's changes to the Internal Revenue Code. While changes to the tax law must be approved by both chambers of Congress, the administration can alter the availability of the credit through implementation guidance released by the Treasury.

Publishing Partner: **Sponsored Content from Kerrigan Advisors**

Kerrigan Advisors' Client Interview Series: Interview With Howard Keyes And Howard Tenenbaum, Keyes Motors

Kerrigan Advisors interviewed its clients, Howard Keyes and Howard Tenenbaum, of Keyes Motors, about the opportunities and challenges facing auto retail in the future.

J.D. Power found in November that 64 percent of premium-brand EV owners said tax credits and other incentives were a primary driver of their decision to buy an EV. Nearly half of mass-market EV owners said they selected their vehicle based on tax credits and incentives.

That is why J.D. Power concluded changes to the tax credit could hamper EV adoption.

Still, the report stresses that the increasing availability of mass-market options is another important factor driving down the cost of electric vehicles.

Tariffs may increase EV prices

Trump has implemented a 25 percent tariff on imports of steel and aluminum. Automakers and suppliers in North America who import the metals from neighboring Canada and Mexico will likely see cost increases.

Trump has also instated a 10 percent tariff on imports from China. There may be more tariffs to come. He had planned to launch 25 percent tariffs on products from Mexico and Canada on Feb. 1, but delayed them into March while the U.S. conducts negotiations with both nations on border issues such as drug trafficking and immigration.

J.D. Power predicts that tariffs may have a negative impact on EV sales because higher materials costs may drive up vehicle prices.

Certain states, such as New York, Florida, Colorado, Michigan and Texas, will see growing rates of EV adoption that buck the national trend, the report said. Those states saw strong EV sales in 2024, and J.D. Power predicts those markets will continue to grow.

California had seen the fastest EV sales adoption in the nation. But the total number of EV registrations there grew by just 5,000 to 387,368 last year, according to the California New Car Dealers Association, and fell 7.5 percent to 94,274 in the fourth quarter. That is a drop from 101,888 EV registrations in the third quarter.

Featured Stories

EXHIBIT J

ALLIANCE
FOR AUTOMOTIVE
INNOVATION

GET CONNECTED

ELECTRIC VEHICLE QUARTERLY REPORT

THIRD QUARTER, 2024

EXHIBIT J

TABLE OF CONTENTS

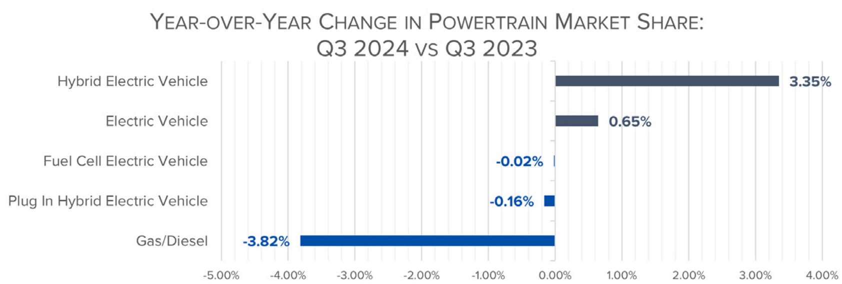
ELECTRIC VEHICLE SALES OVERVIEW (Q3 2024)

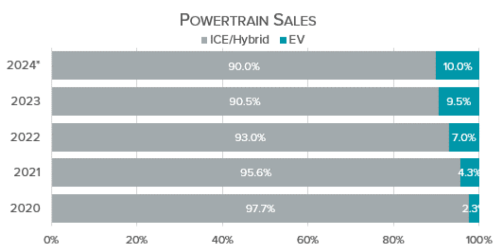
In the third quarter of 2024, automakers sold 408,688 electric vehicles (EVs, including battery, plug-in hybrid, and fuel cell electric vehicles) in the United States, representing 10.6 percent of overall light-duty vehicle sales. This represents a 0.6 percentage point (pp) market share increase over the second quarter of 2024 amounting to an increase of about 22,000 vehicle sales – making EV Sales volume in Q3 the highest on record.

* See appendix - A for month-by-month EV market share

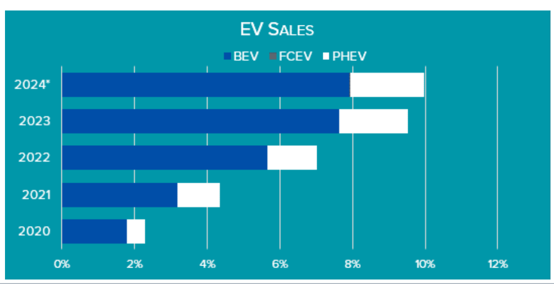
Year-over-year (YoY), EV market share increased 0.47 pp from the third quarter of 2024. The total volume of all light-duty sales in Q3 2024 was 3 percent higher than Q3 2023, while the volume for EVs increased 8 percent (an increase of about 31,000 vehicles). For comparison, internal combustion engine (ICE) vehicle market share decreased by 3.8 pp during Q3 2024 compared to the same period last year. Nearly all of ICE market share was displaced by gains of traditional hybrids and electric vehicles, offset slightly by market share losses from PHEVs and FCEVs.

Nearly 1.14 million EVs were sold in the first three quarters of 2024, 10 percent of all light vehicle sales and an increased market share of 0.7 pp over the same period in 2023. The total volume of all light-duty sales for the first three-quarters of the year is up 2 percent from the same period a year ago, while the volume for EVs increased 10 percent (an increase of about 101,000 vehicles).



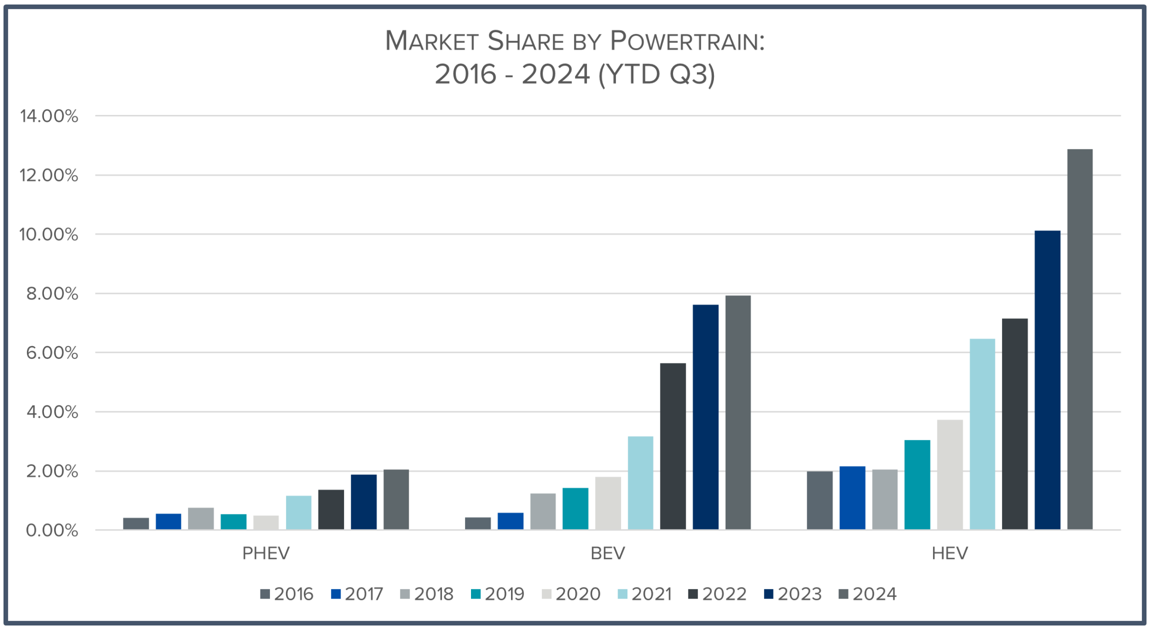


*Through Q3 2024

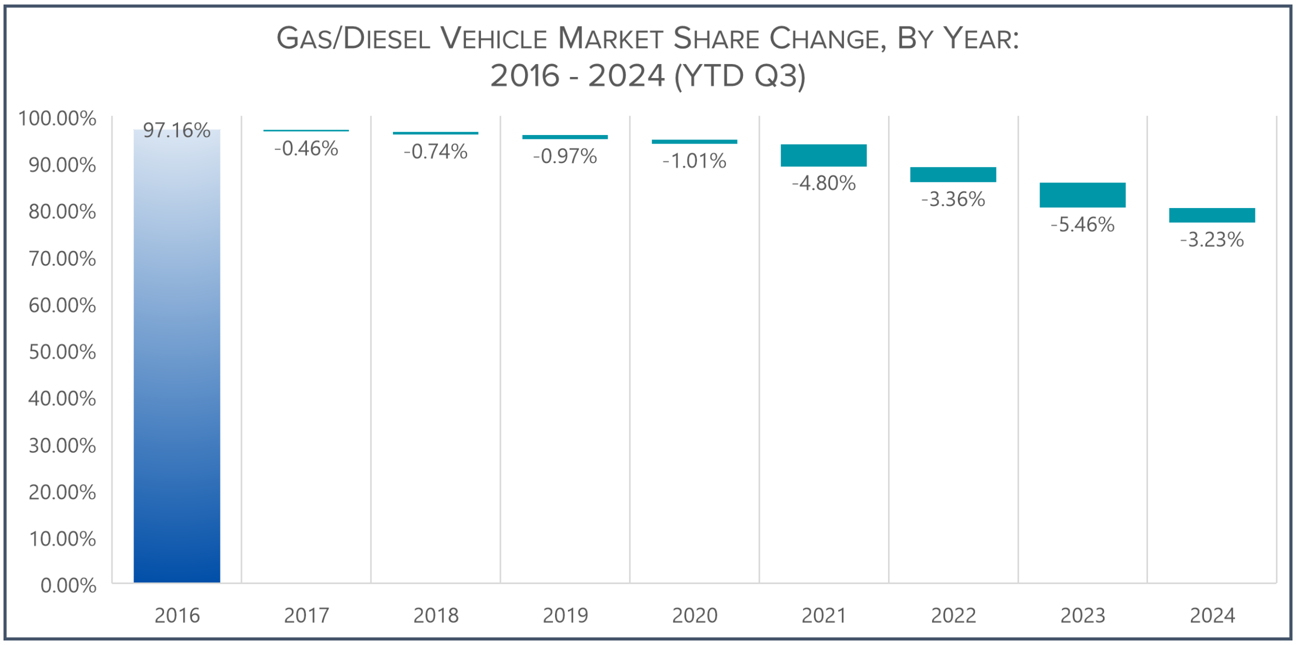


EVOLVING MARKET SHARE OF POWERTRAINS: 2016 - 2024

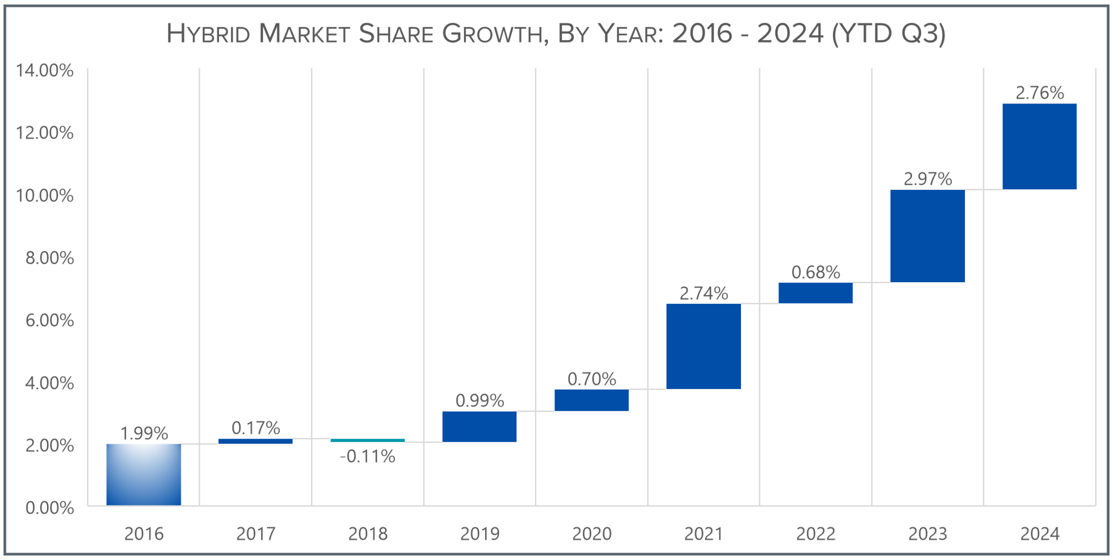
From 2016 through the third quarter of 2024, traditional internal combustion engine (ICE) market share has steadily declined. In 2016, ICE vehicles comprised more than 97 percent of all vehicle sales. Through the third quarter of 2024, the year-to-date ICE share dropped to 77 percent for an overall loss of 20 pp. That said, the ICE market share loss was replaced by increases in share of traditional hybrids, BEVs, and PHEVs. Traditional hybrids made up most of the alternative vehicle gains (+10.9 pp) followed by BEVs (+7.5 pp) and PHEVs (+1.6 pp) over the last eight-plus years.



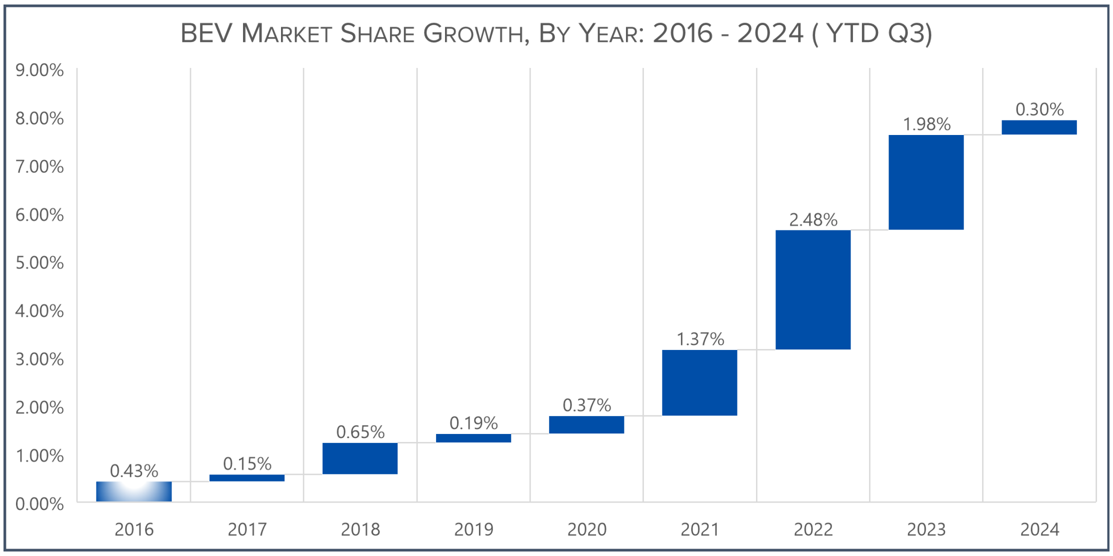
ICE market share decreased from 97 percent in 2016 to 77 percent through Q3 2024 (-20 pp):



Hybrid market share grew from 2 percent in 2016 to 12.8 percent through Q3 2024 (+10.9 pp):

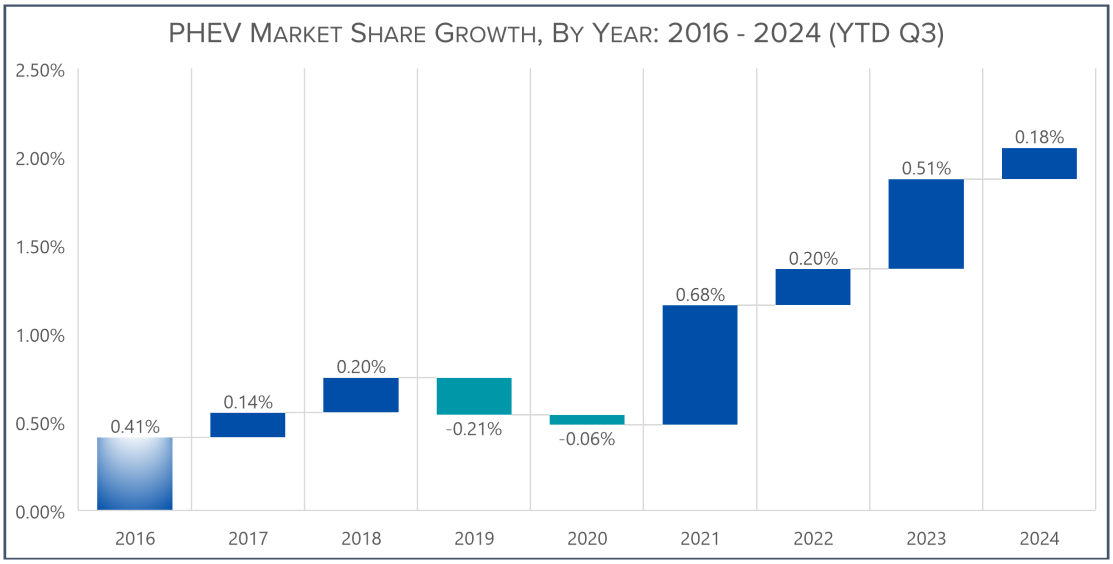


BEV market share grew from .43 percent in 2016 to 7.9 percent through Q3 2024 (+7.5 pp):



PHEV market share grew from .41 percent in 2016 to 2.1 percent through Q3 2024 (+1.6 pp):

[See Additional Historic Data on EV Sales]



ELECTRIC VEHICLE SALES BY SEGMENT

EV Model Availability

125 Vehicle Models Sold in Q3 2024:

71 Battery Electric Vehicles
- 19 Cars
- 40 Utility Vehicles
- 6 Pickups
- 6 Vans

51 Plug-in Hybrid Vehicles
- 20 Cars
- 30 Utility Vehicles
- 1 Van

3 Fuel Cell Electric Vehicles*
- 1 Car
- 2 Utility Vehicle

**Includes Plug-In Hybrid Fuel Cell*

See more information about ***EV CHOICE HERE***

ALLIANCE FOR AUTOMOTIVE INNOVATION

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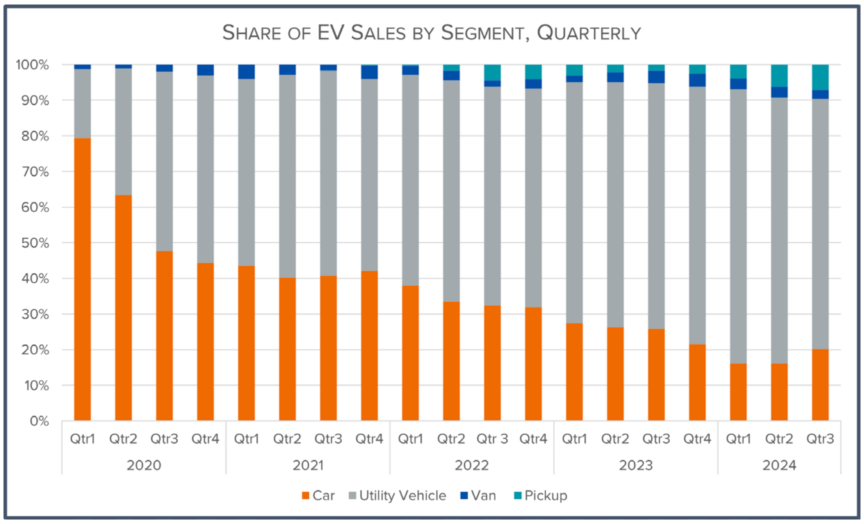
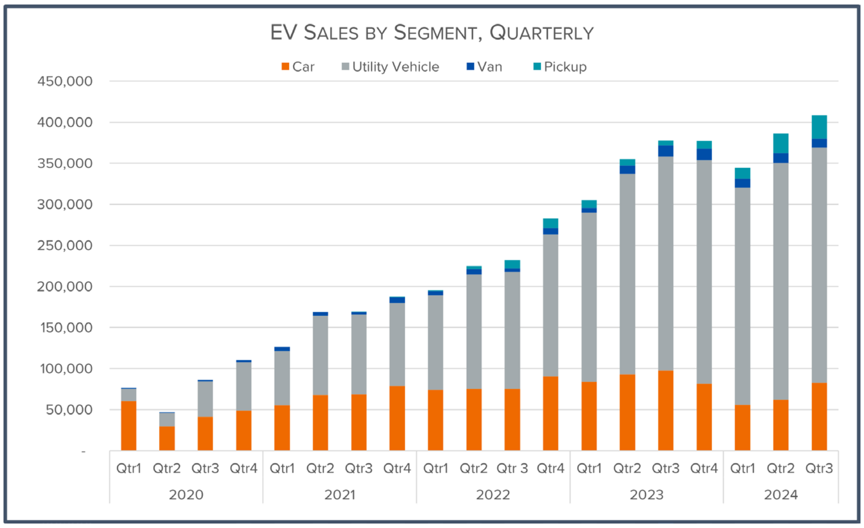
While passenger cars once dominated the EV market, manufacturers continue to introduce new models to satisfy a variety of consumer needs. Utility vehicle (UV) offerings continue to grow, and while electric pickup trucks are a relatively new entry to the market (making their commercial debut in September 2021), there are 6 models available now, with more expected soon. As a result, non-car segments are continuing to make gains, and in the third quarter of 2024, light truck (UVs, minivans, and pickups) sales comprised 80 percent of the EV market – a 6 pp increase over the third quarter of 2023.

Quarterly sales of BEV and PHEV UVs have grown from about 19 percent of EVs at the start of 2020 to 70 percent in the third quarter of 2024. Nearly 26,000 more UVs were sold in the third quarter of 2024 than the third quarter of 2023.

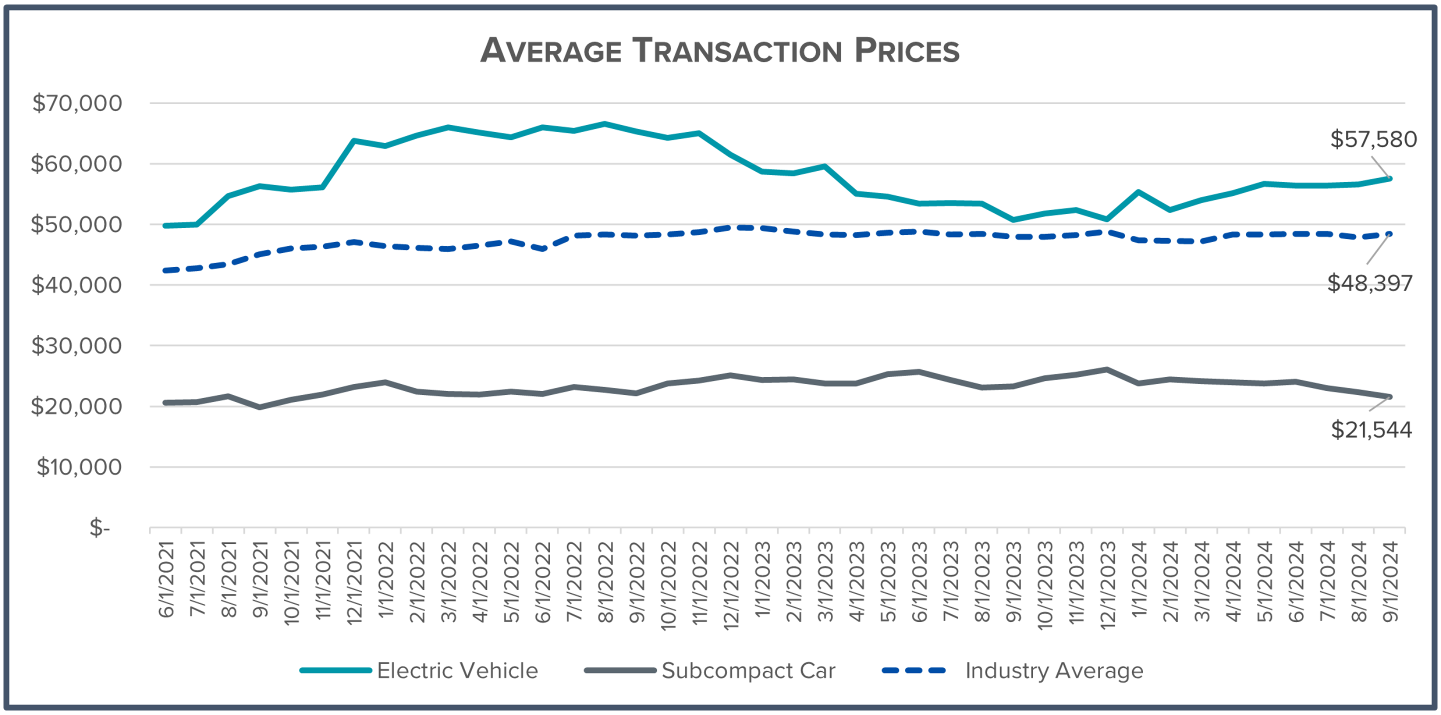




Source: Figures compiled by Alliance for Automotive Innovation with new registrations for retail and fleet data provided by S&P Global Mobility covering January 1, 2020 –September 30, 2024

ELECTRIC VEHICLE TRANSACTION PRICES

"Electric vehicle prices were higher year over year in Q3 but by less than 1%. The average price paid for an EV in Q3 was just over $57,000, a premium of approximately 19% compared to the industry-wide ATP of just over $48,000."[1]



(Compiled from Kelley Blue Book Press Releases, 6/2021 – 9/2024)

[1] Cox Automotive, "Electric Vehicle Sales Mark Another Record in Q3, Thanks to Higher Incentives, More Choices," 10/11/2024

ELECTRIC VEHICLE SALES BY STATE

For the Third Quarter of 2024:

California continued to lead the nation in EV sales, with BEVs, PHEVs and FCEVs making up nearly 27 percent of new light-duty vehicle registrations in the third quarter of 2024. However, with a nearly 8 pp gain year-over-year, Colorado is narrowing in on California for the lead, after posting a 26 percent market share in Q3.

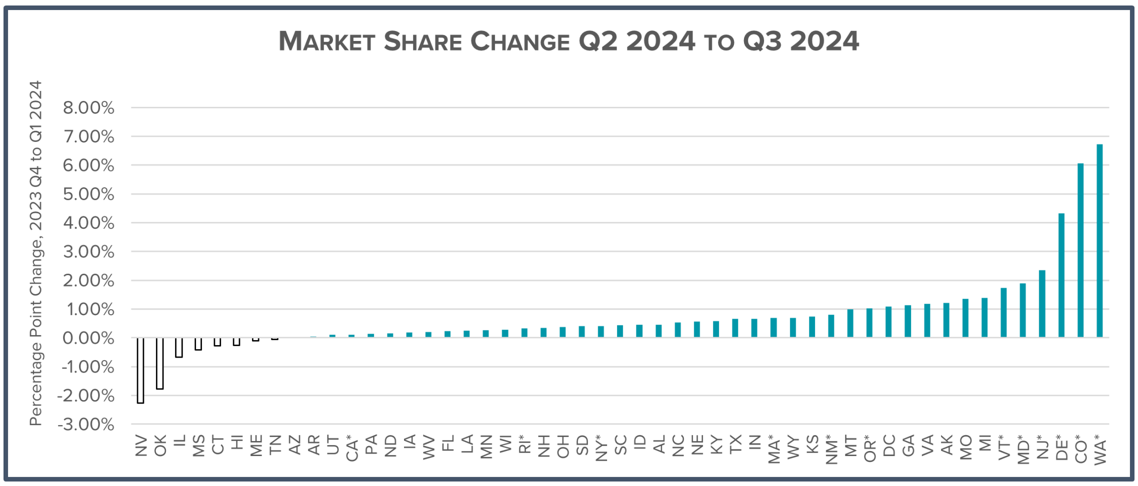
California, Colorado, Washington, and the District of Columbia were all above 20 percent market share in Q3. There are currently ten additional states[2] with new EV registrations above 10 percent (but below 20 percent).

2024 EV Market Share by State (Q3)

1	CA*	26.83%	**11**	MA*	12.26%	**21**	IL	7.54%	**31**	OH	5.41%	**41**	AK	4.00%
2	CO*	25.50%	**12**	DE*	11.88%	**22**	NC	7.52%	**32**	KS	5.36%	**42**	IA	3.83%
3	WA*	24.59%	**13**	CT	11.15%	**23**	MO	7.29%	**33**	IN	5.30%	**43**	AL	3.47%
4	DC	20.44%	**14**	VA	10.09%	**24**	MN	7.17%	**34**	TN	5.15%	**44**	WY	3.18%
5	OR*	16.99%	**15**	NY*	9.84%	**25**	PA	6.83%	**35**	ID	4.98%	**45**	AR	2.68%
6	NJ*	15.59%	**16**	FL	9.70%	**26**	TX	6.77%	**36**	WI	4.74%	**46**	SD	2.62%
7	HI	14.12%	**17**	UT	9.52%	**27**	ME	6.76%	**37**	NE	4.69%	**47**	OK	2.57%
8	VT*	13.66%	**18**	AZ	9.31%	**28**	MI	6.49%	**38**	SC	4.53%	**48**	WV	2.30%
9	MD*	13.20%	**19**	GA	8.74%	**29**	NH	5.83%	**39**	MT	4.52%	**49**	LA	2.15%
10	NV	13.13%	**20**	RI*	8.36%	**30**	NM*	5.59%	**40**	KY	4.21%	**50**	ND	1.81%
												51	MS	1.44%

Year-over-year, for the third quarter of 2024, the market share of new EVs registered increased in three-quarters of the states. Seven states witnessed an increased market share of EVs by 2 pp or more. Making the largest increases were Colorado[3] (7.6 pp), Washington (2.9), Hawaii (2.9 pp), and Vermont (2.7 pp).

All but eight states saw market share growth in Q3 vs. Q2 – thirteen states saw a market share increase of one percentage point or more. Washington led all states, quarter over quarter, with an increase of 6.7 pp; Nevada decreased the most (-2.3 pp).



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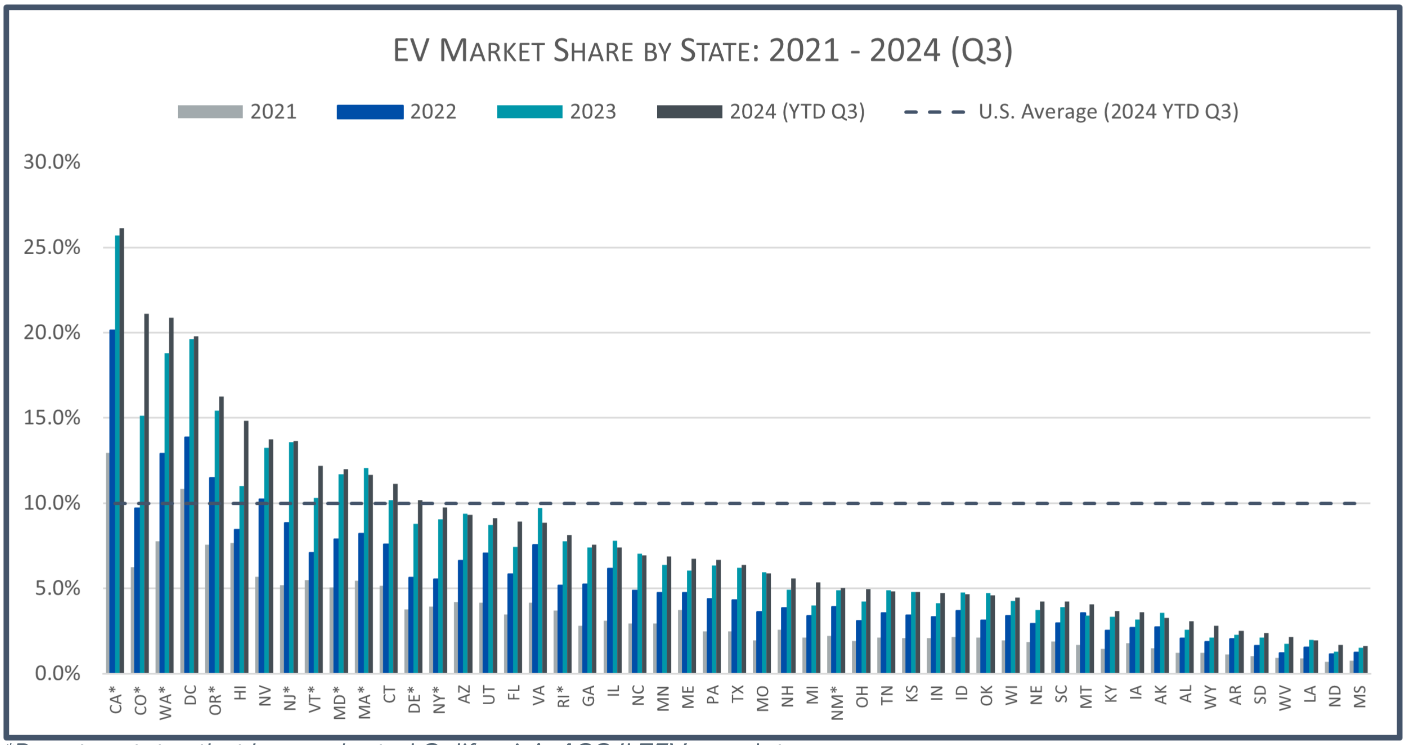
[2] States with more than a 10 percent (but less than 20 percent) market share of EVs: Oregon, New Jersey, Hawaii, Vermont, Maryland, Nevada, Massachusetts, Delaware, Connecticut, and Virginia.
[3] Colorado taxpayers are eligible for a state tax credit of $5,000 for the purchase or lease of a new EV on or after July 1, 2023 with a manufacturer's suggested retail price (MSRP) up to $80,000. Lease agreements must have an initial term of at least two years. Beginning January 1, 2024, Coloradans purchasing an EV with an MSRP up to $35,000 will be eligible for an additional $2,500 tax credit.
[4] Denotes states that have adopted California's ACC II ZEV Mandate

For the First Three-Quarters of 2024:

Through the first three quarters of the year, EV sales represented 10 percent of the market – a 0.7 pp increase over the same period of 2023. More than 26 percent of sales in California were EVs, but Colorado realized the greatest increase in market share, year-over-year with a 7.0 pp increase. Following Colorado, the states with the largest market share gains were Hawaii (4.0 pp), Vermont (2.8 pp), Washington (2.3 pp) and Florida (2.0). Eleven states increased their year-over-year EV market share by 1 pp or more. Six states decreased.

While some states continue to have strong EV sales, seven states had new EV registrations of less than 3 percent; three of those states were under 2 percent. All states had a market share above 1 percent for new EV sales.

