BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

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

NOTICE OF FILING

TO: Don Brown
Clerk of the Board
Illinois Pollution Control Board
60 E. Van Buren St., Suite 630
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, the **PRE-FILED TESTIMONY OF STEVEN DOUGLAS IN OPPOSITION OF RULE PROPONENTS' REGULATORY PROPOSAL** 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: January 21, 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 TESTIMONY OF STEVEN DOUGLAS IN OPPOSITION OF RULE PROPONENTS' REGULATORY PROPOSAL** via electronic mail upon:

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That the number of pages in the email transmission is 416.

That the email transmission took place before 4:30 p.m. on January 21, 2025.

Date: January 21, 2025

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

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

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

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PRE-FILED TESTIMONY OF STEVEN DOUGLAS
IN OPPOSITION OF RULE PROPONENTS' REGULATORY PROPOSAL

1. Introduction

The Alliance for Automotive Innovation (Auto Innovators)[1] by and through counsel, submits the following Pre-Filed Testimony of Steven Douglas in opposition to the Rule Proponents' regulatory proposal for presentation at the March 10-12, 2025 hearing in the above-captioned matter.

2. Qualifications

Steven Douglas is a vehicle emission control policy expert and consultant to Auto Innovators. He has 30 years of experience with federal and state vehicle environmental regulations and legislation. Since 2024, he has worked as an independent consultant, providing policy and strategic advice on the implementation of advanced emission control technologies and alternative fuel vehicle policies to automobile manufacturers and suppliers. Mr. Douglas has testified extensively before state and federal regulatory agencies and state legislatures on vehicle environmental policies since joining the automotive industry in 1995. He worked extensively

[1] Auto Innovators represents the full automotive 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.

with the California Air Resources Board (CARB) and U.S. Environmental Protection Agency (EPA) on virtually every vehicle emission regulation proposed or adopted in that time including California's zero emission vehicle (ZEV) mandate, greenhouse gas (GHG), Advanced Clean Car (ACC) I, ACC II, and On-Board Diagnostics (OBD) regulations, and U.S. EPA's light-duty vehicle Tier 2, Tier 3, and Tier 4 regulations. Mr. Douglas has a Bachelor of Science in Electrical Engineering from Auburn University and prior to joining the automobile industry, he was a qualified submarine officer and nuclear engineer in the U.S. Navy. His resume is attached hereto as **Exhibit A**.

3. Executive Summary

The Auto Innovators respectfully recommends the Illinois Pollution Control Board (IPCB) not adopt California's ACC II regulations.

The ACC II ZEV mandate will quickly eliminate new vehicle choices for Illinois families, farmers, and businesses. While interest in electric vehicles (EVs)[2] is growing, not all Illinois shoppers are ready or able to buy and drive an EV. With ACC II, they will quickly have no choice. At the same time, ACC II criteria and the ACC I greenhouse gas (GHG) regulations will waste Illinois government resources by requiring the state to implement and manage a complex suite of duplicative regulations for vehicles sold in Illinois that are already regulated under strict federal EPA rules adopted less than a year ago. Duplicative regulations add no value and simply make cars and trucks more expensive for Illinois shoppers. Eliminating choice and

[2] Throughout this document, unless otherwise noted "electric vehicles" or "EVs" includes plug-in hybrid, battery, and fuel cell electric vehicle (PHEV, BEV, and FCEV, respectively).

adding cost simply doesn't make sense, especially at this time when many consumers are struggling with inflation and affordability in general.

Today in Illinois, a vehicle shopper has unlimited access to electric vehicles and is free to choose one if this technology fits their family's or business' needs. EVs are great cars, and our members have invested hundreds of billions of dollars to provide a range of great EV choices. Automakers hope that customers will try and consider an EV for their next purchase. However, if a customer is not ready for an EV, they have the choice to select from many other clean technologies such as hybrids or advanced combustion engines with excellent fuel economy and low emissions. The ACC II ZEV mandate eliminates that choice. California policymakers have chosen this path for their drivers and their market, but this does not have to be the fate for Illinois. Auto Innovators and our members support technology diversity and recognize there is no one-size-fits-all solution for Illinois drivers. We urge you to protect their choice.

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).

In addition, this is not some future ambition far out on the horizon, but rather a policy that will lead to dramatic reductions in gasoline vehicle availability and sales in the next few years. We are in the 2026 model year (MY) today, and MY2029 is just three years away when 59 percent of new vehicles sold in Illinois must be EVs if the proposal is adopted. Illinois consumers have not embraced EVs in the necessary quantities, and the infrastructure is not sufficient to support the level of ZEV sales required in MY2029. As a result, adoption of this regulation could have dramatic negative consequences for the Illinois economy and its citizens. This is especially true for Illinois farmers and businesses that demand the capability of gasoline vehicles and is likewise true for low-income residents who do not enjoy the same access to affordable, reliable, and convenient home charging as affluent single-family homeowners currently buying most EVs.

4. Automakers are committed to electrifying the vehicle fleet

Automakers are committed to electrifying the vehicle fleet. By investing $100s of billions in vehicle and battery development and production, they now offer highly competitive EV models in addition to traditional hybrid electric vehicles (HEVs) and advanced technology gasoline vehicles that are highly fuel efficient and ultra-low emitting.

Automakers are committed to a transition to zero-emission and other electrified vehicles and are investing heavily in electrification. Reuters estimated that on a global scale, the auto industry will spend $1.2 trillion by 2030 to develop and produce new battery-powered vehicles.[3] This investment includes the construction of new assembly plants and battery factories, as well as retooling and upgrading existing facilities to support the production of EVs.

In total, automakers have committed nearly $130 billion to EV-related investments in the U.S., with $38 billion allocated for EV manufacturing facilities and $91 billion for battery production.[4] In Illinois, $2 billion has been invested, creating 2,600 new jobs. This investment has occurred without a ZEV mandate in the state. Nationwide, the industry has generated

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[3] Lienert, P. (2022, October 21). Automakers to double spending on EVs, batteries to $1.2 trillion by 2030. *Reuters*. Retrieved from https://www.reuters.com/technology/exclusive-automakers-double-spending-evs-batteries-12-trillion-by-2030-2022-10-21/. Attached hereto as **Exhibit B**.

[4] Alliance for Automotive Innovation. (n.d.). *EV investment dashboard*. Retrieved December 21, 2024, from https://www.autosinnovate.org/resources/ev-investment-dashboard.. Attached hereto as **Exhibit C**.

113,000 new jobs in the EV sector, highlighting the industry's dedication to transforming the automotive landscape.

As of Q2 2024, 117 EV models are available for sale in the U.S. and Illinois. Automakers are offering a wide range of EV styles and types to meet diverse consumer needs, including sedans, crossovers, SUVs, vans, and pickup trucks. This extensive variety ensures that there is an EV for nearly every consumer segment.

There have been concerns that if a state does not adopt California's ZEV mandate, automakers may limit the availability of the EV models most in demand in those states. However, this concern is unfounded. ZEVs are available in all states including Illinois. Indeed, a recent search on Autotrader for new EVs for sale within a 25-mile radius of the 60611 zip code (Chicago) revealed over 1,600 vehicles on dealer lots — over 1,000 battery-electric vehicles and over 600 PHEVs.[5] These EV are being offered by 29 different makes and does not even include EV-only manufacturers like Tesla, Rivian and Lucid, which doesn't sell through dealerships. There is no question that Illinois residents already have an abundance of EVs to choose from (perhaps even an *over*abundance) should they desire to purchase one.

5. <u>The ZEV Mandate does not expand the EV market</u>

Adopting the ACC II ZEV mandate does not ensure robust EV market growth. Automakers already offer a wide range of EVs (sedans, utility vehicles, pickups, vans, 2WD, AWD, PHEV, BEV, etc.) to meet the diverse needs of Illinois consumers. The EV market

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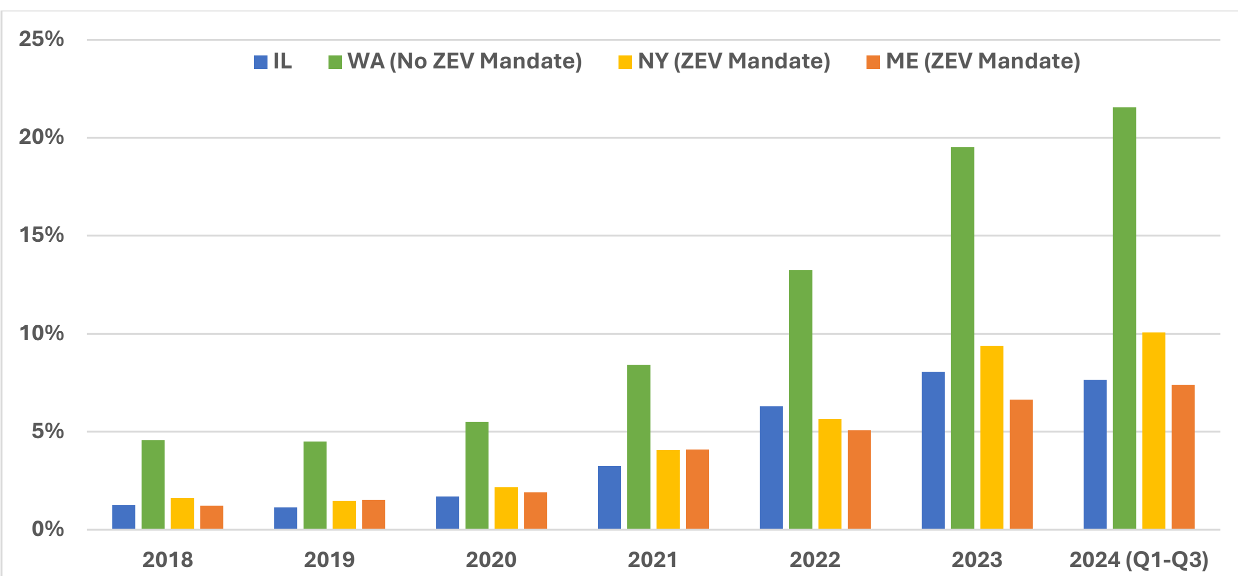
[5] Excerpt of search results from Autotrader's website accessed on January 9, 2025 at https://www.autotrader.com/cars-for-sale/new-cars/chicago-il?fuelTypeGroup=ELE&fuelTypeGroup=PIH&searchRadius=25&startYear=2024&zip=60611 (last accessed January 16, 2025). Attached hereto as **<u>Exhibit D</u>**.

grows through a sustained, substantial, and consistent year-over-year commitment by the state to develop the infrastructure and incentivize the vehicles.

The full scope of California's EV mandate is often misunderstood or misrepresented by ZEV mandate proponents. What they fail to understand is that adopting California's ZEV mandate does not change EV availability nor ensure EV sales growth. In fact, as shown in *Figure 1* below, Maine and New York adopted California's ZEV mandate decades ago, yet their ZEV sales are not significantly different than Illinois ZEV sales. On the other hand, Washington did not have the ZEV mandate until this year, but it has consistently had the second highest ZEV market share (behind only California) for many years. In fact, declining to adopt California's regulations simply leads to a more consumer-driven market where greenhouse gas emissions continue to decline under the stringent EPA emissions standards and market-driven technology availability that includes EVs, plug-in hybrid electric vehicles (PHEVs), conventional hybrid electric vehicles (HEVs), and highly efficient gasoline vehicles.

Figure 1 : ZEV mandate vs. No ZEV mandate States



If Illinois wishes to accelerate its EV market, it should follow Colorado's lead. In the 3rd quarter of 2024, Colorado surpassed California in EV sales rate, with EVs making up 25.3 percent of new vehicles sold in the state. This is the first quarter in history that any state's ZEV sales have topped California's. How did Colorado do it? Aggressive incentives and growing infrastructure.

- All Coloradans were eligible for a $5,000 state tax credit[6] for purchasing or leasing a new EV (battery electric and plug-in hybrid electric) with a manufacturer's suggested retail price (MSRP) under $80,000, and an additional $2,500 for EVs with an MSRP under $35,000 through 2024CY. Starting this year, the tax credit decreases to $3,500. Income-qualified Coloradans exchanging an eligible old or high-emitting vehicle can also take advantage of a $6,000 rebate through the Vehicle Exchange Colorado[7] program for a new EV purchase or lease and a $4,000 rebate for a used EV purchase or lease. Thus, income-qualified Coloradans can enjoy a $11,000 (or $13,500 for an EV with an MSRP under $35,000) state tax credit on the purchase or lease of a new EV.

- Colorado is also aggressively expanding public EV charging. Colorado currently has over 5,500 publicly available L2 and direct-current fast charger (DCFC) charging ports across the state. This compares with just over 4,000 in Illinois, even though Illinois' vehicle market is twice the size of Colorado's.

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[6] Colorado Energy Office. (n.d.). Electric vehicle tax credits. Colorado Energy Office. Retrieved January 6, 2025, from https://energyoffice.colorado.gov/transportation/grants-incentives/electric-vehicle-tax-credits. Attached hereto as **Exhibit E**.

[7] Colorado Energy Office. (n.d.). Vehicle exchange Colorado. Colorado Energy Office. Retrieved January 6, 2025, from https://energyoffice.colorado.gov/vehicle-exchange-colorado. Attached hereto as **Exhibit F**.

6. <u>Overview of U.S. vehicle emission regulations</u>

Vehicle emission regulations – adopted by both EPA and California – control GHG and criteria-pollution emissions. Adopting California's ACC II will dramatically reduce vehicle choice and sales but will not reduce global GHG or criteria-pollution emissions.

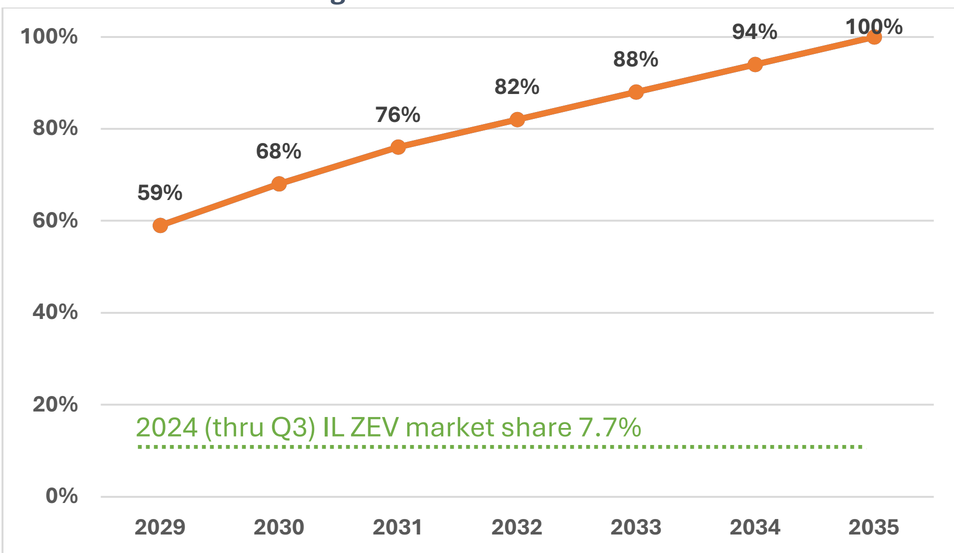
Under the Clean Air Act, the federal government, through the EPA, sets vehicle emissions standards that apply to all vehicles sold in the U.S. However, there is an exception that allows California to set its own vehicle emissions standards, provided it receives a waiver from the federal government. Other 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.