Year to date (through Q3), twelve states and the District of Columbia had an EV market share above 10 percent while three states had an EV market share under 2 percent; California, Colorado, and Washington were the only states above 20 percent.[5]



**Denotes states that have adopted California's ACC II ZEV mandate*

2024 EV Market Share by State (YTD Q3)

1	CA*	26.14%	**11**	MA*	11.66%	**21**	IL	7.39%	**31**	OH	4.95%	**41**	KY	3.66%
2	CO*	21.12%	**12**	CT	11.15%	**22**	NC	6.94%	**32**	TN	4.81%	**42**	IA	3.59%
3	WA*	20.88%	**13**	DE*	10.17%	**23**	MN	6.88%	**33**	KS	4.80%	**43**	AK	3.27%
4	DC	19.77%	**14**	NY*	9.73%	**24**	ME	6.75%	**34**	IN	4.73%	**44**	AL	3.08%
5	OR*	16.25%	**15**	AZ	9.30%	**25**	PA	6.67%	**35**	ID	4.64%	**45**	WY	2.80%
6	HI	14.84%	**16**	UT	9.13%	**26**	TX	6.37%	**36**	OK	4.58%	**46**	AR	2.50%
7	NV	13.75%	**17**	FL	8.91%	**27**	MO	5.88%	**37**	WI	4.47%	**47**	SD	2.38%
8	NJ*	13.64%	**18**	VA	8.84%	**28**	NH	5.59%	**38**	NE	4.24%	**48**	WV	2.13%
9	VT*	12.20%	**19**	RI*	8.13%	**29**	MI	5.35%	**39**	SC	4.22%	**49**	LA	1.94%
10	MD*	11.98%	**20**	GA	7.58%	**30**	NM*	5.01%	**40**	MT	4.06%	**50**	ND	1.69%
												51	MS	1.63%

[5] Figures compiled by Alliance for Automotive Innovation with new registrations for retail and fleet data provided by S&P Global Mobility covering January 1, 2021 – September 30, 2024

Third Quarter 2024, New Light-Duty Vehicle Registrations By Powertrain					Change In Market Share (2024 Q3 vs 2023 Q3), New Light-Duty Vehicle Registrations Powertrain			
State	**Advanced Powertrain Market Share**				**Advanced Powertrain Market Share (Percentage Point Change)**			
	PHEV	BEV	FCEV	EV Total	PHEV	BEV	FCEV	EV Total
AK	0.70%	3.30%	0.00%	**4.00%**	-0.05	0.79	0.00	**0.73**
AL	0.62%	2.85%	0.00%	**3.47%**	0.13	0.73	0.00	**0.86**
AR	0.62%	2.06%	0.00%	**2.68%**	0.15	0.26	0.00	**0.41**
AZ	1.12%	8.19%	0.00%	**9.31%**	-0.01	0.47	0.00	**0.46**
CA*	3.51%	23.29%	0.03%	**26.83%**	-0.22	-0.90	-0.18	**-1.30**
CO*	5.21%	20.29%	0.00%	**25.50%**	0.71	6.84	0.00	**7.56**
CT	3.56%	7.59%	0.00%	**11.15%**	-0.44	0.40	0.00	**-0.04**
DC	5.74%	14.70%	0.00%	**20.44%**	1.89	-0.75	0.00	**1.14**
DE*	2.12%	9.77%	0.00%	**11.88%**	-0.53	2.73	0.00	**2.19**
FL	1.33%	8.37%	0.00%	**9.70%**	0.40	1.90	0.00	**2.30**
GA	0.96%	7.78%	0.00%	**8.74%**	0.22	0.44	0.00	**0.66**
HI	2.85%	11.27%	0.00%	**14.12%**	1.68	1.21	-0.01	**2.88**
IA	1.05%	2.78%	0.00%	**3.83%**	0.13	0.28	0.00	**0.41**
ID	1.34%	3.64%	0.00%	**4.98%**	-0.09	-0.10	0.00	**-0.19**
IL	1.44%	6.10%	0.00%	**7.54%**	0.19	-0.48	0.00	**-0.28**
IN	0.96%	4.34%	0.00%	**5.30%**	0.14	0.63	0.00	**0.78**
KS	0.99%	4.36%	0.00%	**5.36%**	-0.03	0.51	0.00	**0.48**
KY	0.83%	3.38%	0.00%	**4.21%**	0.05	0.28	0.00	**0.33**
LA	0.44%	1.71%	0.00%	**2.15%**	-0.08	0.34	0.00	**0.26**
MA*	3.68%	8.58%	0.00%	**12.26%**	-1.04	0.06	0.00	**-0.98**
MD*	2.87%	10.33%	0.00%	**13.20%**	-0.61	1.04	0.00	**0.43**
ME	2.99%	3.77%	0.00%	**6.76%**	-0.40	0.47	0.00	**0.07**
MI	1.04%	5.45%	0.00%	**6.49%**	0.27	2.24	0.00	**2.51**
MN	1.76%	5.41%	0.00%	**7.17%**	0.46	-0.10	0.00	**0.36**
MO	2.91%	4.38%	0.00%	**7.29%**	-1.31	1.04	0.00	**-0.28**
MS	0.29%	1.15%	0.00%	**1.44%**	-0.13	0.01	0.00	**-0.12**
MT	1.48%	3.04%	0.00%	**4.52%**	0.34	0.96	0.00	**1.31**
NC	1.24%	6.28%	0.00%	**7.52%**	0.12	0.35	0.00	**0.47**
ND	0.47%	1.34%	0.00%	**1.81%**	-0.02	0.32	0.00	**0.30**
NE	1.27%	3.43%	0.00%	**4.69%**	0.14	0.41	0.00	**0.56**
NH	1.97%	3.86%	0.00%	**5.83%**	0.20	0.71	0.00	**0.91**
NJ*	2.55%	13.04%	0.00%	**15.59%**	-0.90	2.15	0.00	**1.25**
NM*	1.11%	4.47%	0.00%	**5.59%**	-0.17	0.24	0.00	**0.07**
NV	1.97%	11.16%	0.00%	**13.13%**	0.24	-0.94	0.00	**-0.70**
NY*	3.05%	6.79%	0.00%	**9.84%**	-1.13	1.80	0.00	**0.67**
OH	1.05%	4.36%	0.00%	**5.41%**	0.16	1.10	0.00	**1.25**
OK	1.23%	1.34%	0.00%	**2.57%**	-2.38	-0.40	0.00	**-2.78**
OR*	3.85%	13.14%	0.00%	**16.99%**	-0.17	0.85	0.00	**0.68**
PA	2.05%	4.78%	0.00%	**6.83%**	-0.61	0.32	0.00	**-0.28**
RI*	2.89%	5.47%	0.00%	**8.36%**	-1.50	0.52	0.00	**-0.98**
SC	0.97%	3.56%	0.00%	**4.53%**	0.23	0.09	0.00	**0.32**
SD	1.02%	1.60%	0.00%	**2.62%**	0.16	0.29	0.00	**0.46**
TN	0.71%	4.44%	0.00%	**5.15%**	0.06	0.13	0.00	**0.20**
TX	0.78%	5.99%	0.00%	**6.77%**	0.13	0.05	0.00	**0.18**
UT	1.66%	7.86%	0.00%	**9.52%**	0.00	0.56	0.00	**0.56**
VA	1.78%	8.31%	0.00%	**10.09%**	0.33	0.29	0.00	**0.62**
VT*	3.85%	9.81%	0.00%	**13.66%**	-0.28	2.95	0.00	**2.66**
WA*	3.07%	21.52%	0.00%	**24.59%**	0.18	2.74	0.00	**2.92**
WI	0.98%	3.76%	0.00%	**4.74%**	0.00	0.11	0.00	**0.12**
WV	0.73%	1.57%	0.00%	**2.30%**	-0.02	0.26	0.00	**0.24**
WY	1.10%	2.08%	0.00%	**3.18%**	0.21	0.75	0.00	**0.96**
U.S.	**1.89%**	**8.70%**	**0.00%**	**10.60%**	**-0.16**	**0.64**	**-0.02**	**0.47**

*Denotes states that have adopted California's ACC II ZEV mandate
Source: Figures compiled by Alliance for Automotive Innovation with new registrations for retail and fleet data provided by S&P Global Mobility covering January 1 – September 30, 2023, and January 1 – September 30, 2024

2024 New Light-Duty Vehicle Registrations By Powertrain (YTD Q3)					Change In Market Share (2024 vs 2023 YTD Q3), New Light-Duty Vehicle Registrations Powertrain			
State	Advanced Powertrain Market Share				Advanced Powertrain Market Share (Percentage Point Change)			
	PHEV	BEV	FCEV	EV Total	PHEV	BEV	FCEV	EV Total
AK	0.65%	2.63%	0.00%	**3.27%**	-0.20	-0.06	0.00	**-0.25**
AL	0.60%	2.48%	0.00%	**3.08%**	-0.08	-0.53	0.00	**0.61**
AR	0.52%	1.99%	0.00%	**2.50%**	-0.01	-0.31	0.00	**0.32**
AZ	1.33%	7.97%	0.00%	**9.30%**	-0.16	-0.09	0.00	**0.25**
CA*	3.50%	22.60%	0.03%	**26.14%**	-0.06	-0.27	0.17	**0.15**
CO*	5.86%	15.26%	0.00%	**21.12%**	-1.73	-5.31	0.00	**7.04**
CT	3.84%	7.31%	0.00%	**11.15%**	-0.50	-0.69	0.00	**1.19**
DC	5.39%	14.39%	0.00%	**19.77%**	-1.41	0.98	0.00	**0.43**
DE*	2.29%	7.88%	0.00%	**10.17%**	-0.19	-1.26	0.00	**1.45**
FL	1.21%	7.71%	0.00%	**8.91%**	-0.31	-1.66	0.00	**1.96**
GA	0.90%	6.67%	0.00%	**7.58%**	-0.20	-0.02	0.00	**0.23**
HI	4.67%	10.17%	0.00%	**14.84%**	-3.63	-0.38	0.00	**4.01**
IA	1.01%	2.58%	0.00%	**3.59%**	-0.14	-0.37	0.00	**0.51**
ID	1.35%	3.29%	0.00%	**4.64%**	-0.05	-0.12	0.00	**0.17**
IL	1.39%	6.00%	0.00%	**7.39%**	-0.24	0.40	0.00	**-0.17**
IN	0.99%	3.74%	0.00%	**4.73%**	-0.15	-0.67	0.00	**0.82**
KS	1.09%	3.71%	0.00%	**4.80%**	-0.20	-0.13	0.00	**0.34**
KY	0.73%	2.93%	0.00%	**3.66%**	0.04	-0.39	0.00	**0.35**
LA	0.50%	1.44%	0.00%	**1.94%**	-0.05	0.00	0.00	**0.05**
MA*	3.83%	7.83%	0.00%	**11.66%**	0.17	0.03	0.00	**-0.20**
MD*	2.76%	9.22%	0.00%	**11.98%**	-0.06	-0.85	0.00	**0.91**
ME	3.14%	3.61%	0.00%	**6.75%**	-0.46	-0.48	0.00	**0.94**
MI	1.05%	4.30%	0.00%	**5.35%**	-0.06	-1.34	0.00	**1.40**
MN	1.76%	5.11%	0.00%	**6.88%**	-0.49	-0.29	0.00	**0.78**
MO	2.20%	3.68%	0.00%	**5.88%**	0.59	-0.27	0.00	**-0.32**
MS	0.38%	1.25%	0.00%	**1.63%**	0.01	-0.27	0.00	**0.26**
MT	1.31%	2.75%	0.00%	**4.06%**	-0.26	-0.69	0.00	**0.95**
NC	1.13%	5.81%	0.00%	**6.94%**	-0.09	0.11	0.00	**-0.02**
ND	0.54%	1.15%	0.00%	**1.69%**	0.04	-0.41	0.00	**0.37**
NE	1.27%	2.97%	0.00%	**4.24%**	-0.20	-0.53	0.00	**0.72**
NH	2.26%	3.33%	0.00%	**5.59%**	-0.63	-0.24	0.00	**0.87**
NJ*	2.78%	10.85%	0.00%	**13.64%**	-0.09	-0.29	0.00	**0.39**
NM*	1.07%	3.93%	0.00%	**5.01%**	0.12	-0.30	0.00	**0.19**
NV	1.77%	11.98%	0.00%	**13.75%**	-0.13	-0.45	0.00	**0.58**
NY*	3.96%	5.77%	0.00%	**9.73%**	-0.53	-1.07	0.00	**1.61**
OH	1.13%	3.82%	0.00%	**4.95%**	-0.21	-0.78	0.00	**0.99**
OK	3.55%	1.03%	0.00%	**4.58%**	-2.08	0.34	0.00	**1.73**
OR*	4.27%	11.98%	0.00%	**16.25%**	-0.72	-0.37	0.00	**1.09**
PA	2.34%	4.33%	0.00%	**6.67%**	-0.25	-0.18	0.00	**0.44**
RI*	3.37%	4.76%	0.00%	**8.13%**	-0.15	-0.56	0.00	**0.71**
SC	1.02%	3.20%	0.00%	**4.22%**	-0.25	-0.14	0.00	**0.39**
SD	0.86%	1.52%	0.00%	**2.38%**	-0.04	-0.34	0.00	**0.38**
TN	0.61%	4.20%	0.00%	**4.81%**	0.03	-0.05	0.00	**0.02**
TX	0.82%	5.55%	0.00%	**6.37%**	-0.17	-0.06	0.00	**0.23**
UT	1.61%	7.52%	0.00%	**9.13%**	-0.09	-0.70	0.00	**0.79**
VA	1.59%	7.25%	0.00%	**8.84%**	-0.27	1.10	0.00	**-0.83**
VT*	4.14%	8.07%	0.00%	**12.20%**	-0.76	-2.07	0.00	**2.83**
WA*	3.17%	17.72%	0.00%	**20.88%**	-0.19	-2.09	0.00	**2.28**
WI	0.95%	3.51%	0.00%	**4.47%**	-0.04	-0.35	0.00	**0.38**
WV	0.70%	1.43%	0.00%	**2.13%**	-0.07	-0.32	0.00	**0.40**
WY	0.95%	1.85%	0.00%	**2.80%**	-0.14	-0.68	0.00	**0.82**
U.S.	**2.05%**	**7.92%**	**0.00%**	**9.98%**	**-0.28**	**-0.44**	**0.02**	**0.70**

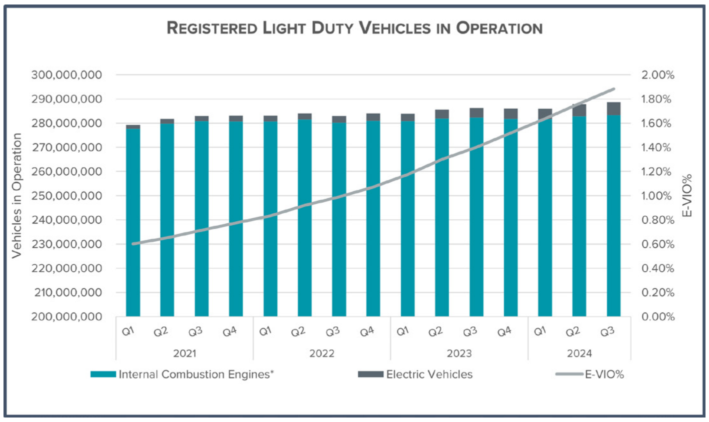
*Denotes states that have adopted California's ACC II ZEV mandate

Source: Figures compiled by Alliance for Automotive Innovation with new registrations for retail and fleet data provided by S&P Global Mobility covering January 1 – September 30, 2023, and January 1 – September 30, 2024

**Note: Colorado taxpayers are eligible for a state tax credit of $5,000 for the purchase or lease of a new EV on or after July 1, 2023 with a manufacturer's suggested retail price (MSRP) up to $80,000. Lease agreements must have an initial term of at least two years. Beginning January 1, 2024, Coloradans purchasing an EV with an MSRP up to $35,000 will be eligible for an additional $2,500 tax credit.

REGISTRATIONS AND CHARGING / REFUELING

Share of Registered EVs In U.S. Light-Duty Fleet Continues to Increase Incrementally. As sales of EVs increase, so does the total number of EVs operating on U.S. roads. There are now more than 5.4 million EVs in operation in the United States (1.9 percent of all light vehicles in operation). EVs represented more than 1 percent of total vehicles in operation (VIO) for the first time at the end of 2022. The electric vehicles in operation (E-VIO) of 1.9 percent is an increase of 0.48 pp since the third quarter of 2023 and more than three times the EV VIO from the first quarter in 2021 (0.60 percent).[6]



U.S. Public Charging Infrastructure: Overview

While the U.S. Department of Energy notes that roughly 80 percent of all EV charging occurs at home, reliable and convenient access to workplace and public charging and refueling stations help to support customers who purchase EVs or are considering purchasing an EV. Workplace and public charging infrastructure not only eases perceived "range anxiety" concerns but also increases consumer awareness of the technology. In addition, achieving the EV market share envisioned by state and/or federal regulators will require moving beyond customers who have access to charging via privately-owned single-family dwellings.

The bipartisan Infrastructure Investment and Jobs Act (IIJA) that was signed into law in November 2021 includes $5 billion in funding for states to establish a nationwide EV charging network (NEVI) every 50 miles along highway corridors and provides $2.5 billion in competitive grants to deploy publicly available EV charging and other alternative fuel stations through 2026. NEVI funding provides funding to states to strategically deploy charging infrastructure and to establish an interconnected network of publicly available charging.

There are currently 46,909 distinct locations with 138,582Level 2 (L2) ports and/or 46,484 DC Fast charging ports. See more on charging locations by state below.

How Available is NEVI Funding?

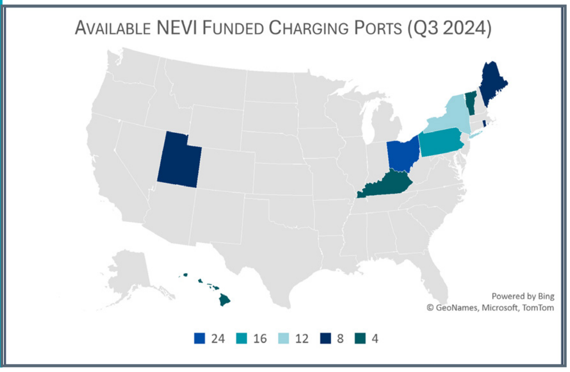
Through Q3 of 2024:

» 9 States Have Installed Charging Ports

» 88 Fash Charging Ports Intalled in 15 Locations

States with NEVI funded charging ports:

1. Ohio (24)
2. Pennsylvania (16)
3. New York (12)
4. Maine (8)
5. Rhode Island (8)
6. Utah (8)
7. Hawaii (4)
8. Kentucky (4)
9. Vermont (4)



[6] Registered vehicles in operation compiled by Alliance for Automotive Innovation with data provided by S&P Global Mobility as of September 30, 2024

Here is a snapshot of publicly available EV charging and refueling infrastructure[7] available across the United States at the end of the second quarter of 2024[8]:

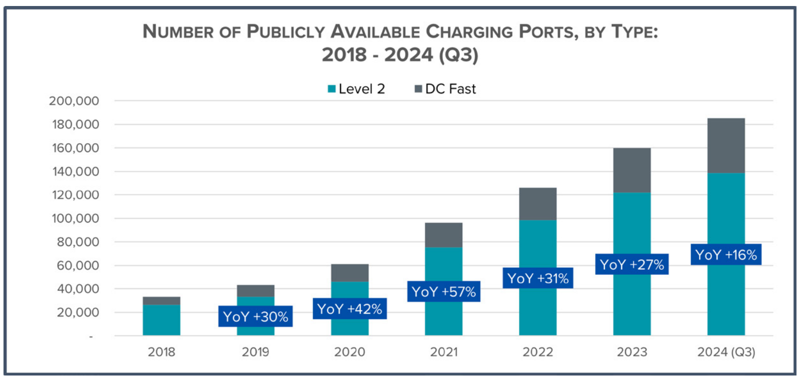
Level 2: 57,022 Locations, 138,582 EVSE Ports
DC Fast: 11,049 Locations, 46,660 EVSE Ports
Hydrogen Refueling: 58 Stations (57 are in California)
U.S. Total: *66,821[9] Locations, 185,124 EVSE Ports*
See Recommended Attributes for EV Charging Stations

State	Locations	L2 Ports	DC Fast Ports	State	Locations	L2 Ports	DC Fast Ports
AK	57	87	33	MT	128	195	220
AL	341	679	524	NC	1266	3,119	1,219
AR	294	731	158	ND	88	134	104
AZ	944	2,789	1,080	NE	222	396	195
CA*	8956	34,638	12,355	NH	205	406	236
CO*	1643	4,263	1,061	NJ*	1063	2,871	1,289
CT	982	2,864	547	NM*	250	443	319
DC	252	1,002	60	NV	424	1,352	833
DE*	177	380	248	NY*	3367	13,278	1,767
FL	2794	7,612	2,786	OH	1321	3,050	983
GA	1343	3,870	1,291	OK	313	468	871
HI	269	676	97	OR*	1058	2,341	944
IA	354	557	370	PA	1392	3,590	1,212
ID	179	328	168	RI*	210	678	100
IL	1038	2,455	1,123	SC	438	920	509
IN	500	1,019	699	SD	93	138	126
KS	321	903	241	TN	660	1,622	698
KY	299	636	272	TX	2644	6,986	2,909
LA	221	476	280	UT	596	2,000	482
MA*	1916	6,987	966	VA	1185	3,359	1,249
MD*	1376	3,835	993	VT*	344	877	192
ME	407	823	250	WA*	1480	4,488	1,405
MI	1154	2,662	919	WI	541	1,057	504
MN	710	1,579	628	WV	135	294	153
MO	720	2,239	554	WY	95	142	124
MS	144	288	138	All States	46,909	138,582	46,484

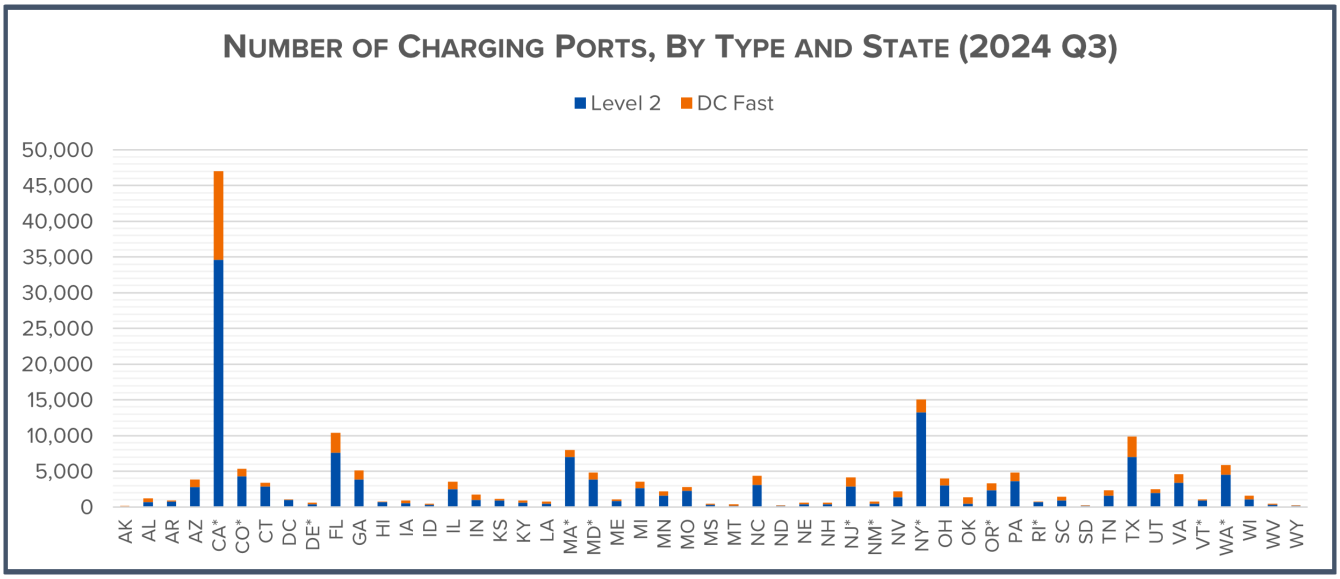
**Denotes states that have adopted California's ACC II ZEV mandate*

Level 2 Chargers and DC Fast Chargers. Both Level 2 and DC Fast charging play important roles in electrifying the light-duty vehicle fleet. However, the key difference between Level 2 and DC Fast chargers is how quickly each will charge an EV's battery. Level 2 equipment is common for home, workplace, and public charging with longer dwell times. Level 2 chargers can fully charge a BEV from empty in 4-10 hours and a PHEV from empty in 1-2 hours. DC Fast charging equipment enables rapid charging of BEVs in 20 minutes to 1 hour along heavy-traffic corridors, in city centers, at transportation hubs, and fleet depots. Wider installation of Level 2 chargers, DC Fast chargers, and hydrogen fueling will be necessary to support wider-scale adoption of EVs.

The number of public Level 2 charging increased 14 percent at the end of the third quarter of 2024 over 2023. DC Fast chargers increased 23 percent. Total charging ports increased 16 percent from the end of 2023.[10] (For context, E-VIO increased 25 percent from the end of 2023 to the end of the third quarter of 2024.) Effectively, this ratio is going in the wrong direction since sales of EVs is increasing faster than the ratio of public charging – which can be a hinderance to public acceptance and convenience for vehicle owners.



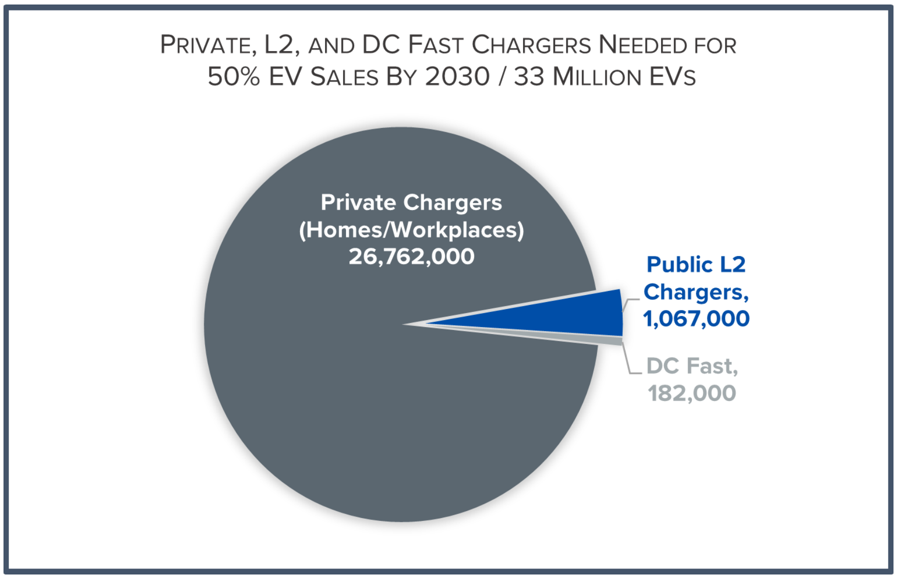
[7] "Stations" denotes stations as counted and identified by U.S. Department of Energy Alternative Fuels Data Center. Stations differs from number of locations as many stations can be at a singular location. Locations denotes unique addresses.
[8] Charging information from U.S. Department of Energy Alternative Fuels Data Center, stations in operation as of September 30, 2024
Note: prior editions of this report excluded proprietary chargers, however Tesla opened their previously proprietary chargers in November 2022 and their "North American Charging Standard" will be widely adopted by automakers.
[9] Some station locations have both Level 2 and DC Fast installed.
[10] Charging information from U.S. Department of Energy Alternative Fuels Data Center, stations in operation as of 9/30/2024



[11]

Infrastructure Investment Necessary

An assessment by the U.S. National Renewable Energy Laboratory (NREL) released in June 2023 estimated that a network of 28 million charging ports would be necessary to support 50 percent EV sales by 2030 (and 33 million EVs on the road).[12] NREL estimates that 96 percent of those charging ports would be privately accessible L1 and L2 chargers located at single-family homes, multifamily properties, and workplaces. The remaining 4 percent (1,249,000 ports) would be split between public L2 and high-speed DC Fast charging ports, with L2 making up 85 percent of those public chargers.

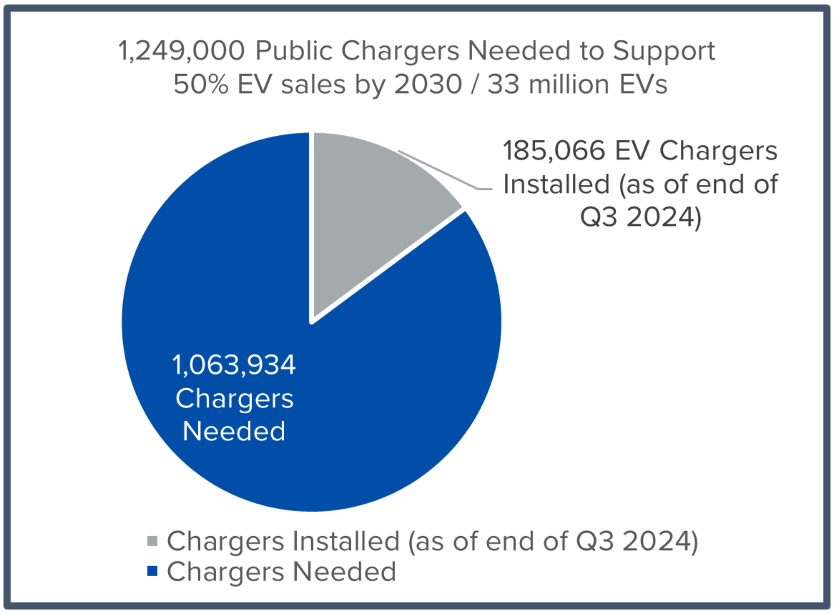


[13]

At the end of Q3 2024, there were about 185,000 public charging ports across the country and 5.4 million EVs on the road. Total installed public charging ports are about 17 percent of the needed estimate to support EV penetration by 2030 according to NREL.

More than 1 million additional public chargers (928,418 L2 and 135,516 DC Fast) will need to be installed to satisfy the necessary infrastructure estimate by 2030. This means that between the end of Q3 2024 and December 31, 2030, 466 chargers need to be installed every day, for the next 6.25 years. Or 3 chargers every 10 minutes through the end of 2030.

[11] Charging information from U.S. Department of Energy Alternative Fuels Data Center, stations in operation as of 9/30/2024; *Denotes states that have adopted California's ACC II ZEV mandate
[12] National Renewable Energy Laboratory, "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure," June 2023
[13] National Renewable Energy Laboratory, "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure," June 2023



14

Between the end of Q3 2024 and December 31, 2030, 466 chargers need to be installed every day, for the next 6.25 years. Or 3 chargers every 10 minutes through the end of 2030.

The Cost of This Substantial Infrastructure Necessity Will Largely Fall on Consumers and Commercial Real Estate Owners as They Install Home and Workplace Charging. According to NREL, a national capital investment of $53–$127 billion in charging infrastructure is needed by 2030 (including as much as $72 billion for private residential charging) to support 33 million EVs. The large range of potential costs is a result of variable and evolving equipment and installation costs across charging networks, locations, and site designs[15]. Notably, the estimates exclude the cost of grid upgrades and distributed energy resources. The estimated cumulative capital investment includes[16]:

» $22–$72 billion for privately accessible Level 1 and Level 2 charging ports

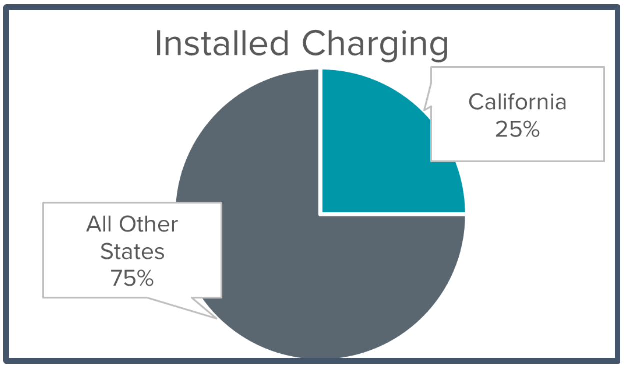
» $27–$44 billion for publicly accessible fast charging ports

» $5–$11 billion for publicly accessible Level 2 charging ports

Infrastructure Disparities by Geography

Geographic disparities in charging infrastructure are pervasive. At the end of Q3 2024, a quarter of all public charging infrastructure was in California, which had 33 percent of all registered EVs.

Alliance for Automotive Innovation is proactively engaging to enable the automotive industry's transformation to electric vehicles through state-level engagement actions such as participation in the Joint Office of Energy and Transportation's Electric Vehicle Working Group, development of a lithium-ion battery recycling policy framework, recommendations for attributes of EV charging stations, and recommendations for the implementation of IRA EV tax credits[17].



[14] National Renewable Energy Laboratory, "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure," June 2023
[15] Various state and federal incentives are available to consumers or businesses that install EV charging infrastructure, including from power utilities.
[16] National Renewable Energy Laboratory, "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure," June 2023
[17] Alliance for Automotive Innovation, Blog, What We Know (and Don't Know) About the New EV Tax Credit Rules, 12/20/2022; Alliance for Automotive Innovation, blog Foreign Entity of Concern: Finally… Some Clarity, 12/1/2023

Vehicles in Operation and Charging by State

Public Charging Outlets And Registerd EVs (as of 9/30/2024)

	EV Level 2	EV DC Fast	H2** Fueling	Total	Percent EVs of Total VIO***	Share of Registered EVs****	EVs Per Charger	EVs Per 10K Residents
AK	87	33	-	120	0.70%	0.08%	34	55.70
AL	679	524	-	1,203	0.40%	0.38%	17	40.92
AR	731	158	-	889	0.39%	0.20%	12	36.06
AZ	2,789	1,080	-	3,869	1.96%	2.49%	35	182.42
CA*	34,638	12,355	57	47,050	5.80%	33.32%	38	464.83
CO*	4,263	1,061	-	5,324	2.76%	2.81%	29	259.68
CT	2,864	547	-	3,411	1.82%	1.04%	17	155.90
DC	1,002	60	-	1,062	3.92%	0.24%	13	195.93
DE*	380	248	-	628	1.58%	0.27%	23	140.18
FL	7,612	2,786	-	10,398	1.86%	6.63%	35	159.46
GA	3,870	1,291	-	5,161	1.33%	2.35%	25	115.63
HI	676	97	1	774	3.22%	0.67%	47	253.99
IA	557	370	-	927	0.53%	0.31%	18	53.14
ID	328	168	-	496	0.76%	0.29%	31	78.87
IL	2,455	1,123	-	3,578	1.48%	2.76%	42	119.62
IN	1,019	699	-	1,718	0.71%	0.81%	26	64.43
KS	903	241	-	1,144	0.67%	0.36%	17	66.70
KY	636	272	-	908	0.47%	0.35%	21	42.16
LA	476	280	-	756	0.36%	0.25%	18	29.82
MA*	6,987	966	-	7,953	2.38%	2.45%	17	190.00
MD*	3,835	993	-	4,828	2.30%	2.17%	24	190.43
ME	823	250	-	1,073	1.30%	0.32%	16	125.18
MI	2,662	919	-	3,581	0.97%	1.53%	23	82.69
MN	1,579	628	-	2,207	1.15%	1.11%	27	104.84
MO	2,239	554	-	2,793	0.75%	0.78%	15	68.70
MS	288	138	-	426	0.21%	0.11%	14	20.77
MT	195	220	-	415	0.47%	0.15%	20	72.84
NC	3,119	1,219	-	4,338	1.13%	2.03%	25	101.80
ND	134	104	-	238	0.24%	0.04%	8	25.21
NE	396	195	-	591	0.58%	0.23%	21	62.60
NH	406	236	-	642	1.33%	0.33%	28	127.17
NJ*	2,871	1,289	-	4,160	2.63%	3.63%	47	212.50
NM*	443	319	-	762	0.85%	0.32%	23	81.76
NV	1,352	833	-	2,185	2.78%	1.30%	32	221.29
NY*	13,278	1,767	-	15,045	2.16%	4.57%	16	126.84
OH	3,050	983	-	4,033	0.82%	1.62%	22	74.94
OK	468	871	-	1,339	1.30%	1.10%	45	148.14
OR*	2,341	944	-	3,285	2.70%	1.93%	32	247.67
PA	3,590	1,212	-	4,802	1.16%	2.35%	27	98.54
RI*	678	100	-	778	1.48%	0.23%	16	113.79
SC	920	509	-	1,429	0.62%	0.62%	24	62.68
SD	138	126	-	264	0.33%	0.06%	13	36.98
TN	1,622	698	-	2,320	0.75%	0.97%	23	73.62
TX	6,986	2,909	-	9,895	1.28%	5.86%	32	104.44
UT	2,000	482	-	2,482	1.97%	1.12%	25	178.01
VA	3,359	1,249	-	4,608	1.56%	2.23%	26	138.87
VT*	877	192	-	1,069	2.80%	0.28%	14	239.09
WA*	4,488	1,405	-	5,893	3.13%	4.04%	37	280.95
WI	1,057	504	-	1,561	0.77%	0.77%	27	70.87
WV	294	153	-	447	0.33%	0.10%	12	29.69
WY	142	124	-	266	0.34%	0.04%	9	38.85
U.S.	**138,582**	**46,484**	**58**	**185,124**	**1.88%**	**100.00%**	**29**	**162.30**

*Denotes states that have adopted California's ZEV program; **Hydrogen count denotes stations
*** VIO is vehicles in operation; **** State share of U.S. Total
Source: Figures compiled by Alliance for Automotive Innovation with registered vehicle data provided by S&P Global Mobility as of September 30, 2024; Charging information from U.S. Department of Energy Alternative Fuels Data Center, as of 9/30/2024

REGISTRATIONS

EV registrations as a share of all registered light-duty vehicles are 1.9 percent (as of September 30, 2024). There are more than 288 million registered light-duty vehicles in the U.S.

At the end of Q3 2024, California accounted for 33 percent of all registered light-duty EVs in the U.S.

States with highest portion of total EVs registered:

1) CA* (1,811,237, 5.8%)

2) DC (13,303, 3.9%)

3) HI (36,451, 3.2%)

4) WA* (219,500, 3.1%)

5) VT* (15,480, 2.8%)

6) NV* (70,685, 2.8%)

7) CO* (152,627, 2.7%)

8) OR* (104,846, 2.7%)

9) NJ* (197,428, 2.6%)

10) MA* (133,028, 2.4%)

States with worst ratio of registered EVs per public charger:

1) NJ*

2) HI

3) OK

4) IL

5) CA*

6) WA*

7) AZ

8) FL

9) AK

10) NV*

SPOTLIGHT ON: SECTION 177 STATES

Background

Under the Clean Air Act, vehicle tailpipe emissions rules are set by the federal government (EPA) and govern all new vehicles sold in the U.S. However, the law allows California to set its own stricter emissions standards using waiver authority that must be formally approved by the U.S. EPA. Section 177 of the Clean Air Act allows states to adopt California's more stringent vehicle emissions standards instead of the federal standards. These states are known as Section 177 states.

Some Section 177 states follow California's Advanced Clean Cars II (ACC II) ZEV Mandate, requiring automakers to sell a specific (and escalating) percentage of zero emission vehicles (ZEVs) starting in model year 2026 through 2035 when 100 percent of new vehicles sales must be ZEVs. Necessarily, the number of new -powered vehicles sold in section 177 states must decline every year between 2026-2035 as well. Effectively, the ACC II ZEV Mandate is an actual electrification sales mandate and ultimately a ban on the sale of new gas-powered vehicles.

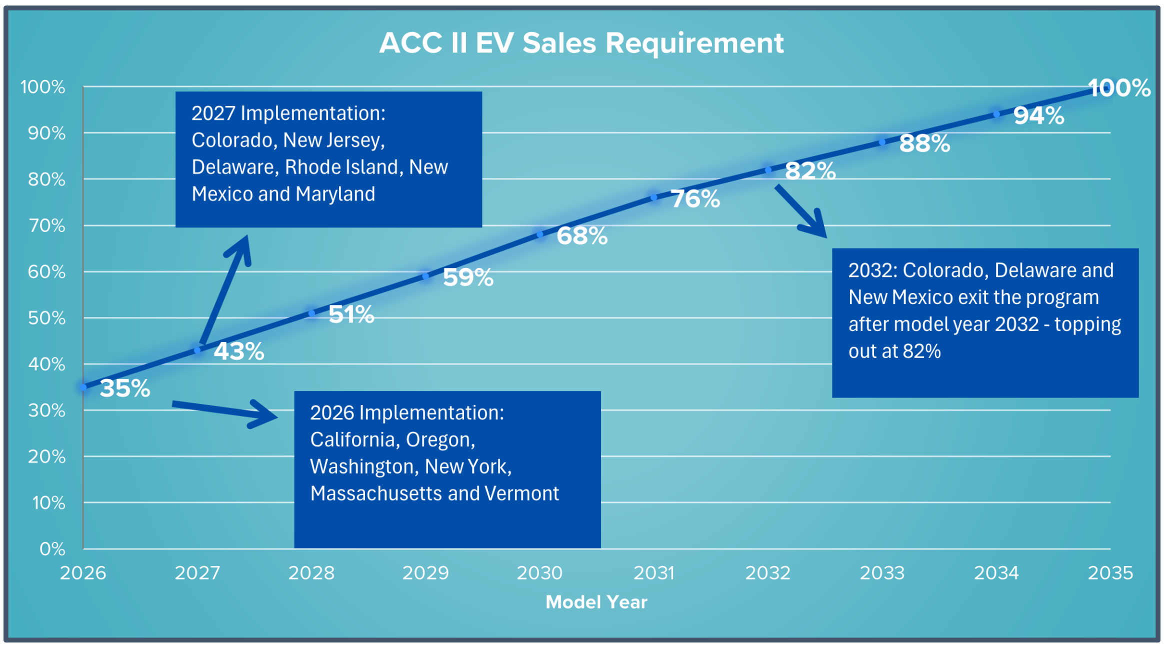
✓ About 30 percent of the U.S. vehicle market (11 states plus California) have adopted those standards.

✓ California, Oregon, Washington, New York, Massachusetts and Vermont have adopted the ACC II ZEV Mandate starting in model year 2026.

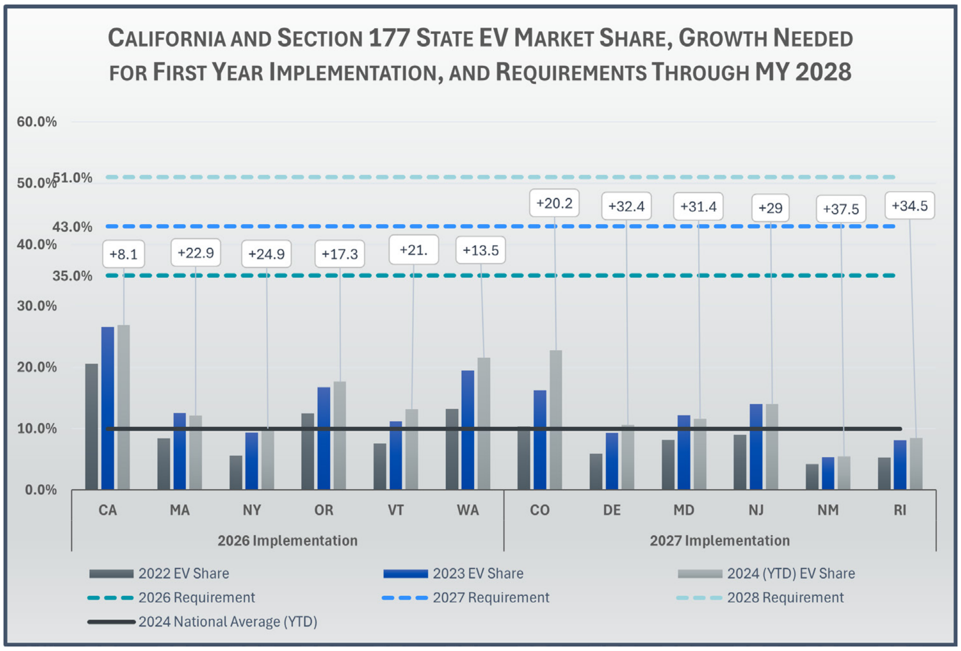
✓ Colorado, New Jersey, Delaware, Rhode Island, New Mexico and Maryland join the program in model year 2027.

X Note: Colorado, Delaware and New Mexico adopted the program through model year 2032 (stopping at an 82 percent ZEV sales mandate).

Model year 2026 requirements are only about 6 months away, and only about a year and a half away from model year 2027.



State of the EV Market in Section 177 States



As noted previously, California leads the nation in EV sales. And while some Section 177 states have seen success in increasing EV adoption, many of those states remain at or near the national average through Q3 2024 (roughly 10 percent of all new vehicle sales – including BEVs, PHEVs, and Fuel Cells.

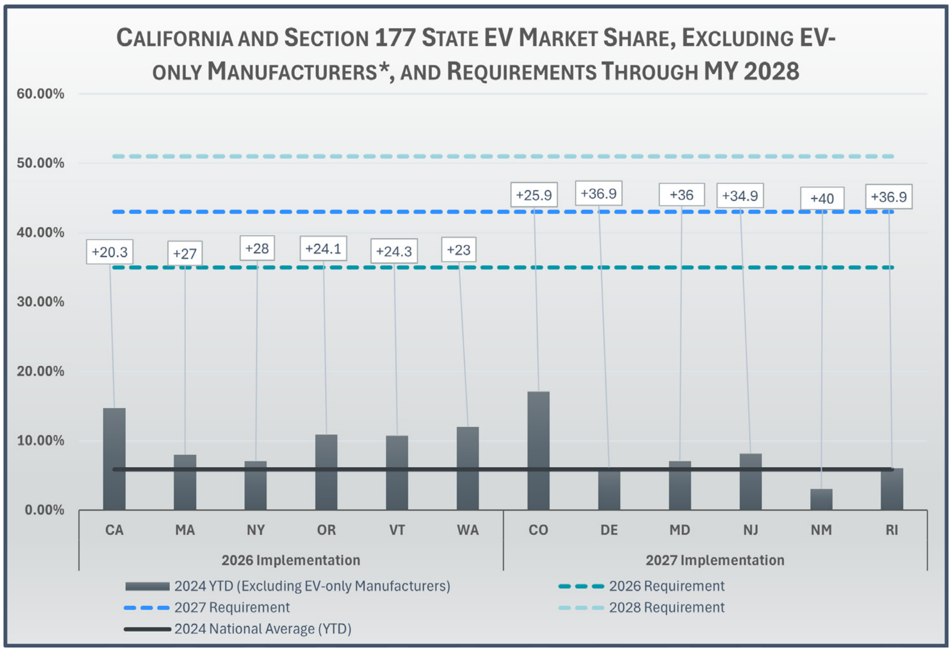
Colorado has made the most progress outside of California and more than doubled their EV market share since 2022. However, Colorado would need to nearly double their market share AGAIN to reach the standard set for 2028 (51 percent). That said, just to reach the standard for the first year of Colorado's implementation (set for 2027) would require a 20 pp increase over 2024 YTD. In fact, every state but California needs to realize double-digit market share growth to reach the initial requirement for their first year of EV sales requirements. Most states need to increase market share by more than 20 pp. Washington and Oregon are the only other states (besides California) that require less than a 20 pp increase.

Double Digit Market Share Growth Needed to Reach 35 percent Standard in Every Section 177 State Joining the Program in 2026, Based on Industry Average; Even Steeper Climb for States Joining the Program in 2027

However, it is important to note that the numbers above are industry averages. The annual EV sales requirements apply to each automaker individually. Looking at incumbent auto manufacturer EV market share in California and the 177 states (and removing EV-only manufacturers like Tesla and Rivian) the sales requirements for legacy automakers to reach the targets is much steeper.

Legacy automakers will require more than a 20 pp increase in EV market share in California and every Section 177 state to reach the first year of the mandate. Legacy automakers in nearly every one of the MY2027 states are more than 30 pp away from the sales obligation.

**EV-only manufacturers excluded: Brightdrop, Cruise, Fisker, Lucid, Rivian, Tesla, and VinFast*



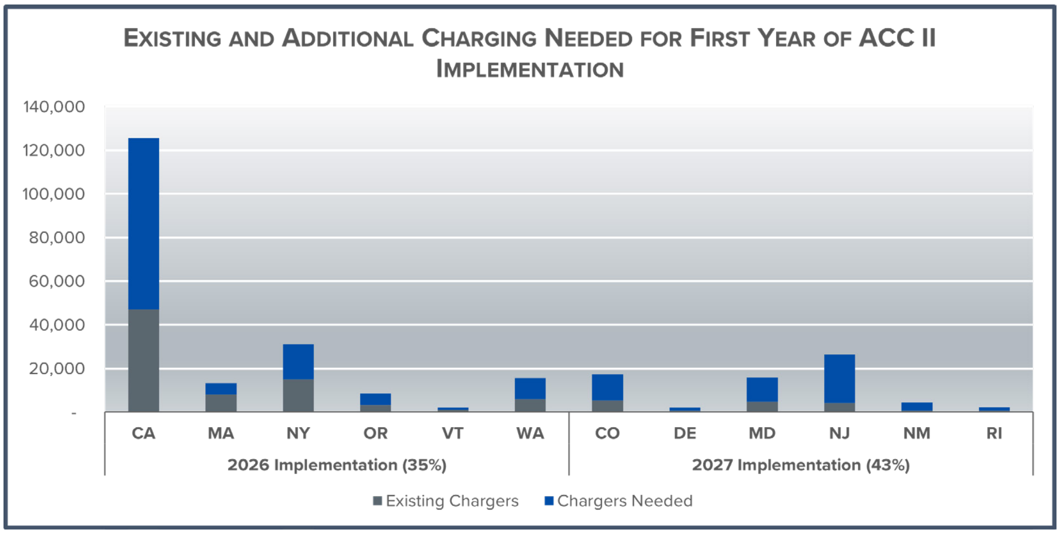
[23] "How Much Of The Global Battery Supply Chain Is Owned By Chinese Companies?" Benchmark Mineral, 8/22/2024
[24] Compiled from company reports, press statements, and other media; investments from 2020 – September 2024

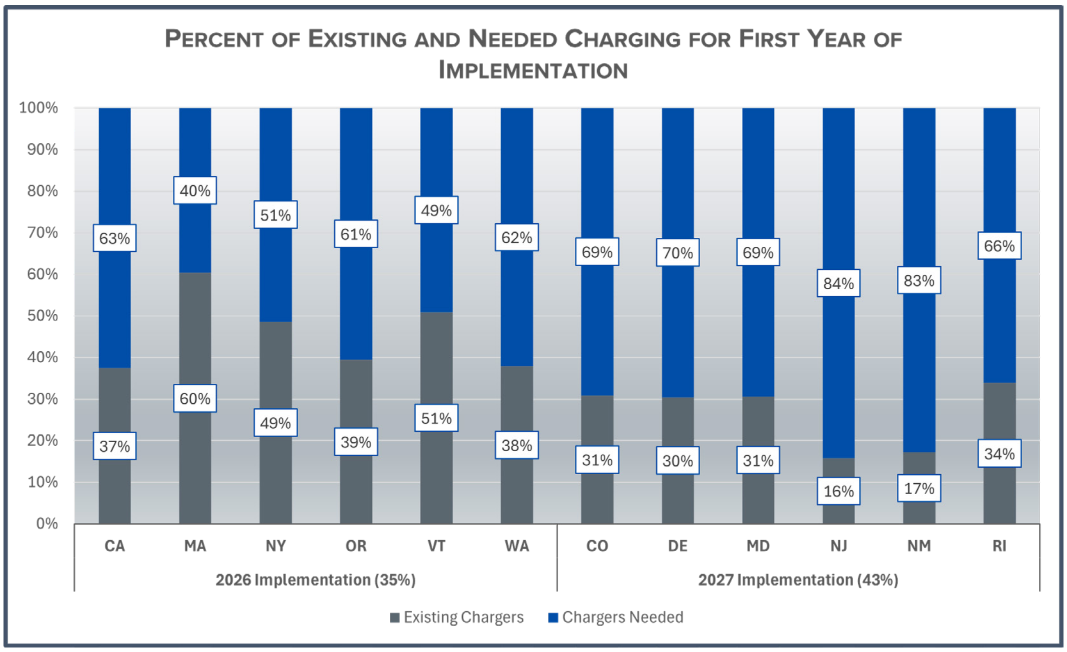
State of Infrastructure in Section 177 States

Due to each state's varying size, density, population, housing demographics, and market size, no "one-size-fits-all" approach to installing charging infrastructure can be put in place. However, the National Renewable Energy Laboratory[18] forecasted the necessary public charging for each state as part of their simulated 2030 national pipeline. The necessary future charging can be viewed as a ratio of EVs to charging ports by dividing the anticipated EVs in operation by the number of recommended chargers. The lower the number, the more charging ports per EV.

Get Connected has been reporting the ratio of EVs to charging ports on a quarterly basis since 2021. Most states will need to make significant progress in bringing the ratio down to meet future requirements. States that are currently at, or near, the target ratio, will need to continue adding charging infrastructure to maintain the target.

The numer of charging ports necessary vary widely by state, with Califonria having installed more than most states will need. However, Califnornia only has 37 percent of the necessary infrastructure installed and needs to add about 78,000 more charging ports to satisfy the ratio for 35 percent of sales in 2026. New Jersey and New Mexico have the least amount of the reccomended necessary charging infrastructure in place, with only 22 percent and 25 percent, respectively.





[18] National Renewable Energy Laboratory, Report "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure"

Repercussions of Sales Mandate

For automakers to meet the increasing sales mandate in 177 States, they have three options. Increase EV sales, decrease total sales, or buy credits. Each option is replete with unintended consequences for automakers and consumers.

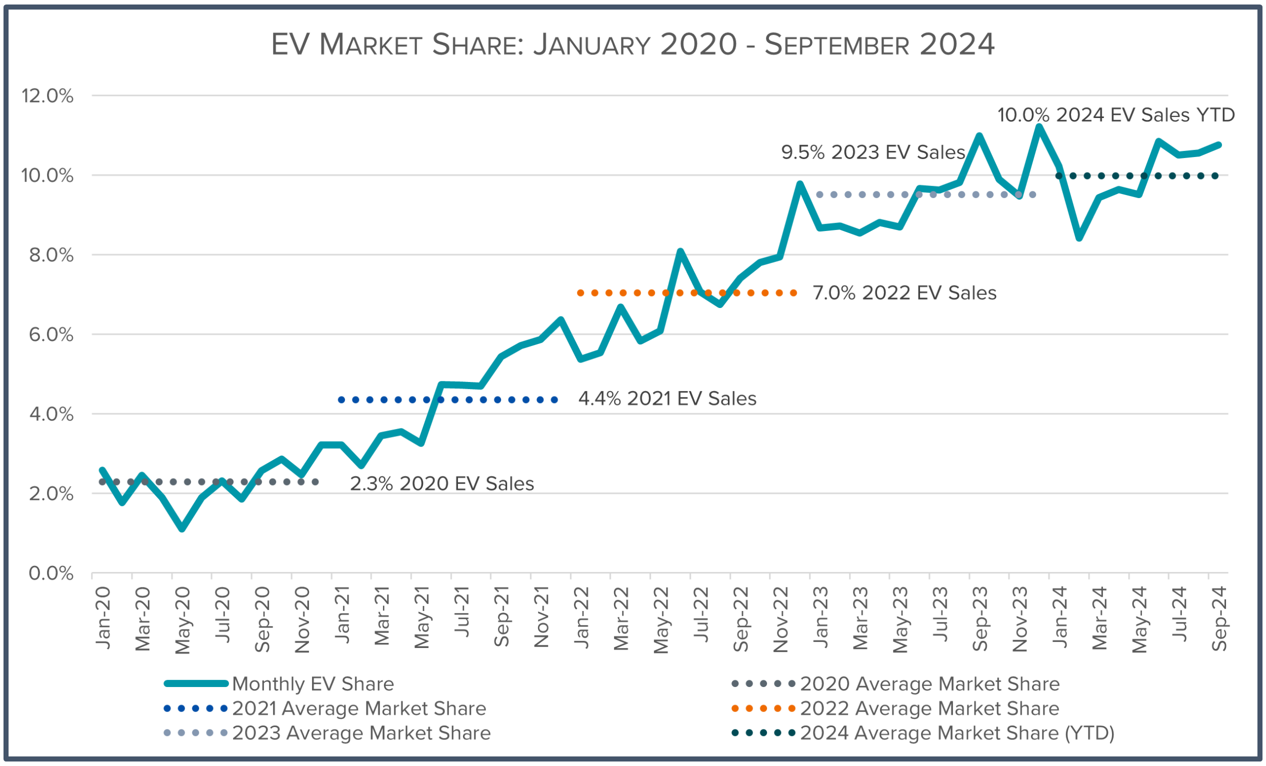
In the first option – automakers can increase sales of EVs and decrease their sales of traditional hybrid vehicles and internal combustion engine vehicles. However, unless consumers begin to rapidly purchase EVs in record-breaking fashion, automakers will be forced to limit the number of non-EVs for purchase in each state. By limiting vehicle options and consumer choice, prices will increase, and economic activity and tax revenue will decrease.

The second option has many of the same ramifications. If automakers limit their sales of vehicles so their EV sales share meets the target, consumer choice will be limited, prices will increase, consumers will be forced to shop out of state where limits are not imposed on the sale of internal combustion engine vehicles. Under this second option, these states could also witness a decrease in economic activity and tax revenue that would have otherwise been collected.

With the third option, automakers can buy clean car credits from EV manufacturers like Tesla who "over-comply" with the mandates. The credits available for purchase in the coming years will decrease as requirements rise, and it's unknown how many will be available on a year-to-year basis. In general, the number of available surplus credits will likely only equate to several percentage points of the requirements at most given the relative sales of EV-only manufacturers and legacy automakers. Effectively, any strategy that requires automakers to buy credits from an EV-only manufacturer will only raise the price of all vehicles to consumers – even if they buy a hybrid or internal combustion engine vehicle.

It appears clear that the start of the ACC II EV sales requirements in Calendar Year 2025 and 2026 will start to change the way consumers shop for a new vehicle that best suits their needs at a price they can afford.

APPENDIX - A


EV MARKET SHARE: JANUARY 2020 - SEPTEMBER 2024
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
10.0% 2024 EV Sales YTD
9.5% 2023 EV Sales
7.0% 2022 EV Sales
4.4% 2021 EV Sales
2.3% 2020 EV Sales
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
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Nov-23
Jan-24
Mar-24
May-24
Jul-24
Sep-24
Monthly EV Share
2020 Average Market Share
2021 Average Market Share
2022 Average Market Share
2023 Average Market Share
2024 Average Market Share (YTD)

EXHIBIT K

Edison Electric INSTITUTE

Electric Vehicle Sales and the Charging Infrastructure Required Through 2035

October 2024

Electric Vehicle Sales and the Charging Infrastructure Required Through 2035

Prepared by:
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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

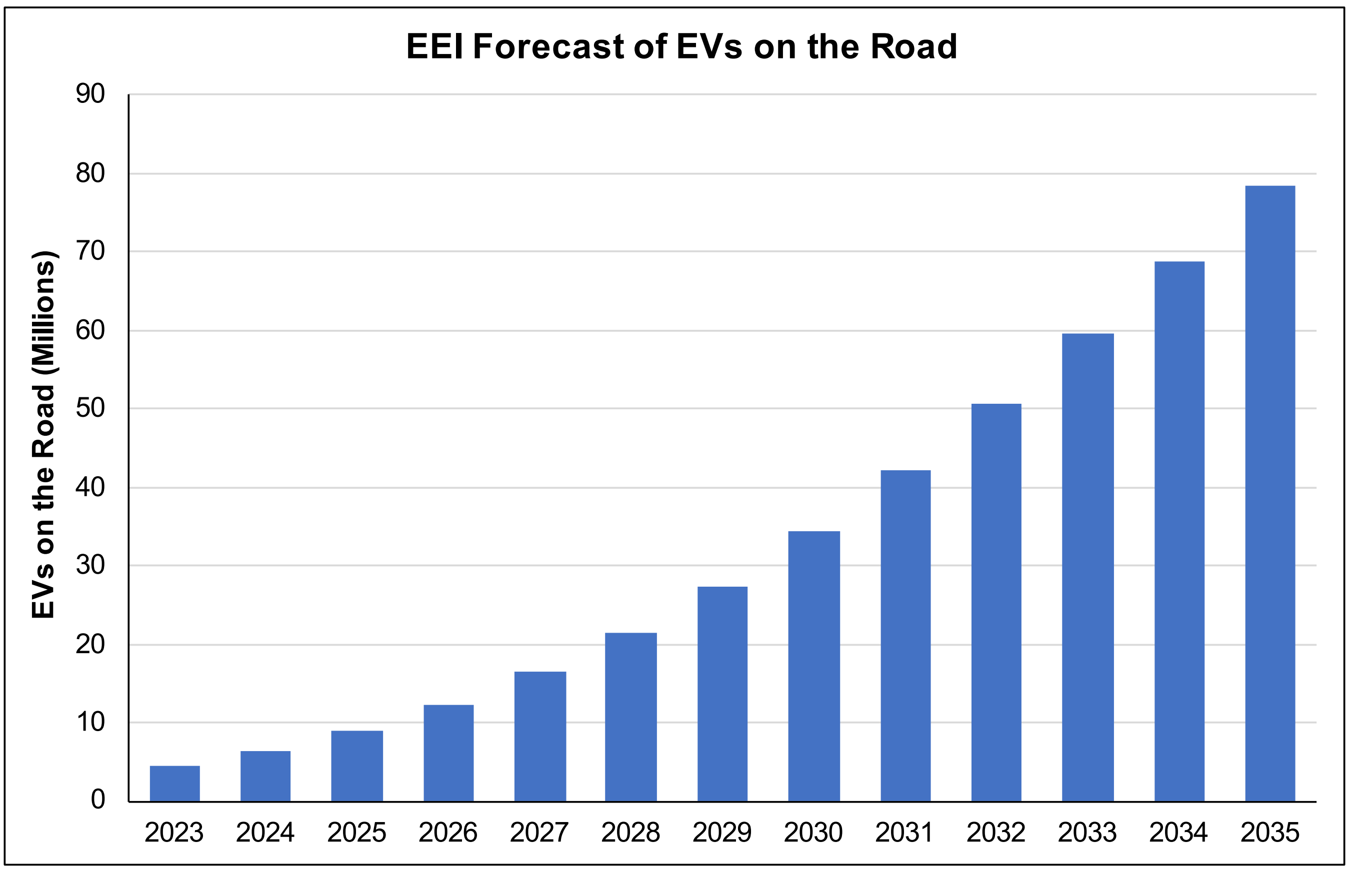
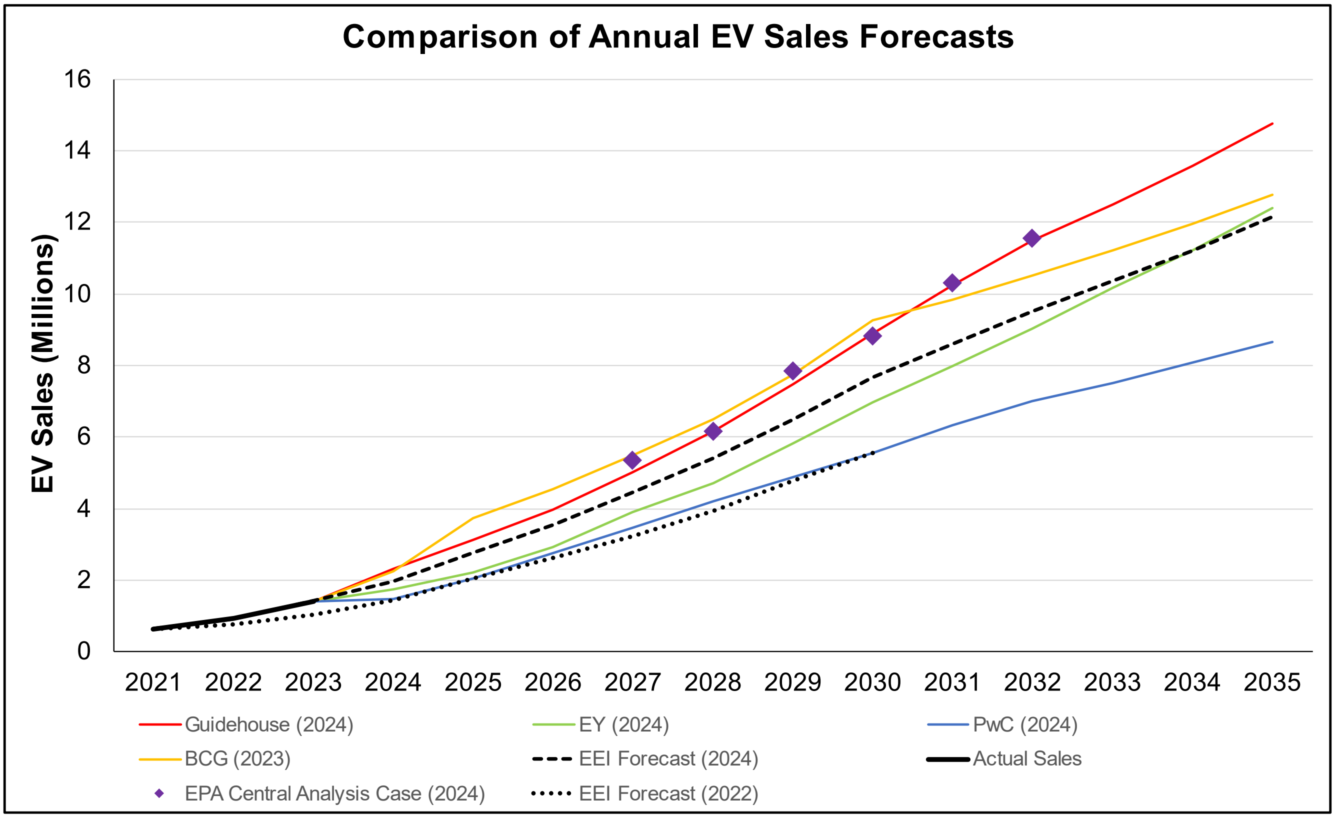


Figure 2. EEI Annual EV Sales Forecast: Nearly 12.2 Million Annual EV Sales in 2035



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]

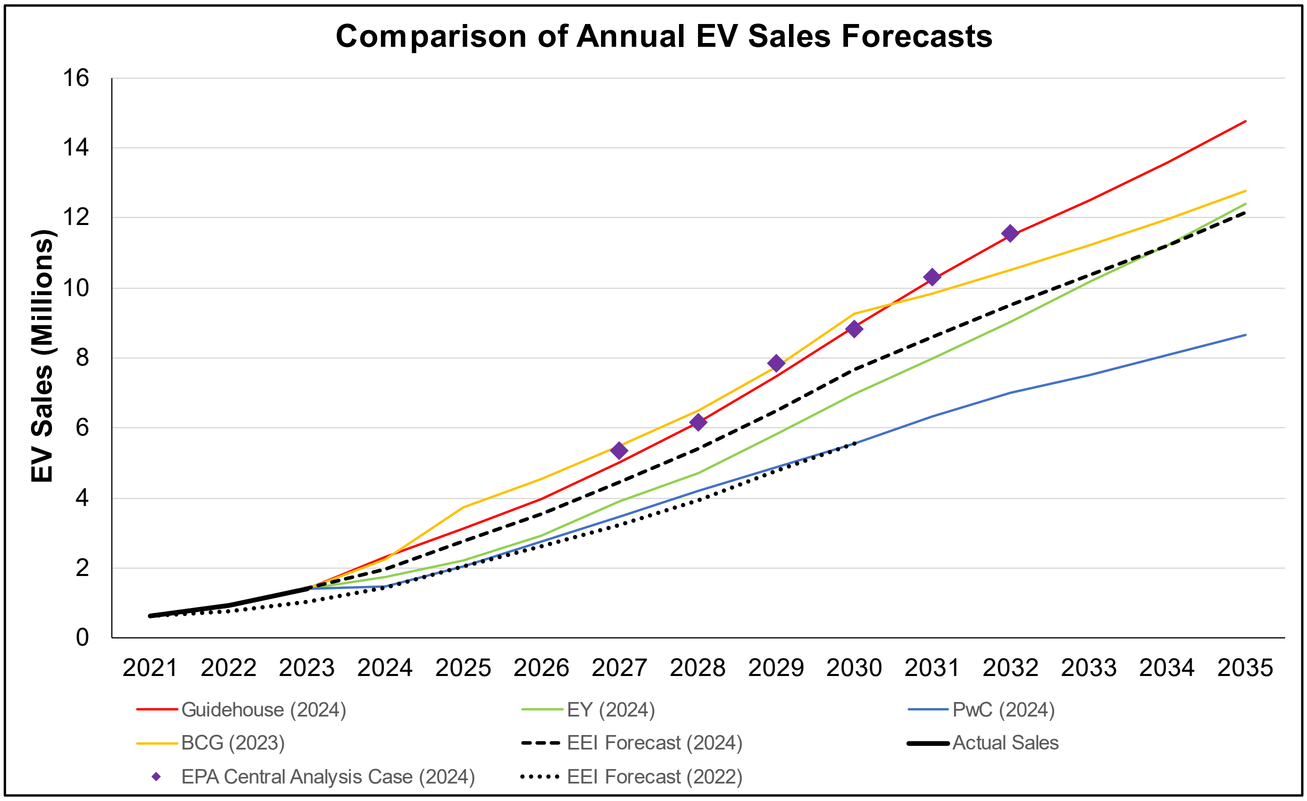
These forecasts were selected because they include three key factors: customer preference models that determine interest in EVs; declining battery costs that influence EV cost competitiveness with ICE vehicles and manufacturer profitability; and fuel efficiency standards and environmental regulations. 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.

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.

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

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.

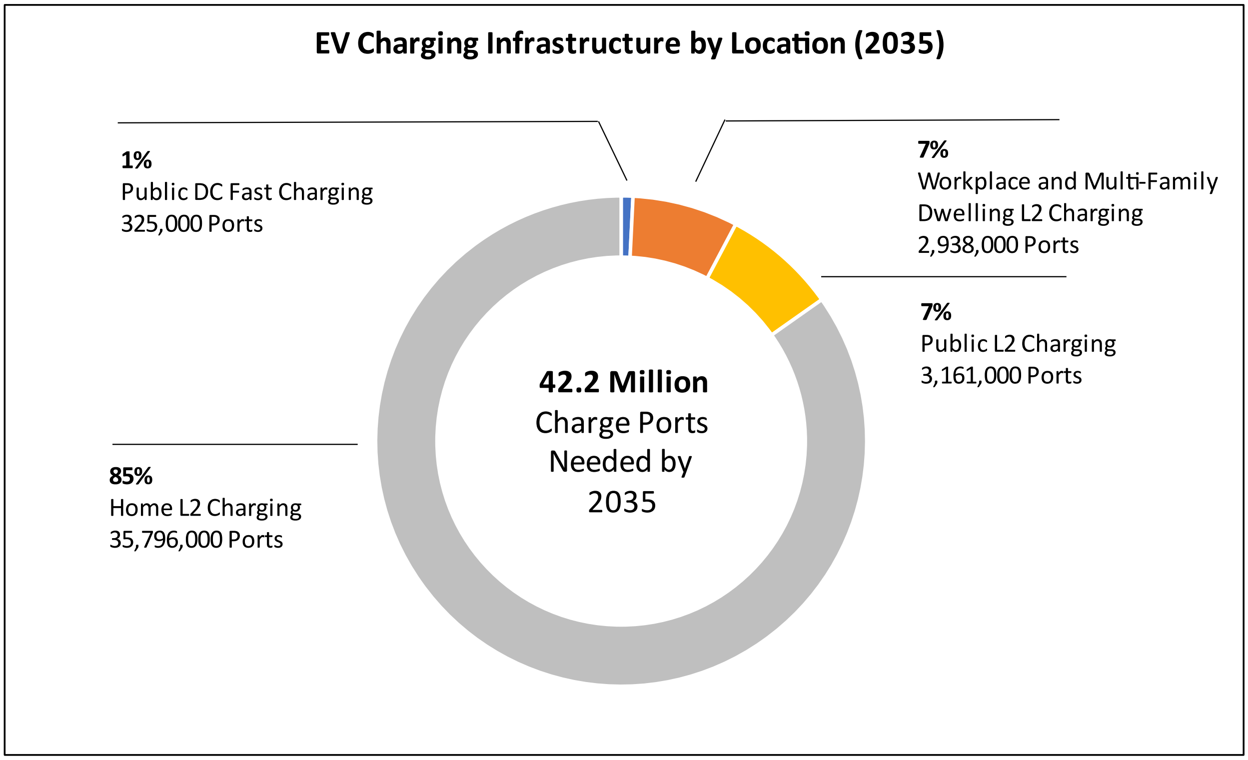
- **Ride-Hailing Electrification**: Research indicates the travel patterns of ride-hail drivers along with the likelihood of reduced access to overnight home charging result in a much higher reliance on fast charging compared to the average driver.[35] To model the need for charging infrastructure to 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.

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*

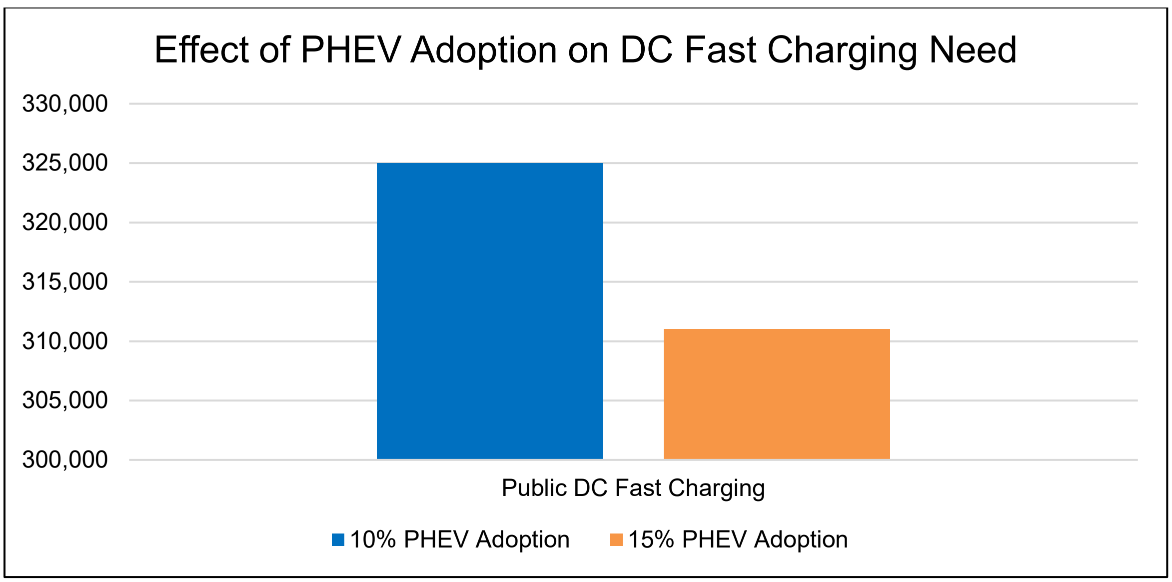
2035, highlighting the critical need to enable the rapid deployment of EV charging infrastructure today to meet the continuing needs of EV drivers through 2035 and beyond.

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

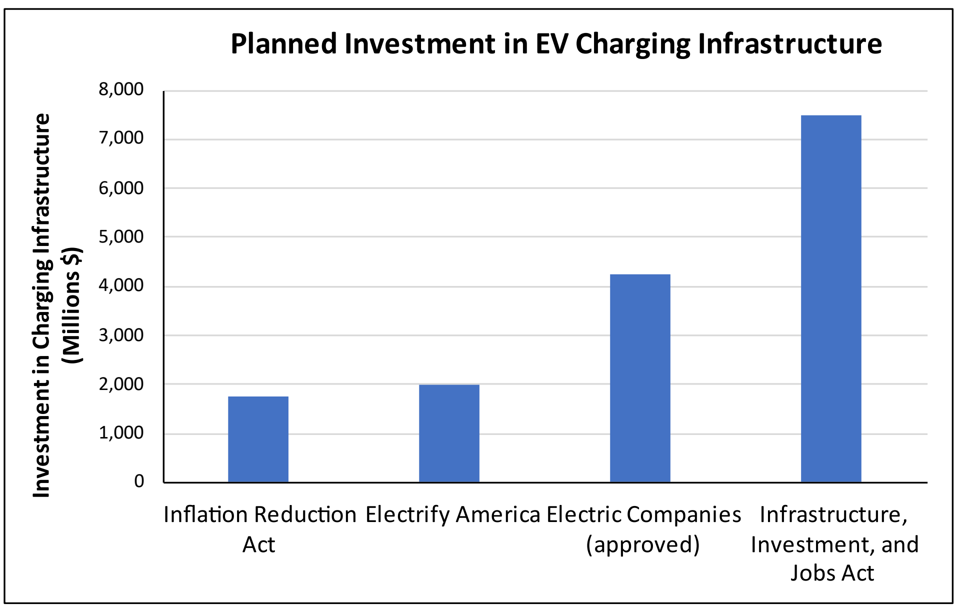
lack of EV charging infrastructure is a primary barrier to EV adoption.[40] The analysis using the EVI-Pro Lite tool in this report estimates the charging infrastructure needed to support a certain level of EVs. In this section, we discuss approaches for deploying EV charging infrastructure.

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.

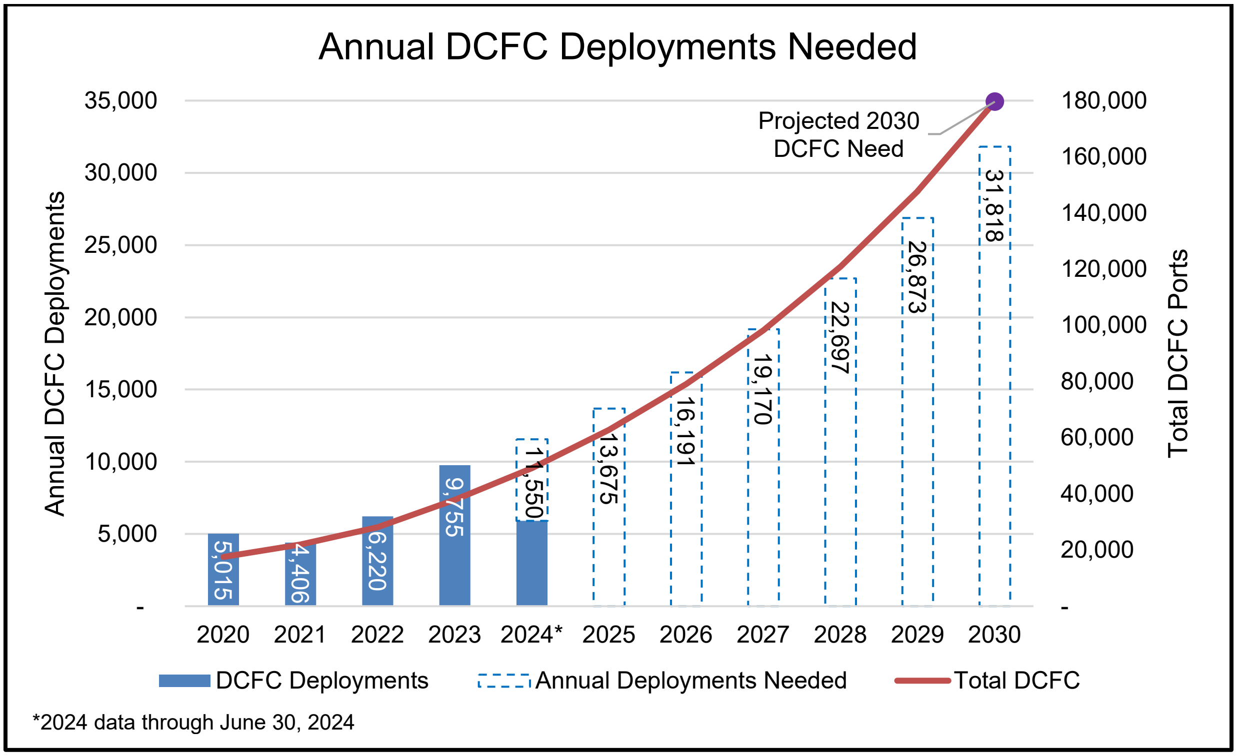
DC Fast Charging Infrastructure Gap

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.

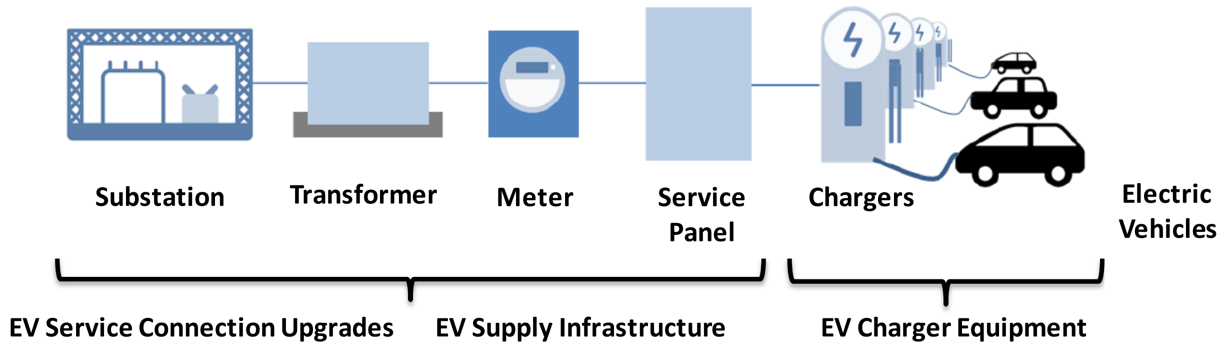
Electric Company Role

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

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.

Organized in 1933, EEI provides public policy leadership, strategic business intelligence, and essential conferences and forums.

For more information, visit our Web site at **www.eei.org**.