Consequently, 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. Both programs aim to reduce vehicle criteria and greenhouse gas emissions. The key difference between them lies in how they require automakers to meet these objectives.

The federal program sets a performance standard for the U.S. vehicle fleet, requiring automakers to sell vehicles that, on average, meet specific emissions targets, measured in grams per mile. To comply, automakers can offer a variety of vehicle types, including battery electric, traditional hybrid or plug-in hybrid, fuel cell, or fuel-efficient gasoline-powered vehicles. Even still, EPA projects that compliance with their newly adopted GHG standards will result in 50 percent ZEVs in 2030MY and 72 percent in 2032MY nationwide.

In contrast, California's ACC II program takes a very prescriptive approach with the ZEV mandate portion of ACC II. It mandates that automakers leap from a current relatively low market share of ZEVs (e.g., 7.7% in Illinois in 2024 through Q3) to 59% in 2029MY when Illinois would begin the ACC II program, if adopted. As shown in <u>*Figure 2*</u>, the initial leap is then followed by further continuous rapid increases in required market share culminating in a 100 percent requirement in 2035MY.[8]

Figure 2 : 2029-2035 ZEV Mandate



The requirements in ***Figure 2*** apply to each individual automaker, not the industry as a whole. They also apply separately in each individual state.[9] Every automaker must meet the specific sales targets for ZEVs in California and in each state that follows California. States are not allowed to modify these percentages; they must adopt CARB's ZEV regulation verbatim. While California's ACC II also contains criteria emission standards, those standards are currently less stringent than those adopted by the EPA in 2024CY. Furthermore, while not part of ACC II, California also has outdated GHG regulations (13 CCR §1961.3, from the 2012 Advanced Clean Cars I regulation), which are also less stringent than EPA's GHG standards.

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[8] Manufacturers may meet up to 20% of the requirement with plug-in hybrid electric vehicles. However, those vehicles must have a much higher electric range than those currently on the market, effectively making them plug-in electric vehicles.

[9] The regulation allows a limited transfer of credits between states. However, as discussed in more detail below, such "flexibility" is not valuable since it requires the automaker (at least non-EV-only automakers) to exceed requirements in another state and forgo more valuable "flexibilities."

a. EPA requirements

Illinois currently follows the federal EPA regulations for GHG and criteria emission standards. While EPA does not have a ZEV mandate, its GHG and criteria emission standards will require increasing ZEV sales. In March 2024, EPA updated its regulations in the "Multi-Pollutant Emission Standards for Model Year 2027 and Later Light-Duty and Medium-Duty Vehicles: Final Rule."[10] This updated regulation establishes very stringent GHG and criteria emission standards for light- and medium-duty vehicles (LDVs and MDVs, respectively) for model years 2027-2032.[11] EPA expects manufacturers to produce about 72 percent ZEVs (including BEVs and PHEVs) by 2032MY to meet the GHG standards. Moreover, Auto Innovators expects that at least 50 percent BEVs will be required to meet EPA's criteria emissions standards.

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 ACC II requirements. Global warming and GHG emissions are global, and Illinois' adoption of ACC II will not even theoretically change global warming or GHG emissions. Of course, criteria emissions are localized and controlling these emissions provide local benefits regardless of the fleet average. EPA's recently adopted regulations are more stringent than California's ACC II.

[10] Environmental Protection Agency. Multi-pollutant emissions standards for model years 2027 and later light-duty and medium-duty vehicles. *89 Federal Register* 27842 (Apr. 18, 2024), publicly available on GovInfo website at https://www.govinfo.gov/content/pkg/FR-2024-04-18/pdf/2024-06214.pdf.
[11] These standards follow the model year 2024-2026 standards which also increase in stringency at over double the rate of historical increases.

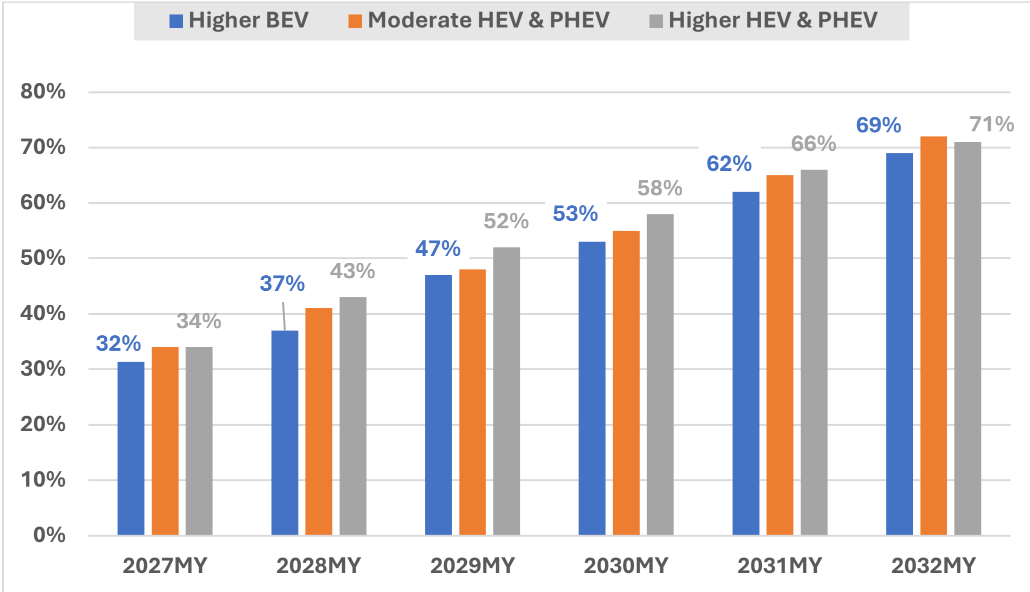
i. GHG

EPA reports its standards are "technology-neutral, performance-based standards," it projects manufacturers will produce 72 percent ZEVs (43% BEVs + 29% PHEVs) in 2032MY to meet the GHG standards under a "Moderate HEV and PHEV Pathway."[12] The other pathways EPA considered for compliance with the GHG regulations show similar ZEV market share (see *Figure 3*). In all cases, EPA projects ZEV penetration rates around 50 percent by 2029MY, when Illinois could first implement California's ACC II. Note that even EPA's projected ZEV penetration rate would require a *525 percent increase in ZEV sales* in Illinois by 2029MY – just three years from now.

Of course, unlike ACC II, EPA's regulation is not a technology mandate, this is just EPA's projection. Some manufacturers might choose a path with 50 percent EVs, while others might choose fewer EVs and more strong HEVs with exceptional fuel economy. Moreover, the ACC II ZEV mandate is state-by-state, so the 59 percent mandate must be met in Illinois. By contrast, the EPA requirements are 50-state, allowing the manufacturers to tailor their state fleets to better meet consumer demands in each state while still meeting the overall requirement.

[12] *Id*. at 27856.

Figure 3: EPA Projected ZEV (BEV+PHEV) Share to Meet Final Rule



ii. <u>Criteria</u>

EPA's criteria emission program – for the control of ozone precursors (hydrocarbon (HC) and oxides of nitrogen (NOx)) and particulate matter (PM) emissions – is more stringent than California's, so adopting California will not result in any criteria emission benefits.

EPA's program differs from California's ACC II in several ways. Nonetheless, manufacturers typically produce 50-state vehicles that meet both EPA and California emission standards, and we expect California to update their criteria regulations to match the more stringent EPA standards.

EPA's fully phased-in PM emission standards are substantially more stringent than ACC II standards. The non-methane organic gas (NMOG) + NOx standards differ between EPA and California in form but not function. California maintains the NMOG+NOx standard at 30 milligrams per mile (mg/mile) but removes electric operation from the fleet average. By contrast, EPA retains electric operation in the fleet average calculations but reduces the fleet average standard from 30 mg/mile to 15 mg/mile between the 2027 and 2032 MYs. 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.

b. California ACC II Requirements

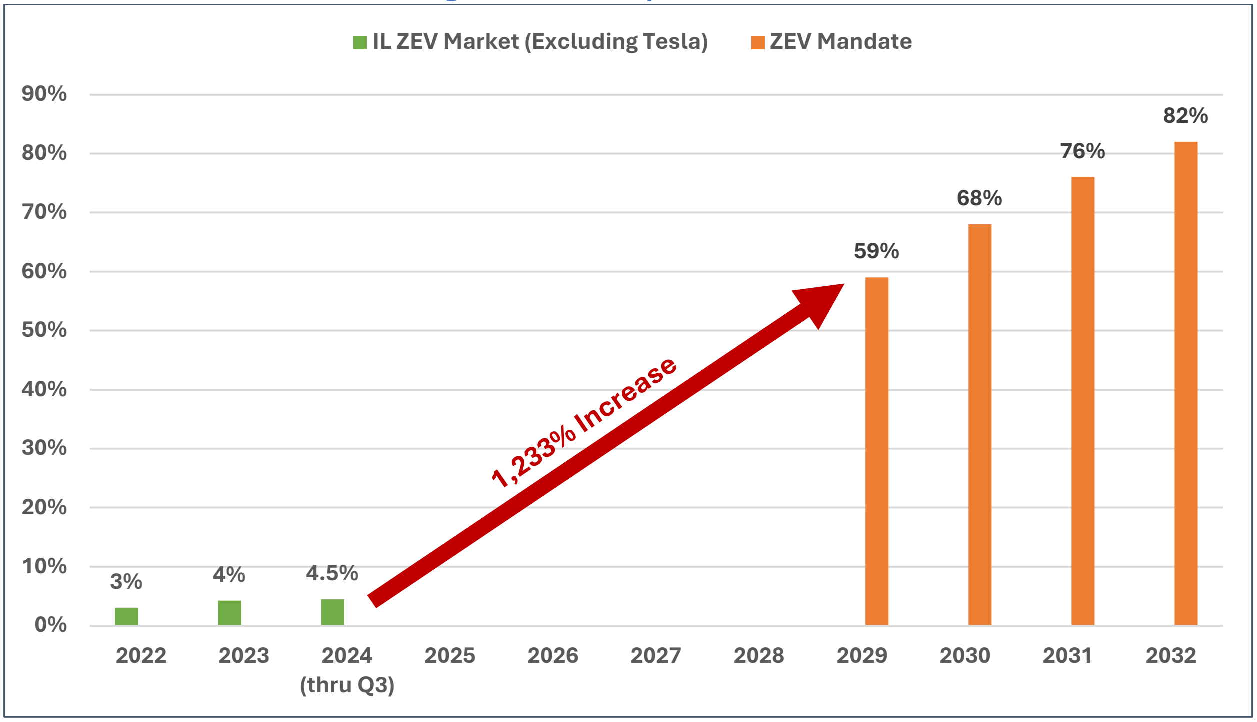
i. <u>ZEV mandate requirements</u>

We should first distinguish between California's ACC I ZEV regulation (2015-2025MY) and its ACC II ZEV regulation (2026-2035MY). The ACC I ZEV regulation is a ***ZEV credit mandate***. That is, the manufacturer is required to produce ZEVs (PHEVs, BEVs, and FCEVs) that generate an increasing number of ZEV credits depending on technology. In ACC I, each vehicle can generate anywhere from 0.5 ZEV credits per vehicle (e.g., low mileage PHEV) to 4 ZEV credits per vehicle (BEVs and FCEVs with a range over ~ 250 miles). Consequently, the 22 percent 2025MY ACC I ZEV mandate can be met by selling 5.5 percent long-range BEVs that each receive 4 ZEV credits.

ACC II, however, is a vehicle mandate. BEVs and FCEVs each receive one (1) credit per vehicle. The 59 percent 2029MY ZEV mandate means that 59 percent of the vehicles sold must be BEVs or FCEVs. PHEVs also receive one (1) credit per vehicle but can make up no more than 20 percent of the requirement. So, in 2029MY, PHEVs can make up no more than 7 percent of vehicle sales, and 52 percent of vehicle sales must be BEVs or FCEVs. Regardless of the makeup, a 59 percent ZEV mandate represents a 1,200 percent increase in ZEV sales from 2024CY (through September) for traditional full-line automakers, and the 2029 MY starts in just three years (see <u>*Figure 4*</u>).[13]

[13] Model year 2026 can begin as early as January 2, 2025.

Figure 4: ZEV Requirements for Illinois



Of course, ACC II ultimately bans the sale of new light-duty vehicles primarily powered with gasoline and diesel fuel by 2035MY – just six years after Illinois would implement ACC II, but as discussed below, automakers will likely need to immediately and substantially reduce gasoline vehicle sales to comply with the mandate.

ii. <u>Criteria emission requirements – generally the same or slightly less stringent than EPA</u>

As noted above, the ACC II criteria emission requirements take a different path from EPA to control ozone precursor emissions (NMOG and NOx) but arrive at about the same place (after amendments to the ACC II criteria regulations).

iii. <u>GHG Requirements</u>

As noted earlier, California GHG regulations have no impact on overall U.S. GHG emissions. Those are controlled by EPA's 50-state GHG fleet average. Some states will have higher emissions while other states have lower emissions, but the EPA GHG fleet average will determine total U.S. GHG emissions.

Regardless, California has GHG regulations under ACC I (adopted in 2012) but did not update those as part of ACC II. Consequently, California's ACC I GHG standards are less stringent than EPA's GHG standards. California has announced plans to incorporate updated GHG requirements in ACC II beginning with the 2030MY. In the meantime (i.e., 2026-2029MYs), the EPA GHG standards will be more stringent than the California GHG standards.

Nonetheless, adopting ACC II and its to-be-updated GHG standards could further restrict vehicle availability. For example, California regulators proposed effectively penalizing PHEVs by basing PHEV GHG emissions on gas-only operation. The large batteries and electric motors in PHEVs make them substantially heavier than a conventional hybrid counterpart. This added weight increases GHG emissions in gas-only operation. Setting standards based on gas-only operation ignores the very substantial benefit from PHEV all-electric operation, and penalizes PHEVs compared to its non-PHEV counterparts.[14]

iv. ACC II ZEV Vehicle Values and Flexibilities

In their pre-filed testimony and during the hearing on December 2nd and 3rd, the proponents relied heavily on the notion that flexibilities in ACC II will ease automakers compliance obligations. This reliance, however, was significantly overblown, and as shown below, the flexibilities in the regulations are of very little use to automakers.