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EXHIBIT L

NREL
Transforming ENERGY

The 2030 National Charging Network:

Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure

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Charles Satterfield……………………………………………………... Edison Electric Institute

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Vincent Riscica……………………New York State Energy Research & Development Authority

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List of Acronyms

BEV	battery-electric vehicle
CBSA	core-based statistical area
CCS	Combined Charging System
DC	direct current
DOE	U.S. Department of Energy
EV	electric vehicle
EVI-X	electric vehicle infrastructure analysis tools
EVSE	electric vehicle supply equipment
FHWA	Federal Highway Administration
ICCT	International Council on Clean Transportation
Joint Office	Joint Office of Energy and Transportation
L1	Level 1
L2	Level 2
LDV	light-duty vehicle
NACS	North American Charging Specification
NHTS	National Household Travel Survey
PEV	plug-in electric vehicle
PHEV	plug-in hybrid electric vehicle
SFH	single-family home
SOC	state of charge
TAF	Traveler Analysis Framework
TNC	transportation network company
VMT	vehicle miles traveled
ZEV	zero-emission vehicle

Executive Summary

U.S. climate goals for economywide net-zero greenhouse gas emissions by 2050 will require rapid decarbonization of the light-duty vehicle[1] fleet, and plug-in electric vehicles (PEVs) are poised to become the preferred technology for achieving this end (U.S. Department of Energy 2023). The speed of this intended transition to PEVs is evident in actions taken by government and private industry, both in the United States and globally. New PEV sales have reached 7%–10% of the U.S. light-duty market as of early 2023 (Argonne National Laboratory 2023). Globally, PEV sales accounted for 14% of the light-duty market in 2022, with China and Europe at 29% and 21%, respectively (IEA 2023). A 2021 executive order (Executive Office of the President 2021) targets 50% of U.S. passenger car and light truck sales as zero-emission vehicles (ZEVs) by 2030, and California has established requirements for 100% light-duty ZEV sales by 2035 (California Air Resources Board 2022), with many states adopting or considering similar regulations (Khatib 2022). These goals were set prior to passage of the landmark U.S. Bipartisan Infrastructure Law and Inflation Reduction Act, which provide substantial policy support through tax credits and investment grants (Electrification Coalition 2023). Companies in the automotive industry have committed to this transition, with most companies rapidly expanding offerings (Bartlett and Preston 2023) and many pledging to become ZEV-only manufacturers. Tesla has been a ZEV-only company since its inception in 2003; Audi, Fiat, Volvo, and Mercedes-Benz are targeting ZEV-only sales by 2030; and General Motors and Honda are targeting ZEV-only sales by 2035 and 2040, respectively (Bloomberg New Energy Finance 2022). The combination of policy action and industry goal-setting has led analysts to project that by 2030, PEVs could account for 48%–61% of the U.S. light-duty market (Slowik et al. 2023). This transition is unprecedented in the history of the automotive industry and will require support across multiple domains, including adequate supply chains, favorable public policy, broad consumer education, proactive grid integration, and (germane to this report) a national charging network.

As established by the Infrastructure Investment and Jobs Act, also known as the Bipartisan Infrastructure Law, the Joint Office of Energy and Transportation (Joint Office) is setting the vision for a national charging network that is *convenient, affordable, reliable, and equitable to enable a future where everyone can ride and drive electric*. This report supports the vision of the Joint Office by presenting a quantitative needs assessment[2] for a national charging network capable of supporting 30–42 million PEVs on the road by 2030.[3]

[1] This study considers personally owned, light-duty vehicles with gross vehicle weight rating of 8,500 pounds or less. Importantly, this definition includes vehicles driven for transportation network companies (ride-hailing) but excludes motorcycles, light-duty commercial vehicles, and Class 2b and 3 work trucks, the implications of which are discussed in Section 4 of this report.
[2] This study is presented as a needs assessment where the national charging network is sized relative to simulated demand from a hypothetical PEV fleet. This is slightly different from an infrastructure forecast, which might make considerations for charging providers being incentivized (by private investors or public funding) to future-proof investments, install charging in quantities far exceeding demand, or deploy charging as part of a larger business model that considers utilization as a secondary metric of success.
[3] National PEV fleet size scenarios have been developed using the National Renewable Energy Laboratory's Transportation Energy & Mobility Pathway Options (TEMPO) model and are consistent with multiple 2030 scenarios developed by third parties. Please see Section 2.2.1 for additional details.

Estimating infrastructure needs at the national level is a challenging analytic problem that requires quantifying the needs of future PEV drivers in various use cases, under region-specific environmental conditions, and with consideration for the built environment. This analysis leverages the National Renewable Energy Laboratory's suite of electric vehicle infrastructure analysis tools (EVI-X) and the best available real-world data describing PEV adoption patterns, vehicle technology, residential access, travel profiles, and charging behavior to estimate future charging needs. Multiple PEV charging use cases are considered, including typical needs to accommodate daily driving for those with and without residential access, corridor-based charging[4] supporting long-distance road trips, and ride-hailing electrification. While the analysis is national in scope, the simulation framework enables inspection of results by state and city, with parametric sensitivity analysis used to test a range of assumptions. This modeling approach is used to draw the following conclusions:

- **Convenient and affordable charging at/near home is core to the ecosystem but must be complemented by reliable public fast charging.** Industry focus groups with prospective PEV buyers consistently reveal that consumers want charging that is as fast as possible. However, consumer preferences tend to shift after a PEV purchase is made and lived experience with charging is accumulated. Home charging has been shown to be the preference of many PEV owners due to its cost and convenience. This dichotomy suggests that reliable public fast charging is key to consumer confidence, but also that a successful charging ecosystem will provide the right balance of fast charging and convenient destination charging in the appropriate locations.[5] Using sophisticated planning tools, this analysis finds that a national network in 2030 could be composed of 26–35 million ports to support 30–42 million PEVs. For a mid-adoption scenario of 33 million PEVs, a national network of 28 million ports could consist of:
    - 26.8 million privately accessible Level 1 and Level 2 charging ports located at single-family homes, multifamily properties, and workplaces[6]
    - 182,000 publicly accessible fast charging ports along highway corridors and in local communities
    - 1 million publicly accessible Level 2 charging ports primarily located near homes and workplaces (including in high-density neighborhoods, at office buildings, and at retail outlets).

  In contrast to gas stations, which typically require dedicated stops to public locations, the PEV charging network has the potential to provide charging in locations that do not

[4] This study defines corridors as all roads within the National Highway System (Federal Highway Administration 2017), including the Interstate Highway System, as well as other roads important to national transportation.
[5] This study considers Level 1 and Level 2 alternating-current (AC) chargers rated between 1.4 and 19.2 kW as destination chargers for light-duty vehicles. Direct-current (DC) chargers with nominal power ratings between 150 and 350+ kW are considered fast chargers for light-duty vehicles in this work. It is the opinion of the authors that referring to all DC charging as "DC fast charging" (DCFC) (as is typically done) is inappropriate given that the use of "fast" as a descriptor ultimately depends on the capacity of the battery being charged. As larger capacity light-duty PEVs enter the market and medium- and heavy-duty model options emerge, it is likely the case that some DC chargers will actually be used to slowly charge PEVs. Thus, the common practice of referring to all DC charging as DCFC is noticeably absent from this report.
[6] This analysis employs a novel charging infrastructure taxonomy that considers workplace charging as a mix of publicly and privately accessible infrastructure at a variety of location types as discussed in Section 2.3.2.

require an additional trip or stop. Charging at locations with long dwell times (at/near home, work, or other destinations) has the potential to provide drivers with a more convenient experience. This network must include reliable fast charging solutions to support PEV use cases not easily enabled by destination charging, including long-distance travel and ride-hailing, and to make electric vehicle ownership attainable for those without reliable access charging while at home or at work.

- **Fast charging serves multiple use cases, and technology is evolving rapidly.** The majority of the 182,000 fast charging ports (65%) simulated in the mid-adoption scenario meet the needs of those without access to reliable overnight residential charging (estimated as 3 million vehicles by 2030 in the mid-adoption scenario). Support for ride-hailing drivers and travelers making long-distance trips accounts for the remainder of simulated fast charging demand (21% and 14%, respectively). While most near-term fast charging demand is simulated as being met by 150-kW DC chargers, advances in battery technology are expected to stimulate demand for higher-power charging. We estimate that by 2030, DC chargers rated for at least 350 kW will be the most prevalent technology across the national fast charging network.
- **The size and composition of the 2030 national public charging network will ultimately depend on evolving consumer behavior and will vary by community.** While growth in all types of charging is necessary, the eventual size and composition of the national public charging network will ultimately depend on the national rate of PEV adoption, PEV preferences across urban, suburban, and rural locations, access to residential/overnight charging, and individual charging preferences. Sensitivity analysis suggests that the size (as measured by number of ports) of the 2030 national public charging network could vary by up to 50% (excluding privately accessible infrastructure) by varying the share of plug-in hybrids, driver charging etiquette, and access to private workplace charging (see alternate scenarios presented in Section 3.3). Additionally, the national network is expected to vary dramatically by community. For example, densely populated areas will require significant investments to support those without residential access and ride-hailing electrification, while more rural areas are expected to require fast charging along highways to support long-distance travel for those passing through.
- **Continued investments in U.S. charging infrastructure are necessary.** A cumulative national capital investment of \$53–\$127 billion[7] in charging infrastructure is needed by 2030 (including private residential charging) to support 33 million PEVs. The large range of potential capital costs found in this study is a result of variable and evolving equipment and installation costs observed within the industry across charging networks, locations, and site designs. The estimated cumulative capital investment includes:
    - \$22–\$72 billion for privately accessible Level 1 and Level 2 charging ports
    - \$27–\$44 billion for publicly accessible fast charging ports
    - \$5–\$11 billion for publicly accessible Level 2 charging ports.

  The cost of grid upgrades and distributed energy resources have been excluded from these estimates. While these excluded costs can be significant in many cases and will

[7] The scope of cost estimates can be generally defined as capital expenses for equipment and installation necessary to support vehicle charging. Please refer to Section 2.3.4 for additional detail.

ultimately be critical in building out the national charging network, they tend to be site-specific and have been deemed out of scope for this analysis.

- **Existing announcements put the United States on a path to meet 2030 investment needs.** This report estimates that a \$31–\$55-billion cumulative capital investment in publicly accessible charging infrastructure is necessary to support a mid-adoption scenario of 33 million PEVs on the road by 2030. As of March 2023, we estimate \$23.7 billion of capital has been announced for publicly accessible light-duty PEV charging infrastructure through the end of the decade,[8] including from private firms, the public sector (including federal, state, and local governments), and electric utilities. Public and private investments in publicly accessible charging infrastructure have accelerated in recent years. If sustained with long-term market certainty grounded in accelerating consumer demand, these public and private investments will put the United States on a path to meeting the infrastructure needs simulated in this report. Existing and future announcements may be able to leverage direct and indirect incentives to deploy charging infrastructure through a variety of programs, including from the Inflation Reduction Act and the Low Carbon Fuel Standard, ultimately extending the reach of announced investments.

While this analysis presents a needs-based assessment where charging infrastructure is brought online simultaneous to growth in the vehicle fleet, actual charging infrastructure will likely be necessary before demand for charging materializes. The position that infrastructure investment should "lead" vehicle deployment is based on the understanding that many drivers will need to see charging available at the locations they frequent and along the highways they travel before becoming confident in the purchase of an electric vehicle (Muratori et al. 2020). On the other hand, infrastructure investment should be careful not to lead vehicle deployment to the point of creating prolonged periods of poor utilization, thereby jeopardizing the financial viability of infrastructure operators.[9] These considerations suggest the balance of supply and demand for charging should be closely monitored at the local level and that steps should be taken to enable the efficient deployment of charging (defined as minimizing soft costs [Nelder and Rogers 2019]), including streamlined permitting and utility service connection processes (Hernandez 2022). While not the case today, an environment where infrastructure can be deployed efficiently enables the industry to responsively balance the supply of infrastructure subject to forecasts for unprecedented increases in demand.

This study leads us to reflect on how charging infrastructure planning has often been analogized to a pyramid, with charging at home as the foundation, public fast charging as the smallest part of the network at the tip of the pyramid, and destination charging away from home occupying the middle of the pyramid. While this concept has served a useful purpose over the years, we recommend a new conceptual model. The balance of public versus private charging and fast

[8] Based on investment tracking conducted by Atlas Public Policy.
[9] While utilization is a key metric to most station owners, it is not the only metric of success. Business models underlying charging networks are complex and evolving, with some stations collocated with more lucrative retail activities (as is the case with most gas stations today offering fuel at lower margins than items in the convenience store) and some stations deployed at a loss to help "complete" the network in areas critical for enabling infrequent, long-distance travel. Business relationships between charging networks, automakers, advertisers, and site hosts also make it difficult to measure the success of an individual station from utilization alone.

charging versus destination charging suggests a planning philosophy akin to a tree, as shown in Figure ES-1.

As with a tree, there are parts of the national charging network that are visible and those that are hidden. Public charging is the visible part of the network that can be seen along highways, at popular destinations, and through data accessible online. Private charging is the hidden part of the network tucked away in personal garages, at apartment complexes, and at certain types of workplaces. This private network is akin to the roots of a tree, as it is foundational to the rest of the system and an enabler for growth in more visible locations.

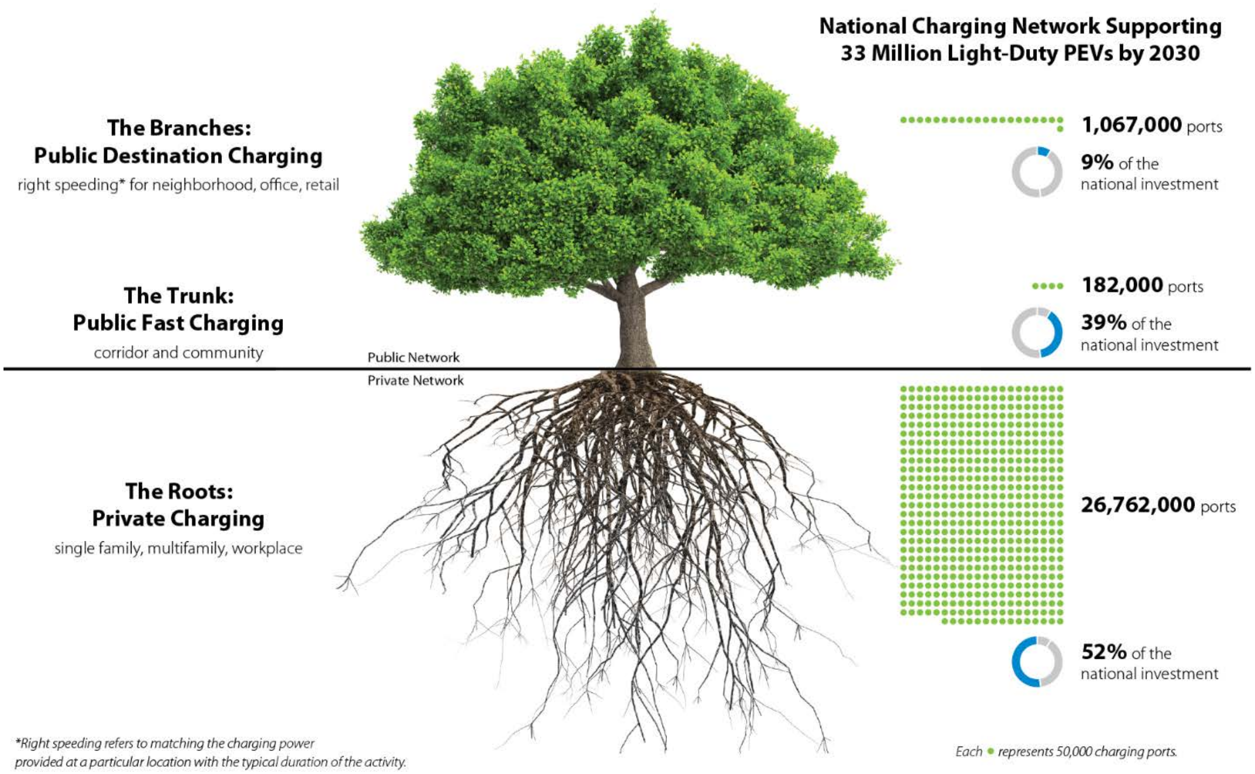

Figure ES-1. Conceptual illustration of national charging infrastructure needs

If access to private charging are the roots of the system, a reliable public fast charging network is the trunk, as it benefits from access to charging at home and other private locations (a key selling point of PEVs) and ultimately helps grow the system by making PEV ownership more convenient (enabling road trips and supporting those without residential access). While fast charging is estimated to be a relatively small part of the national network in terms of number of total ports, it requires significant investment and is vital to enabling future growth by assuring drivers they will be able to charge quickly whenever they need or want.

The last part of the system is a broad set of publicly accessible destination charging locations in dense neighborhoods, office buildings, and retail outlets where the speed of charging can be designed to match typical parking times ("right-speeding"). This network is similar to the branches of a tree in that its existence is contingent on a broad private network and a reliable fast charging network. As with the branches of a tree, the public destination charging network is ill-equipped to grow without the support of charging elsewhere.

This analysis envisions a future national charging network that is strategic in locating the right amount of charging, in the right locations, with appropriate charging power. Ensuring that this infrastructure is reliable will be essential to establishing driver confidence and accelerating widespread adoption of PEVs. A successful national charging network will position PEVs to provide a superior driving experience, lower total cost of ownership for drivers, become profitable for industry participants, and enable grid integration, all while meeting U.S. climate goals.

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1. Introduction

U.S. climate goals for economywide net-zero greenhouse gas emissions by 2050 will require rapid decarbonization of the light-duty vehicle (LDV) fleet, and plug-in electric vehicles (PEVs) are poised to become the preferred technology for achieving this end (U.S. Department of Energy 2023). The speed of this intended transition to PEVs is evident in actions taken by government and private industry, both in the United States and globally. New PEV sales have reached 7%–10% of the U.S. light-duty market as of early 2023 (Argonne National Laboratory 2023). Globally, PEV sales accounted for 14% of the light-duty market in 2022, with China and Europe at 29% and 21%, respectively (IEA 2023). A 2021 executive order (Executive Office of the President 2021) targets 50% of U.S. passenger car and light truck sales as zero-emission vehicles (ZEVs) by 2030, and California has established requirements for 100% light-duty ZEV sales by 2035 (California Air Resources Board 2022), with many states adopting or considering similar regulations (Khatib 2022). These goals were set prior to passage of the landmark U.S. Bipartisan Infrastructure Law and Inflation Reduction Act, which provide substantial policy support through tax credits and investment grants (Electrification Coalition 2023). Companies in the automotive industry have committed to this transition, with most companies rapidly expanding offerings (Bartlett and Preston 2023) and many pledging to become ZEV-only manufacturers. Tesla has been a ZEV-only company since its inception in 2003; Audi, Fiat, Volvo, and Mercedes-Benz are targeting ZEV-only sales by 2030; and General Motors and Honda are targeting ZEV-only sales by 2035 and 2040, respectively (Bloomberg New Energy Finance 2022). The combination of policy action and industry goal-setting has led analysts to project that by 2030, PEVs could account for 48%–61% of the U.S. light-duty market (Slowik et al. 2023). This transition is unprecedented in the history of the automotive industry and will require support across multiple domains, including adequate supply chains, favorable public policy, broad consumer education, proactive grid integration, and (germane to this report) a national charging network.

As established by the 2021 Bipartisan Infrastructure Law, the U.S. Joint Office of Energy and Transportation (Joint Office) is setting the vision for a national charging network that is *convenient, affordable, reliable, and equitable to enable a future where everyone can ride and drive electric*. This report supports the vision of the Joint Office by presenting a quantitative needs assessment for a national charging network capable of supporting 30–42 million PEVs on the road by 2030.

Estimating infrastructure needs at the national level is a challenging analytic problem that requires quantifying the needs of future PEV drivers in various use cases, under region-specific environmental conditions, and with consideration for the built environment. This analysis leverages the National Renewable Energy Laboratory's (NREL's) suite of electric vehicle infrastructure analysis tools (EVI-X) and the best available real-world data describing PEV adoption patterns, vehicle technology, residential access, travel profiles, and charging behavior to estimate future charging needs. Multiple PEV charging use cases are considered, including typical needs to accommodate daily driving for those with and without residential access, corridor-based charging supporting long-distance road trips, and ride-hailing electrification. While the analysis is national in scope, the simulation framework enables inspection of results by state and city, with parametric sensitivity analysis used to test a range of assumptions.

The remainder of Section 1 reviews the current state of the U.S. PEV and electric vehicle supply equipment (EVSE) markets, discusses recent EVSE initiatives and analysis studies, highlights equity considerations in the deployment of charging infrastructure, and outlines the structure used for the remainder of the report.

1.1. Current State of U.S. PEV and EVSE Markets

Mass-market PEV sales began in the United States at the end of 2010 with just a few models available to consumers. As new plug-in models have been introduced and production volumes have increased, sales have accelerated accordingly. It took nearly 8 years to reach 1 million cumulative sales, but just 2 1/2 more years to reach 2 million cumulative sales in June 2021. As of February 2023, U.S. cumulative PEV sales have surpassed 3.4 million, with PEV sales at 7%–10% of all LDVs in early 2023 (Argonne National Laboratory 2023). The growth in PEV sales has been accompanied by a similar growth in PEV capabilities, with electric driving range and maximum charging power improving dramatically in recent years.

The U.S. Department of Energy's (DOE's) Alternative Fueling Station Locator contains information on public and private nonresidential alternative fueling stations in the United States and Canada, including PEV charging infrastructure. PEV charging continues to experience rapidly changing technology and growing infrastructure. According to the Station Locator, as of March 2023, about 132,000 publicly accessible charging ports are currently installed in the United States. This includes about 29,000 direct-current (DC) charging ports and 103,000 Level 2 (L2) ports.

While strides have been made in recent years to improve interoperability[10] of PEV charging, the U.S. network remains fragmented. Today, nearly all U.S. PEV manufacturers equip their new battery-electric vehicles (BEVs) with DC charging inlets compatible with the SAE standard Type 1 Combined Charging System (CCS-1). Tesla, the largest PEV manufacturer in the U.S. and operator of the largest U.S. DC charging network,[11] does not follow this standard. Tesla BEVs sold in the U.S. have historically been equipped with a proprietary inlet type exclusive to Tesla with compatible DC chargers available through the Tesla Supercharger network.

However, Tesla has recently taken steps to open their charging network. In a November 2022 release, Tesla announced they are opening their connector design to other charging providers and vehicles manufacturers (Tesla 2022). Tesla's North American Charging Specification (NACS) is currently available at select third-party charging stations, including some locations on EVgo's network (EVgo 2023). Tesla has also recently taken steps to open their Supercharger network to other vehicles (Tesla 2023). A small number of Superchargers in New York and California have recently been retrofitted to support charging vehicles with CCS-1 inlets relying on activation through the Tesla mobile app. Tesla has announced plans to make 7,500 chargers publicly accessible to non-Tesla PEVs by the end of 2024 (including 3,500 Superchargers) (The White House 2023). Finally, Tesla has recently reached agreements that will soon give all Ford and

[10] While interoperability related to connector compatibility is discussed in the body of the report, interoperability of competing charging networks to allow for roaming is another important dimension. Absence of network-to-network interoperability forces drivers to maintain multiple sets of apps and credentials in order to access individual charging networks (a substandard experience relative to the convenience of legacy fueling infrastructure).

[11] As of March 2023.

General Motors customers access to the majority of Tesla's North American Supercharger network via adapters, with new Ford and General Motors BEVs being equipped with NACS inlets starting in 2025 (Ford Motor Company 2023; General Motors 2023).

The U.S. L2 network also remains fragmented, but to a lesser extent. There are two L2 connectors used in the United States: the SAE J1772 connector (used by all PEV manufacturers except Tesla) and the Tesla NACS connector. The NACS connector is natively only compatible with Tesla vehicles; however, an adapter is available that allows Tesla vehicles to charge using J1772 connectors. L2 NACS connectors are currently available as part of Tesla's network of Destination Chargers and account for 12% of all publicly accessible L2 charging ports.

Despite the fragmented nature of today's charging ecosystem, this analysis makes no attempt to develop charging infrastructure scenarios by connector. Such scenarios would require estimating future market shares and corporate strategies for different light-duty PEV manufacturers to project the future interoperability of charging networks, which is beyond the purview of this analysis. The remainder of this report will not address interoperability challenges or fragmentation between connector types. Additional information on PEV charging infrastructure trends can be found on DOE's Alternative Fuels Data Center (2023b).

1.2. Recent Charging Infrastructure Investment and Analysis Studies

Significant investments are being made in U.S. charging infrastructure for PEVs. At the forefront of these investments is the federal government's commitment to invest up to $7.5 billion into publicly accessible PEV charging infrastructure through the Bipartisan Infrastructure Law. This consists of the $5.0-billion National Electric Vehicle Infrastructure (NEVI) Formula Program administered by the U.S. Department of Transportation through the states, District of Columbia, and Puerto Rico and the $2.5-billion Charging and Fueling Infrastructure Discretionary Grant Program being administered through the U.S. Department of Transportation (the latter including eligibility for all alternative fuel infrastructure). An additional $3.0 billion in public investment has been made across all levels of government, led by programs from the state of California.

Atlas Public Policy's EV Hub tracks domestic investments in PEV charging infrastructure. As of April 1, 2023, EV Hub reports a cumulative total of $11.2 billion in charging infrastructure announcements from the private sector, led by companies including Tesla, Electrify America, BP, General Motors, Daimler, and Mercedes. This excludes an estimated $3.0 billion in capital raised by charging companies (including ChargePoint, EVgo, Blink, and Volta), some percentage of which is expected to be invested in EVSE hardware and installation. EV Hub reports an additional $2.0 billion in approved utility filings, led by utilities including Southern California Edison, Consolidated Edison, and Pacific Gas & Electric.

As of March 2023, we estimate $23.7 billion has been announced for publicly accessible light-duty PEV charging infrastructure through the end of the decade.[12] Importantly, this estimate excludes financial incentives to deploy charging infrastructure through a variety of programs,

[12] While based on data provided by Atlas Public Policy, NREL's estimate deviates from a recent Atlas Public Policy assessment (Nigro 2023), which reports cumulative U.S. public charging infrastructure funding at $19.9 billion. This discrepancy is primarily due to NREL's inclusion of funding assumed to primarily (though not exclusively) support deployment of public charging infrastructure (most notably the Charging and Fueling Infrastructure Discretionary Grant Program, which includes eligibility for all alternative fuel infrastructure).

including from the Inflation Reduction Act and the Low Carbon Fuel Standard in place in California, Oregon, and Washington. While these incentives are significant and will ultimately extend the reach of announced investments, their value is dependent on factors outside the purview of this analysis and are thus excluded from this report's estimate of announced charging infrastructure investments.

At least four existing studies have attempted to estimate the national charging infrastructure investment need for light-duty PEVs. The International Council on Clean Transportation's (ICCT's) 2021 white paper "Charging Up America: Assessing the Growing Need for U.S. Charging Infrastructure Through 2030" estimates that 26 million light-duty PEVs would require a total of 2.4 million workplace and public charging ports (Bauer et al. 2021). This results in an estimated $28-billion investment for nonresidential charging infrastructure (including installation labor costs but excluding utility upgrades). When accounting for private-access charging at single-family and multifamily residences (estimated at $20.5 billion), ICCT finds a total of $48.5 billion in cumulative investment will be needed by the end of the decade.

Atlas Public Policy's 2021 *U.S. Passenger Vehicle Electrification Infrastructure Assessment* examined the charging infrastructure investment necessary through 2030 to put the United States on a path to 100% light-duty PEV sales by 2035 (McKenzie and Nigro 2021). Atlas finds that $39 billion in public charging infrastructure will be necessary by 2030 (including installation labor costs but excluding utility upgrades). When accounting for private-access charging at single-family and multifamily residences and private depot charging, Atlas finds a total need of $87 billion in cumulative investment by 2030.

McKinsey & Company's 2022 article "Building the electric-vehicle charging infrastructure America needs" examines a scenario with 50% of LDV sales as PEVs by 2030 (Kampshoff et al. 2022). This analysis estimates 1.2 million public chargers and 28 million private chargers will be necessary by 2030 (a 20x increase over today's network).

S&P Global Mobility's 2023 report *EV Chargers: How many do we need?* finds that U.S. PEV charging infrastructure will need to quadruple by 2025 and grow by a factor of 8 by 2030 (S&P Global Mobility 2023). Assuming 28 million PEVs on the road by 2030, this report estimates 2.13 million Level 2 and 172,000 DC chargers in public locations will be necessary. These estimates are in addition to privately accessible residential chargers.

These findings are all consistent in showing that continued investment in U.S. charging infrastructure is necessary to support the electrification of the light-duty fleet. A comparison of these findings with this report is included in the discussion section.

1.3. Equity Considerations

Equitable deployment of charging infrastructure for all populations is of critical importance as investments accelerate. This analysis indirectly addresses equitable infrastructure deployment by considering the needs of individuals without reliable access to residential charging, drivers for ride-hailing platforms, and (in some cases) ride-hailing drivers without access to residential charging. These individuals are more likely to be from low-income households, renters, and those without access to off-street parking. As discussed later in this report, charging infrastructure supporting these populations is explicitly considered in this study.

A broader set of analytic tools that directly address equitable charging infrastructure deployment is being developed by the Joint Office United Support for Transportation (JUST) Lab Consortium with leadership from Argonne National Laboratory, Lawrence Berkeley National Laboratory, and NREL (Joint Office of Energy and Transportation 2023). The JUST Lab Consortium is conducting actionable research on integrating equity into federally funded PEV infrastructure deployment efforts. This consortium builds on prior efforts at each lab that have developed foundational capabilities, including launch of an Electric Vehicle Charging Justice40 Map (Argonne National Laboratory 2022), application of geospatial analysis to prioritize charging deployments for underserved communities (Zhou et al. 2022), and development of the Electric Vehicle Infrastructure for Equity (EVI-Equity) model for quantifying equity metrics of proposed charging network designs (Lee et al. 2022). Embedding these tools within the national framework presented in this report is a key objective for future research.

1.4. Report Motivation and Structure

This report is being published at a unique time in the evolution of the national charging network. In September 2022, the U.S. Department of Transportation, in consultation and coordination with the new Joint Office, approved Year 1 NEVI plans for all 50 states (plus Washington, D.C., and Puerto Rico) as part of a $5-billion investment funded by the Bipartisan Infrastructure Law (U.S. Department of Transportation 2022). In March 2023, the U.S. Department of Transportation opened applications for the first round of funding under the $2.5-billion Charging and Fueling Infrastructure Discretionary Grant Program, also funded by the Bipartisan Infrastructure Law (U.S. Department of Transportation 2023). In the private sector, Tesla continues its trajectory of expanding the country's largest DC network (including opening some Superchargers to non-Tesla vehicles), Electrify America is halfway through its 10-year, $2-billion mandatory investment period, and many other charging networks are entering the market and expanding their footprint.

Amidst these ongoing investments, this work aims to provide a shared point of reference for the near-term (through 2030) charging infrastructure needs of U.S. light-duty PEVs. Given the broad coalition of stakeholders dependent on and investing in charging infrastructure (including automotive manufacturers, charging network providers, electric utilities, and governments at every level), a public document of this nature can serve as a common reference for the industry.

The remainder of this report describes the integrated approach used for estimating needs of multiple LDV use cases (including typical driving needs, long-distance travel, and ride-hailing electrification), introduces and justifies modeling assumptions, describes potential alternate futures, and presents results over time at various levels of geographic resolution.

2. An Integrated Approach for Multiple LDV Use Cases

This report builds on the foundation of years of research and collaboration at NREL and beyond. Several recent analytic works serve as the basis for this study and will be referenced throughout the remainder of the report (see Table 1). The building blocks of this report include development and ongoing refinement of models used to estimate charging infrastructure needs for light-duty PEVs in multiple use cases.

The core tools used in this study are:

- EVI-Pro: For typical daily charging needs
- EVI-RoadTrip: For fast charging along highways supporting long-distance travel
- EVI-OnDemand: For electrification of transportation network companies (TNCs).

Each of these models is described in more detail in Section 2.1.

In addition to modeling tools, several assumptions must be made to define vehicle use scenarios and estimate the corresponding charging demands. These include scenario-specific assumptions on vehicle adoption (number of PEVs with regional variation), fleet composition (PEV chassis types and preference for BEVs/plug-in hybrid electric vehicles [PHEVs]), technology attributes (e.g., vehicle efficiency/range, charging efficiency/speed), and driving/charging behavior. A key determinant of charging behavior—particularly the demand for public charging—is the share of PEV owners able to access charging at their primary residence. Home charging is typically the most convenient and affordable charging location for those that have access, but many do not—as discussed at length by Ge et al. (2021). Assumptions for each of these “demand-side” considerations are discussed in Section 2.2.

This section concludes by establishing charging network terminology (with help from DOE’s Alternative Fuels Data Center) and proposes a new charging infrastructure taxonomy that explicitly decouples location type (e.g., home, work, retail) from access type (e.g., public, private). Finally, real-world observations of public charging utilization (Borlaug et al. 2023) and installed cost (Borlaug et al. 2020) are presented as “supply-side” considerations in Section 2.3.

Table 1. Foundational Studies Underlying National Analysis

Citation	Title	Venue	Technical Contribution
Wood et al. 2017	National Plug-In Electric Vehicle Infrastructure Analysis	DOE Office of Energy Efficiency and Renewable Energy technical report	Introduced coverage vs. capacity concept; first national instance of EVI-Pro
Wood et al. 2018	Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio	NREL technical report	Initial use of large-scale telematics data within EVI-Pro
Moniot, Rames, and Wood 2019	Meeting 2025 Zero Emission Vehicle Goals: An Assessment of Electric Vehicle Charging Infrastructure in Maryland	NREL technical report	Piloted use of EVI-Pro for scenarios with low levels of residential access
Borlaug et al. 2020	Levelized Cost of Charging Electric Vehicles in the United States	*Joule* article	Compiled public data on installed cost of charging (updated on rolling basis)
Alexander et al. 2021	Assembly Bill 2127: Electric Vehicle Charging Infrastructure Assessment: Analyzing Charging Needs to Support Zero-Emission Vehicles in 2030	California Energy Commission report	Revised EVI-Pro methodology to account for emerging charging behavior observations and implemented demand-based network sizing; introduced EVI-RoadTrip for corridor-based analysis
Ge et al. 2021	There's No Place Like Home: Residential Parking, Electrical Access, and Implications for the Future of Electric Vehicle Charging Infrastructure	NREL technical report	Collected novel survey data on residential parking and electrical access; proposed likely adopter model for estimating evolution of residential access as a function of PEV fleet size
Moniot, Ge, and Wood 2022	Estimating Fast Charging Infrastructure Requirements to Fully Electrify Ride-Hailing Fleets Across the United States	*IEEE Transactions on Transportation Electrification* article	Developed and applied EVI-OnDemand model for quantifying national infrastructure needs of ride-hailing electrification
Alexander and Lee 2023	California Electric Vehicle Infrastructure for Road Trips: Direct Current Fast Charging Needs to Enable Interregional Long-Distance Travel for Electric Vehicles	California Energy Commission staff report, forthcoming	Technical documentation for EVI-RoadTrip methodology
Borlaug et al. 2023	Public Electric Vehicle Charging Station Utilization in the United States	*Transportation Research Part D: Transport and Environment* article	Quantitative analysis of real-world infrastructure utilization; used as basis for network sizing approach

2.1. Modeling Philosophy and Simulation Pipeline

The core tools used in this study are EVI-Pro (for typical daily charging needs), EVI-RoadTrip (for fast charging along highways supporting long-distance travel), and EVI-OnDemand (for ride-hailing electrification). The development and application of individual models dedicated to specific use cases provides at least two benefits: (1) increased modularity maximizes the flexibility in our modeling; namely, models may be combined or run in isolation (where appropriate), as demonstrated in many of the studies listed in Table 1; and (2) each model can be tailored to the unique driving and charging behaviors of their associated use case. The models used in this study are a subset of the larger EVI-X modeling suite maintained by NREL for network planning, site design, and financial analysis across light-, medium-, and heavy-duty vehicles (National Renewable Energy Laboratory 2023).

LDV use cases vary widely and have unique infrastructure requirements that must be accommodated to facilitate a seamless transition to PEVs. Typical daily use of LDVs tends to be characterized by short trips with long dwell periods (e.g., 70% of daily driving under 40 miles and 95% under 100 miles with vehicles typically parked 95% of their lifetime). These periods present ample opportunities for destination charging (most notably at home and workplace locations) that is "right-speeded" to match typical dwell times. EVI-Pro assumes such an opportunistic approach to charging, attempting to make use of low-cost destination charging where convenient and rely on fast charging only when necessary.[13]

In contrast, the use of PEVs for long-distance travel and in ride-hailing applications requires that they can pull over in convenient locations and charge quickly to either resume a road trip or return to service. EVI-RoadTrip and EVI-OnDemand both employ this charging behavior philosophy but rely on distinct data sets to describe the geographic footprint of long-distance vs. ride-hailing travel patterns. Long-distance travel requires a network of fast charging stations along highways (including urban and rural areas that these highways pass through), while ride-hailing electrification necessitates access to fast charging within the urban areas where such services are most common (such as near urban centers and airport locations). Additional details of each model will be discussed in the following subsections of this report.

Each of these individual models is integrated into a shared simulation pipeline, as shown in Figure 1. Models are provided with a self-consistent set of exogenous inputs that prescribe the size, composition, and geographic distribution of the national PEV fleet; technology attributes of vehicles and charging infrastructure; assumed levels of residential/overnight charging access; and regional environmental conditions. Each model uses these inputs in bottom-up simulations of charging behavior by superimposing the use of a PEV over travel data from internal combustion engine vehicles. By relying on historical travel data from conventional vehicles, these models implicitly design infrastructure networks capable of making PEVs a one-to-one

[13] EVI-Pro assumes fast charging as being necessary only when long dwell time opportunities to charge slowly are not present in the detailed driving pattern data sets used as inputs. In reality, charging preferences will be dictated by myriad conditions that are challenging to anticipate in a model. For this reason, EVI-Pro has been configured in this analysis to simulate a minority of BEV drivers (10%) as preferring fast charging over slower alternatives, including opportunities to charge at home. The size of this behavior cohort is believed to be consistent with the limited set of real-world charging behavior observations available in the literature. BEV manufacturers are arguably in the best position to observe actual charging behavior in the field and are encouraged to consider publishing aggregated charging behavior statistics to inform the efficient deployment of charging infrastructure.

replacement for internal combustion engine vehicles, effectively minimizing impacts to existing driving behavior and identifying the most convenient network of charging infrastructure capable of meeting driver needs.