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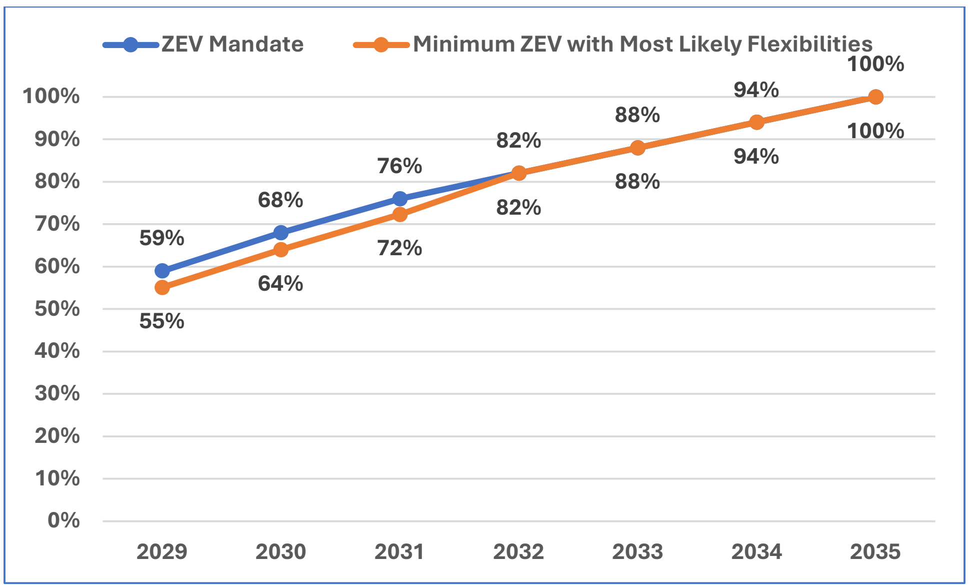
[14] For example, the 2024 Hyundai Tucson Hybrid Blue (conventional hybrid) combined fuel economy is 38 mpg, while the Tucson Plug-In Hybrid is 35 mpg in gas-only mode but 80 mpg combined considering electric and gas operation. "Compare side-by-side," U.S. Dep't of Energy, FuelEconomy.gov (retrieved December 18, 2024, last accessed on Jan. 16, 2025), available at https://www.fueleconomy.gov/feg/Find.do?action=sbs&id=47495&id=46722. Attached hereto as **Exhibit G**.

(a) Overview of ACC II flexibilities and their likely use

ACC II provides several "flexibilities" that an automaker could use to reduce the ZEV mandate in a specific MY. However, many of these flexibilities are not available (or at least not practically available) in Illinois, and all of them are capped so that they can make up no more than a specified percentage of the requirement.

Figure 5 below shows the most-likely actual minimum ZEV sales levels that will be required in Illinois under ACC II based on reasonable and generous expectations for the use of all available flexibilities, which we discuss in more detail below. Scenarios with substantially higher "flexibility" credits are simply unrealistic.

Figure 5: ZEV Mandate w/Most Likely Flexibilities



(b) Available Flexibilities

The following summarizes the flexibilities, and the assumptions made to generate the most-likely scenario. Note that most of the flexibilities expire after 2030MY, and there are no flexibilities after 2031MY (just three years after Illinois could implement ACC II).

- Early Compliance Values (15% cap, 2029-2031MY, §1962.4(e)(3)): ACC II allows automakers to "bank" 2027 and 2028MY ZEV sales that are more than 7 percent of their sales to use in 2029-2031MYs. For example, if a manufacturer sold 10 percent ZEVs in 2028MY, it could bank 3 percent as Early Compliance Values (ECVs) and use those to meet the ZEV mandate in 2029-2031MYs. An automaker can meet up to 15% of the ZEV requirements using these credits. However, excluding Tesla, Illinois' 2024MY ZEV sales are only about 4.5 percent through September, and the 2027MY can begin a year from now. Even assuming sales for non-EV-only companies almost triple to 12 percent (effectively in one year) by 2027MY and maintain that in 2028MY, this provides just 10 percent "bankable" ZEV values from 2027 and 2028MY ZEV sales. This 10 percent could be spread across three MYs (2029-2031), reducing the ZEV mandate by about 3.3 percentage points each year (i.e., 2029MY requirement would be 55.7 rather than 59 percent).

  To maximize the use of ECVs, manufacturers would need to sell over 22% ZEVs in 2027 and 2028MYs. For non-EV-only companies, this requires ZEV sales to increase by 400 percent in the next year. Even if companies pay EV-only manufacturers for their ECV credits, it still requires a 190 percent increase in total ZEV sales. These scenarios are simply not realistic.

  For purposes of calculating a most-likely scenario, we assume ZEV sales increase to 12 percent ZEVs (a 58 percent increase from current total ZEV market share) in 2027 and 2028MYs. This will generate a cumulative 10 percent ECVs (across both

of those years) that can be used to reduce the ZEV mandate by about 3.3 percent each year in 2029-2031MY.

- “Converted Credits” (15% cap, 2027-2030MY, §1962.4(g)(2)(A)): ACC II allows use of discounted credits from excess ZEVs sold under ACC I. Since ACC I ends long before the Illinois program begins, this flexibility is not available in Illinois.

  This flexibility is not available in Illinois.

- Pooled Credits (Declining cap, 10% in 2029MY; 5% in 2030MY, §1962.4(g)(1)(D)): ACC II allows automakers to over-comply in one ZEV state and transfer those credits to another ZEV state. However, the way this flexibility is implemented, automakers must forgo other flexibilities and thus sell vastly more ZEVs than required in one state, just to transfer a few credits to another state.[15] Consequently, this flexibility is of no value to automakers beyond possibly EV-only automakers, but their credits will likely be used in the state they were generated.

  For purposes of calculating a most-likely scenario, we assume ZERO use of this flexibility 2029-2030MYs.

- Proportional fuel cell electric vehicle (FCEV) Credit (10% cap, 2029-2030MY, §1962.4(g)(4)): This flexibility applies only to FCEVs sold in a ZEV State. Only

[15] For example, a manufacturer could meet the 59% requirement in a state by selling 51 percent ZEVs and using “converted credits” (not available in Illinois) to meet the remaining 8 percent. However, to transfer just 1 percent to another state, it must sell 60% ZEVs and forgo the “converted credits.” Thus, for a 1 percent transfer the automaker would need to sell 11 percent more ZEVs than required in another state.

two automakers currently sell FCEVs, so this is a very limited flexibility on an industrywide basis. This flexibility transfers ZEV values to all ZEV states for FCEVs sold in California. This transfer is capped at the lesser of:

i. The percentage of the ZEV sales requirement met by FCEVs.
ii. 10% of the ZEV requirement (e.g., 5.9% of the 59% requirement in 2029MY).

Even the automaker with the highest FCEV sales would receive less than 1 percent credit, but that would be just for that one automaker, no other automakers can use this flexibility. Moreover, FCEV sales have plummeted with the rising price of hydrogen fuel.

For purposes of calculating a most-likely scenario, we assume automakers use this flexibility to meet 0.5% of the ZEV requirement for 2029-2030MY (i.e., a reduction in the sales requirement of 0.3% in those two years).

- Environmental Justice (EJ) credits (5% Cap, 2026-2031MY§1962.4(e)(2)): EJ credits can make up 5% of the ZEV requirement in each MY through 2031MY (e.g., in 2029MY, an automaker could meet 2.95% of the 59% ZEV requirement (5% x 59% = 2.95%) using EJ credits). ACC II provides three ways to generate EJ credits:

i. *Community-based clean mobility programs (CBCMP)*: The automaker must sell the 2024+MY ZEV into a qualifying CBCMP at a price at least 25% below the MSRP. ACC II contains several requirements to determine whether a CBCMP qualifies.

California provides substantial funding and vetting of CBCMPs. For example, California allocated $59.5 million to the Sustainable Transportation Equity Project (STEP) as of November 2022 and $92.9 million to its Clean Mobility Options program. These are just two of the many California programs directed at CBCMP.

To our knowledge, Illinois has nothing similar in scope or scale.

ii. *Sold at End of Lease to Participating Dealership*: A leased 2026+MY ZEV sold to a dealership "participating in a dealer financial assistance program" qualifies for $1/10^{th}$ of a vehicle credit. This only applies to leased ZEVs, not purchased ZEVs.

California has allocated $436 million to its Clean Cars for All (CC4A) program that provides up to $12,000 for replacing an older gas vehicle with a new ZEV. Dealerships that participate in this program are considered "participating in a dealer financial assistance program" under ACC II.

Again, it is not clear that Illinois has dealerships "participating in a financial assistance program." However, we assume this could be addressed before 2029MY when most 2026MY ZEVs will start coming off lease.

iii. *Low-Cost ZEVs*: ACC II also provides $1/10^{th}$ of a vehicle credit for 2026+MY ZEVs with an MSRP < $20,275 for passenger car ZEVs and with an MSRP < $26,670 for light-duty truck ZEVs. The lowest priced passenger BEV in 2024MY was over $26,000, and the lowest priced light-truck ZEV was over $35,000. Auto Innovators does not anticipate EV prices reaching this level in the time period being considered.

While automakers participate in and support equity and environmental justice programs, it is unlikely manufacturers will be able to utilize this provision in Illinois beyond perhaps the End of Lease provision. Maximizing the use of this credit is uncertain even in California despite years of dedicated programs, substantial investments in the $100s of millions, and work across multiple agencies (CARB, Energy Commission, Pollution Control Districts, Governor's office, etc.) with established community-based organizations to develop these programs. In Illinois, none of these dedicated programs or investments currently exist.

For purposes of calculating a most-likely flexibility, we assume automakers can use EJ credits to meet 0.5% of the ZEV requirement in 2029, 2030, and 2031MY (i.e., a reduction in the sales requirement of 0.3%, 0.3% and 0.4%, respectively).

(c) Summary of ACC II Flexibilities:

Figure 6 provides a summary table of requirements, most-likely flexibility usage, and minimum total requirement by MY.

Figure 6: Flexibilities Summary

	Model Year						
Requirement/Flexibility*	2029	2030	2031	2032	2033	2034	2035
ZEV Mandate 1962.4(c)(1)(B)	**59%**	**68%**	**76%**	**82%**	**88%**	**94%**	**100%**
- EJ Values (e)(2) - 5% Cap**	-0.3%	-0.3%	-0.4%	NA	NA	NA	NA
- Early Compliance Values (e)(3) - 15% Cap**	-3.3%	-3.3%	-3.3%	NA	NA	NA	NA
- Pooled Credits (g)(1)(D) - Declining cap (10% in 2029; 5% in 2030)	0.0%	0.0%	NA	NA	NA	NA	NA
- Converted Credits (g)(2)(A) - 15% Cap**	NA	NA	NA	NA	NA	NA	NA
- Proportional FCEV (g)(4) - ***	-0.3%	-0.3%	NA	NA	NA	NA	NA
Minimum Actual ZEV Requirement	**55.1 %**	**64.0 %**	**72.3 %**	**82.0 %**	**88.0 %**	**94.0 %**	**100.0 %**

*ACC II ZEV Regulations 13 CCR §1962.4 see:
https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/accii/2acciifro1962.4.pdf
** Percent cap is the maximum percent of the requirement (e.g., 5% cap in 2026 = 5% * 35%; 1.75% of the 35% requirement can be met with EJ credits).
*** The cap for FCEV proportional credits = the lesser of either (% of the manufacturers ZEV requirement met with FCEVs) or 10% of the requirement. Only 2 companies sell FCEVs - Toyota and Hyundai. In 2021, Toyota sold 2,597 FCEVs in California. If Toyota FCEV sales increased 15% annually between 2022-2030, the maximum credit would be 2.8%. However, this is only for Toyota, industry-wide a better estimate is 0.5%.

7. ACC II in Illinois

As explained below, while ACC II ultimately bans the sale of all new non-plug-in gasoline vehicles (including conventional hybrids) in 2035, it will likely force the elimination of most gasoline vehicles within the next few years.

In 2024 (through September), the Illinois ZEV market share is 7.7%, which is *down* from 8% in 2023. Reaching the 59% ZEV mandate by 2029 would require a 620% increase in the ZEV market share in just 4 years. It is highly unlikely that automakers can meet the ACC II ZEV mandate requirements in Illinois with their current vehicle availability and sales.

The ZEV mandate is a ratio of ZEV sales to all vehicle sales, $\frac{ZEV\ sales}{(ZEV + Gas\ vehicle\ sales)}$.

Thus, automakers have three options to avoid non-compliance with the ZEV mandate:

- Option 1: Sell more ZEVs to increase the numerator.
- Option 2: Sell fewer gas vehicles to decrease the denominator.
- Option 3: Buy credits (to the extent available) from automakers that over-comply with the ZEV mandate.

For automakers, non-compliance is not an option in any state regardless of the penalty. However, the proposed Section 242.126(c) assesses a maximum civil penalty of $50,000 per ZEV not delivered.[16] This crippling and inappropriate per vehicle fine could amount to $100s of millions to a single automaker in just one state in just one year. As discussed in more detail below, option 3 is also not a viable or sustainable compliance plan.

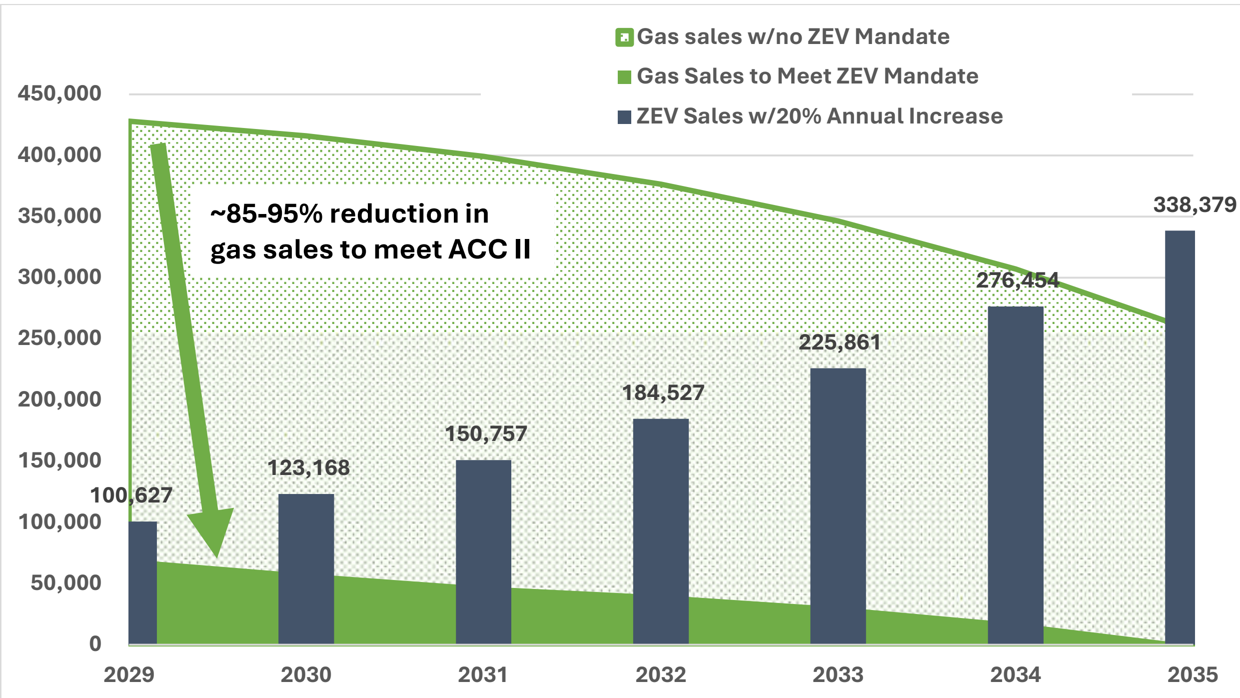
Thus, automakers are left to increase ZEV sales and dramatically decrease gas vehicle sales. For example, if we look at the current situation in Illinois, a very aggressive (and possibly unrealistic) assumption is that the ***ZEV market share grows by 20% every year starting in 2025***. Under this assumption and assuming traditional full-line automakers buy every excess credit from Tesla and other EV-only companies, automakers would need to ***eliminate 84 percent (or 358,000 sales) of gasoline vehicle sales*** in the first year of implementation (2029) to meet the 59 percent mandate **–** ***for Illinois auto dealers, this is a loss of over $17 billion in revenue. The state would lose over $1.2 billion in sales tax revenue and cities and counties would lose $100+***

[16] 415 ILCS 5/42.

million more in sales tax[17]. Moreover, the portion of gasoline vehicles that must be eliminated only grows as shown in ***Figure 7*** below.

In total, even if ZEV sales grow by 20 percent every year through 2035MY, automakers would need to eliminate over 2 million gasoline vehicle sales to meet the mandate, which represents $96 billion in lost sales at dealerships, and $7 billion in lost state sales tax revenue, and almost $500 million in lost local sales tax revenue. These are vehicles that Illinoisans will no longer have access to purchase, both increasing vehicle prices and constraining their personal freedom of movement. A likely inevitable outcome is Illinoisans keeping their older (dirtier and less efficient) vehicles longer.

Figure 7: Gas Vehicle Sales Lost to Meet ZEV Mandate w/20% Annual ZEV Sales Increase

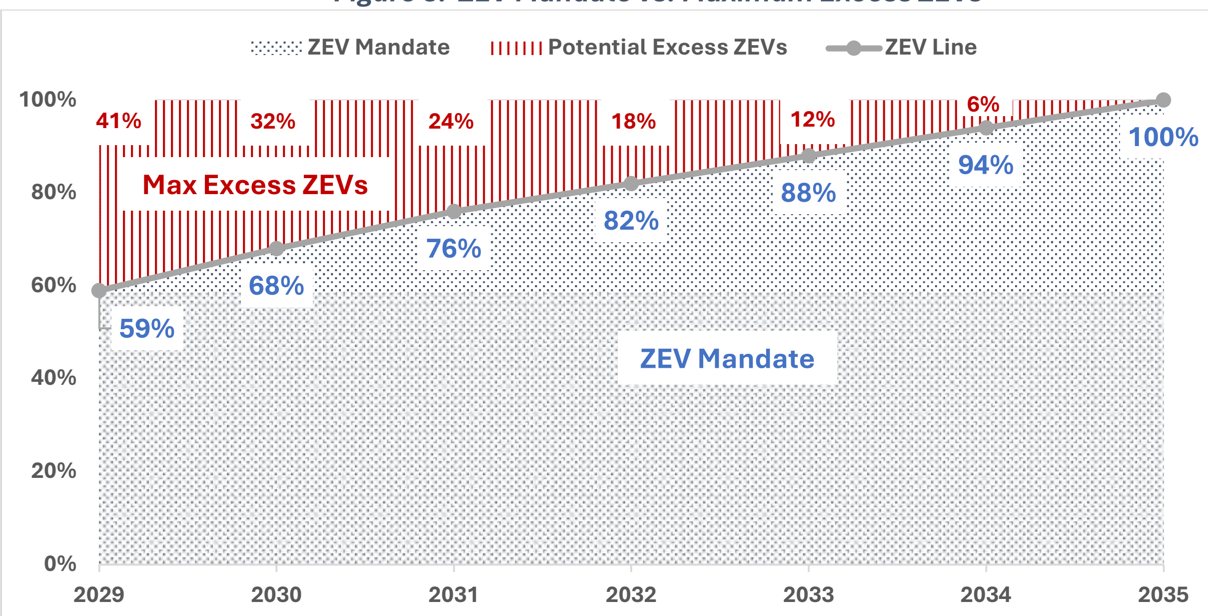


[17] Assuming $48,000 new vehicle price, 7.25% Illinois state sales tax, and city and county sales tax ranging from 1.25% in Chicago and 0.25% to 0.75% elsewhere in the state.

Even EV-only manufacturers, like Tesla and Rivian, must meet the ZEV mandate under ACC II. As shown in ***Figure 8*** below, this means the number of excess ZEV credits available for sale diminishes every year as the mandate ramps up. The likely result is credit costs rapidly increasing for the shrinking pool of credits and the rapidly increasing ZEV requirements.

Thus, a plan that relies on automakers purchasing credits to comply with the ZEV mandate is not a sustainable solution. These credits are expensive and divert crucial capital away from the necessary investments automakers need to make in the costly transition to electric vehicles (EVs).

Figure 8: ZEV Mandate vs. Maximum Excess ZEVs



Additionally, the money spent on compliance credits doesn't go toward building EV charging infrastructure, upgrading utilities, or expanding customer incentives — investments that could actually accelerate EV adoption in the long run. Instead, payments for these credits go directly to automakers like Tesla, which "over comply" with the mandates by selling only EVs.

In fact, Tesla's revenue from regulatory credits was $739 million in the last quarter, marking the second highest quarter in the company's history.[18]

8. Feasibility

The necessary conditions for EV market success – ubiquitous public and residential infrastructure, low vehicle and fuel costs, and driving convenience – are not sufficient in Illinois to support the level of ZEV sales required to achieve even the first year of the ACC II ZEV Mandate in the state.

a. Necessary Conditions

As noted above, automakers are committed to electrification and currently offer many EVs that are safe, reliable, and fun to drive. However, building great EVs is only a small part of the transition. The following discusses some of other conditions necessary for a successful transition that includes all drivers and all communities.

i. Infrastructure

The growth of EV sales is significantly dependent on the development of charging infrastructure. As highlighted by the National Renewable Energy Laboratory (NREL) in their National Charging Network Report, convenient and affordable charging at or near home is critical to the success of the EV ecosystem.[19] However, NREL stresses that home charging must be complemented by reliable public fast charging stations to address the needs of all EV drivers,

[18] "Tesla shows signs of a turnaround with higher profits," The Washington Post (October 23, 2024), attached hereto as **Exhibit H**.

[19] "The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure," National Renewable Energy Laboratory (NREL) (2023), available at https://www.nrel.gov/docs/fy23osti/85654.pdf. Attached hereto as **Exhibit I**.

particularly those without access to home-based chargers. Public fast charging infrastructure is also essential for reducing range anxiety and enabling long-distance travel for EV users.

In the U.S., there is a recognized shortage of public chargers. Automotive News[20] reports that 47 states are facing significant gaps in public charging infrastructure, limiting the adoption of electric vehicles. In Illinois alone, a report from Illinois Answers[21] estimates that $678 million is required to support just one million EVs by 2030. This highlights the substantial investment needed to upgrade and expand charging infrastructure to meet growing demand. The California Energy Commission[22] (CEC) has approved $1.4 billion to deploy 17,000 chargers in that state, but the question remains how many chargers Illinois would need to keep pace with EV adoption. The proportional cost to meet these needs is a key part of the conversation, and it will likely involve a combination of state and local government, public utility, and private sector investments and collaboration. These matters are beyond the control of automakers but directly impact the ability of automakers to comply with the ZEV mandate.

The Illinois Public Utilities Commission (PUC) will be essential in coordinating these investments, ensuring that funds are allocated efficiently to support both residential and public charging. Illinois has already benefited from previous investments in infrastructure, but much more is required. For example, the Edison Electric Institute's October 2024 report[23] (*Figure 9*)

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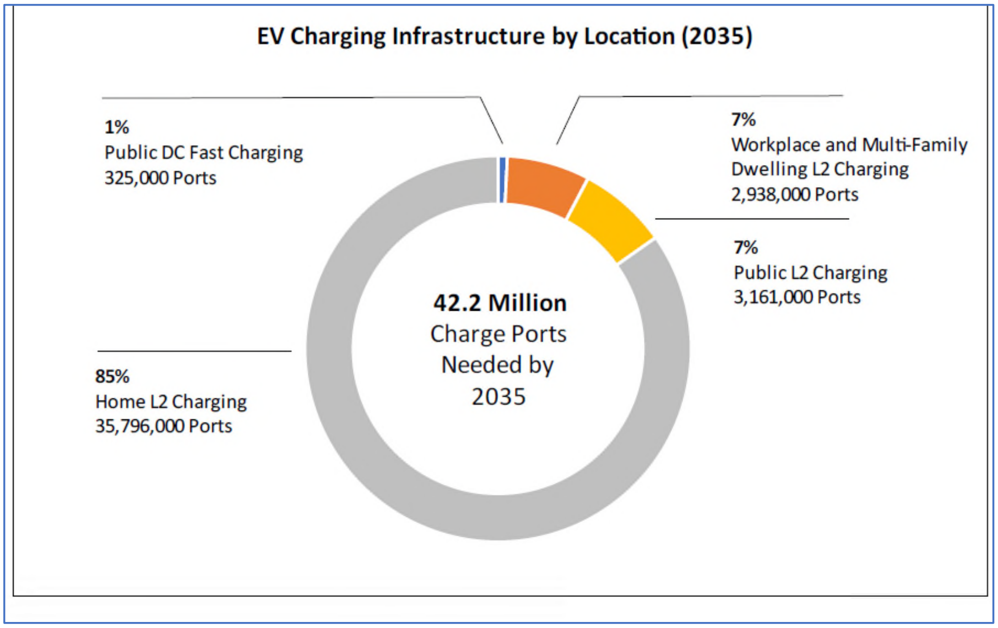
[20] "47 states fail to meet the ideal ratio of chargers to EVs, report says," Automotive News (Sep. 9, 2024). Attached hereto as **Exhibit J**.
[21] "The Feds Are Pushing for Millions More Electric Vehicles on the Road, But is Illinois Ready?" Illinois Answers Project (Apr. 21, 2023), available at https://illinoisanswers.org/2023/04/21/illinois-electric-vehicle-epa-charging-stations-environment/. Attached hereto as **Exhibit K.**
[22] "CEC Approves $1.4 Billion Plan to Expand Zero-Emission Transportation Infrastructure," News Release, California Energy Commission (Dec. 11, 2024), available at https://www.energy.ca.gov/news/2024-12/cec-approves-14-billion-plan-expand-zero-emission-transportation-infrastructure. Attached hereto as **Exhibit L**.
[23] "Electric Vehicle Sales and the Charging Infrastructure Required Through 2035," Edison Electric Institute (Oct. 2024), available at https://www.eei.org/-/media/Project/EEI/Documents/Issues-and-Policy/Electric-Transportation/EV-Forecast-Infrastructure-Report.pdf?la=en&hash=FF7F1A5913E3B48E8F92FA26E2AFB79FDBE0E89C. Attached hereto as **Exhibit M**.

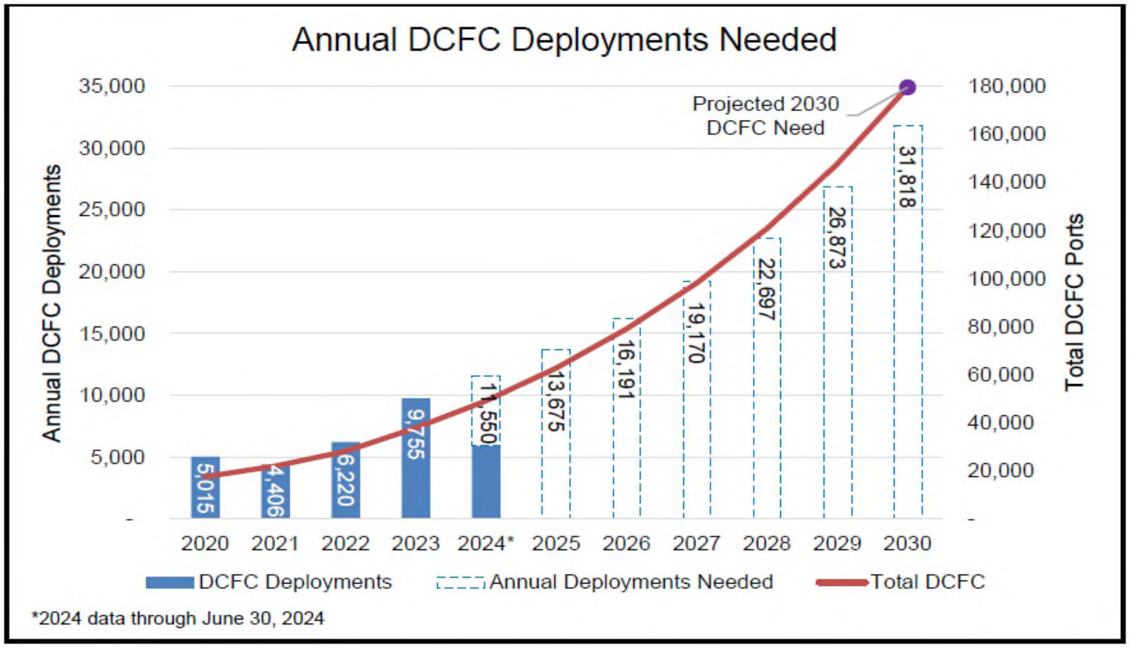
projects that by 2035, more than 42.2 million charge ports will be necessary nationwide to support the 78.5 million EVs expected on U.S. roads. This will include a mix of L2 at homes, workplaces, and in public spaces, as well as fast-charging DC ports.