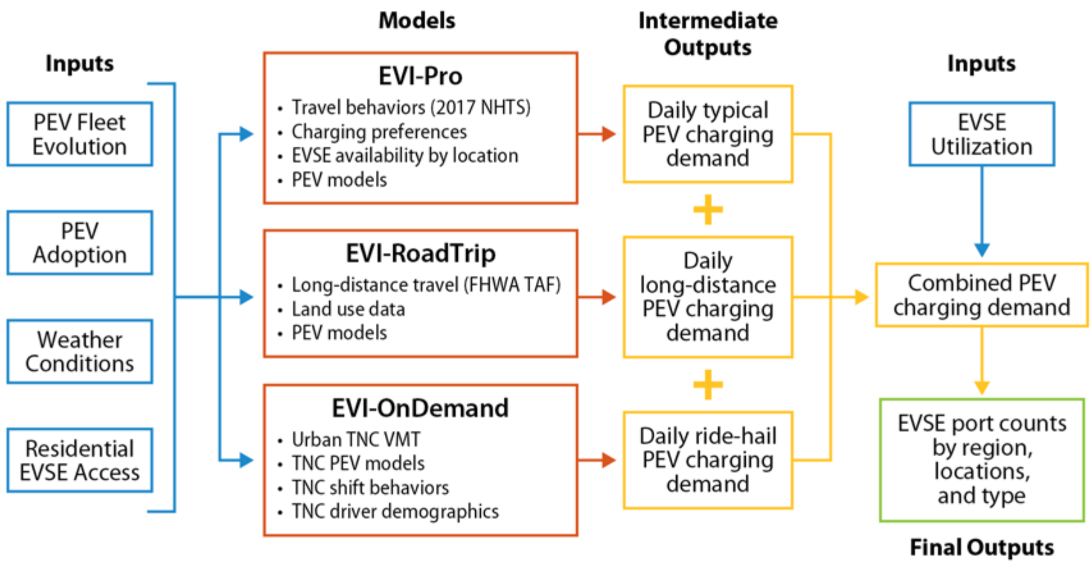

Figure 1. Shared simulation pipeline integrating EVI-Pro, EVI-RoadTrip, and EVI-OnDemand

The independent (but coordinated) simulations produce a set of intermediate outputs estimating daily charging demands for typical PEV use, long-distance travel, and ride-hailing electrification. These intermediate outputs are indexed in time (hourly over a representative 24-hour period) and space (core-based statistical area [CBSA] or county level) such that they can be aggregated into a composite set of charging demands across multiple use cases. Once combined, the peak hour for every combination of charging type (e.g., Level 1 [L1], L2, DC), location type (e.g., home, work, retail), and geography (e.g., CBSA) is identified for the purpose of network sizing. Rather than sizing the simulated charging network to precisely meet the peak hourly demand in all situations, the simulation pipeline uses an assumed networkwide utilization rate in the peak hour to "oversize" the network by some margin. This sizing margin accounts for the fact that charging demand tends to vary seasonally and around holidays. As the EVI-X modeling ensemble simulates demand on a typical day, the network sizing approach attempts to account for periods of peak demand, which could far exceed what is experienced on a typical day. This margin is calibrated based on analysis of real-world utilization data, as described later in this section.

The resulting final output of the pipeline is a set of charging infrastructure port counts by region, location type, and charging type that can be aggregated up to the national level or reported out for individual states or CBSAs. The remainder of Section 2.1 will be used to briefly describe the simulation models and data used as the justification for future utilization assumptions.

2.1.1. EVI-Pro: Charging Demands for Daily Travel

EVI-Pro is a tool for projecting consumer demand for PEV charging infrastructure under typical daily conditions. EVI-Pro uses detailed data on personal vehicle travel patterns, vehicle attributes, and charging station characteristics in bottom-up simulations to estimate the quantity and type of charging infrastructure necessary to support regional adoption of PEVs. A block diagram of data flows within EVI-Pro is shown in Figure 2. EVI-Pro has been used in multiple detailed planning studies including Wood et al. (2017, 2018), Moniot et al. (2019), and Alexander et al. (2021).

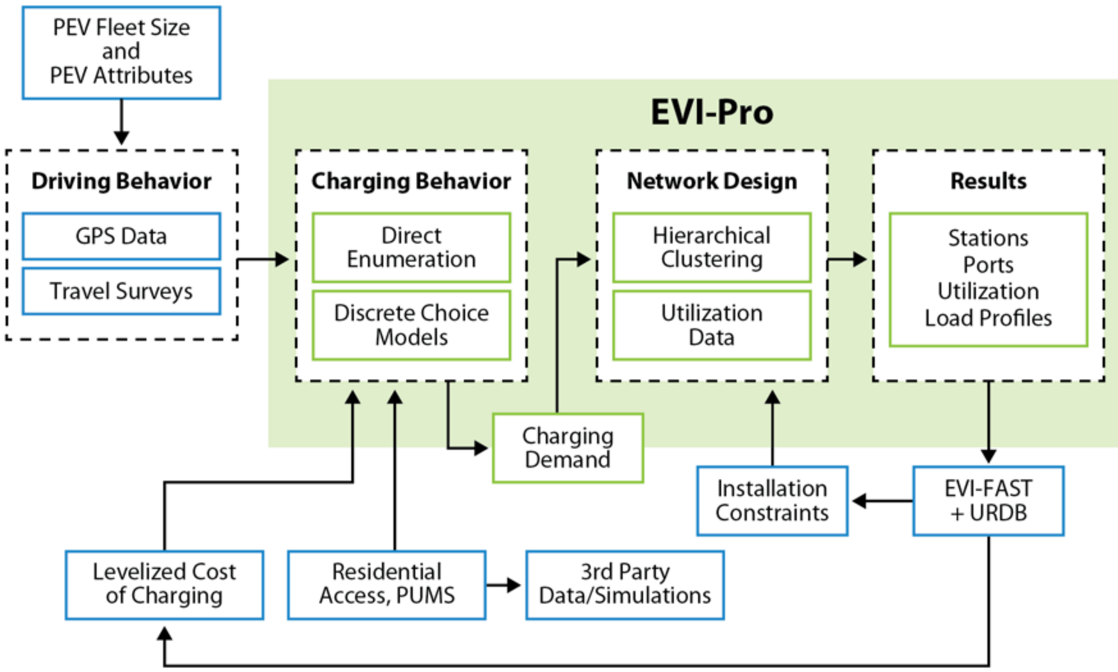

Figure 2. EVI-Pro block diagram for charging behavior simulations and network design

2.1.2. EVI-RoadTrip: Charging Demands for Long-Distance Travel

EVI-RoadTrip projects the amount and locations of DC charging infrastructure needed for BEVs' long-distance travel needs (i.e., >100 miles). This model addresses an under-researched but increasingly important use case for vehicle electrification: long-distance road trips. A fast charging network connecting regions across the nation is critical to accelerate the transition to electric vehicles (EVs) by enabling timely interregional travel and reducing range anxiety. The model follows three key steps within the context of this analysis (as shown in Figure 3): trip data generation, driving/charging simulation, and station siting/sizing. The model simulates interregional road trips by BEVs (including across state lines), estimates energy use and charging demand along the road trip routes, calculates geographic clusters of charging demand, and simulates the existence of charging stations to serve those clusters, typically locating them in locations zoned for retail activity. EVI-RoadTrip was introduced by Alexander et al. (2021) and is documented in Alexander et al. (2023).

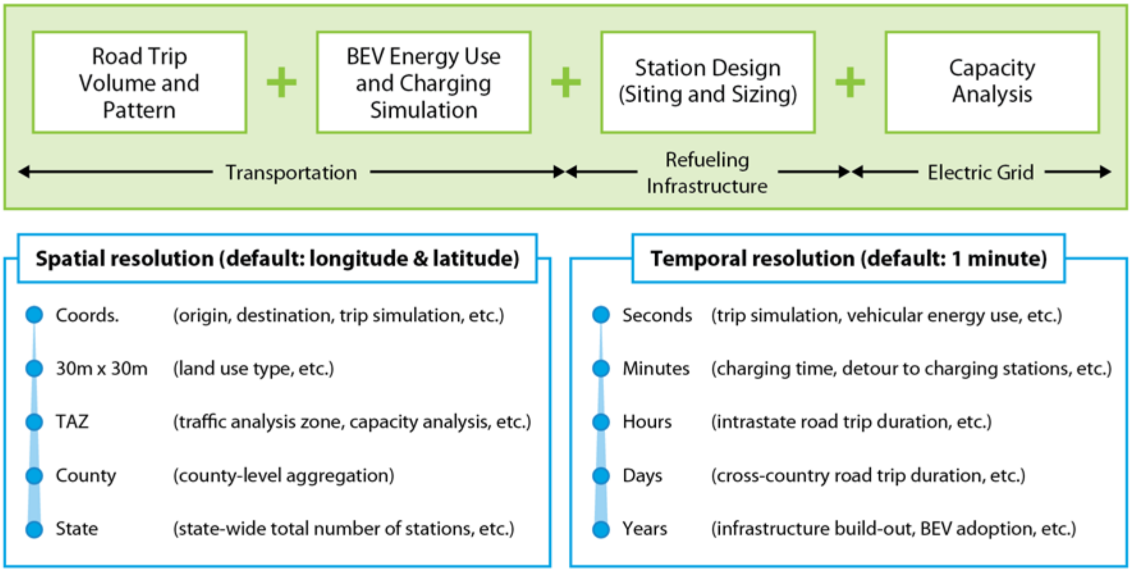

Figure 3. EVI-RoadTrip block diagram for traffic generation, charging behavior simulations, and network design

2.1.3. EVI-OnDemand: Charging Demands for Ride-Hailing PEVs

The charging demands from ride-hailing fleets are given unique attention within this study given the aggressive rate of fleet electrification pledged by major ride-hailing companies (Uber 2020; Lyft 2020) and the likely reliance on public infrastructure for many of these ride-hailing vehicles (Jenn 2020; Moniot et al. 2022). Further, ride-hailing vehicles operate distinctly from vehicles used for personal travel and are not comprehensively characterized in travel surveys. These factors motivated the use of EVI-OnDemand for estimating ride-hailing charging demand.

EVI-OnDemand simulates ride-hailing fleets operating in urban areas in a spatially implicit manner given the lack of data made available by prominent ride-hailing companies. The model estimates charging infrastructure necessary to support all-electric ride-hailing fleets with market shares consistent with present-day operations. Fleetwide charging demand for each geography is obtained through repeated simulations of heterogeneous drivers, until the total mileage across all drivers matches the projected total within the urban area being evaluated. As shown in Figure 4, drivers are uniquely modeled based on probabilistic sampling of driver shift length and the likelihood of overnight charging access. These factors influence the demand for fast charging mid-shift, modeled as time-sensitive en route charging. For instance, drivers with short shifts and access to overnight charging are unlikely to require access to fast charging infrastructure. In contrast, drivers with longer shifts and no access to overnight charging will depend more heavily on public-access DC charging. The model also considers local driving speeds and ambient conditions to produce plausible energy consumption rates while drivers are on shift.

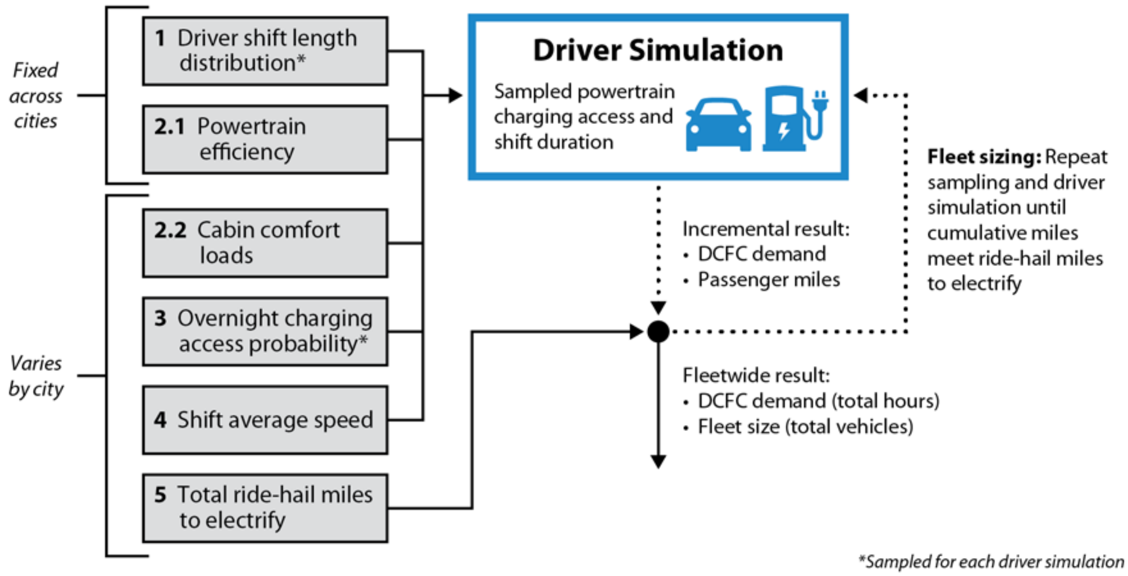

Figure 4. EVI-OnDemand block diagram for driver simulations and related assumptions

The key output from EVI-OnDemand for this study is the aggregate fleetwide demand for DC charging by city to support drivers mid-shift when needed. The aggregate demand for DC charging is disaggregated by time of day by leveraging emerging empirical data in the literature characterizing when ride-hailing vehicles frequent DC chargers (Jenn 2020). Additional documentation of the EVI-OnDemand simulation model can be found in Moniot, Ge, and Wood (2022) and the model source code (GitHub 2023).

2.1.4. Utilization-Based Network Sizing

Following independent use case simulations, charging demand from each model is aggregated in time and space to form a composite estimate of demand for each geography. The peak hourly demand from the composite profile is used to size each component of the network, represented as a combination of location type and charger type (e.g., public office L2, public retail 150-kW DC). This process is conceptually illustrated in Figure 5.

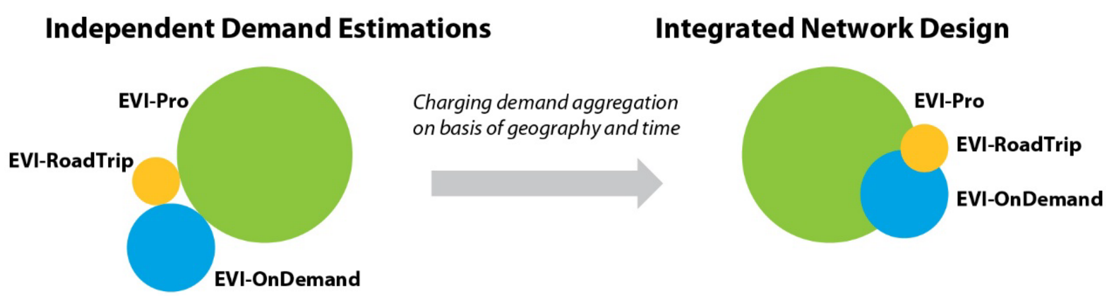

Figure 5. Conceptual diagram illustrating independent demand estimations, demand aggregation, and integrated network design

Demand aggregation allows for the resultant simulated charging network to incorporate resource sharing across different use cases, as is common in the real world (e.g., ride-hailing PEVs charging alongside road trippers or employees charging alongside shoppers). This effectively reduces the modeled network requirements when contrasted with a counterfactual where the network is synthesized for each use case independently and then summed, since the spatiotemporal charging demands for the different use cases may not necessarily align. An example of this occurrence is shown in Figure 6 for a simulated fast charging network in an illustrative region.

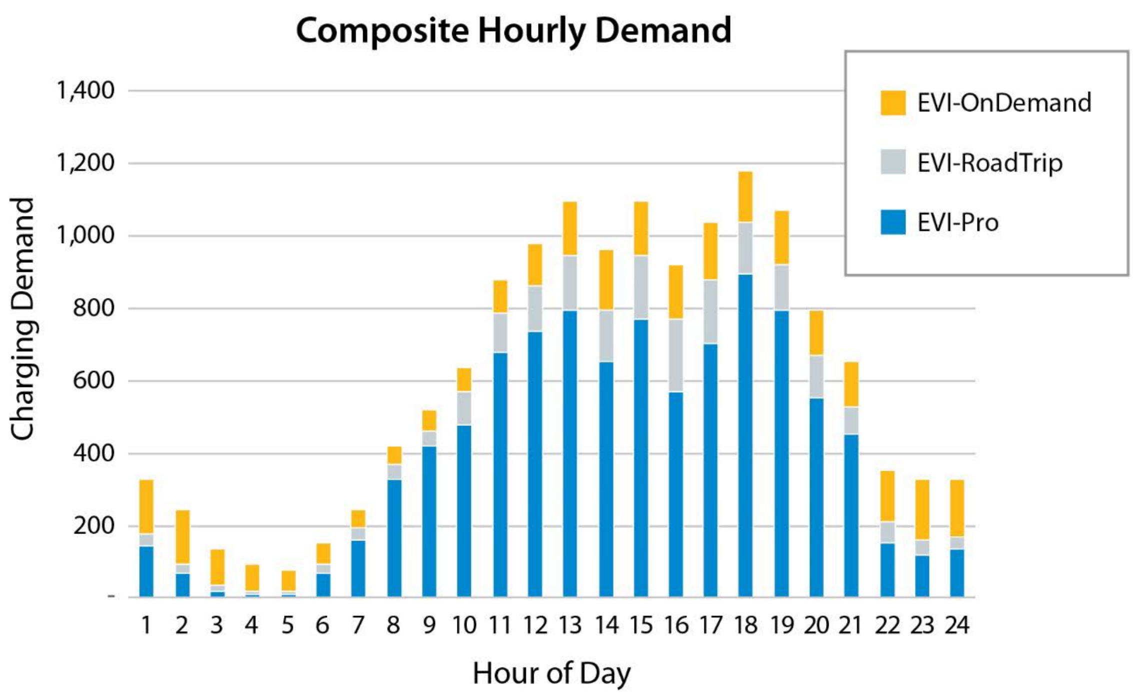

Figure 6. Composite hourly demand for DC charging by use case for an illustrative region

2.2. Demand-Side Considerations: Defining PEV Use Case Scenarios

Several input parameters must be specified and synchronized across the three EVI-X models used in this report to estimate comprehensive charging infrastructure needs for light-duty PEVs in the United States by 2030. This study considers multiple PEV use case scenarios relying on "demand-side" input assumptions, including fleet size, geographic distribution, vehicle and infrastructure technology attributes, residential charging access, and driving/charging behavior. To assess potential futures, a baseline scenario is first presented using demand-side assumptions shown in Table 2. Plausible alternatives to the baseline scenario are explored using parametric sensitivity analysis as defined by Table 3. These scenarios are not intended to be exhaustive in terms of the potential evolution pathways for the national charging network of 2030, but rather informative of the impacts of various considerations that will be important for charging infrastructure stakeholders to consider.

Table 2. Demand-Side Assumptions Used in the Mid-Adoption Scenario

Modeling Parameter	2030 Nominal Assumption
PEV fleet size (LDV only)	33 million (2.7 million registered as of 2022)
PEV powertrain shares	BEV = 90% (2022: 72%) PHEV = 10% (2022: 28%)
PEV body type distribution	Sedan = 24% (2022: 58%) C/SUV = 56% (2022: 40%) Pickup = 17% (2022: 0%) Van = 3% (2022: 2%)
Average PEV electric range (model year 2030)	BEV = 280 miles PHEV = 45 miles
BEV minimum DC charge time (model year 2030; 20%–80% state of charge [SOC])	20 minutes [a]
Maximum DC power rating (per port)	350+ kW
Geographical distribution	Scaled proportional to existing PEV and gasoline-hybrid registrations with a ceiling of 35% of LDVs on the road in 2030 as PEVs in high adoption areas and a floor of 3% in low adoption areas
PEVs with reliable access to residential charging	90%
Weather conditions	Typical ambient conditions are used for each simulated region, impacting electric range accordingly
Driving behavior	EVI-Pro: Consistent with Federal Highway Administration (FHWA) 2017 National Household Travel Survey (NHTS) EVI-RoadTrip: Directly applies FHWA Traveler Analysis Framework (TAF) EVI-On Demand: Consistent with Balding et al. (2019)
Charging behavior	All models attempt to maximize use of home charging (when available) and utilize charging away from home only as necessary. When fast charging is necessary, BEVs prefer the fastest option compatible with their vehicle, up to 350+ kW.

[a] Tesla recently reported an average charge duration of 27.5 minutes on their Supercharger network (Kane 2023), and a median duration of 36 minutes has been calculated from public 50-kW DC chargers as part of the EV WATTS program (Energetics 2023). These estimates are provided as context for the 2030 modeling assumption, despite the fact neither statistic necessarily aligns with 20%–80% SOC events in all cases.

Table 3. Description of Select Plausible Alternates to the Baseline Scenario

Scenario	Description
High Adoption	PEV fleet size growth to 42 million PEVs on the road by 2030 (baseline: 33 million PEVs by 2030)
Low Adoption	PEV fleet size growth to 30 million PEVs on the road by 2030 (baseline: 33 million PEVs by 2030)
Low Home Charging Access	Assumes 85% of PEV drivers with residential access based on the "existing electrical access" scenario from Ge et. al (2021) (baseline: 90% residential access)
High Home Charging Access	Assumes 98% of PEV drivers with residential access based on the "potential electrical access" scenario from Ge et. al (2021) (baseline: 90% residential access)
Reduced Daily Travel	PEVs are driven 60% of days, 25% less than the baseline (80% of days)
Bad Charging Etiquette	PEVs are not unplugged during public destination L2 charging until the driver's activity at the destination is complete and the vehicle departs (baseline: PEVs are capable of being unplugged when they are finished charging and made available for another PEV)
PHEV Success	PHEVs retain 2022 PEV market share (28%) through 2030 (baseline: PHEVs have 10% PEV market share in 2030)
Alternate PEV Adoption	PEV adoption is geographically uniform in 2030 with no urban early adopter preference (baseline: geographic distribution of PEVs in 2030 reflects 2022 distribution of PEVs and hybrid electric vehicles)
Extreme Weather	EVSE network designed for extreme (95th percentile) weather conditions affecting PEV range and increasing charging demand (baseline: EVSE network designed for average weather conditions)
Slow TNC Electrification	TNC fleets are only 50% PEVs by 2030 (baseline: 100% TNC PEVs by 2030)
Private Workplace Charging	100% of workplace charging at private EVSE through 2030 (baseline: 100% in 2022, decreasing to 50% by 2030)

The remainder of this subsection reviews demand-side assumptions in greater detail, including assumptions for fleet size/composition, technology attributes, residential charging access, and driving/charging behavior.

2.2.1. PEV Adoption and Fleet Composition

National PEV adoption scenarios were developed using NREL's Transportation Energy & Mobility Pathway Options (TEMPO) model, an all-inclusive transportation demand model that covers the entire United States (Muratori et al. 2021). This study examines three TEMPO PEV adoption scenarios (shown in Figure 7), each of which implicitly assumes the shape of the sales curve between 2022 and 2030. The low adoption scenario assumes 30 million light-duty PEVs on the road by 2030 (correlating with 43% of light-duty sales as PEVs by 2030); the mid-adoption scenario assumes 33 million (correlating with 50% of sales); and the high adoption scenario assumes 42 million (correlating with 68% of sales). This report's baseline scenario uses the mid-adoption national fleet size scenario of 33 million light-duty PEVs on the road by 2030.

The TEMPO PEV adoption scenarios are largely consistent with scenarios developed as part of infrastructure analysis studies conducted by ICCT, Atlas Public Policy, McKinsey & Company, and S&P Global Mobility (as described in Section 1.2). These studies consider national 2030 PEV fleet sizes between 26 and 48 million.

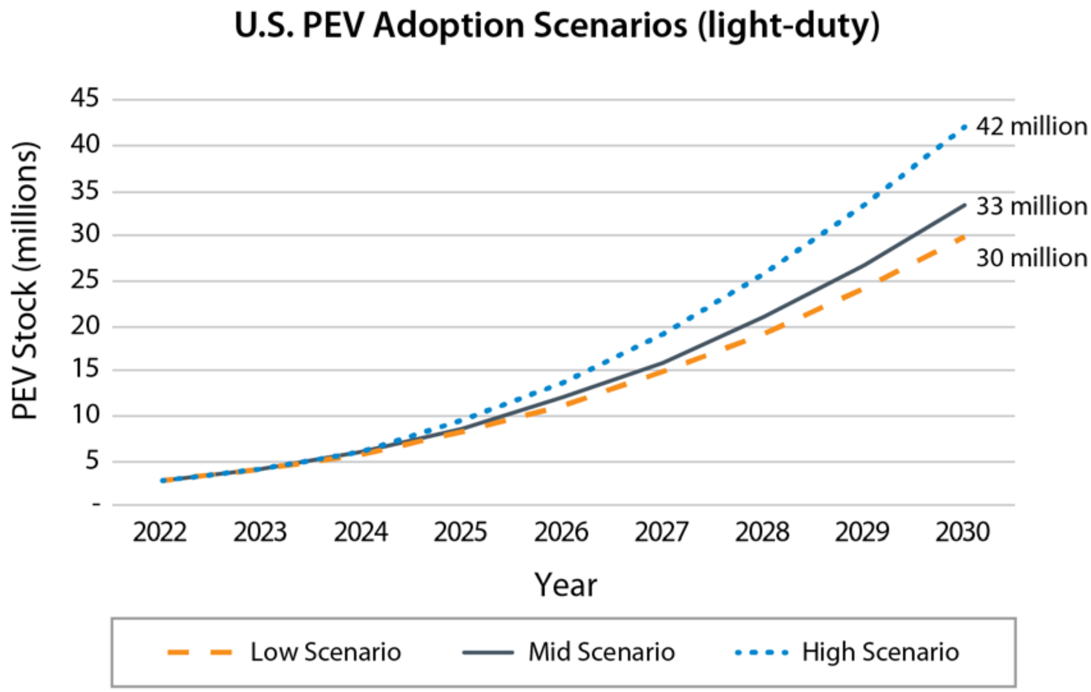

Figure 7. U.S. national light-duty PEV stock under three adoption scenarios

As of 2022, PHEVs accounted for 28% of total PEV stock. Recent sales trends and manufacturer announcements suggest the industry is trending toward increased shares of BEVs. The baseline scenario assumes 90% of 2030 PEVs are BEVs, with the remainder of the PEV fleet consisting of PHEVs. The "PHEV Success" scenario is provided to consider potential impacts to the national charging network resulting from PHEVs holding constant at 28% of the growing PEV fleet.

Regarding body type, PEV sales to date have been dominated by sedans, accounting for 58% of all PEV registrations in 2022. However, this trend is expected to shift in coming years as the supply of C/SUV and pickup PEVs increases. The baseline scenario assumes the 2030 PEV fleet mirrors the body type distribution of new (<2 years old) vehicle registrations in 2022 with 24% sedan, 56% C/SUV, 17% pickup, and 3% van.

The spatial distribution of the 2030 PEV fleet is assumed to be proportional to existing PEV and gasoline-hybrid registrations. As visualized in Figure 8, this approach results in the greatest PEV adoption occurring in urban areas with up to 35% of LDVs on the road as PEVs in 2030, and the lowest levels of PEV adoption in the rural areas with as low as 3% of LDVs on the road as PEVs in 2030. This assumption is tested using the "Alternate PEV Adoption" scenario, in which PEV adoption in 2030 is assumed uniform across all states and CBSAs. While this alternate adoption scenario is not intended as a projection, it is useful in illustrating the impact of more homogeneous PEV adoption across urban and rural areas.

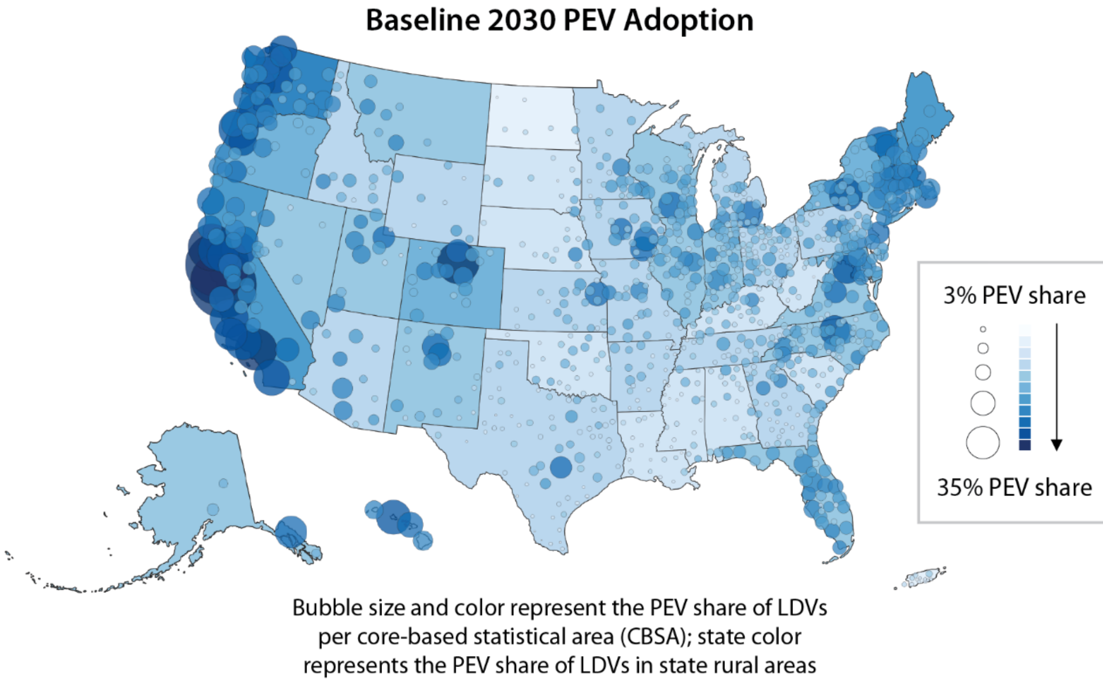

Figure 8. Assumed spatial distribution of 33 million PEVs in 2030 by CBSA and state

In addition to modeling regional preferences for PEVs, the baseline scenario also considers regional preferences for body types, as shown in Figure 9. Using 2022 LDV registration data, we find that:

- Sedans tend to be most popular in urban areas and rural parts of the Southeast.
- C/SUVs tend to be most popular in Colorado, Michigan, and the Northeast.
- Pickups tend to be most popular in rural areas west of the Mississippi River.
- Vans tend to be most popular in urban and rural areas around the Great Lakes.

These trends are reflected in the adoption scenarios, with the 2030 PEV fleet disaggregated independently by body type using regional preferences reflected in the 2022 LDV registration data for all fuel types.

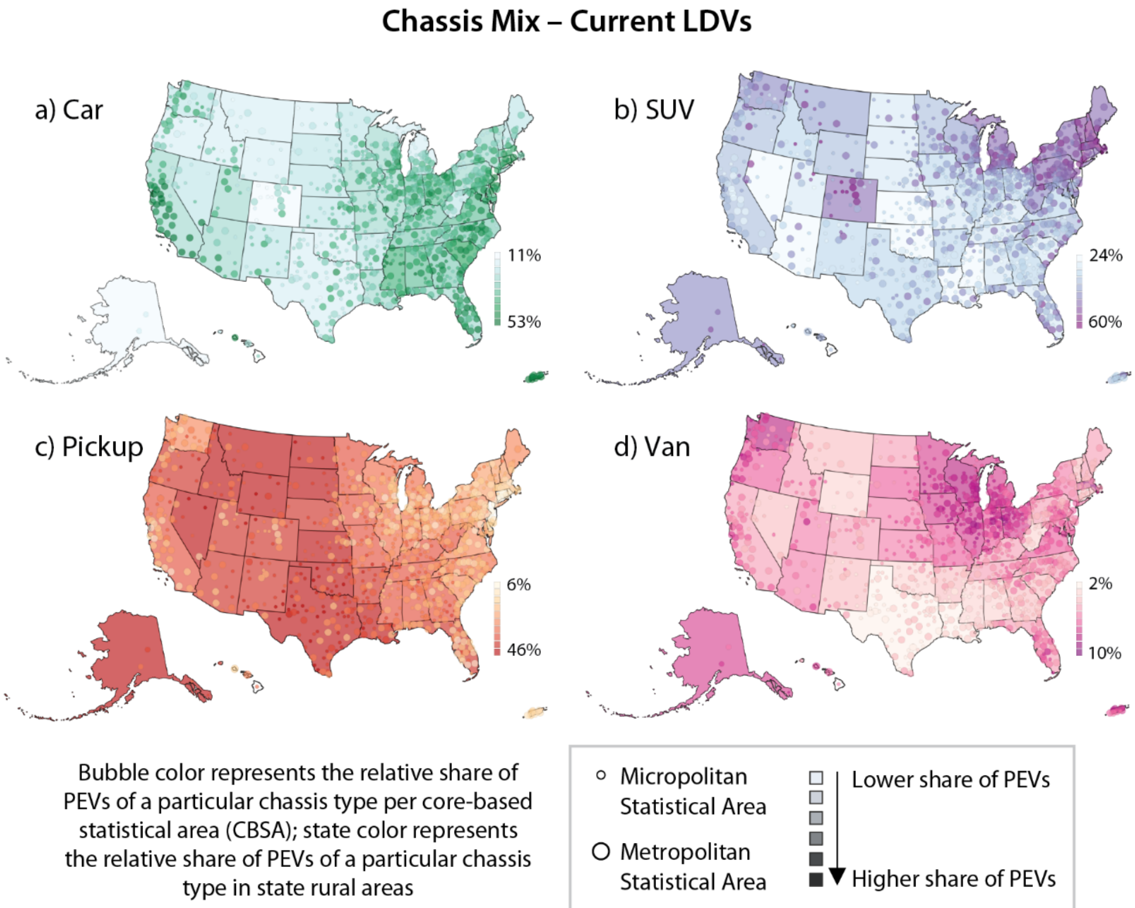

Figure 9. Spatial distribution of new (2019–2022) LDV registrations by body type.

Source: Experian LDV registrations

2.2.2. PEV Technology Attributes

Eight PEV types are represented in this study, resulting from the combination of two powertrain types (BEV and PHEV) and four body types (sedan, C/SUV, pickup, and van). Each PEV type includes up to three vintages, referred to as model year groups. The 2020 model year group is meant to capture PEVs sold up to 2020, the 2025 model year group captures PEVs sold between 2021–2025, and the 2030 model year group captures 2026–2030. While the actual PEV market is far more diverse than this simple representation, the vehicles used in this study are meant to serve as exemplars of the larger market and believed to provide a sufficient level of detail for analysis of 2030 charging infrastructure needs. Table 4 provides a summary of vehicle attributes used in the baseline scenario.

Table 4. Vehicle Model Attributes Used in the Baseline Scenario

Vehicle Model	Model Year Group	Energy Consumption Rate, Wh/mi [a]	Nominal Electric Driving Range, mi	Peak DC Charge Power, kW	Minimum DC Charge Time, minutes [b]
BEV sedan	2020 2025 2030	320 300 300	190 260 290	150 150 250	26 24 20
PHEV sedan	2020 2025 2030	290 290 290	45 50 55	N/A N/A N/A	N/A N/A N/A
BEV C/SUV	2020 2025 2030	390 430 420	190 240 280	150 150 350	30 30 20
PHEV C/SUV	2020 2025 2030	370 380 370	35 40 40	N/A N/A N/A	N/A N/A N/A
BEV pickup	2020 2025 2030	– 570 500	– 280 300	– 250 350+	– 24 20
PHEV pickup	2020 2025 2030	– 440 420	– 35 35	– N/A N/A	– N/A N/A
BEV van	2020 2025 2030	– 460 440	– 240 280	– 150 350	– 30 20
PHEV van	2020 2025 2030	– 390 380	– 35 40	– N/A N/A	– N/A N/A

[a] Excludes charging efficiency losses. Alternating-current (AC) charging assumed as 90% efficient in all cases.
[b] Assumes 20% to 80% SOC under ideal conditions (preconditioned pack, moderate ambient temperature, no power derating, etc.).

Given the adoption trajectory assumed in the baseline scenario, the 2030 PEV fleet in this analysis is dominated by the 2030 model year group. Stock turnover and a dramatic increase in projected PEV sales toward the end of the decade result in the 2020, 2025, and 2030 model year groups representing 5%, 20%, and 75% of the 2030 on-road fleet, respectively.

PEV technology is assumed to improve over the period of this analysis, most dramatically with respect to DC charge acceptance increasing from peak power ratings of 150 kW in the 2020 model year group to 250–350 kW in the 2030 model year group.[14] Most modern BEVs are capable of relatively high DC charging rates under low-SOC conditions, but as SOC increases during a charging event, a vehicle's battery management system begins to taper its charge rate to protect the pack from overvoltage and thermal abuse.

[14] PHEVs are assumed to be incapable of DC charging in this analysis.

This analysis assumes that advances in battery technology (potentially including prevalence of 800-V packs, multilayer cathodes, electrolyte improvements, and advanced charge protocols) will not only enable higher peak power levels at low SOC, but also decrease overall DC charge times. All BEVs sold after 2025 are assumed to be capable of 20-minute DC charge times assuming 20% to 80% state of charge under ideal conditions (preconditioned pack, moderate ambient temperature, no power derating, etc.). In the real world, actual DC charging times will vary based on arrival and departure SOC, pack thermal conditions (temperatures that are too high or too low will result in power derating), the vehicle's battery management system, and the capabilities of the charging station.

2.2.3. Residential Charging Access (There's No Place Like Home)

The key enabler for early adoption of PEVs has been home charging at residential locations, where vehicles tend to remain parked for long durations overnight. Going forward, there is uncertainty around how effectively home charging can scale as the primary charging location for PEV owners. As the PEV market expands beyond early adopters (typically high-income single-family homes [SFHs] that have access to off-street parking) to mainstream consumers, planners must consider developing charging infrastructure solutions for households without consistent access to overnight home charging. This includes, but may not be limited to, renters, residents of apartment buildings (and other multifamily dwellings), and individuals in SFHs without access to off-street parking. In situations where residential off-street charging access is unattainable, a portfolio of solutions may be possible, including providing access to public charging in residential neighborhoods (on street), at workplaces, at commonly visited public locations, and (when necessary) at centralized locations via high-power fast charging infrastructure (similar to existing gas stations).

The future of U.S. residential charging access was explored in depth by Ge et al.'s (2021) report *There's No Place Like Home*. This research reviewed public information on residential housing attributes with implicit relation to home charging access, including national data on vehicle ownership, residence type, housing density, and housing tenure (i.e., rent or own). These public data were complemented by a panel survey sample of 3,772 U.S. individuals to uncover previously unknown distributions of residential parking availability, parking behavior, existing electrical access, and perceived potential for new electrical access by parking location. These responses connected parking availability and existing or potential electrical access to residence type to inform charging access scenarios that were incorporated into the final projection framework. Charging access trends with respect to residence type were identified and coupled with a PEV likely adopter model to infer national residential charging access scenarios as a function of the national PEV fleet size.

This work serves as the basis of residential charging access assumptions in this report, which assumes 90% of PEVs have reliable access to overnight charging in a scenario with 33 million PEVs nationwide. Alternate 2030 scenarios for residential access explore home charging as low as 85% and as high as 98%. The distribution of residential access across CBSAs is shown in Figure 10. Note that residential access and fleet size are coupled within the national framework, such that locations with high PEV adoption tend to be estimated with lower levels of residential access, as can be seen for CBSAs in California and the Pacific Northwest where residential access decreases over time as the size of the PEV fleet increases.