Figure 9: EV Charging Infrastructure by Location (Edison Electric Institute)



As part of this expansion, the report also notes that approximately 325,000 DCFC ports will be needed by 2035. DCFC stations are crucial to alleviating range anxiety, particularly for drivers who do not have access to home charging. These stations enable faster, more convenient charging, which is vital for long-distance EV travel and for individuals without dedicated parking spots where a charger can be installed. *Figure 10* shows the Edison Electric Institute (EEI) projected nationwide deployment necessary through 2030.

Figure 10: Nationwide Annual DCFC Deployment



In Illinois, the residential landscape presents its own set of challenges for expanding charging infrastructure. As shown in ***Figure 11***, a significant portion of Illinois residents live in multi-family homes or rental properties[24], which impacts their ability to install chargers. This is consistent with the rest of the nation, where only about half of the residents have access to dedicated off-street parking – a prerequisite for installing home EV chargers. In Chicago, many residents only have access to on-street parking, which makes it difficult, if not impossible, to install EV chargers. For those in multi-family homes with shared parking, the costs and complexities of adding charging stations are even higher, as upgrades to transformers and grid infrastructure are often necessary.

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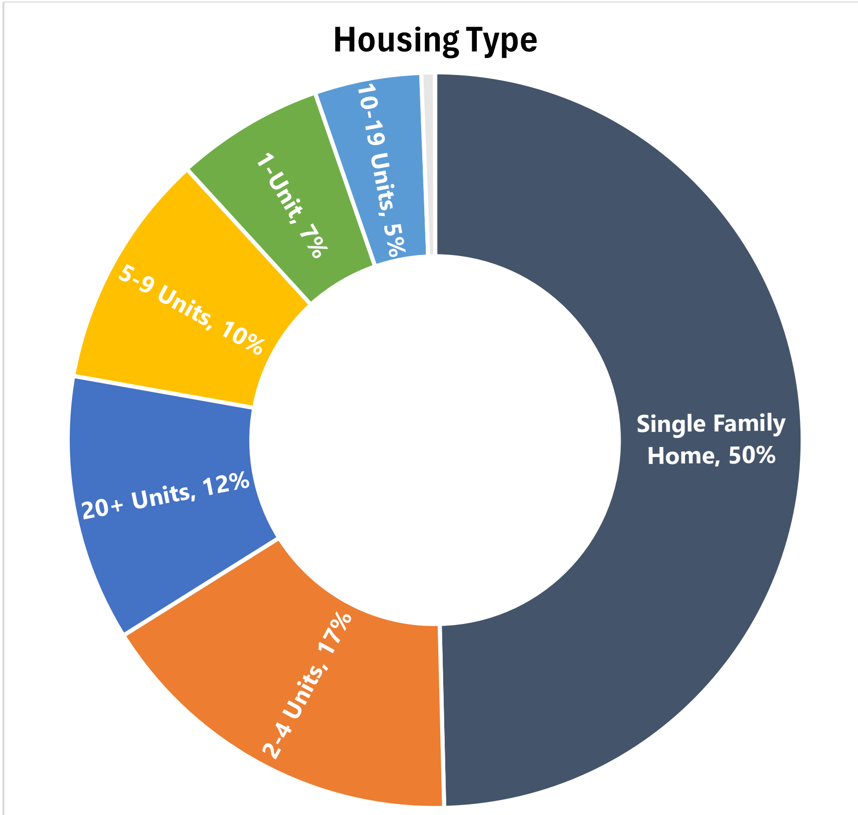
[24] "Economic Insights; Illinois State Facts," Alliance for Automotive Innovation (accessed on Dec. 19, 2024), available at https://www.autosinnovate.org/resources/insights/il. Attached hereto as **Exhibit N**.

Figure 11: Illinois Housing[25]



Further complicating residential installations in Illinois is the fact that 67% of households use natural gas for cooking.[26] These homes will likely have limited electric panel capacity making EV charger installation more complicated and significantly more expensive, particularly if an electric panel upgrade is required. Moreover, as more homes are retrofitted to accommodate EV charging, the need for grid upgrades at both residential and commercial locations will intensify. This includes potential transformer upgrades in residential neighborhoods.

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[25] Figures compiled by Alliance for Automotive Innovation with data provided U.S. Census Bureau and American Community Survey 2021. See **Exhibit N**.

[26] "Highlights for appliances in U.S. homes by state, 2020," U.S. Energy Information Administration (March 2023), available at https://www.eia.gov/consumption/residential/data/2020/state/pdf/State%20Appliances.pdf. Attached hereto as **Exhibit O**.

Installing DCFC stations can and usually does require substantial grid upgrades with exceptionally long lead-times. To put the load of a DCFC plaza into perspective, a plaza with just ten 350 kW ports would require 3.5 MW of power. Delivering this level of power can require a minimum of 4 to 5 years of lead time *after* the utility has committed to the project and assuming streamlined approval process.

Addressing these challenges will require coordinated efforts from state and local governments, utility companies, utility commissions, and private sector stakeholders to ensure that Illinois is ready to support the growing demand for electric vehicles. Expanding and upgrading charging infrastructure is essential to support EV growth.

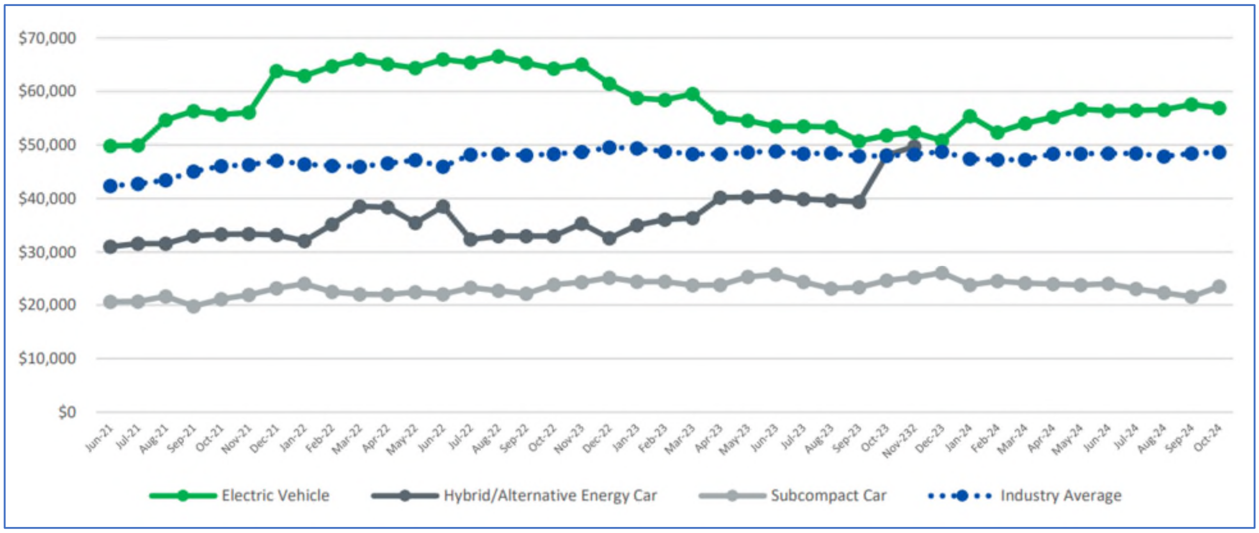
ii. Costs

(a) Vehicle Costs

While EV prices have come down, a look at current data in ***Figure 12*** below shows EV prices still significantly exceed the costs of gasoline vehicles. Kelly Blue Book reports the average transaction price for EVs was over $55,000 in November 2024.[27] This price is significantly higher than the average vehicle price of $48,000 and over twice the price of a subcompact car – the most affordable ICE vehicle category.

[27] "Kelley Blue Book report: New vehicle prices climb in November, while higher incentives continue to entice buyers," Kelley Blue Book (Dec. 11, 2024), available at https://mediaroom.kbb.com/2024-12-11-Kelley-Blue-Book-Report-New-Vehicle-Prices-Climb-in-November,-While-Higher-Incentives-Continue-to-Entice-Buyers. Attached hereto as **Exhibit P**.

Figure 12: Average Transaction Prices by Segment[28]



While there are certainly lower cost EVs available, these prices suggest that average EV buyers are far more likely to be affluent single-family homeowners that do not represent a cross-section of Illinois drivers or even new car buyers.

High EV transaction prices are partially offset by incentives in the Inflation Reduction Act (IRA), which can range from $7,500 consumer and lease incentive to $12,000 per vehicle, when the battery tax credits are included. However, the incoming administration and Congress could eliminate this incentive, further increasing EV prices. Moreover, tariffs on imported EVs and EV components such as batteries, battery parts, and critical minerals, combined with the exceptionally long lead-times needed to source all these products from within the U.S. could drive EV prices higher still in the coming years.

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[28] "Reading the Meter: A look inside a cleaner, safer, smarter auto industry," Alliance for Automotive Innovation (2024), available at https://www.autosinnovate.org/posts/papers-reports/Reading%20the%20Meter%2012-5-2024.pdf. Attached hereto as **Exhibit Q**.

(b) Fuel Costs

Across the nation, including in Illinois, there is a notable cost disparity between charging an EV at home and using a DCFC. The average residential electricity rate in Illinois is about $0.16 per kWh (an increase of 8.4% from 2023[29]). Thus, the cost to charge a 100 kWh EV battery at home is about $16. In contrast, the cost of using a DCFC in Illinois averages around $0.48 per kWh[30], so charging the same 100 kWh EV battery at a DCFC station would cost about $48 – three times more than charging at home. This price difference will significantly impact EV owners, particularly lower income owners without access to low-cost home charging.

When comparing the cost of charging an EV to fueling a conventional hybrid vehicle, the disparity becomes even more apparent. For example, fueling a 45-mile-per-gallon (mpg) hybrid in Illinois, where the average gas price is $3.70 per gallon, would cost roughly $8.22 for 100 miles of driving. Charging an EV at home would only cost about $5 for the same 100 miles of driving. However, the cost would jump to $16 per 100 miles when using DCFCs, making it much more expensive than both residential EV charging and gasoline hybrid fueling.

This pricing disparity creates challenges for drivers in multi-family homes, such as apartment dwellers, and renters who lack access to low-cost home charging options. The result – low-income EV drivers in multi-family housing pay three times as much to drive an EV than affluent EV drivers that own a single-family home.

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[29] "Electricity Rates by State," Choose Energy (last updated Jan. 2025), available at https://www.chooseenergy.com/electricity-rates-by-state/. Attached hereto as **Exhibit R**.
[30] "EV Charging Pricing Trends: Explore high-quality data on national EV charging station pricing," Stable (accessed on Jan. 16, 2025), available at https://stable.auto/insights/electric-vehicle-charger-price-by-state. Attached hereto as **Exhibit S**.

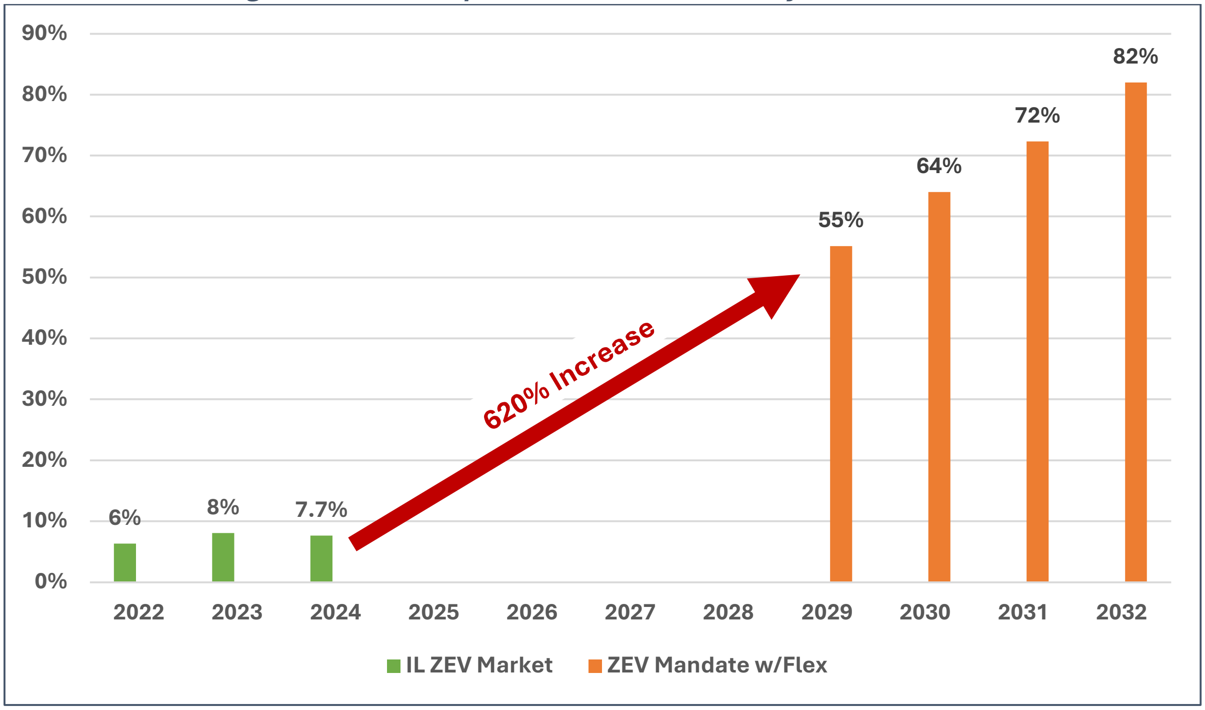
iii. Convenience

In addition to vastly higher cost, public charging (even DCFC) is considerably less convenient than either filling up a gasoline car or charging at home. A gas fill-up takes about 5 minutes and gas stations are ubiquitous throughout the state. On the other hand, the dearth of DCFC stations and ports means a specific trip to the DCFC station. Once there, charging takes 20-45 minutes if there's an open DCFC plug. If not, it could take an hour or more to charge. Compare that to most current EV buyers that are single-family homeowners with home charging. They pull-in, plug-in, and wake up with a full charge every morning.

b. Illinois ZEV Market today and future

Like all states, ZEV sales have stagnated in Illinois and the 7.7 percent 2024CY ZEV market share marks a slight reduction from the 8 percent share in 2023CY. While this small reduction is not necessarily notable on its own, it is distinctly going in the wrong direction. 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. In fact, even California, with over a decade of supportive ZEV policies, isn't even halfway to the 2029MY ZEV sales requirement.

Figure 13: ZEV Requirements w/Most-Likely Flexibilities



Of course, an alternative approach to forcing more ZEVs onto unwilling buyers is to dramatically restrict gasoline vehicle sales. In 2029MY, the 59 percent ZEV mandate means that an automaker must sell 6 EVs for every 4 gasoline vehicles. Just two years later (in 2031MY), for every 1 gasoline vehicle, an automaker must sell 3 EVs. Dramatically reducing gasoline vehicle sales as shown in *Figure 7* will severely and negatively impact the Illinois economy and its citizens. Moreover, as noted above, there are no exceptions for farmers, electricians, plumbers, lawncare professionals, carpenters, and other businesses that rely on these vehicles.

9. State Comparison

California is over a decade ahead of Illinois in developing the ZEV market. The state has invested billions of dollars for vehicle incentives, public education, and infrastructure at every level (hydrogen fueling stations, DCFCs, public and home L2 charging). Illinois needs to match that investment and commitment to achieve a similar EV market results. However, even California is nowhere near meeting the 59 percent ZEV sales required in 2029MY.

If Illinois adopts ACC II, automakers must meet the exact same ZEV mandate as in California. However, because automakers do not have access to the same "flexibilities" in Illinois as in California (e.g., converted credits), the effective *ZEV mandate in Illinois is more stringent than California*. Even if Illinois did not have to meet a more stringent ZEV mandate, automakers are still unlikely to sell enough EVs to achieve the ZEV mandate in Illinois. First, since adopting the ZEV mandate 35 years ago, California has focused on developing the ZEV market. It spent billions of taxpayer and ratepayer dollars to build up the ZEV market through education and outreach, vehicle incentives, and ZEV infrastructure development. Even with all of this, California ZEV sales, which stagnated over the last year, are still less than half-way to meeting 2029MY ZEV requirements. Far more will be needed even in California to increase the ZEV market enough to meet the ZEV mandate. Given that Illinois is way behind California in terms of its investment in the EV market and EV sales, investments here in Illinois would need to exceed its relative proportion to California's market.

a. California investment

For over a decade, California has developed and implemented a consistent, integrated, and comprehensive suite of policies to support ZEV market development. The ZEV market has responded to those policies and California has the highest ZEV market penetration in the nation (other than Colorado in Q3 2024) at more than 25 percent ZEV sales. However, these policies are not without cost and did not come about overnight.

Figure 14 is a non-exhaustive list of the ZEV support programs implemented in California by several large state agencies.

Figure 14: California ZEV Funding Programs

Program	Purpose	Amount (million)	Year(s)
CEC Clean Transportation Program (CTP) EV Infrastructure	LDV, MDV, and HDV Infrastructure	$1,400	2025-29
2022-23FY Budget, Zero Emission Vehicle Package	HDV ZEV: $1.5 billion Low Income LDV ZEV: $76 million ZEV Infrastructure: $383 million ZEV and Infrastructure mfg.: $250 million Cap-and-Trade low-income ZEV: $676 million ZEV School buses: $1.5 billion	$4,385	2022-26
2021-22FY Budget	HDV ZEV: $2 billion LDV ZEV: $1.2 billion ZEV and Infrastructure mfg.: $250 million	$3,450	2021-24
CEC CTP EV Infrastructure	LDV EV Infrastructure	$44	2021-2023
CEC Block Grant to CSE & CALSTART	LDV EV Infrastructure	$490	2021-2022
Clean Vehicle Assistance Project	Low Income EV and infrastructure incentive	$45	2018-2023
Drive Clean Assistance Program	Low Income financial assistance program	$8	2016-2023
Clean Cars for All (CC4A)	Low Income EV incentive (Scrap old ICE vehicles)	$435	2015-2023
CEC - CTP	H2 Infrastructure Station development	$140	2014-2023
Clean Vehicle Rebate Project	EV Incentive (including low-income)	$1,500	2010-2023
CEC CTP EV Infrastructure	LDV EV Infrastructure	$192	2010-2021
CPUC NRG Settlement	LDV EV Infrastructure (DCFC, L2)	$100	
CPUC Transportation Electrification	LDV EV Infrastructure	$803	
CPUC Transportation Electrification	MDV and HDV EV Infrastructure	$739	
Total		$13,731	

This does not include a dedicated ZEV Market Development team in the Governor's office[31] to coordinate state government ZEV activities and ZEV action plans for 28 different state

[31] "Zero-Emission Vehicle Market Development Strategy," California Governor's Office of Business and Economic Development (accessed on Jan. 16, 2025), available at https://business.ca.gov/industries/zero-emission-vehicles/zev-strategy-2. Attached hereto as **Exhibit T**.

agencies.[32] The Governor's Office of Business and Economic Development (GO-Biz) also publishes a triennial ZEV Market Development strategy document.[33]

b. Illinois investment

Illinois is taking action to accelerate EV adoption. For example, Governor Pritzker signed the Climate and Equitable Jobs Act (CEJA) September 15, 2021, which directs incentives for infrastructure and vehicles. The Governor also appointed a State EV Officer, directed the development and implementation of a program to expand the use of EVs in the state fleet, established the state agency EV working group, and plans to deploy EV chargers over 5 years using $148 million from the National Electric Vehicle Infrastructure (NEVI) program.

We applaud the Governor, legislature, and agencies' efforts to accelerate EV adoption, and Auto Innovators is committed to working with the state in this effort. However, in scale, scope, and duration, Illinois is far behind California's efforts. For example, California provided EV incentives 15 years ago (2010), the legislature provided $100 million annually for EV infrastructure (including $20 million annually for hydrogen fueling stations) over 10 years ago (2013), and the PUC began developing utility-based transportation electrification programs for infrastructure about 7 years ago.

c. Summary Comparison

As a result, California is years ahead of Illinois. As shown in ***Table 1*** below, California has 3.5 times more new vehicle sales, but 11.5 times more new ZEV sales. California has 10

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[32] "Agency ZEV Action Plans," California Governor's Office of Business and Economic Development (accessed on Jan. 16, 2025), available at https://business.ca.gov/agency-zev-action-plans/. Attached hereto as **Exhibit U**.
[33] "Zero-Emission Vehicle Market Development Strategy," California Governor's Office of Business and Economic Development (2021) (accessed in Jan. 16, 2025), available at https://business.ca.gov/wp-content/uploads/2021/02/ZEV_Strategy_Feb2021.pdf. Attached hereto as **Exhibit V.**

times the number of DCFC ports. Yet with all California has accomplished, far more is needed. This is why the California Energy Commission approved another $1.4 billion for ZEV infrastructure just last month (December 2024).

Table 1: Illinois and California Comparison

Metric	Illinois	California	Ratio of IL to CA
2024 New Vehicle Sales	460,200	1,590,000	1 to 3.5
Gas Stations	4,537	10,986	1 to 2.4
2024 (thru Sep) ZEV Sales	25,642	294,276	**1 to 11.5**
DCFC Stations[34]	285	2,288	**1 to 8**
DCFC Charging Ports[24]	1,272	12,827	**1 to 10**
Hydrogen Fueling Stations	**0**	**63**	**NA**

10. Conclusion

Auto Innovators recommends the IPCB reject adoption of California's ACC II regulations. Illinois is simply not prepared to mandate the elimination (or dramatic reduction) in gasoline vehicles in favor of electric vehicles. Infrastructure is not in place and customer demand has not developed. This is unlikely to change in the next 2-3 years before the ZEV mandate begins. Adoption of ACC II would significantly harm the Illinois economy and its consumers and would likely result in lower income drivers keeping older, higher-emitting vehicles longer, further worsening air quality in their neighborhoods.

Respectfully submitted,
Alliance for Automotive Innovation

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

Dated: January 21, 2025

[34] "Alternative Fuels Data Center: Electric Vehicle Charging Station Locations." Includes SAE J1772 CCS and J3400 DCFC connectors," U.S. Department of Energy (accessed on Dec. 20, 2024), available at https://afdc.energy.gov/stations#/analyze?tab=fuel&fuel=ELEC&ev_levels=dc_fast.

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PH: (217) 528-3674

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

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

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Exhibit K	"The Feds Are Pushing for Millions More Electric Vehicles on the Road, But is Illinois Ready?" Illinois Answers Project (Apr. 21, 2023)
Exhibit L	"CEC Approves $1.4 Billion Plan to Expand Zero-Emission Transportation Infrastructure," News Release, California Energy Commission (Dec. 11, 2024)
Exhibit M	"Electric Vehicle Sales and the Charging Infrastructure Required Through 2035," Edison Electric Institute (Oct. 2024)
Exhibit N	"Economic Insights: Illinois State Facts," Alliance for Automotive Innovation Website (accessed on Dec. 19, 2024)
Exhibit O	"Highlights for appliances in U.S. homes by state, 2020," U.S. Energy Information Administration (March 2023)
Exhibit P	"Kelley Blue Book report: New vehicle prices climb in November, while higher incentives continue to entice buyers," Kelley Blue Book (Dec. 11, 2024)

Exhibit Q	"Reading the Meter: A look inside a cleaner, safer, smarter auto industry," Alliance for Automotive Innovation (2024)
Exhibit R	"Electricity Rates by State," Choose Energy (last updated Jan. 2025)
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Exhibit V	"Zero-Emission Vehicle Market Development Strategy," California Governor's Office of Business and Economic Development (2021)

EXHIBIT A

Steven P. Douglas

Founder, Douglas Environmental Advisors

2012 Gunn Road, Carmichael, CA 95608

Phone: (916) 712-4579 • sdouglas77@gmail.com

Experience

Vice President, Energy & Environment | **Alliance for Automotive Innovation**

January 2020 – October 2023 (3 years 9 months) | Sacramento, CA

Coordinated the vehicle environmental policymaking activities of 39 automotive companies including car companies that produce about 98 percent of the new vehicles in the U.S. and the leading Tier 1 suppliers and technology companies. Major activities:

- Led the auto industry's work on the California Air Resources Board (CARB) Advanced Clean Cars II (ACC II) program, including Low Emission Vehicle (LEV) and Zero Emission Vehicle (ZEV) regulations. Formulated, drafted, coordinated, and presented industry positions on all aspects of the ACC II program.
- Led the auto industry's work with CARB staff to update On-Board Diagnostic II regulations. These changes were adopted by the CARB with auto industry support.
- Coordinated the Energy and Environment department's work on ZEVs, GHG, and fuel economy regulation and legislation at both the federal and state level. This includes substantial work to develop, support, and implement supportive electric vehicle policies (e.g., infrastructure and incentives).

Senior Director, Energy & Environment | **Alliance of Automobile Manufacturers**

February 1999 – Dec 2020 (21 years) | Sacramento, CA

Represented 12 automakers on vehicle emission requirements. Identified and analyzed legislative and regulatory issues affecting automakers. Coordinated with members, developed and presented industry positions to state legislative and regulatory agencies, U.S. EPA, National Highway Traffic Safety Administration (NHTSA), U.S. Copyright Office, and other organizations. Significant accomplishments:

- Coordinated with California automaker lobbyists, utilities, and NGOs to secure $100+ million for ZEV incentives annually. Worked with other stakeholders to ensure simple and rapid distribution of these rebates.
- Coordinated with California automaker lobbyists to draft, sponsor, and pass legislation providing high occupancy vehicle (HOV) stickers for ZEVs.
- Led the technical portion of negotiations on right-to-repair legislation in Massachusetts (2012). The legislation replaced a ballot measure, provided repair technicians the information and tools needed, while minimizing the cost and security risks to automakers and drivers. Automakers subsequently agreed to voluntarily apply the technical requirements nationwide.
- Headed industry negotiations on the California Air Resources Board (ARB) Advanced Clean Cars (ACC) program, which includes ZEV, greenhouse gas, and tailpipe exhaust regulations. Formulated, drafted, and presented industry positions on all aspects of the ACC program.

EXHIBIT A

- Founder, board member, and immediate past Chairman of the National Automotive Service Task Force (NASTF) that coordinates efforts between automakers, dealers, aftermarket service technicians, equipment and tool companies, and service trainers. This organization now has over 22,000 members and processes well over one million vehicle key code and security information requests annually.

- Testified on behalf of the industry at state legislative and regulatory hearings in AZ, CA, CO, DE, FL, IL, MN, NM, VT, and WA.

Staff Engineer **American Automobile Manufacturers Association**
September 1995 – December 1998 (3 years 4 months)

Liaison between Chrysler, Ford, and General Motors and the ARB on California vehicle pollution control regulations.

- Coordinated automaker technical response Zero Emission Vehicle (ZEV) mandate. This mandate required that electric vehicles make up 10 percent of all new vehicle sales starting in 2003.
- Formulate, develop, and present positions for vehicle On-Board Diagnostic ("check engine light") requirements.
- Assist in the preparation for and the design and implementation of an annual, three-day gathering of automakers and California government policymakers to discuss and review new vehicle technology, testing, laboratory procedures.

Captain **Submarine Officer, U.S. Navy**
August 1983 – March 2019 (35 years)

Commanding Officer – U.S. Navy Reserve (1997-2019) Pacific Strike Group Operations

- Led a Navy Reserve unit providing trained, proficient, and operational officers and enlisted sailors to Submarine Group 7 in Yokosuka, Japan for submarine operations in the Seventh Fleet.

- Coordinated fleet anti-submarine warfare exercises with U.S., Japanese, and South Korean navies.

Submarine Officer (1983-1995) – Active-Duty U.S. Navy

Education

McGeorge School of Law
Justice Anthony M. Kennedy Fellow
2001, recalled to active-duty Navy during first semester

Auburn University
BS, Electrical Engineering
1985 – 1988

EXHIBIT B

Exclusive: Automakers to double spending on EVs, batteries to $1.2 trillion by 2030

By **Paul Lienert**

October 25, 2022 5:54 PM CDT · Updated 9 months ago

EXHIBIT B

Summary Companies

Graphic on EV investments:

Oct 21 (Reuters) - The world's top automakers are planning to spend nearly $1.2 trillion through 2030 to develop and produce millions of electric vehicles, along with the batteries and raw materials to support that production, according to a Reuters analysis of public data and projections released by those companies.

The EV investment figure, which has not previously been published, dwarfs previous investment estimates by Reuters and is more than twice the most recent calculation published just a year ago.