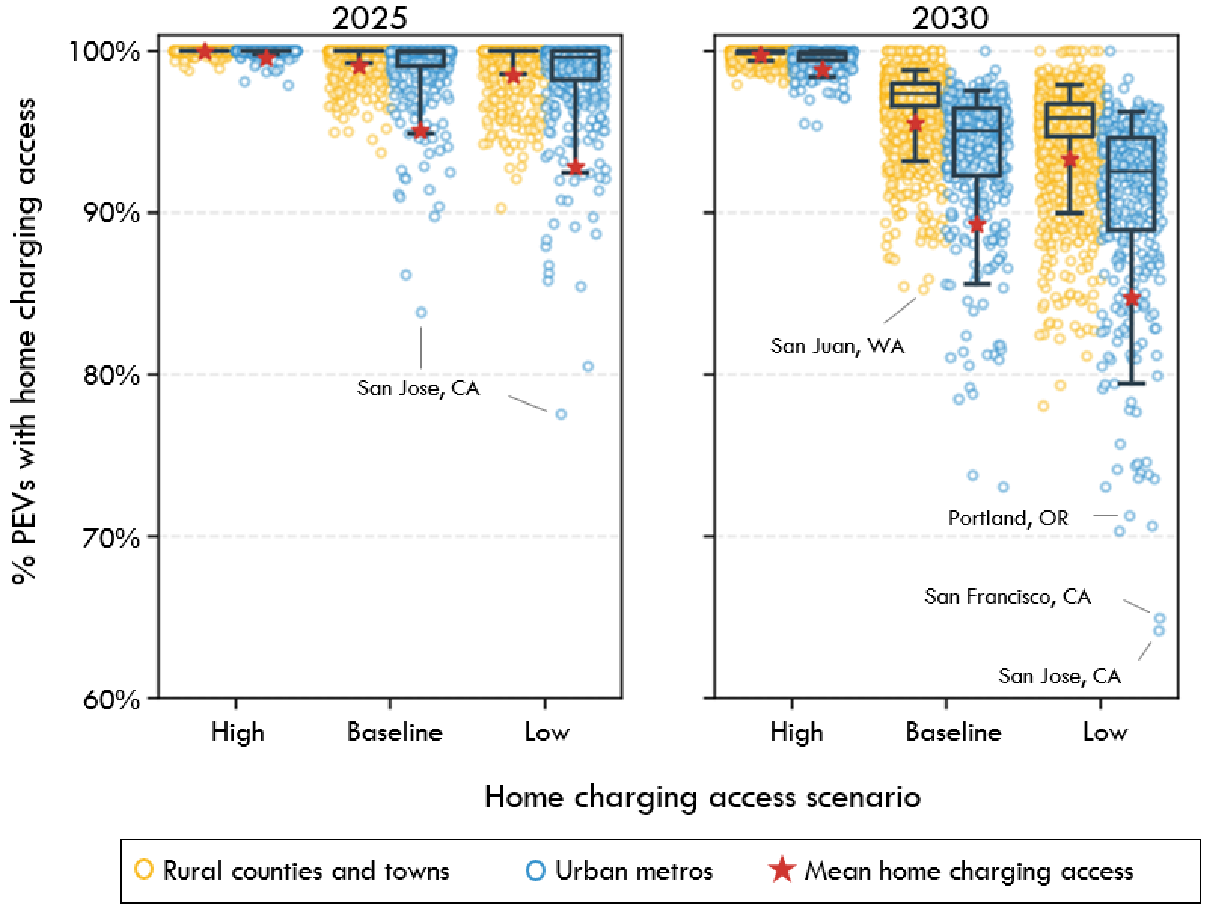

Figure 10. Residential charging accessibility scenarios as a function of PEV stock share. In the boxplot figure, the box reflects the inner quartile range (25%–75%), with the horizontal line reflecting the median value. Whiskers represent the 5th and 95th percentile values, respectively.

This analysis pays special attention to the demographics of ride-hailing drivers, who (consistent with industry goals) are assumed to achieve 100% adoption of PEVs by 2030. Drivers for ride-hailing services are disproportionately lower income, complicating opportunities to leverage data sources representative of the general population. This analysis introduces a means of characterizing the likelihood of access to overnight charging for ride-hailing drivers. Note that emerging business models, such as leased vehicles with overnight charging at a depot location or leases where public charging is included in the lease of the vehicle, are not explicitly considered. However, such models could be evaluated in the future by assuming greater rates of overnight charging access irrespective of driver housing status or through a driver preference for midday fast charging.

Consistent with the approach outlined by Moniot, Ge, and Wood (2022), Ge et al.'s (2021) report is once again leveraged for estimating residential access among ride-hailing drivers. Although this survey was intended to be representative of the broader population, the survey produced relationships between demographic descriptors—tenure, housing type, and income—and overnight charging access, which allows for the estimation of ride-hailing drivers' residential charging access if their income distribution is known. Ride-hailing driver income data[15] (Benenson Strategy Group 2020) were combined with demographic data from the U.S. Census and information from Ge et al. (2021) to estimate regional-specific residential access rates among ride-hailing drivers. This approach enables differentiation across geographies by accounting for variability in housing stock and household income, leading to consideration of lower overnight charging access in dense CBSAs (such as New York City) versus more sprawling CBSAs with a greater availability of more affordable housing options with more favorable rates of overnight charging (such as Houston).

The baseline scenario distribution of residential access across CBSAs is shown in Figure 11. This distribution results in a national average of 60% for residential charging access among ride-hailing drivers (significantly lower than the 90% assumed for the overall PEV fleet). These CBSA-specific residential access rates are used by EVI-OnDemand when simulating charging behavior among ride-hailing drivers.

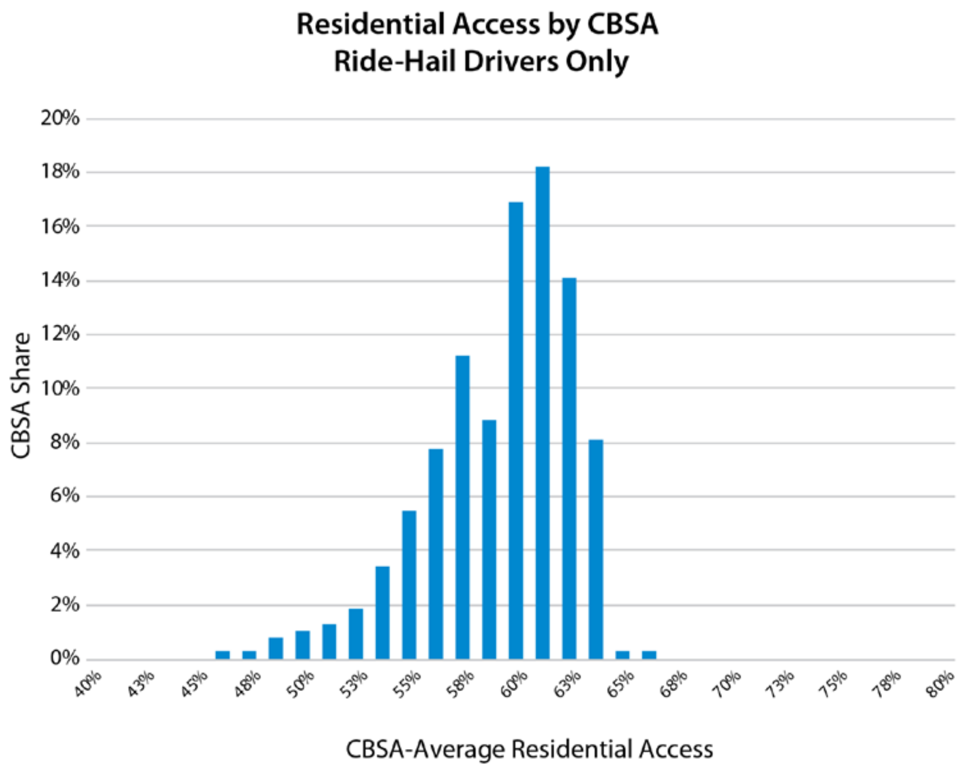

Figure 11. Likelihood of overnight charging access for ride-hailing drivers for the baseline scenario across all metropolitan CBSAs

[15] Driver household income data are used instead of the income obtained exclusively from ride-hailing services. Household income includes additional revenue from separate forms of employment and across all household members. This value is considered to be a more accurate indicator of the type of housing the driver lives in, and also enables direct comparison against household-level census data.

2.2.4. Driving Patterns

PEV driving patterns in this analysis are represented by an ensemble of data sets from conventional vehicles, which are simulated as PEVs to estimate the charging infrastructure necessary for supporting electrification of LDVs in multiple use cases. EVI-Pro simulations rely on FHWA's 2017 NHTS and a national data set licensed from INRIX. EVI-RoadTrip utilizes FHWA's TAF to describe long-distance driving trends, and EVI-OnDemand employs observations from a Fehr & Peers analysis of the ride-hailing industry in select U.S. markets (Balding et al. 2019). As each of these datasets were developed prior to the onset of the COVID-19 pandemic in March 2020, their use within this study imply an assumption that mobility patterns have fully returned to the pre-pandemic state by 2030. Estimating the near-term evolution of personal mobility in the United States was deemed out of scope for this analysis.

Driving pattern inputs to EVI-Pro are derived from the 2017 NHTS. The NHTS is a national travel survey conducted every 6–8 years to describe travel activity at the household level across all transportation modes (e.g., walk, bike, drive, ride-hail, transit, air). In addition to being publicly accessible, the NHTS enables "trip chaining," or the linking of automobile trips in a sequential manner. This is a key feature for PEV charging simulations in EVI-Pro, as it enables battery SOC to be estimated over a 24-hour period. A visualization of 2017 NHTS auto weekday trip distribution by hour of day and activity type is shown in Figure 12 for illustrative purposes.

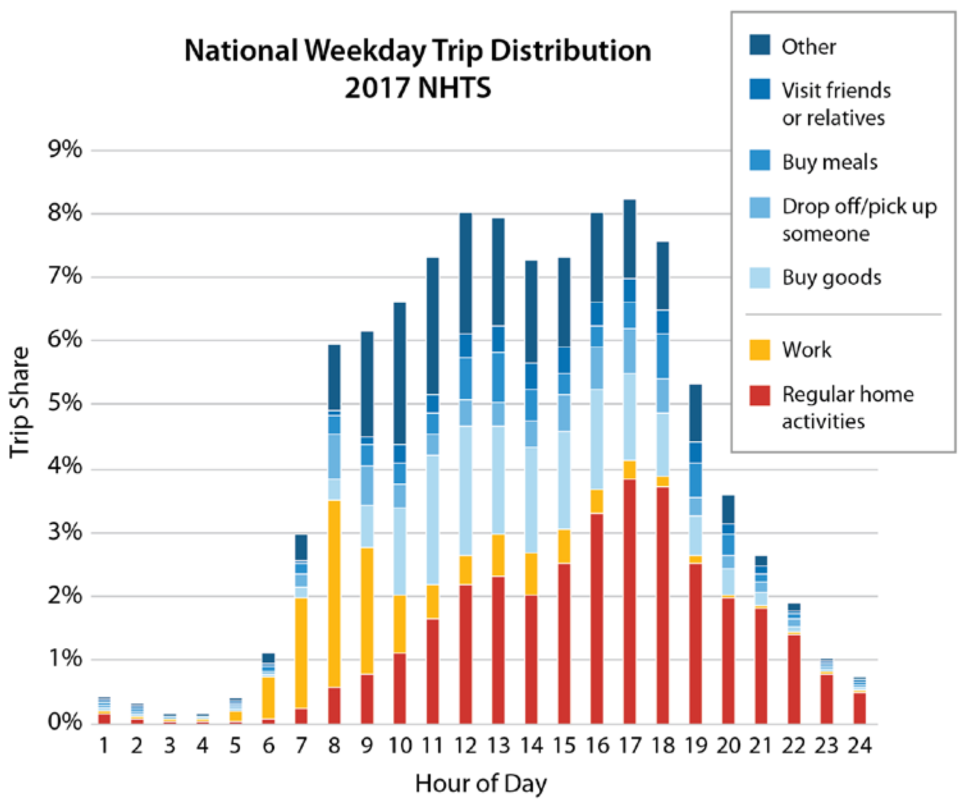

Figure 12. 2017 NHTS auto weekday trip distribution by hour of day and activity type ("other" activities include general errands, buy services, exercise, recreational activities, health care visits, religious or community activities, work-related meetings, volunteer activities, paid work from home, attending school as a student, changing type of transportation, attending childcare, and attending adult care)

While the NHTS data include data points for hundreds of thousands of household vehicles, select cities and states are intentionally oversampled, leaving many geographies with sparse samples. To derive trip chains from all CBSAs and rural counties, a procedure for drawing weighted samples from the NHTS that are representative of any target geography was developed. This method relies on broadly accessible demographic variables from the U.S. Census to sample household vehicles from the NHTS that are representative of a particular census tract in question. This approach was calibrated using standard in-sample linear regression techniques and independently validated using out-of-sample travel survey data from the 2012 California Household Travel Survey.

One limitation of the NHTS is a lack of spatial information regarding trip destinations. Use of NHTS driving data in EVI-Pro requires that attention be paid to appropriately defining geographies. While geographic precision is often desired, small geographies run the risk of vehicles crossing boundaries during normal operation and placing demand for charging outside the geography in which their "home" is located. To ensure appropriate spatial resolutions are considered when using NHTS data for EVI-Pro simulations, a spatially explicit analysis was required. For this analysis, we relied on a large, national data set of real-world travel patterns with geocoded trip origins and destinations. The data provider for this analysis was INRIX, and the data included millions of trips from Jan.–Feb. 2020 (data during the COVID-19 lockdown were intentionally excluded). This data set is visualized in Figure 13.

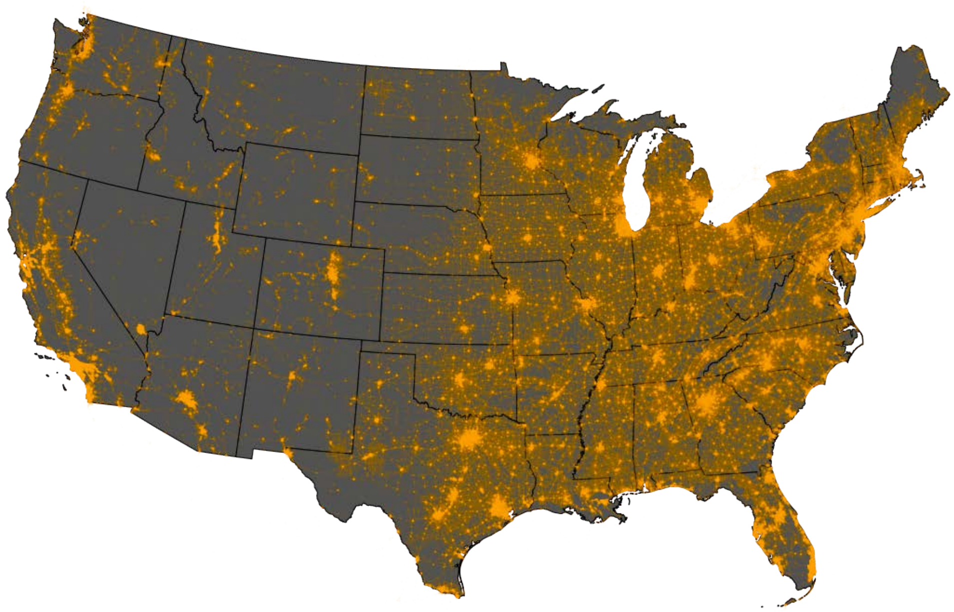

Figure 13. National origin-destination data set from Jan.–Feb. 2020 (licensed from INRIX)

Multiple geographies were evaluated using this data set, including counties, census urbanized areas, and CBSAs (including metropolitan and micropolitan statistical areas). For each geography, the frequency of interregional travel was tested and evaluated for suitability of a net-zero charging demand difference in EVI-Pro. This analysis revealed that CBSAs were the smallest geography with national coverage for which a modeling assumption of net-zero flow in charging demand could be considered valid. Consequently, CBSAs are the default geography for aggregating the individual EVI-Pro simulations that depend on the weighted sampling of NHTS driving days.

EVI-RoadTrip relies on long-distance travel data from the TAF. Since long-distance travel tends to be underrepresented in travel surveys and often crosses political boundaries, FHWA developed a synthetic data set with national coverage to estimate long-distance passenger travel. FHWA's TAF was modeled using a variety of predictors, such as population and economic activity, and calibrated to a large travel survey (Federal Highway Administration 2018). TAF consists of a set of county-to-county trip tables for long-distance passenger trips (defined as trips longer than 100 miles) by automobile, bus, air, and rail. The TAF projects person-trip flows for auto travel in 2008 and for 2040, the latter of which is shown in Figure 14.

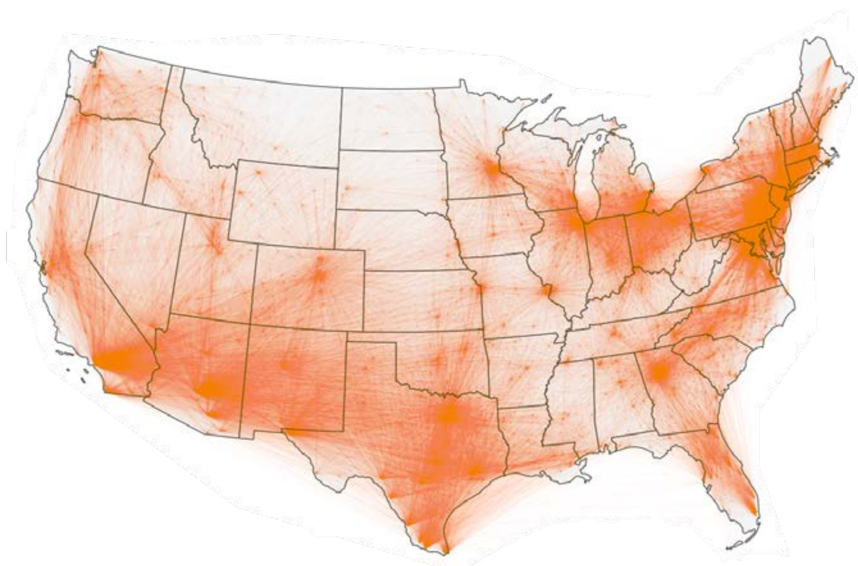

Figure 14. County-to-country origin-destination flows visualized from the FHWA TAF data set

EVI-OnDemand requires the total passenger miles served by PEVs in ride-hailing fleets in order to estimate charging demands. Few data are available in the literature regarding the share of miles affiliated with ride-hailing fleets outside of an analysis performed by Fehr & Peers. In the analysis, the authors aggregated real-world ride-hailing miles provided by Uber and Lyft from September 2018 across the six metropolitan areas of Seattle, San Francisco, Los Angeles, Chicago, Washington, D.C., and Boston. Moniot, Ge, and Wood (2022) compared the total miles across the ride-hailing fleets for each region against the overall number of vehicle miles traveled (VMT) for the month as reported by the local metropolitan planning organization. It found that ride-hailing fleets comprise between 2% and 3% of VMT within the six regions analyzed, with greater rates of penetration within the urban cores of each region.

The VMT shares found by Fehr & Peers are used for the six regions provided, and a VMT share of 1.5% is assumed for all other regions in lieu of more granular data. The VMT shares reported by Fehr & Peers are assumed to have above-average rates of VMT penetration given the high household incomes and prominence of technology and information workers in the regions analyzed. VMT penetrations for each CBSA were multiplied by the inferred number of vehicle miles traveled in each CBSA. Total VMT values were obtained at the CBSA level by disaggregating state-level VMT values reported in Table VM-2 of the 2019 Highway Statistics Report (U.S. Department of Transportation 2020) based on vehicle registrations, which were separately sourced from IHS Markit (2017) at the ZIP code level and aggregated to CBSA and state levels.

A key variable influencing the charging demands of ride-hailing vehicles is the time vehicles are assumed to be spent on shift. Full-time drivers operating vehicles for ride-hailing services accrue significantly more miles than part-time drivers and will thus induce greater demand for charging. However, a greater share of full-time drivers may also reduce the total population of vehicles given the fleet sizing procedure introduced previously. Accurately characterizing drivers based on hours driving per shift or shifts per week is difficult given the lack of publicly available data pertaining to ride-hailing drivers. One study from 2019 found 11% of drivers to be full time using data from RideAustin (Wenzel et al. 2019). More recently, a blog post published by an Uber economist (Mishkin 2020) suggested that the vast majority of drivers are part time through analysis of proprietary driver data sourced from all Uber drivers in California. The assumed national composition of ride-hailing drivers by shift type and residential charging access is shown in Figure 15.

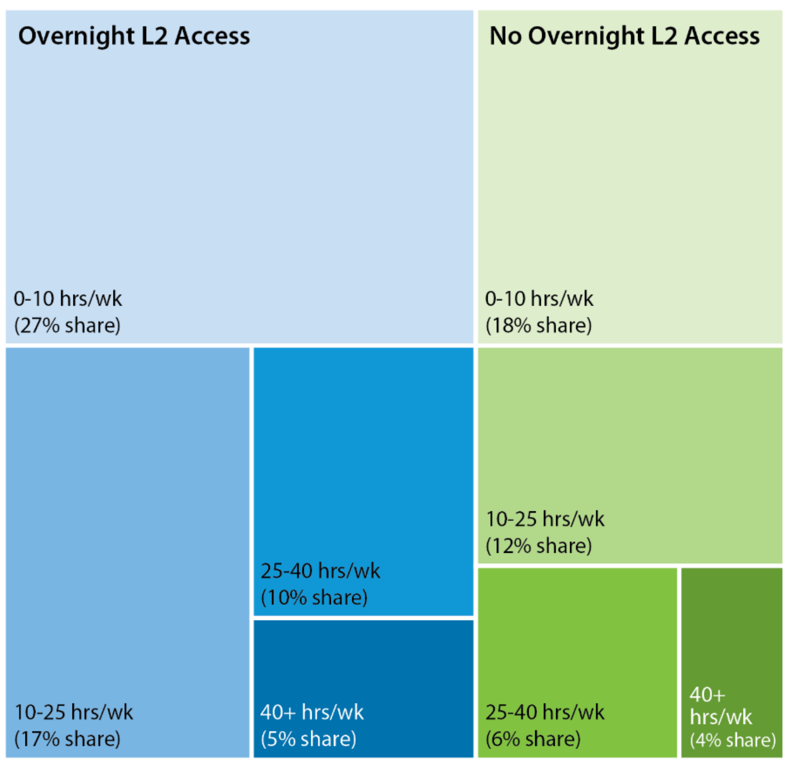

Figure 15. Assumed national composition of ride-hailing drivers by shift type and residential charging access

2.2.5. Charging Behavior

The final demand-side input into the national framework is assumed PEV charging behavior. Charging behavior assumptions embedded in EVI-RoadTrip and EVI-OnDemand are relatively straightforward. In these models, BEVs operate for as long as possible before crossing some range or SOC threshold, then seek out DC charging at the highest possible rate and return to their long-distance trip or ride-hail shift once sufficiently charged. The more complicated charging decisions are addressed by EVI-Pro during typical daily driving, particularly for those without residential access.

In support of this analysis, many informal conversations with industry stakeholders were conducted. Over these conversations, a consensus emerged on several key points, including:

- Home is likely the most convenient and cost-effective charging location (for those with access). The industry should take measured steps toward improving access to charging at or near home locations.
- For those with residential access, PEV technology is progressing in such a way (longer electric driving ranges) that home is likely the only place that *most* people will *need* to charge on a *regular* basis.
- For those without residential access, some drivers will find L2 charging away from home to be an effective solution, but only when appropriately collocated with activities with long dwell times (e.g., 8+ hours).

An interesting point of discussion in these interviews involved the design of fast charging installations, the primary question being "How fast is fast enough?" Historically, a significant share of the publicly accessible DC charging network has been rated at 50 kW. However, there is a recent trend toward "future proofing" DC stations, with a greater share of new installations at higher power ratings, including up to 350 kW. This trend is motivated by driver preferences for faster charging; however, battery technology tends to be the limiting factor on DC charging times. As previously discussed, modern BEVs have a maximum DC acceptance rating, which tends to decrease throughout the course of a fast charge event and can further be derated under adverse thermal conditions. Additionally, some destination charging locations may feature typical dwells of over an hour, providing ample opportunity for charging on units rated for 50–150 kW.

Ultimately, this study elected to employ a baseline charging behavior approach within EVI-Pro that attempts to maximize the use of residential charging as a first priority, then takes advantage of L2 charging away from home at locations with sufficiently long dwells (typically workplaces), and finally relies on fast charging to meet the needs of drivers that don't have access to home charging and don't exhibit dwell time away from home compatible with L2 charging speeds.[16]

[16] EVI-Pro assumes fast charging as being necessary only when long dwell time opportunities to charge slowly are not present in the detailed driving pattern datasets used as inputs. In reality, charging preferences will be dictated by a myriad of conditions that are challenging to anticipate in a model. For this reason, EVI-Pro has been configured in this analysis to simulate a minority of BEV drivers (10%) as preferring fast charging over slower alternatives, including opportunities to charge at home. The size of this behavior cohort is believed to be consistent with the limited set of real-world charging behavior observations available in the literature. BEV manufacturers are arguably in the best position to observe actual charging behavior in the field and are encouraged to consider publishing aggregated charging behavior statistics to inform the efficient deployment of charging infrastructure.

When fast charging is employed within EVI-Pro, the highest rated power unit is selected among the set of 50-, 150-, 250-, and 350-kW charging so long as the selected charger does not exceed the maximum DC acceptance rate of the vehicle being simulated.

The decision to employ charging behavior that prioritizes the fastest possible DC charging (when other options have been exhausted) is based on several considerations. First, stakeholder feedback is consistent that when drivers seek fast charging, they prefer fast charging that is at least as fast as what their vehicle is rated for. Second, the industry (to this point) has largely stayed away from pricing models that incentivize fast charging that is only "as fast as necessary." While there is theoretically potential to optimize installation and operating costs by incentivizing drivers to charge only as fast as necessary, consensus is that such a sophisticated pricing model is inappropriate for this nascent industry. As of 2022, the general population has relatively minimal exposure to PEV charging. Overly complicated pricing models run the risk of introducing detrimental consumer experiences and slowing consumer acceptance of this new technology. The baseline scenario assumes drivers prefer DC charging that is "as fast as possible."

2.3. Supply-Side Considerations: Charging Network Terminology, Taxonomy, Utilization, and Cost

Multiple input parameters must be specified across the three EVI-X models used in this report to estimate the charging infrastructure needs for 33 million light-duty PEVs in the United States by 2030. This subsection reviews critical "supply-side" input assumptions, including EVSE terminology, EVSE taxonomy, network utilization, and infrastructure costs.

2.3.1. EVSE Terminology

Charging infrastructure terminology in this report is consistent with definitions used by the Federal Highway Administration (2023) and is aligned with Open Charge Point Interface (OCPI) terminology for the hierarchy of PEV charging stations, as shown in Figure 16 (adapted from DOE's Alternative Fuel Data Center):

- **Station location:** A site with one or more EVSE ports at the same address. Examples include a parking garage or a mall parking lot.
- **EVSE port:** Provides power to charge only one vehicle at a time, even though it may have multiple connectors. The unit that houses EVSE ports is sometimes called a charging post, which can have one or more EVSE ports.
- **Connector:** What is plugged into a vehicle to charge it. Multiple connectors and connector types (e.g., Tesla, CCS, CHAdeMO) can be available on one EVSE port, but only one vehicle will charge at a time. Connectors are sometimes called plugs.

As discussed in Wood et al. (2017), charging infrastructure needs can be thought of in terms of coverage and capacity, wherein coverage needs tend to be defined in terms of number of stations and capacity needs tend to be defined in terms of number of ports. This analysis is primarily concerned with estimating future demand for charging, and thus presents results in terms of port counts (as opposed to stations).

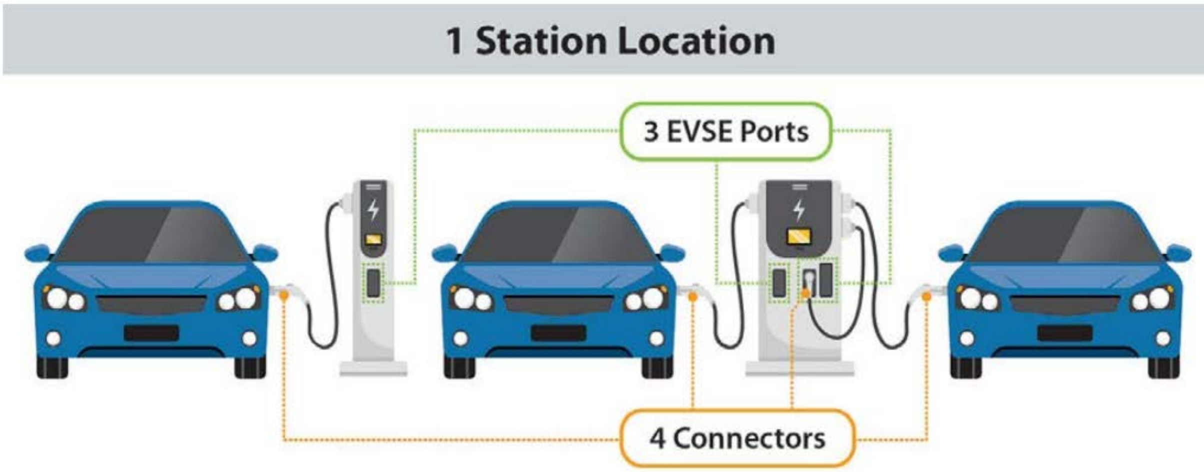

Figure 16. PEV charging infrastructure hierarchy.

Source: Alternative Fuels Data Center (2023a)

2.3.2. EVSE Taxonomy

Traditional EVSE taxonomy approaches adopt a pyramid concept that communicates charging needs in terms of home, workplace, and public charging. This legacy approach has the potential to confuse access type (e.g., public, private) and location type (e.g., home, office, retail). Further, the legacy pyramid concept is particularly ambiguous with respect to workplace charging. Work is commonly described as an activity type in travel surveys (used in analysis studies such as this report), but infrastructure investment is primarily concerned with the types of locations where people work. This ambiguity has the potential to mislead an audience into believing that most workplace charging should be located outside office buildings, when in reality the ability to charge at work is most valuable for those that cannot charge at home. While some office workers will have challenges accessing residential charging, employees working in the retail/service industry may have greater challenges and benefit more from access to charging at their workplace. This analysis proposes EVSE taxonomy along three dimensions, as shown in Figure 17.

The first dimension, access type, simply consists of public and private charging. Public charging is understood within this analysis as charging that is available to any driver regardless of their relation to the EVSE owner/operator. In contrast, access to private charging is determined by the EVSE owner/operator, who could be a homeowner, multifamily housing property manager, employer, or charging network company.

The second dimension, location type, describes types of properties where charging can be located (within the purview of this analysis). This dimension is defined as independent from the access type dimension. For example, charging located at an office building could be public or private access. Similarly, charging located at a retail outlet could be public (potentially designed for customers) or private (potentially designed for employees).

The inclusion of workplace and office as location types within this taxonomy may at first appear to be redundant. The use of workplace as a location type in this analysis is used exclusively alongside private-access charging as a catch-all for all occupation types (including people working in office buildings, retail outlets, recreation centers, health care facilities, schools/universities, community centers, places of worship, etc.). While most charging provided to employees at their workplace today is believed to be private access at office buildings, expected growth in PEV sales suggests that a broader set of occupations should be considered for charging while at work, potentially including charging that is publicly accessible. This analysis classifies 100% of simulated at-work charging as private access in 2022, which decreases to 50% by 2030. Public-access charging while at work is distributed between the aforementioned location types proportional to 2030 employment share forecasts from the Bureau of Labor Statistics (assuming no bias between likely 2030 PEV owners and occupation types). Expected occupations for PEV drivers in 2030 is a relatively under-researched area and a key topic for future study.

EVSE Taxonomy

Access Type	Public	Private
Location Type	Home: SFH Home: MFH Neighborhood Workplace Office Retail	Recreational Health Care School Community Center Transit Hub
EVSE Type	Level 1 Level 2 DC 50 kW	DC 150 kW DC 250 kW DC 350+ kW

Figure 17. EVSE taxonomy employed by this analysis

The third dimension is simply EVSE type using common definitions for L1, L2, and DC charging. Notably, multiple levels of DC charging are available to simulations within this analysis. DC charging rated at 50, 150, 250, and 350 kW are all considered with 350-kW charging labeled as DC350+ as a reflection that BEVs capable of charging above 350 kW are likely to enter the market over the next several years, and DC charging network operators are potentially considering the near-term deployment of charging infrastructure that exceeds 350 kW per port.

2.3.3. Network Utilization

Network sizing within the national simulation pipeline hinges on an assumed regional networkwide peak hour utilization rate (as previously described in this section). Peak hour utilization assumptions in this analysis are primarily informed by Borlaug et al. (2023), in which real-world utilization from tens of thousands of EVSE ports was analyzed. An excerpt of this analysis is shown in Figure 18, where average hourly utilization across a large network of chargers is plotted by location and EVSE type. Consistent with EVI-X modeling results, utilization of residential EVSE peaks in the evening hours and nonresidential use peaks between late morning and midday.

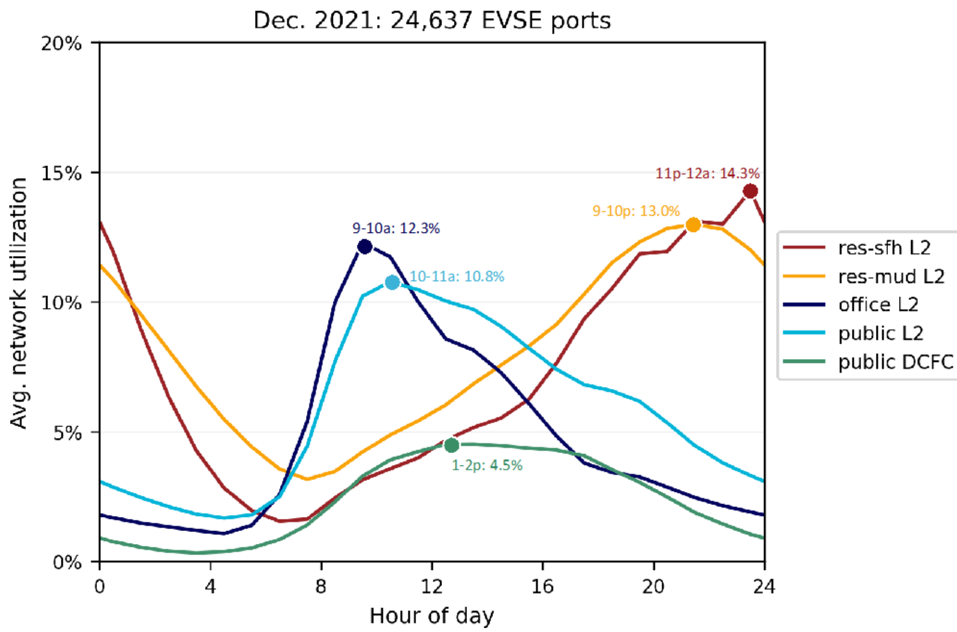

Figure 18. Average network utilization across 24,637 ports from December 2021 by location and EVSE type.

Source: Borlaug et al. (2023)

Analysis of historical EVSE data tends to find relatively low utilization rates (e.g., less than 10%). A common assumption is that EVSE utilization will improve as more PEVs hit the road and demand for charging increases. What is often overlooked is that the supply of charging infrastructure is also increasing in parallel to increases in demand. Thus, projections for increased EVSE utilization should consider the balance of infrastructure supply and demand.

This analysis leverages historical data to inform assumptions for networkwide peak hour utilization. Networkwide peak utilization is treated as a simplified metric for how a charging provider attempts to balance their supply of charging with observed demand from PEVs. Given that the industry is currently in a period of growth with charging supply and demand both increasing rapidly, it is assumed that charging providers are currently trying to stay ahead of increases in demand and proactively grow their networks to minimize congestion for charging to avoid queueing and negative driver perception of availability. In attempting to estimate the needs of the 2030 PEV fleet, this analysis primarily considers a scenario where supply of charging more closely matches the demand for charging. Historical EVSE data are used to quantify the 95th percentile of peak hourly networkwide utilization from existing EVSE for Office-L2 and Public-L2 and 90th percentile for Public-DC chargers (as defined by Borlaug et al. [2023]).

Figure 19 shows distributions of average daily and peak hourly utilization across thousands of real-world EVSE for the aforementioned charger types. This analysis finds peak hourly utilization of Office-L2, Public-L2, and Public-DC charging to be 60%, 55%, and 20%, respectively. These values are directly used within this analysis for network sizing based on simulated demand. The high peak hourly networkwide utilization of L2 EVSE (relative to DC EVSE) is believed to be a product of consistent and long-duration activity patterns aligned with use of the L2 units (such as arrival times at workplaces), whereas the timing of DC charging throughout the day is less predictable with short-duration events, and the network is consequently sized more conservatively to avoid queueing, resulting in relatively low utilization.

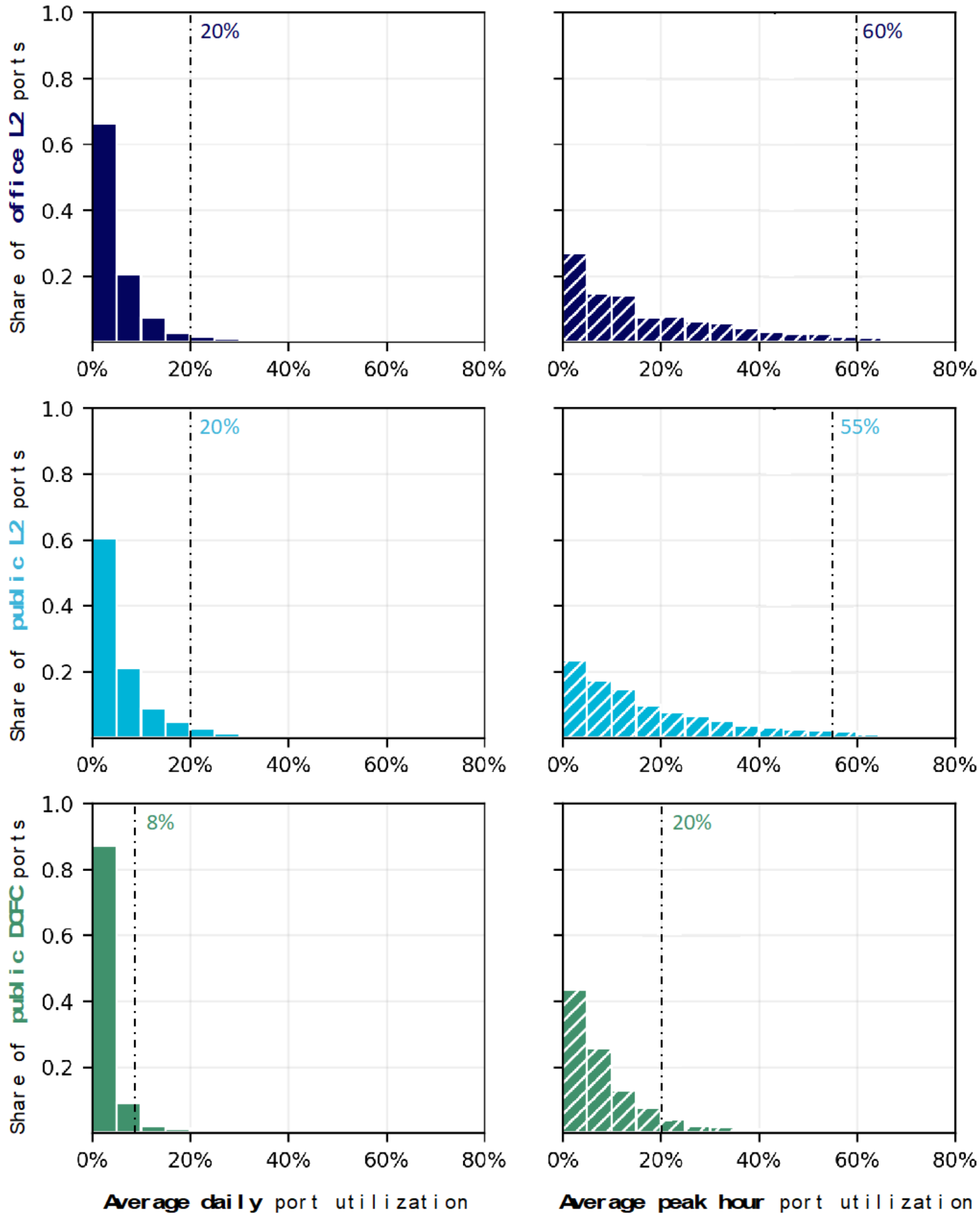

Figure 19. Distribution of average daily port utilization and average peak hour port utilization by location and EVSE type.

Source: Borlaug et al. (2023)

2.3.4. Cost

Charging infrastructure costs are used within the national pipeline as a postprocessing step to estimate the cumulative capital investment required to deploy the simulated network. These costs are based on historical observations from an ensemble of publicly accessible reports, as shown in Table 5. These costs include charging equipment and installation costs which are intended to reflect labor and materials for construction on the customer-side of the meter.

Cost estimates exclude cost of front-of-meter utility upgrades (such as new transformers and line extensions), distributed energy resources (such as on-site storage or generation), operating costs (such as utility energy and demand charges), maintenance costs (necessary for ensuring a high level of reliability), and certain construction soft costs (such as delays associated with local permitting utility service connection). While these additional cost elements are beyond the scope of this analysis (due primarily to a lack of publicly accessible data), they are far from trivial and could significantly contribute to overall costs for the national charging network. Additionally, lead times for these upgrades will dictate the pace of deployment. Previous studies have estimated that while charging infrastructure projects can often take 3-10 months to complete, situations requiring feeder upgrades can add one year to this timeline, and substation upgrades can potentially add up to 4 years (Borlaug et al. 2021).

Table 5. EVSE Capital Cost Assumptions

Charger Hardware		Unit Cost per Port	Install Cost per Port [a]	References
L1 residential	Low: High:	$0 $0 [b]	$100 $1,000	(Fixr.com 2022; Courtney 2021; HomeAdvisor 2022)
L2 residential	Low: High:	$400 $1,200	$500 $1,700	(Borlaug et al. 2020; Fixr.com 2022; Courtney 2021; HomeAdvisor 2022)
L2 commercial	Low: High:	$2,200 $4,600	$2,200 $6,000	(Nicholas 2019; Nelder and Rogers 2019; Borlaug et al. 2020; Bloomberg New Energy Finance 2020; Pournazeri 2022)
DC 150 kW	Low: High:	$66,400 $102,200	$45,800 $94,000	(Nicholas 2019; Nelder and Rogers 2019; Borlaug et al. 2020; Bloomberg New Energy Finance 2020; Borlaug et al. 2021; Gladstein, Neandross & Associates 2021; Bennett et al. 2022)
DC 250 kW	Low: High:	$91,400 $134,800	$54,750 $105,950	Inferred from DC 150-kW and 350-kW costs
DC 350+ kW	Low: High:	$116,400 $167,400	$63,700 $117,900	(Nicholas 2019; Bloomberg New Energy Finance 2020; Borlaug et al. 2021; Gladstein, Neandross & Associates 2021; Bennett et al. 2022)

[a] These ranges do not span the set of all possible situations. They are meant to be plausible optimistic (low) and pessimistic (high) estimates for assessing network capital costs at scale. In some cases, it was not possible to verify exactly what was included within each study's estimate for installation costs, thus some discrepancies may be present across sources.

[b] L1 chargers tend to be included with the purchase of a PEV and are thus excluded as an infrastructure cost from this analysis.

Regarding the costs that are in scope (charging equipment and installation), no attempt is made to forecast how these costs may evolve in the future. In stakeholder interviews, it was revealed that future costs could plausibly trend in either direction. Economies of scale could put downward pressure on equipment prices, but economywide supply chain challenges could counteract these effects, particularly in a high-demand environment. Similarly, installation costs could decrease as installers continue to accumulate experience with charging projects and identify efficiencies, but installation costs are notorious for being site-specific (proximity to an existing transformer being a key consideration) and per-site costs could plausibly increase as "low-hanging fruit" continues to be picked. For these reasons, this analysis relies solely on historical observations for making cost estimates with no attempt to estimate future cost trajectories.

Estimates for out of scope costs, including how to measure soft costs (including permitting and site acquisition), how to account for fixed civil construction costs and their effect on station sizing and design, how to adequately account for the cost of maintaining a reliable network, how to optimize distributed energy resources (or mimic industry best practices), and approximate cost of and time associated with distribution system upgrades as a function of service connection power requirements are proposed as areas for future research.

3. The National Charging Network of 2030

Results of the national simulation pipeline (described in Section 2) are examined in detail throughout Section 3. First, a detailed breakdown of the 2030 network under the baseline scenario is presented by EVSE taxonomy, PEV use case, and geography. Next, the baseline national network growth trajectory necessary between 2022 and 2030 is presented. Finally, alternate scenario results are presented examining impacts of PEV adoption rate, residential access, TNC electrification rate, and others on the size and cost of the national charging network.

3.1. 2030 Results by EVSE Taxonomy, PEV Use Case, and Region

3.1.1. Results by EVSE Taxonomy

Tables 6 and 7 respectively summarize charging network size and investment need (with breakouts by EVSE taxonomy) based on analysis of the baseline scenario. Simulation results suggest that in this scenario, there is a need for 28 million charging ports by 2030 (85 ports/100 PEVs), with most of that infrastructure dedicated to private L2 charging located at SFHs. This finding is a result of several factors.

Home is assumed to be the most convenient and affordable charging location for those with access, and a large majority of PEV owners (approximately 90% nationally) in 2030 are assumed to have access to charging at home. While this high level of residential access is not representative of all drivers, the likely adopter model underlying this estimate assumes that in the near term, the majority of PEVs will be adopted by drivers with favorable residential access conditions. These conditions vary geographically across the country and will be explored later in this section. A scenario with lower levels of residential charging access is also presented in the sensitivity analysis later in this chapter. Low levels of residential charging access can be used to represent scenarios where infrastructure planning considers PEV adoption among a more diverse set of households than assumed by this report's baseline approach to identifying likely adopters.

After SFHs, over 1 million L2 ports (3 ports/100 PEVs) are simulated at privately accessible multifamily and workplace locations, and over 500,000 L2 ports (1.5 ports/100 PEVs) at publicly accessible neighborhood and office locations. This result reflects the need for destination charging located at or near long-duration activities (such as time spent at home and/or work). These long-duration activities provide ample time for L2 charging, which (like charging at SFHs) PEV drivers tend to find as convenient options for charging.

Approximately 500,000 L2 ports (1.5 ports/100 PEVs) are simulated at a variety of publicly accessible locations, including retail outlets, recreation centers, health care facilities, schools/universities, religious/community centers, and transportation hubs. These locations offer potential for occasional long-duration charging and (more often) short-duration convenience charging.

Finally, the national network includes 182,000 DC ports (0.6 ports/100 PEVs) with varying power capabilities. The simulated public DC network includes 63,000 DC150 ports, 55,000 DC250 ports, and 64,000 DC350+ ports. While the total count of public DC ports pales in comparison to the private and public L2 networks, they are core to the success of the overall network. Access to reliable, convenient, and affordable DC infrastructure supports the vehicle market by giving prospective drivers assurance they can get a fast charge when they need it and supports BEV drivers in a multitude of use cases (including road trips, those without residential access, and ride-hailing electrification).

Table 6. Simulated Cumulative National Network Size Through 2030 by Access, EVSE, and Location Types (includes a total of 28 million ports)

Port (thousands)

Public	1,248		
		Level 2	**1,067**
		Neighborhood	305
		Office	206
		Retail	178
		Health Care	100
		Recreational	84
		Transport Hub	75
		School	62
		Com. Center	56
		DC Fast	**182**
		DC150	63
		DC250	55
		DC350+	64
Private	26,762		
		Level 1	**7,024**
		Single Family	7,024
		Level 2	**19,738**
		Single Family	18,686
		Multifamily	568
		Workplace	485

The simulated 2030 national network has an estimated capital cost of \$53–\$127 billion. 39% of this cost (\$27–\$44 billion) is dedicated to public DC infrastructure. The remainder of the public infrastructure investment need is dedicated to public L2 (\$5–\$11 billion, 9% of the total investment) and is distributed across a broad set of locations serving a variety of use cases. The majority of the national investment is dedicated to the private network (\$22–\$72 billion, 52% of the total investment), with charging at SFHs playing a prominent role for the reasons previously discussed.

Table 7. Simulated Cumulative National Infrastructure Investment Need Through 2030 by Access, EVSE, and Location Types (a total of $53–$127 billion). Excludes cost of utility upgrades, distributed energy resources, operating costs, and maintenance costs.

Access	Access cost	EVSE cost	Cost (% of total)	
Public				**48%**
	$31 Billion to $55 Billion	*$5 Billion to $11 Billion*	**Level 2**	**9%**
			Neighborhood	3%
			Office	2%
			Retail	1%
			Recreational	1%
			Health Care	1%
			School	1%
			Com. Center	1%
			Transport Hub	0%
		$27 Billion to $44 Billion	**DC Fast**	**39%**
			DC150	11%
			DC250	12%
			DC350+	16%
Private				**52%**
	$22 Billion to $72 Billion	*$1 Billion to $7 Billion*	**Level 1**	**4%**
			Single Family	4%
		$21 Billion to $65 Billion	**Level 2**	**48%**
			Single Family	39%
			Multifamily	5%
			Workplace	4%

3.1.2. Results by PEV Use Case

This analysis considers three overarching PEV use cases: (1) typical daily driving, (2) long-distance travel, and (3) ride-hailing. Each of these use cases contributes to the demand for a robust national network of DC charging. Figure 20 shows the simulated size of the national 2030 DC network assuming only demand for individual use cases and the combined demand across three use cases. When considered independently, long-distance travel needs contribute 29,600 corridor ports to the national network, local needs contribute 134,400 community ports, and ride-hailing contributes about another 43,700 ports. If modeled in isolation, these three distinct networks would require about 208,000 ports, but when considering the opportunity for shared use (as is the case in the real world), the size of the national network decreases to 181,500 ports (an efficiency improvement of 13% enabled by shared use).

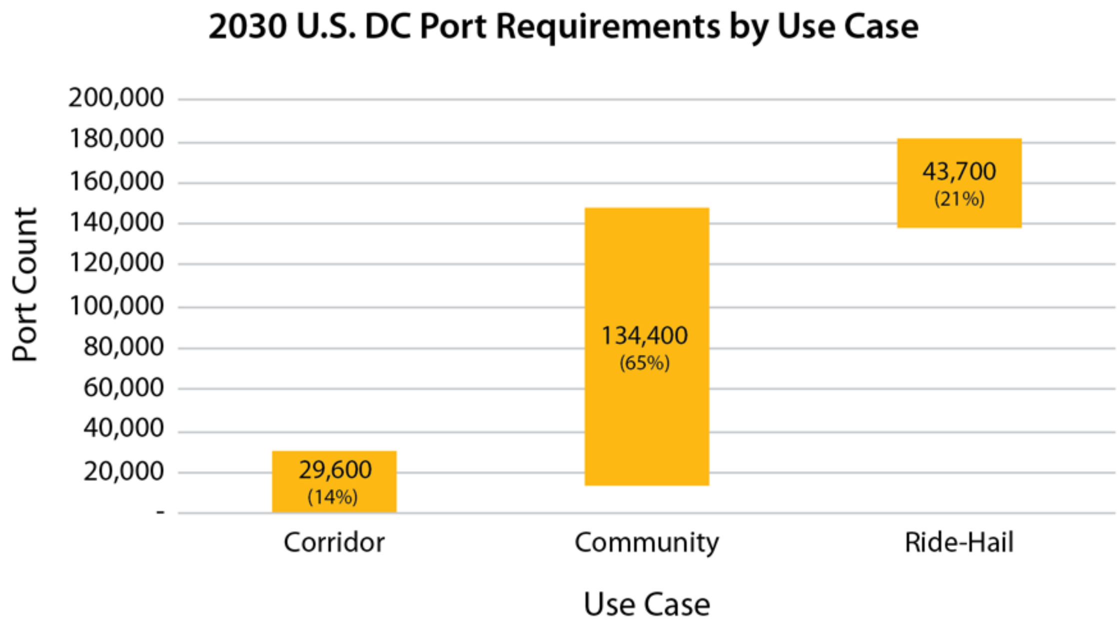

Figure 20. Simulated national DC charging network sized individually by use case and sized by consolidating demand

While 100% of the charging demand from EVI-RoadTrip is attributed to public DC, EVI-Pro and EVI-OnDemand simulate the balance of private and public charging based on vehicle technology, residential access, and travel patterns.

Figure 21 shows the daily charging demand from typical use of light-duty PEVs as simulated by EVI-Pro. Demand (expressed in daily kWh/vehicle) is broken out by powertrain type (BEV/PHEV), body style (sedan, C/SUV, pickup, van), and residential access. BEVs with access to residential charging can be seen to provide relatively low levels of demand for charging away from home, instead relying on home charging for most of their daily driving needs. Conversely, BEVs without residential access are exclusively reliant on charging while at work and other publicly accessible locations, particularly public DC. PHEVs exhibit similar charging patterns as BEVs, with lower overall charging demands and absence of public DC charging. As PHEVs are assumed not to be capable of DC charging, the only charging options within EVI-Pro for PHEVs without residential access are L2 charging at work and publicly accessible locations.

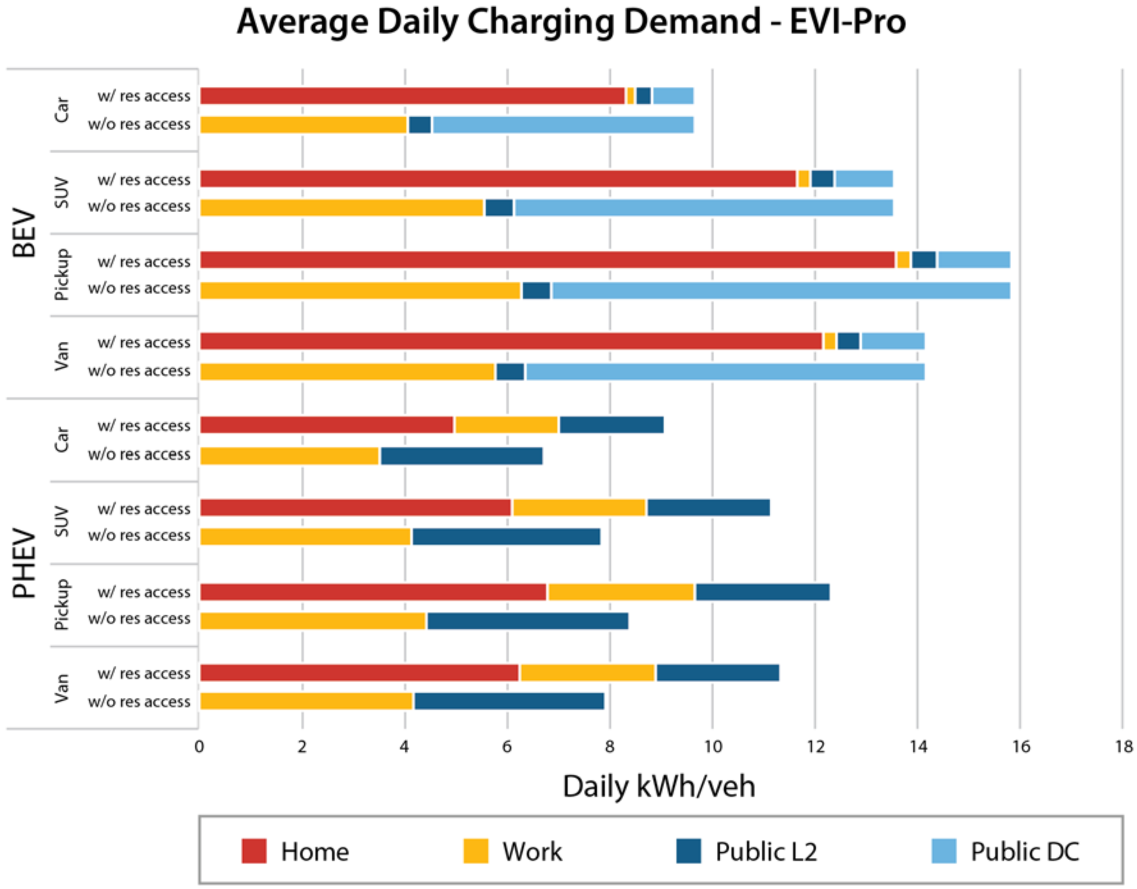

Figure 21. Average daily charging demand simulated by EVI-Pro for typical daily travel, broken out by powertrain type, body style, and residential access

Figure 22 shows the daily charging demand simulated by EVI-OnDemand for ride-hailing use cases, broken out by shift duration (expressed as hours worked per week) and residential access. Overall charging demands for the ride-hailing use case are significantly higher per vehicle than the typical daily use case. Ride-hailing charging demand is also a strong function of shift duration, with full-time drivers (40+ hours/week) demanding approximately 5 times more charging than those that only operate occasionally (0–10 hours/week). The composition of charging demand is a strong function of shift duration and residential access. Occasional drivers with residential access are typically simulated as providing no demand for public DC charging, while full-time drivers with residential access can require public DC to meet approximately 60% of their needs. Conversely, all drivers without residential access are simulated as needing 100% of their charging needs to be met by public DC charging.

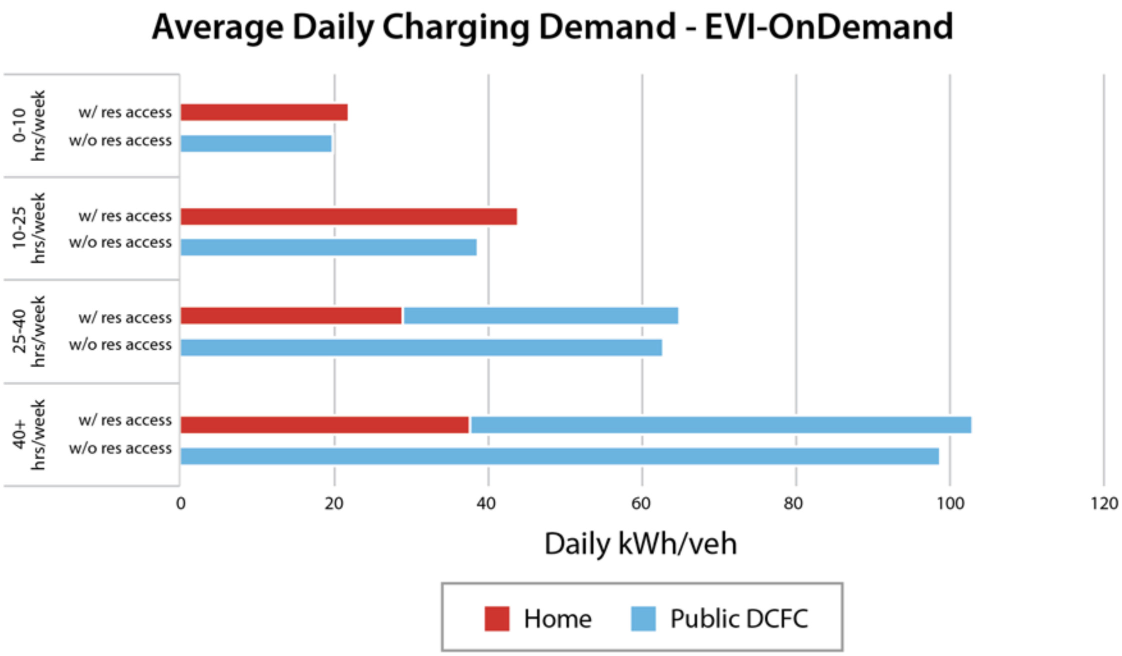

Figure 22. Average daily charging demand simulated by EVI-OnDemand for ride-hailing use cases, broken out by shift duration and residential access

3.1.3. Results by Region

Tables 8, 9, and 10 provide baseline 2030 results by state (including D.C. and Puerto Rico). Tables are provided for the private, public L2, and public DC networks in each state, respectively.

Table 8. State-Level Port Count Summary for the Simulated 2030 Private Network

State	PEVs	Single Family	Multifamily	Workplace	Total
AK	60,000	46,000	1,100	1,000	48,100
AL	310,000	266,000	900	3,800	270,700
AR	190,000	159,000	300	2,200	161,500
AZ	780,000	635,000	4,900	10,200	650,100
CA	7,330,000	5,073,000	157,800	154,000	5,384,800
CO	790,000	619,000	11,300	10,900	641,200
CT	340,000	264,000	9,900	5,000	278,900
DC	70,000	53,000	1,600	1,200	55,800
DE	100,000	79,000	800	1,300	81,100
FL	1,900,000	1,515,000	60,000	20,000	1,595,000
GA	810,000	670,000	6,800	10,600	687,400
HI	170,000	125,000	8,200	2,300	135,500
IA	270,000	230,000	1,100	3,500	234,600
ID	210,000	170,000	600	2,800	173,400
IL	1,100,000	893,000	34,600	14,600	942,200
IN	500,000	421,000	3,700	6,200	430,900
KS	230,000	192,000	700	3,100	195,800
KY	300,000	255,000	1,800	3,800	260,600
LA	230,000	193,000	1,400	2,600	197,000
MA	810,000	600,000	34,200	13,200	647,400
MD	680,000	517,000	10,900	10,500	538,400
ME	160,000	128,000	2,700	3,000	133,700
MI	720,000	614,000	4,000	9,800	627,800
MN	560,000	454,000	6,200	10,000	470,200
MO	450,000	377,000	2,700	5,700	385,400
MS	150,000	129,000	200	1,800	131,000
MT	100,000	84,000	400	1,600	86,000
NC	890,000	718,000	5,500	11,600	735,100
ND	50,000	46,000	200	900	47,100
NE	160,000	138,000	400	2,000	140,400
NH	170,000	128,000	6,100	2,800	136,900
NJ	820,000	616,000	35,700	12,000	663,700
NM	200,000	162,000	800	2,600	165,400
NV	320,000	252,000	3,600	4,300	259,900
NY	1,420,000	1,086,000	53,900	21,400	1,161,300
OH	860,000	722,000	6,100	10,700	738,800
OK	240,000	205,000	500	3,300	208,800
OR	720,000	519,000	6,200	13,000	538,200
PA	1,060,000	872,000	7,600	14,300	893,900
PR	90,000	70,000	4,200	1,400	75,600
RI	100,000	76,000	3,500	1,400	80,900
SC	380,000	314,000	2,400	4,500	320,900
SD	70,000	61,000	100	1,200	62,300
TN	530,000	442,000	3,300	6,700	452,000
TX	2,230,000	1,850,000	12,400	28,000	1,890,400
UT	380,000	303,000	3,600	5,100	311,700
VA	950,000	739,000	13,100	14,200	766,300
VT	100,000	80,000	1,700	1,600	83,300
WA	1,340,000	975,000	20,300	23,800	1,019,100
WI	530,000	437,000	7,500	7,500	452,000
WV	120,000	97,000	300	1,500	98,800
WY	50,000	43,000	100	700	43,800

Table 9. State-Level Port Count Summary for the Simulated 2030 Public L2 Network

State	PEVs	Neighborhood	Office	Retail	Other	Total
AK	60,000	500	500	400	1,200	2,600
AL	310,000	2,400	1,700	1,600	3,800	9,500
AR	190,000	1,400	1,300	1,000	2,500	6,200
AZ	780,000	6,900	3,500	4,300	7,600	22,300
CA	7,330,000	74,400	44,000	54,400	89,300	262,100
CO	790,000	7,300	4,100	4,500	9,200	25,100
CT	340,000	3,100	1,500	1,800	3,300	9,700
DC	70,000	800	400	500	800	2,500
DE	100,000	900	400	500	900	2,700
FL	1,900,000	19,400	7,100	8,100	16,100	50,700
GA	810,000	6,900	4,100	4,500	9,000	24,500
HI	170,000	1,900	800	900	1,700	5,300
IA	270,000	2,100	1,900	1,500	4,000	9,500
ID	210,000	1,600	1,300	1,200	3,200	7,300
IL	1,100,000	11,000	5,100	6,000	10,900	33,000
IN	500,000	4,100	2,600	2,600	5,600	14,900
KS	230,000	1,800	1,800	1,300	3,000	7,900
KY	300,000	2,400	1,900	1,600	4,200	10,100
LA	230,000	1,800	1,200	1,100	2,500	6,600
MA	810,000	7,900	4,200	5,300	9,100	26,500
MD	680,000	7,300	3,400	4,400	7,000	22,100
ME	160,000	1,400	1,100	1,200	2,300	6,000
MI	720,000	6,100	3,600	4,100	7,700	21,500
MN	560,000	4,900	3,700	4,300	7,700	20,600
MO	450,000	3,600	2,700	2,500	5,500	14,300
MS	150,000	1,100	1,100	800	2,200	5,200
MT	100,000	800	800	700	1,600	3,900
NC	890,000	7,300	4,400	4,900	9,500	26,100
ND	50,000	400	600	400	1,200	2,600
NE	160,000	1,300	1,300	900	2,000	5,500
NH	170,000	1,600	1,000	1,100	2,400	6,100
NJ	820,000	8,900	3,600	4,800	7,600	24,900
NM	200,000	1,600	1,100	1,100	2,400	6,200
NV	320,000	2,700	1,600	1,800	3,500	9,600
NY	1,420,000	14,100	7,200	8,000	15,400	44,700
OH	860,000	7,200	4,000	4,500	8,500	24,200
OK	240,000	1,900	1,600	1,400	3,300	8,200
OR	720,000	5,500	4,200	5,500	9,000	24,200
PA	1,060,000	10,100	4,900	6,000	10,900	31,900
PR	90,000	1,000	500	500	1,200	3,200
RI	100,000	900	500	600	1,000	3,000
SC	380,000	3,100	1,800	1,900	3,800	10,600
SD	70,000	500	700	500	1,500	3,200
TN	530,000	4,400	2,800	2,900	5,900	16,000
TX	2,230,000	18,600	10,600	11,900	22,300	63,400
UT	380,000	3,300	1,800	2,200	3,800	11,100
VA	950,000	9,200	5,000	6,000	10,700	30,900
VT	100,000	800	700	600	1,900	4,000
WA	1,340,000	11,100	7,200	10,000	15,700	44,000
WI	530,000	4,500	2,800	3,200	6,100	16,600
WV	120,000	900	800	700	1,700	4,100
WY	50,000	400	400	300	1,000	2,100

Table 10. State-Level Port Count Summary for the Simulated 2030 Public DC Network

State	PEVs	DC150	DC250	DC350+	Total
AK	60,000	200	200	300	700
AL	310,000	900	900	700	2,500
AR	190,000	800	900	700	2,400
AZ	780,000	1,200	1,100	1,500	3,800
CA	7,330,000	10,700	7,500	10,900	29,100
CO	790,000	1,500	1,200	1,500	4,200
CT	340,000	600	400	500	1,500
DC	70,000	100	100	100	300
DE	100,000	100	100	100	300
FL	1,900,000	2,800	2,600	2,400	7,800
GA	810,000	1,800	1,800	1,500	5,100
HI	170,000	300	200	200	700
IA	270,000	900	1,000	900	2,800
ID	210,000	600	500	700	1,800
IL	1,100,000	2,000	2,000	1,700	5,700
IN	500,000	1,100	1,100	1,000	3,200
KS	230,000	800	800	900	2,500
KY	300,000	800	900	900	2,600
LA	230,000	600	700	600	1,900
MA	810,000	1,300	1,100	1,100	3,500
MD	680,000	1,100	800	900	2,800
ME	160,000	400	300	400	1,100
MI	720,000	1,700	1,500	1,400	4,600
MN	560,000	1,500	1,200	1,500	4,200
MO	450,000	1,200	1,300	1,100	3,600
MS	150,000	600	700	600	1,900
MT	100,000	600	500	700	1,800
NC	890,000	1,700	1,600	1,600	4,900
ND	50,000	400	300	400	1,100
NE	160,000	600	600	700	1,900
NH	170,000	300	200	300	800
NJ	820,000	1,200	900	1,000	3,100
NM	200,000	500	600	1,200	2,300
NV	320,000	600	600	1,100	2,300
NY	1,420,000	2,500	1,800	2,000	6,300
OH	860,000	1,700	1,700	1,600	5,000
OK	240,000	600	800	800	2,200
OR	720,000	1,200	900	1,500	3,600
PA	1,060,000	1,900	1,600	1,900	5,400
PR	90,000	200	100	200	500
RI	100,000	200	100	100	400
SC	380,000	700	700	600	2,000
SD	70,000	400	300	400	1,100
TN	530,000	1,100	1,200	1,000	3,300
TX	2,230,000	3,900	4,400	5,000	13,300
UT	380,000	700	700	1,200	2,600
VA	950,000	1,800	1,500	1,700	5,000
VT	100,000	300	200	300	800
WA	1,340,000	2,100	1,400	2,100	5,600
WI	530,000	1,300	1,100	1,100	3,500
WV	120,000	400	400	500	1,300
WY	50,000	200	200	400	800

Table 11 provides a port count summary for the private charging network in the top 10 CBSAs by modeled PEV population. As was the case with the national summary, the private network in these markets is simulated as being dominated by EVSE installed at SFHs. Los Angeles is by far the largest CBSA simulated in this analysis, nearly double the size of the next largest CBSA (San Francisco) in terms of assumed PEV fleet size.

Table 11. Port Count Summary for the Simulated Private Network in the Top 10 CBSAs in Terms of Assumed PEV Adoption

		Private Ports		
CBSA	PEVs	Single Family	Multifamily	Workplace
Los Angeles-Long Beach-Anaheim, CA	2,468,000	1,701,000	67,000	43,000
New York-Newark-Jersey City, NY-NJ-PA	1,422,000	1,048,000	7,000	20, 000
San Francisco-Oakland-Berkeley, CA	1,216,000	759,000	40,000	29,000
Washington-Arlington-Alexandria, DC-VA-MD-WV	868,000	628,000	19,000	14,600
Chicago-Naperville-Elgin, IL-IN-WI	848,000	658,000	36,000	11,000
Seattle-Tacoma-Bellevue, WA	805,000	558,000	17,000	15,000
San Diego-Chula Vista-Carlsbad, CA	676,000	466,000	18,000	11,000
Dallas-Fort Worth-Arlington, TX	651,000	542,000	4,000	9,000
Riverside-San Bernardino-Ontario, CA	641,000	486,000	5,000	11,000
Boston-Cambridge-Newton, MA-NH	595,000	426,000	30,000	10,000

Tables 12 and 13 provide port count summaries for the public L2 and DC charging networks in the top 10 CBSAs, respectively. As was the case with the national summary, the public network in these markets is simulated as being dominated by L2 EVSE in terms of port count. On the basis of cost, the public DC network is expected to require the majority of financial resources in all of these markets.

Table 12. Port Count Summary for the Simulated Public L2 Network in the Top 10 CBSAs in Terms of Assumed PEV Adoption

		Public L2 Ports			
CBSA	PEVs	Neighborhood	Office	Retail	Other
Los Angeles-Long Beach-Anaheim, CA	2,468,000	27,000	18,000	14,000	27,000
New York-Newark-Jersey City, NY-NJ-PA	1,422,000	16,000	8,000	6,000	13,000
San Francisco-Oakland-Berkeley, CA	1,216,000	14,000	12,000	9,000	18,000
Washington-Arlington-Alexandria, DC-VA-MD-WV	868,000	9,000	6,000	4,000	9,000
Chicago-Naperville-Elgin, IL-IN-WI	848,000	9,000	4,000	3,000	7,000
Seattle-Tacoma-Bellevue, WA	805,000	7,000	7,000	4,000	9,000
San Diego-Chula Vista-Carlsbad, CA	676,000	7,000	5,000	4,000	7,000
Dallas-Fort Worth-Arlington, TX	651,000	6,000	4,000	3,000	6,000
Riverside-San Bernardino-Ontario, CA	641,000	6,000	5,000	4,000	7,000
Boston-Cambridge-Newton, MA-NH	595,000	6,000	4,000	3,000	6,000

Table 13. Port Count Summary for the Simulated Public DC Network in the Top 10 CBSAs in Terms of Assumed PEV Adoption

		Public DC Ports		
CBSA	PEVs	DC150	DC250	DC350+
Los Angeles-Long Beach-Anaheim, CA	2,468,000	3,000	2,200	3,200
New York-Newark-Jersey City, NY-NJ-PA	1,422,000	1,900	1,400	1,500
San Francisco-Oakland-Berkeley, CA	1,216,000	2,000	1,100	1,600
Washington-Arlington-Alexandria, DC-VA-MD-WV	868,000	1,300	900	1,000
Chicago-Naperville-Elgin, IL-IN-WI	848,000	1,300	1,100	900
Seattle-Tacoma-Bellevue, WA	805,000	1,000	700	1,100
San Diego-Chula Vista-Carlsbad, CA	676,000	800	600	900
Dallas-Fort Worth-Arlington, TX	651,000	900	900	700
Riverside-San Bernardino-Ontario, CA	641,000	900	700	800
Boston-Cambridge-Newton, MA-NH	595,000	900	800	800

Table 14 identifies the top 10 CBSAs in terms of simulated DC ports per 1,000 PEVs. This table highlights areas where demand for DC charging seemingly exceeds expectations based on the local fleet size. Within the context of this analysis, EVI-Pro and EVI-OnDemand assume that all charging demand from vehicles owned within a given CBSA is self-contained within that geography. However, EVI-RoadTrip simulated charging demand on long-distance trips in a spatially explicit way that considers the frequency of BEV travel between counties using an origin-destination matrix from FHWA's TAF (as shown in Figure 23). Charging demand from vehicles "passing through" is believed to be the cause of elevated demand in these locations. For example, the California CBSAs of Merced, Redding, and Bakersfield along the I-5 and CA-99 north-south corridors are relatively small PEV markets where demand from vehicles on long trips between larger surrounding CBSAs make an outsized impact.

Table 14. Top 10 CBSAs by Simulated DC Ports per 1,000 PEVs

CBSA	PEVs	DC Ports	DC Ports per 1,000 PEVs
Merced, CA	26,000	349	13.2
Redding, CA	24,000	236	9.7
Bakersfield, CA	83,000	639	7.7
El Paso, TX	50,000	365	7.3
Lafayette, LA	24,000	173	7.2
St. George, UT	27,000	191	7.1
Gainesville, FL	29,000	202	6.9
Duluth, MN	24,000	161	6.8
Green Bay, WI	27,000	177	6.6
Youngstown-Warren-Boardman, OH-PA	31,000	202	6.5
Top 200 CBSAs	**27,621,000**	**110,000**	**4.0**

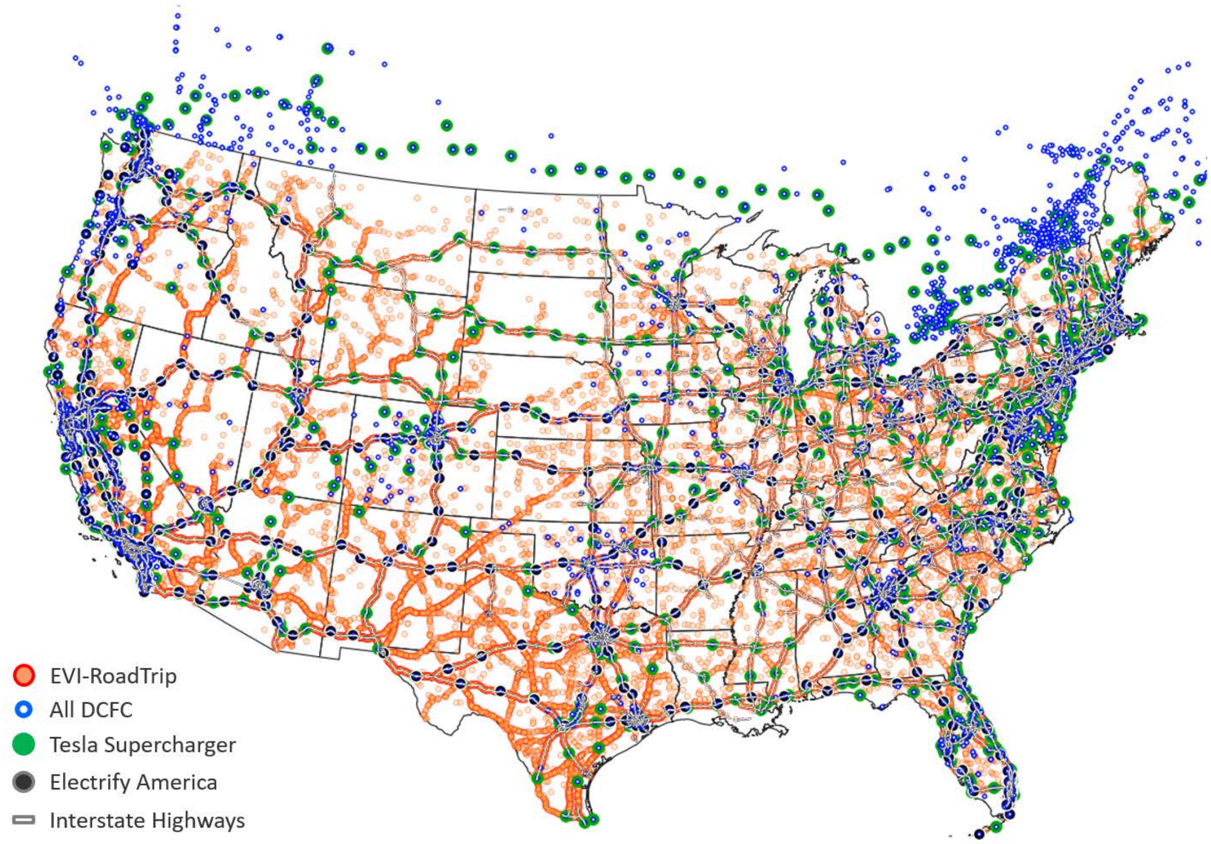

Figure 23. Example charging demand from EVI-RoadTrip overlaid with locations of existing DC stations, including those part of the Tesla Supercharger and Electrify America networks

A closer look at the EVI-RoadTrip simulation results reveals significant variability in simulated utilization across the national corridor network. As shown in Figure 24, among the 1,300 simulated corridor stations (nominally spaced every 50 miles), 60% are estimated to experience four or fewer charging events in the peak hour of a typical day. Of course, some station locations are simulated as having much higher demand; about 10% of stations are estimated to experience 10 or more events during the peak hour of a typical day. This variability of utilization speaks directly to the potential financial viability of operating a national network of corridor stations. In order to achieve national coverage, a significant number of sites are required where low utilization (and revenue) should be expected, even in a national environment with 33 million PEVs on the road.