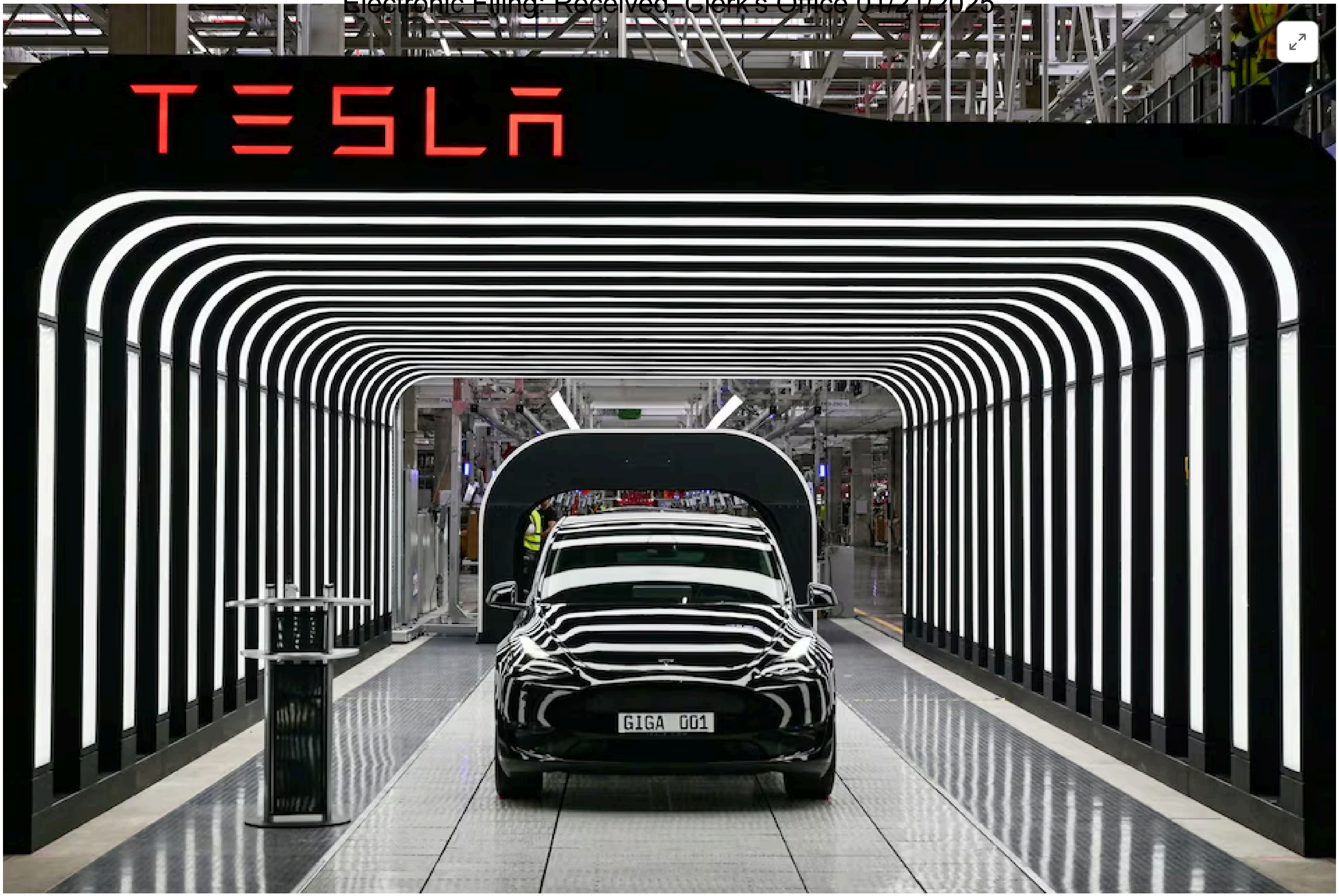
To put the figure in context, Alphabet (GOOGL.O), the parent company of Google and Waymo, has a market cap of $1.3 trillion.

Automakers have forecast plans to build 54 million battery electric vehicles in 2030, representing more than 50% of total vehicle production, according to the analysis.

To support that unprecedented level of EVs, carmakers and their battery partners are planning to install 5.8 terawatt-hours of battery production capacity by 2030, according to data from Benchmark Mineral Intelligence and the manufacturers.

Leading the charge is Tesla (TSLA.O), where Chief Executive Elon Musk has outlined an audacious plan to build 20 million EVs in 2030, requiring an estimated 3 terawatt-hours of batteries. Musk in late October said Tesla already is working on a smaller vehicle platform targeted to cost half as much as the Model 3 and Model Y.

While Tesla has not fully disclosed its spending plans, such exponential growth - a 13-fold increase over the estimated 1.5 million vehicles it hopes to sell this year - will come at a cost of hundreds of billions of dollars, according to a Reuters analysis of Tesla's financial disclosures and forecasts for global EV demand, and battery and battery mineral production.



[1/2] Model Y cars are pictured during the opening ceremony of the new Tesla Gigafactory for electric cars in Gruenheide, Germany, March 22, 2022. Patrick Pleul/Pool via REUTERS/File Photo Purchase Licensing Rights

Germany's Volkswagen (VOWG_p.DE), while lagging behind Tesla, has ambitious plans through the end of the decade, targeting well over $100 billion to build out its global EV portfolio, add new battery "gigafactories" in Europe and North America and lock up supplies of key raw materials.

Japan's Toyota Motor Corp (7203.T) is investing $70 billion to electrify vehicles and produce more batteries, and expects to sell at least 3.5 million battery electric models (BEVs) in 2030. It plans at least 30 different BEVs and expects to transition the entire Lexus range to battery electric over that span.

Ford Motor Co (F.N) keeps boosting its spending level on new EVs - now at $50 billion - and at least 240 gigawatt-hours of battery capacity with its partners as it aims to produce around 3 million BEVs in 2030 - half its total volume.

Mercedes-Benz (MBGn.DE) has earmarked at least $47 billion for EV development and production, nearly two-thirds of that to boost its global battery capacity with partners to more than 200 gigawatt-hours.

BMW (BMWG.DE), Stellantis (STLA.MI) and General Motors (GM.N) each plan to spend at least $35 billion on EVs and batteries, with Stellantis laying out the most aggressive battery program: A planned 400 gigawatt-hours of capacity with partners by 2030, including four plants in North America.

Read more:

The long road to electric cars

INSIGHT-Global automakers face electric shock in China

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Reporting by Paul Lienert in Detroit; Editing by Ben Klayman and Lisa Shumaker

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EXHIBIT C

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EV Investment Dashboard

On a global scale, automakers are planning to spend an estimated $1.2 trillion through 2030 to develop and build new battery-powered vehicles. From new assembly plants and battery factories to retooling and upgrading existing facilities, the automotive industry is investing in vehicle electrification.

This interactive investment dashboard is designed to easily see where commitments have been made. This dashboard only attempts to capture investments made for the purposes of electrifying vehicles from 2019 – September 2024.

Battery Investments

EV Investments

Timeframe

2/1/2019 | 10/1/2024

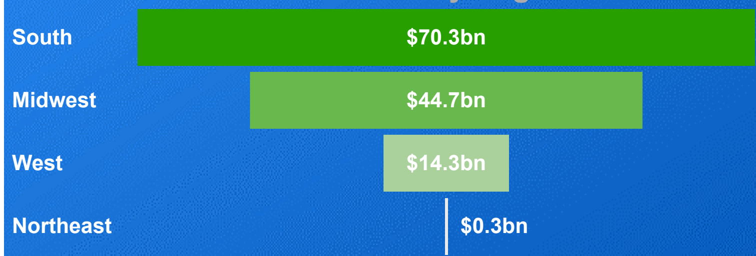
Total Investments
$129.6bn
Jobs Created: 113K *(100% U.S.)*

EV Facility Investments
$38.3bn
EV Jobs Created: 48K *(42.1% U.S. Jobs)*

Battery Facility Investments
$91.3bn
Battery Jobs Created: 66K *(57.9% U.S. Jobs)*
GWh Added: 957 *(100% U.S.)*

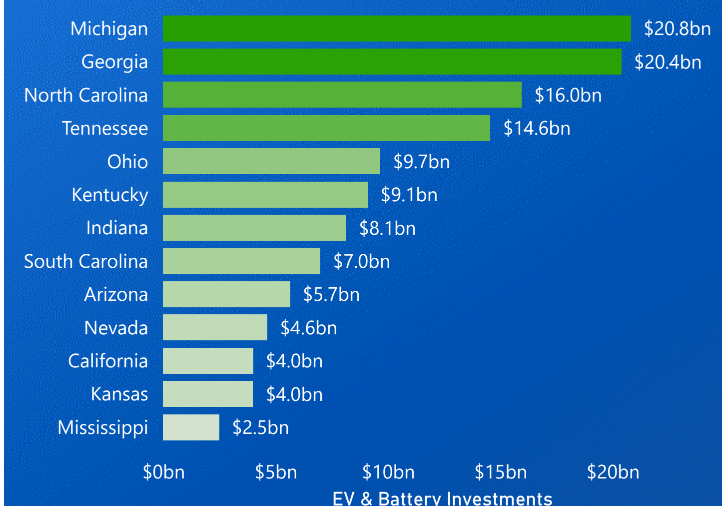
Investment | Total Jobs | EV Jobs | Battery Jobs | GWH

EV Investments by Region

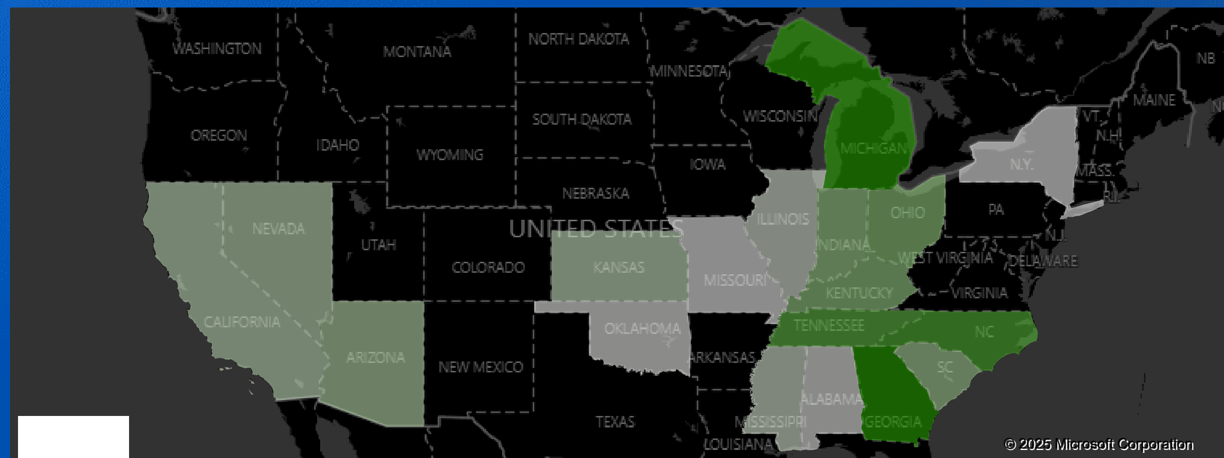


Investments

$0.1bn – $20.82bn



Source: Compiled from company reports, press statements, and other media. Investments from 2019 - September 2024



Company	Investment	Jobs Created	GWh Created
AESC	$5,120,000,000	4,700	60
American Battery Factory	$1,200,000,000	1,000	3
American Battery Solutions	$7,000,000	148	0
Amplify Cell Technologies (Accelera, Daimler, PACCAR, EVE)	$2,000,000,000	2,000	21
Arrival Automotive	$53,000,000	400	0
BlueOval SK (Ford, SK On)	$8,600,000,000	8,000	129
Total	$129,632,100,000	113,297	957

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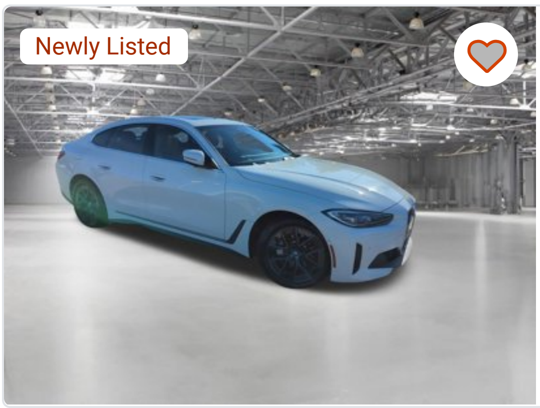

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EXHIBIT D

EXHIBIT E

COLORADO (/)
Energy Office

Colorado's Electric

Tax credits are available in Colorado for the purchase or lease of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs). Coloradans can save money on the upfront cost of purchasing an EV and on fuel and maintenance costs over the course of the vehicle's lifespan.

EXHIBIT E

Vehicle Tax Credits

Colorado is leading the charge on vehicle electrification.

Funding Overview:

Eligibility: Residents, Business & Industry
Types of Funding: State Tax Credits

Note: The Colorado Energy Office does **not** offer tax advice. For questions about the state EV tax credit, please reach out to the **Colorado Department of Revenue (https://tax.colorado.gov/)**.

For questions about the federal EV tax credit, please visit the **U.S. Internal Revenue Service's website (https://www.irs.gov/credits-deductions/credits-for-new-clean-vehicles-purchased-in-2023-or-after)**.

Information for Residents & Businesses:

Colorado provides zero-emission vehicle tax credits for the purchase or lease of new electric vehicles. Tax incentives are available for both personal and commercial electric vehicles. This includes both battery electric and plug-in hybrid electric vehicles. A motor vehicle, truck, or trailer must be titled and registered in Colorado to qualify for the credit.

See list of full electric and plug-in hybrid electric vehicles (https://afdc.energy.gov/vehicles/search)

Colorado taxpayers are eligible for a state tax credit of $3,500 for the purchase or lease of a new EV with a manufacturer's suggested retail price (MSRP) up to $80,000, and an additional tax credit of $2,500 for the purchase or lease of a new EV with an MSRP up to $35,000. Lease agreements must have an initial term of at least two years.

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Some EV dealers allow Coloradans to assign the tax credit to the dealer in order to receive the tax credit amount as a point-of-sale discount off the purchase price of the vehicle. We recommend reaching out to your local EV dealer to find out if they offer this option.

Learn more about the state EV tax credit (https://tax.colorado.gov/sites/tax/files/documents/ITT_Innovative_Motor_Vehicle_Credit_Feb_2024.pdf)

Tax credits are also available for light-, medium-, and heavy-duty electric (including hydrogen) trucks. Learn more in the **Innovative Truck Credit overview document (https://tax.colorado.gov/sites/tax/files/documents/ITT_Innovative_Truck_Credit_Feb_2024.pdf)**.

Additional Resources

If you are just learning about EVs, you are not alone! Learn more about available incentives, the benefits of driving an EV, charging, and more on the EV CO website.