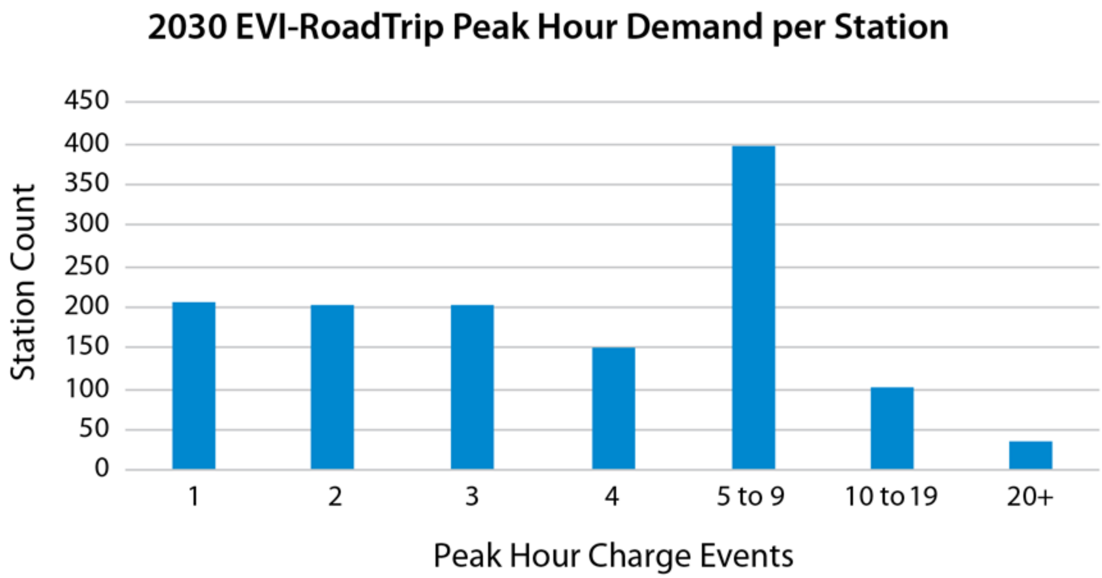

Figure 24. Distribution of peak hourly utilization across corridor stations as simulated by EVI-RoadTrip

For the last example of regionally specific results, we revisit the EVI-OnDemand simulations. Figure 25 shows a scatter plot of normalized DC charging demand across CBSAs as a function of worst-case ambient conditions (based on the Extreme Weather scenario). Ambient conditions are known to impact charging demand, as PEVs tend to consume more energy while being driven in hot and cold environments, typically due to increased electrical loads for operating cabin and powertrain thermal management systems. Charging speeds can also be impacted in extreme environmental conditions, resulting in decreased throughput that could be compensated for with additional infrastructure. In this analysis, BEV sedans are simulated in EVI-OnDemand as achieving energy consumption rates between 300 and 550 Wh/mi while in ride-hailing service. Increased energy consumption is shown to directly correlate to elevated infrastructure needs with EVI-OnDemand.

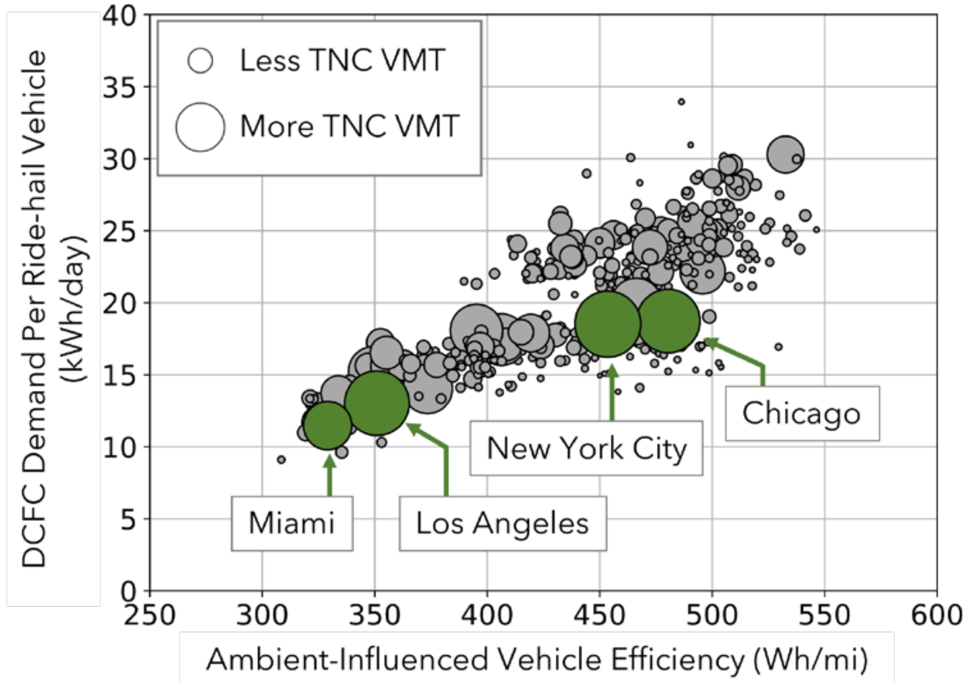

Figure 25. Normalized DC charging demand across CBSAs as a function of worst-case ambient conditions

3.2. Network Growth From 2022 to 2030

National results from the simulation pipeline between 2022 and 2030 are shown in Figure 26. Under the baseline scenario, the size of the national charging network is estimated to require growth from approximately 3.1 million ports in 2022 to 28 million ports by 2030, with the vast majority of this infrastructure simulated as privately accessible L2 units. Isolating for size of the public network, a total of 1.2 million publicly accessible ports (3.6 public ports/100 PEVs) are estimated as being necessary to support 33 million light-duty PEVs in 2030.

Given the large cost differences in L2 and DC infrastructure (reviewed in Section 2), port shares alone may mislead readers as to the significant levels of investment needed to build out the public DC charging network. A cumulative investment of $31–$55 billion in publicly accessible charging infrastructure is estimated through 2030, with a 20/80 share between L2 and DC charging ports (in terms of cost). When including the needs of the private network, the cumulative national infrastructure investment estimate increases to $53–$127 billion with a 52/39/9 share between private, public DC, and public L2 (in terms of cost).

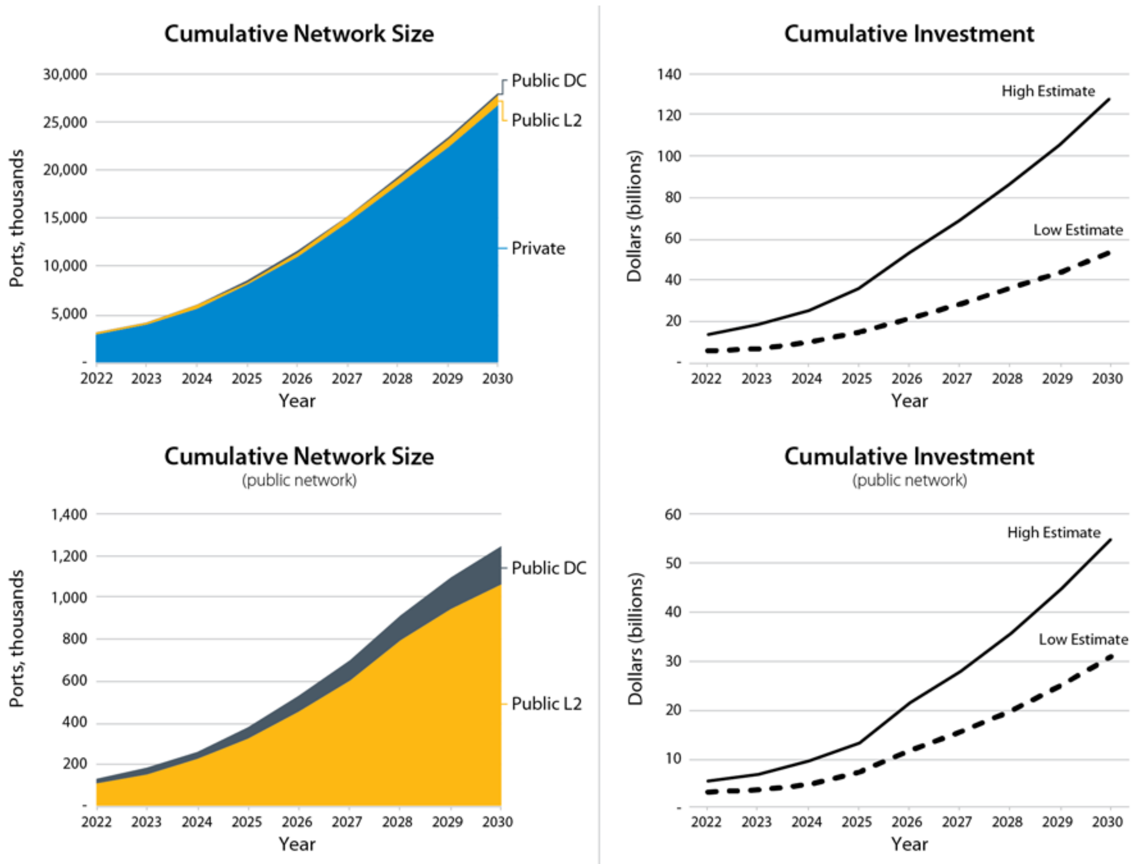

Figure 26. Simulated cumulative network size (left column) and cumulative investment (right column) between 2022 and 2030. Both private and public infrastructure estimates are shown in the top row, while the bottom row isolates the public network result.

The trajectory for network growth and investment needs is shown in Figure 27, with annual needs shown between 2023 and 2030. National simulations estimate annual growth in private and public ports increasing from 1 million in 2023 to 4.5 million in 2030, the vast majority being private EVSE. When isolating publicly accessible charging, simulations suggest annual growth of the public network increasing from 50,000 ports in 2023 to over 200,000 ports in 2028. Interestingly, annual growth in the public network slows after 2028 despite PEV sales continuing to accelerate. This trend is due to a reduced rate of public L2 deployment. While simulated demand for public L2 continues to grow in 2029 and 2030, a significant portion of the new demand is modeled as being met by public L2 infrastructure already installed (implying improved utilization of the simulated public L2 network over time).

Again, the composition of the public network undersells the significance of DC charging. Annual investment in the public network is simulated as increasing from \$0.7–\$1.4 billion in 2023 to \$6.2–\$10.4 billion in 2030, with most of this investment dedicated to DC charging (approximately 80%). As PEV charging technology matures and larger batteries are deployed in PEVs to support longer driving ranges and larger body styles, the mix of DC charging trends toward higher-power installations. While 80% of the 2023 investment in public DC is dedicated to DC150, this share decreases to 27% by 2030, with the majority of investment need shifting to DC350+ by 2026.

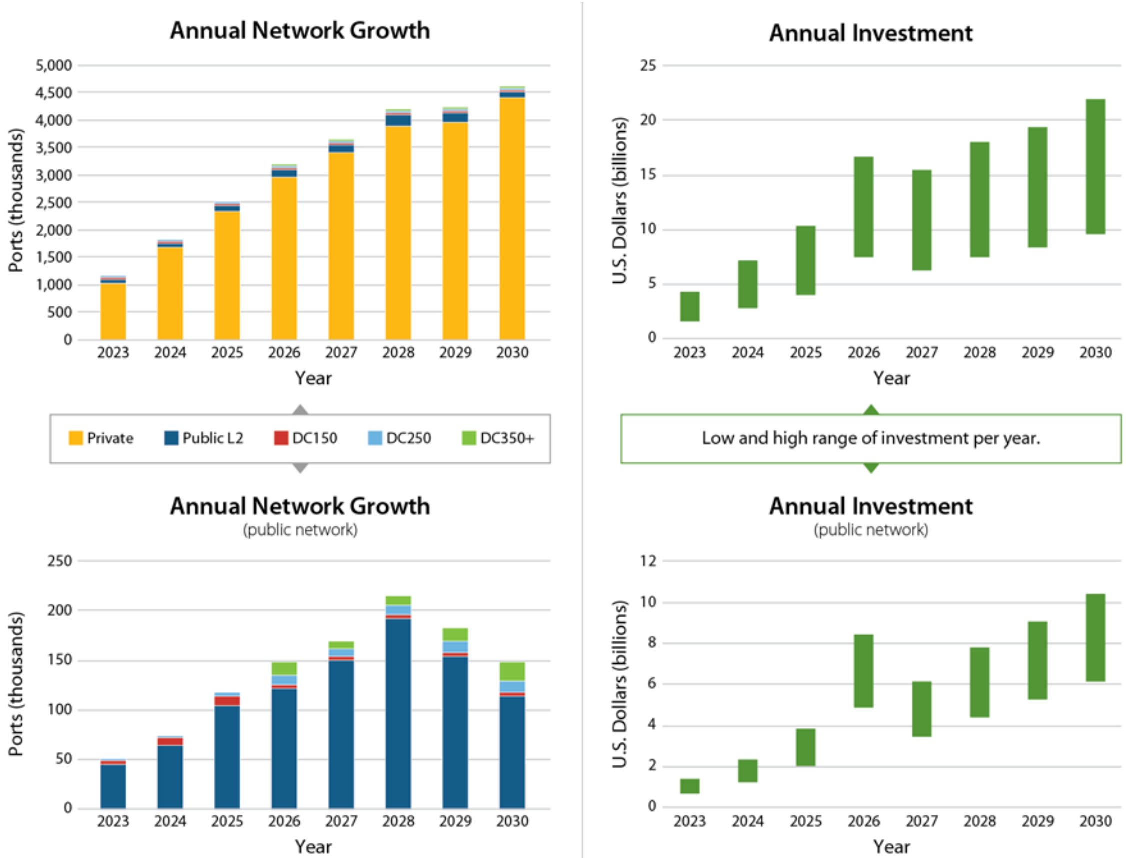

Figure 27. Simulated annual network growth (left column) and investment need (right column) between 2023 and 2030. Both private and public infrastructure estimates are shown in the top row, while the bottom row isolates the public network result.

3.3. Alternate Scenarios

In addition to baseline results presented thus far, a number of alternate scenarios have been simulated to examine impacts of PEV adoption rate, residential access, TNC electrification and more on the size and cost of the national charging network. These scenarios are once again shown in Table 15 (repeated from Section 2.2).

Table 15. Description of Select Plausible Alternates to the Baseline Scenario

Scenario	Description
High Adoption	PEV fleet size growth to 42 million PEVs on the road by 2030 (baseline: 33 million PEVs by 2030)
Low Adoption	PEV fleet size growth to 30 million PEVs on the road by 2030 (baseline: 33 million PEVs by 2030)
Low Home Charging Access	Assumes 85% of PEV drivers with residential access based on the “existing electrical access” scenario from Ge et. al (2021) (baseline: 90% residential access)
High Home Charging Access	Assumes 98% of PEV drivers with residential access based on the “potential electrical access” scenario from Ge et. al (2021) (baseline: 90% residential access)
Reduced Daily Travel	PEVs are driven 60% of days, 25% less than the baseline (80% of days)
Bad Charging Etiquette	PEVs are not unplugged during public destination L2 charging until the driver’s activity at the destination is complete and the vehicle departs (baseline: PEVs are capable of being unplugged when they are finished charging and made available for another PEV)
PHEV Success	PHEVs retain 2022 PEV market share (28%) through 2030 (baseline: PHEVs have 10% PEV market share in 2030)
Alternate PEV Adoption	PEV adoption is geographically uniform in 2030 with no urban early adopter preference (baseline: geographic distribution of PEVs in 2030 reflects 2022 distribution of PEVs and hybrid electric vehicles)
Extreme Weather	EVSE network designed for extreme (95th percentile) weather conditions affecting PEV range and increasing charging demand (baseline: EVSE network designed for average weather conditions)
Slow TNC Electrification	TNC fleets are only 50% PEVs by 2030 (baseline: 100% TNC PEVs by 2030)
Private Workplace Charging	100% of workplace charging at private EVSE through 2030 (baseline: 100% in 2022, decreasing to 50% by 2030)

Alternate scenario results are presented in Tables 16 and 17 for changes in the composition and cost of the national charging network, respectively, relative to the baseline scenario. As a reminder, the baseline scenario considers 33 million PEVs requiring 28 million charging ports at a cumulative cost of $53–$127 billion. This hypothetical network consists of 26.8 million private L2 ports at a cost of $22–$72 billion, 1 million public L2 ports at a cost of $5–$11 billion, and 182,000 public DC ports at a cost of $31–$55 billion.

At first glance, significant variability in the size and composition of the simulated national charging network can be observed across alternate scenarios. Relative to the baseline scenario, national network size and capital cost vary by ±25% across the range of scenarios considered (±50% when isolating to the public network).

Table 16. Relative Port Counts Resulting from Parametric Sensitivity Analysis

Baseline	**26,762**	**1,067**	**182**	**28,010**
Relative Port Counts (thousands)				
Scenario	**Private**	**Public L2**	**Public DC**	**Total**
High Adoption	7,038	302	29	7,370
Low Adoption	(2,120)	(111)	(8)	(2,239)
Low Home Charging Access	(1,236)	70	13	(1,153)
High Home Charging Access	2,459	(167)	(33)	2,259
Reduced Daily Travel	(157)	(180)	(22)	(358)
Bad Charging Etiquette	360	473	(0)	833
PHEV Success	388	615	(17)	986
Alternate PEV Adoption	1,736	16	7	1,758
Extreme Weather	87	162	49	298
Slow TNC Electrification	(41)	(10)	(17)	(69)
Private Workplace Charging	436	(450)	(0)	(15)

Table 17. Relative Infrastructure Costs Resulting from Parametric Sensitivity Analysis

Baseline	$22B to $72B	$5B to $11B	$27B to $44B	$53B to $127B
	Relative Cost ($ billions)			
Scenario	Private	Public L2	Public DC	Total
High Adoption	$12.5	$2.3	$5.9	$20.7
Low Adoption	($3.9)	($0.8)	($1.7)	($6.5)
Low Home Charging Access	($1.5)	$0.5	$2.5	$1.5
High Home Charging Access	$2.8	($1.3)	($6.2)	($4.6)
Reduced Daily Travel	($1.0)	($1.3)	($4.3)	($6.7)
Bad Charging Etiquette	$2.9	$3.5	($0)	$6.4
PHEV Success	$1.6	$4.6	($3.4)	$2.7
Alternate PEV Adoption	$2.2	$0.1	$1.1	$3.4
Extreme Weather	$0.9	$1.2	$9.1	$11.2
Slow TNC Electrification	($0.1)	($0.1)	($3.0)	($3.2)
Private Workplace Charging	$3.5	($3.4)	($0)	$0.1

The “Low Adoption” and “High Adoption” scenarios result in different PEV fleet sizes, impacting the size of the simulated charging network. “Low Adoption” assumes a national PEV fleet size of 30 million. This results in decreased demand for charging of all types, with 2.2 million fewer ports and cost reduced by $6.5 billion. Conversely, the “High Adoption” scenario assumes an on-road fleet of 42 million by 2030. Naturally, this increases demand for charging such that 7.3 million more ports are necessary at an incremental cost of $20.7 billion. Of the scenarios explored, the “High Adoption” scenario increases the size and cost of the national charging network by the most significant margin.

The “High Home Charging Access” and “Low Home Charging Access” scenarios adjust the baseline assumption of 90% overnight residential charging access to 98% and 85%, respectively. The “Low Home Charging Access” scenario shifts demand toward nonresidential locations such that the national public charging network increases by 83,000 ports at an incremental cost of $3.0 billion. Conversely, high residential access is simulated as shifting charging demand away from nonresidential locations such that the national public charging network decreases by 200,000 ports at a cost savings of $7.5 billion.

The “Reduced Daily Travel” scenario decreases driving across the fleet by 25%. As expected, this leads directly to a decrease in size and cost of the national network with 358,000 few ports needed at a cost savings of $6.7 billion. Of the scenarios explored, the "Reduced Daily Travel" scenario decreases the cost of the national charging network by the most significant margin.

While PEVs are assumed to be unplugged when finished L2 charging at nonresidential locations in the baseline scenario, the "Bad Charging Etiquette" scenario assumes L2 chargers are not available until the driver departs that location. This behavior scenario results in a less efficient utilization of infrastructure and increases the network size requirement by 833,000 ports at a cost of $6.4 billion.

The baseline scenario assumes PHEVs comprise 10% of on-road PEVs by 2030. The implications of this assumption are tested in the "PHEV Success" scenario, where PHEV on-road share is increased to 28% (consistent with present-day adoption). In this scenario, the shift to more PHEVs impacts the composition of the simulated national charging network, with L2 EVSE (private and public) increasing by 1 million ports and public DC charging ports decreasing by 17,000 ports (a consequence of PHEVs being simulated as primarily relying on L2 charging away from home and BEVs primarily relying on DC charging away from home).

The baseline scenario assumes PEVs in 2030 are adopted proportional to existing PEV and gasoline-hybrid registrations, with up to 35% of vehicles on the road as PEVs in urban areas and as low as 3% of vehicles on the road as PEVs in rural areas. The implications of this assumption are tested in the "Alternate PEV Adoption" scenario in which PEV adoption is enforced as uniform across the country. This scenario shifts PEVs from urban areas into rural areas and ultimately has the effect of dispersing demand for charging across larger areas and depressing sharing potential (utilization). This increases the cost of the national network by $3.4 billion.

The baseline scenario considers infrastructure needs under typical ambient conditions for each region. The "Size Network for Extreme Weather" scenario instead simulates demand assuming vehicle efficiency in line with the hottest or coldest day of a typical year in each location (whichever is worse). This increases the energy consumption of PEVs (even for the same amount of driving) and requires additional infrastructure to meet said demand. This scenario increases the size of the national charging network by 298,000 ports at a cost of $11.2 billion.

While the two largest U.S. TNCs (Uber and Lyft) have announced targets for 100% electrification of their operations by 2030, the "Slow TNC Electrification" scenario is used to demonstrate the impacts to national infrastructure needs in the event these firms fall short of their electrification goals. This scenario assumes 50% of on-road ride-hailing vehicles are converted to PEVs by 2030. Given that EVI-OnDemand (as deployed within this analysis) simulates electric TNCs primarily relying on DC charging away from home, impacts to L2 port counts are relatively muted. On the other hand, slow TNC electrification significantly decreases national fast charging needs (primarily in urban areas), with 17,000 fewer DC ports required at a cost savings of $3.0 billion.

4. Discussion

This report spans several areas worthy of further discussion. The final section of this report is organized into discussion of philosophical contributions, modeling uncertainty, cost estimate considerations, critical topics for future research, and avenues for accessing EVI-X modeling capabilities.

4.1. Philosophical Contribution

This analysis proposes a novel EVSE taxonomy that independently decouples access type, location type, and charger type. While the legacy home/work/public charging pyramid so often used to conceptualize conversation around infrastructure has served a useful purpose, we argue it inadvertently confuses issues of access type (e.g., public, private) and location type (e.g., home, office, retail) and is particularly ambiguous with respect to workplace charging (as discussed in Section 2.3.2). The analytic results of this analysis have been used to conceptualize an infrastructure planning philosophy that is akin to a tree (as shown in Figure 28).

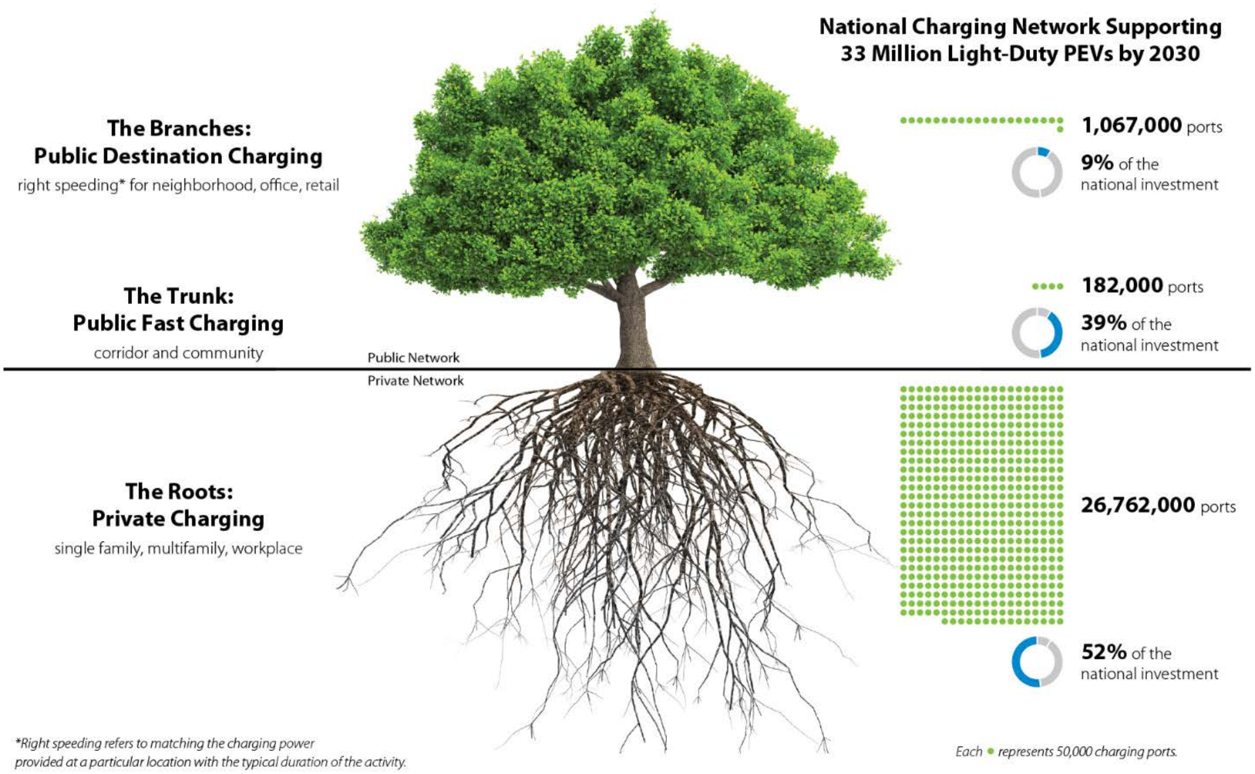

Figure 28. Conceptual illustration of national charging infrastructure needs

As with a tree, there are parts of the national charging network that are visible and those that are hidden. Public charging is the visible part of the network that can be seen along highways, at popular destinations, and through data accessible online. Private charging is the hidden part of the network tucked away in personal garages, at apartment complexes, and at certain types of workplaces. This private network is akin to the roots of a tree, as it is foundational to the rest of the system and an enabler for growth in more visible locations.

If access to private charging at home is the roots of the system, a reliable public fast charging network is the trunk, as it benefits from access to charging at home and other private locations (a key selling point of PEVs) and ultimately helps grow the system by making PEV ownership more convenient (enabling road trips and supporting those without residential access). While fast charging is estimated to be a relatively small part of the national network in terms of number of total ports, it requires significant investment and is vital to enabling future growth by assuring drivers they will be able to charge quickly whenever they need or want.

The last part of the system is a broad set of publicly accessible destination charging locations in dense neighborhoods, office buildings, and retail outlets where the speed of charging can be designed to match typical parking times ("right-speeding"). This network is similar to the branches of a tree in that its existence is contingent on a broad private network and a reliable fast charging network. As with the branches of a tree, the public destination charging network is ill-equipped to grow without the support of charging elsewhere.

4.2. Modeling Uncertainty

Throughout this study, the importance of residential charging shines through. Based on survey data, 90% of PEVs nationally are assumed to have access to reliable, overnight charging access in the baseline 2030 scenario. This assumption implies over 26 million private residential ports installed by 2030 (at single-family and multifamily locations) at a cost of $20–$67 billion. Sensitivity analysis on this assumption to adjust residential access up to 98% shows that capital costs can be decreased by $4.6 billion in the "High Home Charging Access" scenario. While there is undeniable value to having access to midday charging away from home to better align with expectations for increased solar penetration on the electric grid (Powell 2022), efforts to improve U.S. residential charging access have the potential to not only reduce capital costs on the public network, but also provide drivers with a primary charging location that offers maximal affordability, convenience, and flexibility. This report reinforces recent findings on the value of residential charging (Pierce and Slowik 2023).

While not necessarily a large part of the 2030 fleet in terms of number of vehicles, PEVs used within ride-hailing services present an outsized demand on public infrastructure, particularly fast charging (Jenn 2020). This analysis adopts an aggressive electrification assumption for TNCs based on recent announcements from Uber and Lyft for 100% ZEVs by 2030. Under this assumption, the ride-hailing use case represents approximately 21% of simulated fast charging demand nationally. As shown in the "Slow TNC Electrification" scenario, reducing 2030 TNC electrification to 50% decreases capital costs by $3.2 billion. The sensitivity between TNC electrification rates and charging infrastructure investment needs (particularly public fast charging) should motivate close coordination between charging network investors (public and private) and TNCs.

Geographically, this study finds that the majority of public infrastructure necessary in rural communities is likely to serve travelers from larger, urban areas passing through on long-distance travel. This finding is the product of relatively low levels of PEV adoption and high levels of residential charging access in rural areas (as compared to urban). This situation presents opportunities for economic activity in rural communities. Foot traffic from travelers visiting local retailers while charging presents an economic opportunity facilitated by new federal tax credits for refueling infrastructure passed in the Inflation Reduction Act of 2022.

As discussed in Section 1.2, several recent U.S. charging infrastructure assessments have been completed for 2030 scenarios, as shown in Table 18. While assumptions, methods, and results differ across these studies, there is consensus that the U.S. PEV fleet is poised for dramatic growth that will require significant investments in publicly accessible charging infrastructure. While evolving consumer preferences and charging business models will ultimately dictate the size and composition of the public network, the baseline scenario and associated sensitivity analysis are believed to provide a reasonable baseline that balances the cost and convenience advantages of destination charging at long-duration locations with the need for fast charging that supports those without residential access, long-distance travel, and ride-hailing electrification.

Table 18. Summary of Recent 2030 U.S. Charging Infrastructure Assessments

Organization (Reference)	Light-Duty PEV Stock	Est. 2030 Public Ports (including DC)	Est. 2030 DC Ports
ICCT (Bauer et al. 2021)	26,000,000	2,400,000	180,000
Atlas Public Policy (McKenzie and Nigro 2021)	48,000,000	600,000	300,000
McKinsey (Kampshoff et al. 2022)	44,000,000	1,200,000	600,000
S&P Global (S&P Global Mobility 2023)	28,000,000	2,300,000	172,000
NREL (current report)	33,000,000	1,250,000	182,000

4.3. Cost Estimate Considerations

This report estimates that a $53–$127-billion cumulative national charging infrastructure investment, including $31–$55 billion for publicly accessible charging infrastructure, is necessary to support charging infrastructure needs under the baseline scenario. Considering the estimate does not explicitly account for the cost of grid upgrades beyond charging hardware and installation costs, this estimate is likely a conservative one.

As of March 2023, we estimate $23.7 billion has been announced for publicly accessible light-duty PEV charging infrastructure through the end of the decade, including from the Bipartisan Infrastructure Law, private firms, state and local governments, and electric utilities. Public and private investments in publicly accessible charging infrastructure have accelerated in recent years. If sustained with long-term market certainty grounded in accelerating consumer demand, these public and private investments will put the United States on a path to meeting the infrastructure needs simulated in this report. Existing and future announcements may be able to leverage direct and indirect incentives to deploy charging infrastructure through a variety of programs, including from the Inflation Reduction Act and the Low Carbon Fuel Standard, ultimately extending the reach of announced investments.

Interpretation of the infrastructure cost estimates made by this report should also take into account that hardware and installation cost parameters have been developed purely based on historic observations in the literature. While these estimates reflect the best available public data and charging infrastructure costs to date, they are neither comprehensive of all charging installers nor predictive of how costs may evolve over time. For example, some observers have speculated that Tesla's Supercharger network is being developed at costs far below industry average by taking advantage of their unique scale and experience (Lambert 2022). While it has long been understood that charging infrastructure capital costs vary dramatically from site to site based on a variety of suitability measures, perhaps it should come as no surprise that costs also vary dramatically between charging developers. Regarding the evolution of charging infrastructure capital costs, valid arguments can be made in favor of costs decreasing or increasing over time (as previously discussed in Section 2.3.4).

Uncertainty aside, the magnitude of these costs underscores the need to take measures to improve the efficiency of charging infrastructure installations (both cost and time) for the benefit of all stakeholders. For example, many states today employ a just-in-time construct where infrastructure is only built as new service is requested by customers. Such a framework would likely need to be revised to allow for both a more cost-efficient, resource-efficient, and time-efficient advanced build of utility infrastructure to accommodate EVs ahead of need and, especially, ahead of a rapid onset of new high-power service requests; otherwise, the necessary number of chargers may not be in place during a period of accelerating demand for EVs. In a recent analysis, the Interstate Renewable Energy Council argues that "*to accommodate the required growth, utilities must have efficient processes in place to interconnect new chargers to the grid, especially in preparation for a surge of new service requests that could result from federal spending*" (Hernandez 2022). Such efficiencies could potentially be achieved by all stakeholders (utilities, charging networks, and government) having access to an objective estimate of connection needs with sufficient spatial and temporal resolution as to facilitate a robust planning process. It is our hope this analysis will serve as the foundation for such a planning tool and enable modernizing the regulatory framework to meet the new transportation sector needs.

4.4. Critical Topics for Future Research

While this study attempts to exhaustively consider key use cases for charging personally owned light-duty PEVs, it does not consider the charging infrastructure needs of light-, medium-, and heavy-duty PEVs used for commercial purposes (with the exception of ride-hailing services). Medium-duty commercial vehicles (work trucks) in the 2b–3 segment (gross vehicle weight rating of 8,500–14,000 pounds) are of particular interest because they represent a large number of vehicles on the road and traditionally take advantage of the same fueling infrastructure used by light-duty vehicles. Manufacturers are bringing 2b–3 electric work trucks to market that will likely take advantage of much of the same public charging infrastructure prescribed for personal use of light-duty vehicles in this report. While not explicitly considered here, this incremental demand would likely improve utilization of infrastructure ostensibly deployed to support light-duty vehicles and necessitate additional charging infrastructure beyond what has been estimated in this work. While the unique nature of commercial vehicles (in terms of travel patterns and overnight access to private/depot charging infrastructure) make them ill-suited to the methods/data underlying this analysis, quantifying synergies with charging infrastructure primarily deployed for supporting personally owned, light-duty vehicles is a topic ripe for future research.

While not the focus of this report, we would be remiss to not comment on the importance of reliable charging infrastructure. This analysis envisions a future national charging network that is strategic in locating the right amount of charging, in the right locations, with appropriate charging speeds. However, this vision is irrelevant if the public concludes that charging infrastructure is ultimately unreliable. Even if a relatively small amount of infrastructure fails drivers, this could negatively impact the public's perception of electric mobility. There is perhaps no charging infrastructure topic more urgent at this moment than ensuring that all new installations going forward are designed and supported over the long term with reliability front of mind.

4.5. Accessing EVI-X Capabilities

Great care was taken to structure this analysis in a way to provide users with maximum flexibility in defining customizable scenarios and viewing results at a state or local level. Unfortunately, the medium of a technical report does not lend itself well to exposing all of these results in a readily accessible format. To that end, this report is published alongside a set of downloadable data tables summarizing analysis results from the baseline and alternate scenarios at the state and CBSA level (https://data.nrel.gov/submissions/214). Updates to the online version of EVI-Pro (EVI-Pro Lite) are also being made and should be accessible online late in 2023 to enable customized scenario development at the local level. These updates are expected to include capabilities derived from EVI-RoadTrip and EVI-OnDemand.

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Appendix: 2022 Modeling Comparison

A basic test of the simulation pipeline is applied by comparing the national network size from the 2022 simulation to the actual size of the public network as of 2022. As shown in Figure A-1, the 2022 simulation result produces 115,000 publicly accessible L2 ports and 22,000 DC charging ports. This results in a network that is 7% larger than the 100,000 publicly accessible L2 ports and 27,000 DC charging ports reported by the Station Locator on DOE's Alternative Fuels Data Center (as of Dec. 16, 2022). The large disparity in DC ports is due to the simulation dispatching exclusively high-power DC ports (i.e., 80% 150 kW and 20% 250 kW) when charging "as fast as possible" (default for the baseline scenario), whereas the actual DC network has been developed over time and primarily consists of <150-kW ports, with higher-powered options only becoming more common as of late.

While significant effort has been invested in designing realistic models and populating them with the best available data, no specific effort to calibrate the model against observed size of the national network has been made.

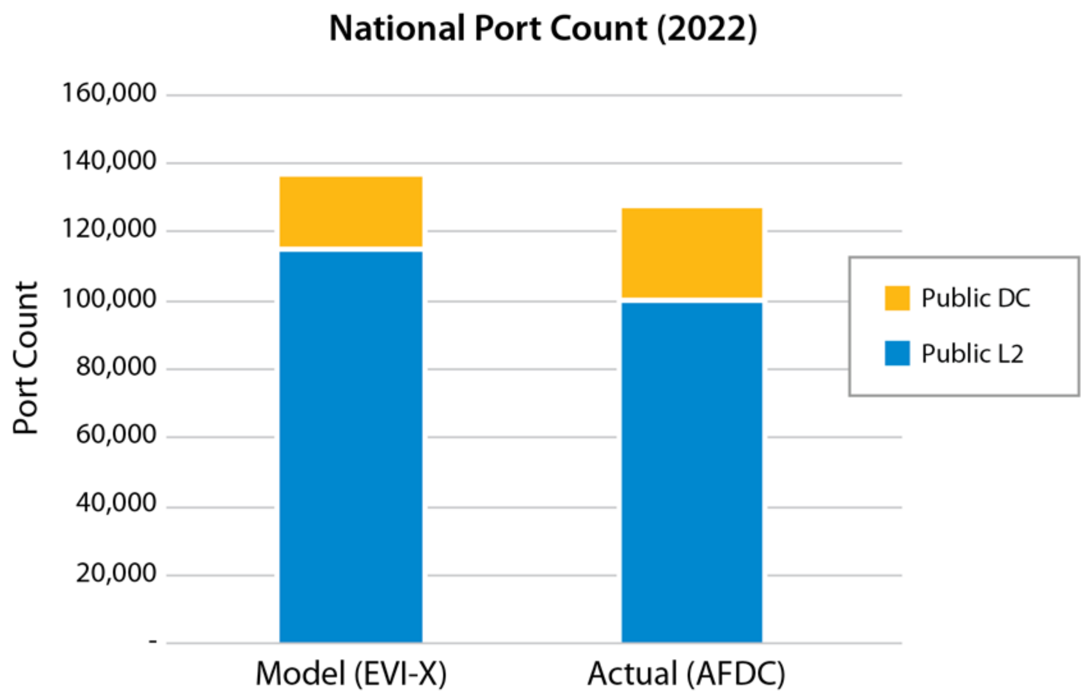

Figure A-1. Size of the 2022 national charging network as simulated in the national pipeline compared to the actual network as measured by the Alternative Fuels Data Center

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