Go to EV CO Website (https://evco.colorado.gov/)

Additional EV incentives for businesses and residents include:

- **Federal commercial tax credits** – Learn more on the Internal Revenue Service (IRS) website (https://www.irs.gov/credits-deductions/credits-for-new-clean-vehicles-purchased-in-2023-or-after).
- **Vehicle Exchange Colorado (VXC)** – A statewide rebate program for income-qualified Coloradans to replace old or high-emitting vehicles with electric vehicles.

  Vehicle Exchange Colorado (https://energyoffice.colorado.gov/vehicle-exchange-colorado)

- **Utility Rebates** - Some utility providers offer rebates to consumers to offset the cost of purchasing an EV or the cost to install EV chargers at homes or at businesses. Reach out to your utility provider to learn more.
- **Fleet Zero-Emission Resource Opportunity (Fleet-ZERO)** - Provides funding for EV charging to support the transition of light-, medium-, and heavy-duty fleets to EVs.

Fleet Zero-Emission Resource Opportunity (https://energyoffice.colorado.gov/fleet-zero)

- CDPHE's Clean Fleet Vehicle and Technology Grant Program - A statewide competitive application process for new fleet vehicles, vehicle conversions, and clean fleet technology.

Clean Fleet Vehicle and Technology Grant Program (https://cdphe.colorado.gov/clean-fleet-vehicle-technology-grant-program#:~:text=The%20Clean%20Fleet%20Enterprise%27s%20(CFE,and%20heavy%2Dduty%20fleet%20vehicles.)

Find more EV incentives for consumers interested in purchasing or leasing an electric vehicle or installing a charger

View Drive Electric Colorado Website (https://driveelectriccolorado.org/incentives/)

Stay in Touch with CEO

We regularly launch new programs, including new funding opportunities. Sign up to receive updates (https://socgov27.my.site.com/CEOForms/s/contact-lists) about upcoming programs that can save you money and reduce your emissions.

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EXHIBIT F

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COLORADO (/)
Energy Office

The Vehicle Exchange Colorado (VXC) program helps income-qualified Coloradans recycle and replace their old or high-emitting vehicles with electric vehicles (EVs). The VXC rebate partially covers the upfront cost of the EV at the time of purchase or lease from an authorized automobile

EXHIBIT F

Vehicle Exchange Colorado (VXC) Program

Colorado's vehicle exchange program makes your upgrade to an EV more affordable.

Ver la pagina en español (https://energyoffice.colorado.gov/vehicle-exchange-colorado-espanol)

dealer.

We encourage income-qualified Coloradans who own eligible old or high-emitting vehicles to apply for this rebate.

Sign-up to receive email updates about the Vehicle Exchange Colorado program.

Sign Up for Email Updates (https://socgov27.my.site.com/CEOForms/s/contact-lists/vehicle-exchange)

How It Works

Vehicle Exchange Colorado

Please carefully read the Terms and Conditions for full details about program rules and eligibility.

View Participant Terms & Conditions (https://drive.google.com/file/d/1S7R_soeEzbjj8OPTS7fX80vJkHxV6ssy/view)

Confirm eligibility.

Check income and old or high-emitting vehicle eligibility requirements for a rebate. See Eligible Applicants and Eligible Vehicles sections below.

Gather application materials.

You will need to provide your name, contact information, driver license, proof of income-qualification, proof of current Colorado address, and old or high-emitting vehicle information. See Eligible Applicants and Eligible Vehicles sections below for more information about acceptable documentation.

Submit an online application

through the Vehicle Exchange Colorado Application portal

Apply now **(https://coloradoenergyoffice.aptim.com/)**

Get application approval.

We will reach out to you if there are any issues with your application that need to be fixed.

Trade-in your old or high-emitting vehicle at a participating automobile dealer

for a point-of-sale rebate on a qualifying EV purchase or lease.

For assistance with your VXC application or any questions about the program, please contact the program's customer service team:

Phone: 833-933-9602
Email: vxc@aptim.com (mailto:vxc@aptim.com)

Note: Program procedures, requirements, and point-of-sale rebate levels are subject to change or cancellation without notice and are subject to available program funds.

Eligible Applicants

Note: Only one VXC rebate is allowed per tax household.

In order to qualify for the VXC program, a participant must:

- ☐ Live in Colorado
- ☐ Be 18 years old or older
- ☐ Be eligible to purchase or lease a vehicle in Colorado
- ☐ Own an eligible old or high-emitting vehicle (see the Eligible Vehicles section below)

Meet at least one of the following income requirements:

- ☐ Household income below 80% of the area median income in the county where the resident lives

View 80% AMI chart (https://docs.google.com/spreadsheets/d/1I9wrt5zJ6khmLR3ZeFCKlz5EmNKUusaFYAK4oeKO4wY/edit?gid=0#gid=0)

OR Enrollment in any one of the following financial assistance programs:

- ☐ Colorado Affordable Residential Energy (CARE) Program
- ☐ Colorado's Weather Assistance Program (WAP)

Acceptable Proof of Income and Address Documentation

Income

If not enrolled in an income-qualified program, applicants can prove income with the first page of either your 2022, 2023, or 2024 Federal tax form 1040 (Line 9 - Total Income is used). Alternatively, pay stubs can be provided to prove income (at least four consecutive weeks of pay stubs which must all be fewer than six months old).

Address

Acceptable proof of address documents must be dated within one year of the application and include the following:

- ☐ Current and valid Colorado Driver License or ID
- ☐ Computer-generated bill (utility, credit card, doctor, hospital, etc.)
- ☐ Printed bank statement
- ☐ Pre-printed pay stub (from a period within the last three months)
- ☐ First-class mail (from a government agency or court)
- ☐ Current homeowners, renter's, or motor vehicle insurance policy
- ☐ Mortgage, lease, or rental contract

- ☐ Medicaid
- ☐ Regional Transportation District (RTD) LiVE
- ☐ Section 8 voucher holder
- ☐ Social Security Disability Insurance (SSDI)
- ☐ Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)
- ☐ State of Colorado Low-Income-Energy Assistance Program (LEAP)
- ☐ Supplemental Nutrition Assistance Program (SNAP)
- ☐ Supplemental Security Income (SSI)
- ☐ Transcript or report card from an accredited school
- ☐ Motor vehicle registration
- ☐ USPS Change of Address Form CNL107
- ☐ DD Form 214

Eligible Vehicles

Old or high-emitting vehicles that are eligible to trade-in for an EV rebate must meet the following requirements:

- Operational gasoline- or diesel-powered vehicle
- Model year is 12 years or older (e.g., model year 2013 or older for a 2025 application) or vehicle fails a Colorado emissions test
- Vehicle is currently titled in Colorado and the applicant name matches the name on the title. Vehicle title is solely issued to VXC applicant (see the **DMV Titles - FAQs page (https://dmv.colorado.gov/titles-faqs)** if you have a vehicle title with more than one owner listed)
- Vehicle title does not have a lien (e.g., there is no outstanding loan for the vehicle)
- Vehicle is currently registered with the Colorado Department of Motor Vehicles under the applicant’s name

- Title is a clear title, bonded title, reconstructed title, affidavit title, rebuilt title, water damage title, or odometer rollback title. It cannot be a salvage title, junk title, or dismantled title.

Note: electric vehicles, hybrid vehicles, motorcycles, recreational vehicles (RVs), campers, and boats are not eligible to exchange through VXC at this time.

Applicants who receive a VXC rebate may use it to purchase or lease a new or used:

- **Battery Electric Vehicle (BEV)**, or fully electric vehicle, which is powered completely by a battery.
- **Plug-in Hybrid Electric Vehicle (PHEV)**, which is powered by a battery, with an average range of 20-50 miles, and a traditional gas tank and engine.

Eligible Coloradans can receive the following rebate amounts for a qualified electric vehicle purchase or lease (**note:** a lease term must be a minimum of two years):

- New electric vehicle (BEV or PHEV): $6,000
- Used electric vehicle (BEV or PHEV): $4,000

New vehicles must have a manufacturer's suggested retail price (MSRP) of $80,000 or less (see page 3 of the **Innovative Motor Vehicle Tax Credit guidance (https://tax.colorado.gov/sites/tax/files/documents/ITT_Innovative_Motor_Vehicle_Credit_Feb_2024.pdf)**); and used vehicles must have a final negotiated price of $50,000 or less (note: the final negotiated price does not include destination charges or optional items added by the dealer, or taxes and fees).

The title for the EV must include the VXC participant. VXC rebate recipients may take out a loan (with or without a cosigner) to finance the vehicle purchase.

The State allows VXC participants to combine the VXC program rebate with state and federal tax credits and other EV rebates. However, other EV rebate programs may not allow participants to combine their rebate with a VXC rebate or other EV incentive (e.g., tax credits). We recommend that participants reach out directly to these other EV rebate programs to find out whether they allow participants to combine their rebate with the VXC rebate and other EV incentives for the same vehicle purchase or lease.

After applying all other available rebates, tax credits, or other discounts, the VXC rebate may not exceed the remaining purchase or lease price of the vehicle.

Terms

Participating Automobile Dealers

Rebate recipients can only redeem a VXC rebate to purchase or lease an EV from an authorized automobile dealer. The vehicle must be purchased or leased **after** you have been approved for a VXC rebate. Rebates are **not** retroactive to past purchases or leases.

List of Participating Automobile Dealers
(https://docs.google.com/spreadsheets/d/1G-nzeJoPgiBLMnGAeZNzFGHpmBbSRfVzNkSfIdHf8dg/edit?usp=sharing)

Map of Participating Dealers
(https://www.google.com/maps/d/embed?mid=1LxRcvrfu91ediw5-CbtKTiQmk84txOY&ehbc=2E312F&noprof=1)

If you are interested in participating in the VXC program as an authorized automobile dealer, please fill out the **Vehicle Exchange Colorado pre-registration form for automobile dealers (https://forms.gle/He5T9Z4XVMiVJMJW7)**. Additional VXC registration information for automobile dealers can be found at the link below:

Registration Information for Automobile Dealers
(https://docs.google.com/document/d/1a5Dsg0-z7QH7K8dk1S8V_HZt_XsVd8qSRuuv0_hc7uM/edit)

Please carefully read the Terms and Conditions for full details about program rules and eligibility.

View Dealer Terms & Conditions (https://drive.google.com/file/d/1x8URdqoBwl8aM_fZHnlMKAzD1tk3lPtf/v

Additional Resources

For more information, please refer to the Vehicle Exchange Colorado - FAQ.

VXC - Frequently Asked Questions (https://docs.google.com/document/d/1jQ3jTf_MA8PHMC8wbbRiG6SzbmAsePbRVN-DEe4KykI/edit)

Additional incentives available for Coloradans looking to purchase or lease an electric vehicle, include:

- State and federal **EV tax credits (https://energyoffice.colorado.gov/zero-emission-vehicles/zero-emission-vehicle-tax-credits)**
- Utility rebates - some utility providers offer rebates to consumers to offset the cost of electric vehicles, and to install home EV Chargers. Reach out to your utility provider to learn more.

If you are interested in learning more about the benefits, costs, and types of electric vehicles, visit the **EV CO website (https://evco.colorado.gov/)**.

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We regularly launch new programs, including new funding opportunities. Sign up to receive updates (https://socgov27.my.site.com/CEOForms/s/contact-lists) about upcoming programs that can save you money and reduce your emissions.

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Accessibility (/Accessibility)

EXHIBIT G

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

EPA OFFICE of TRANSPORTATION and AIR QUALITY

www.fueleconomy.gov

the official U.S. government source for fuel economy information

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Fuel Economy | Energy and Environment | Safety | Specs

	2024 Hyundai Tucson Plug-in Hybrid X	2024 Hyundai Tucson Hybrid Blue X	
Personalize	Plug-in Hybrid Vehicle Gasoline-Electricity  1.6 L, 4 cyl, Automatic (AM-S6), Turbo MSRP: $38,725 - $45,450 Plug-in Hybrid Calculator	Hybrid Vehicle Gasoline  1.6 L, 4 cyl, Automatic (AM-S6), Turbo MSRP: $32,575	Add a Vehicle
EPA Fuel Economy 1 gallon of gasoline=33.7 kWh Show electric charging stations near me	**Elec + Gas** 80 MPGe combined city/highway .0 gal/100mi of gas + 42 kWh/100mi; **Reg. Gas** 35 MPG combined city/highway 2.9 gal/100mi; Gasoline Only: 33 miles Elec + Gas, All Elec: 0-33 mi; 420 miles Total Range	**Regular Gasoline** 38 MPG combined city/highway; 38 city; 38 highway; 2.6 gal/100mi; Gasoline: 521 miles Total Range	
	About Plug-in Hybrid Cars		

EXHIBIT G

Unofficial MPG Estimates from Vehicle Owners Learn more about "My MPG" Disclaimer	**119.4** MPG **107** → **135** Lo Hi Average based on 2 vehicles ! Not comparable to EPA fuel economy because these estimates do not include electricity use.	User MPG estimates are not yet available for this vehicle
You save or spend* Note: The average 2024 vehicle gets 28 MPG	**You SAVE** **$2,500** in fuel costs over 5 years compared to the average new vehicle	**You SAVE** **$2,000** in fuel costs over 5 years compared to the average new vehicle
Annual Fuel Cost*	Electricity + Gasoline: $1,100	$1,200
Cost to Drive 25 Miles	$1.57 (on a single charge) ⓘ	$1.97
	$2.14 (driving on gas only)	
Cost to Fill the Tank	$33 (gas only)	$41
Tank Size	11.1 gallons	13.7 gallons

*Based on 45% highway, 55% city driving, 15,000 annual miles and current fuel prices. Personalize.
MSRP and tank size data provided by Edmunds.com, Inc.
Range on a tank and refueling costs assume 100% of fuel in tank will be used before refueling.

Mobile | Download Data | USA.gov | Info for Auto Dealers | Privacy/Security | Feedback

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EXHIBIT H

Democracy Dies in Darkness

Tesla shows signs of a turnaround with higher profits

After two consecutive quarters of declining profits and vehicle sales, the electric-car maker reported deliveries and net income grew in the third quarter.

Updated October 23, 2024

2 min 145

By Hannah Ziegler

Tesla posted better-than-expected third-quarter earnings Tuesday, reversing a trend of declining profits in the first two quarters of the year.

The electric-vehicle maker led by Elon Musk reported earnings of 72 cents per share, a 9 percent increase from the same quarter last year and above analysts' expectations. Tesla posted $2.2 billion in third-quarter profit, up 17 percent from a year ago.

Revenue came in at $25.2 billion, an 8 percent increase from the same period last year but just shy of many analysts' expectations. The company's shares jumped nearly 12 percent in after-hours trading.

Tesla's profit margins were boosted by growth in vehicle deliveries and $739 million in revenue from selling emissions credits to other automakers seeking to comply with regulators.

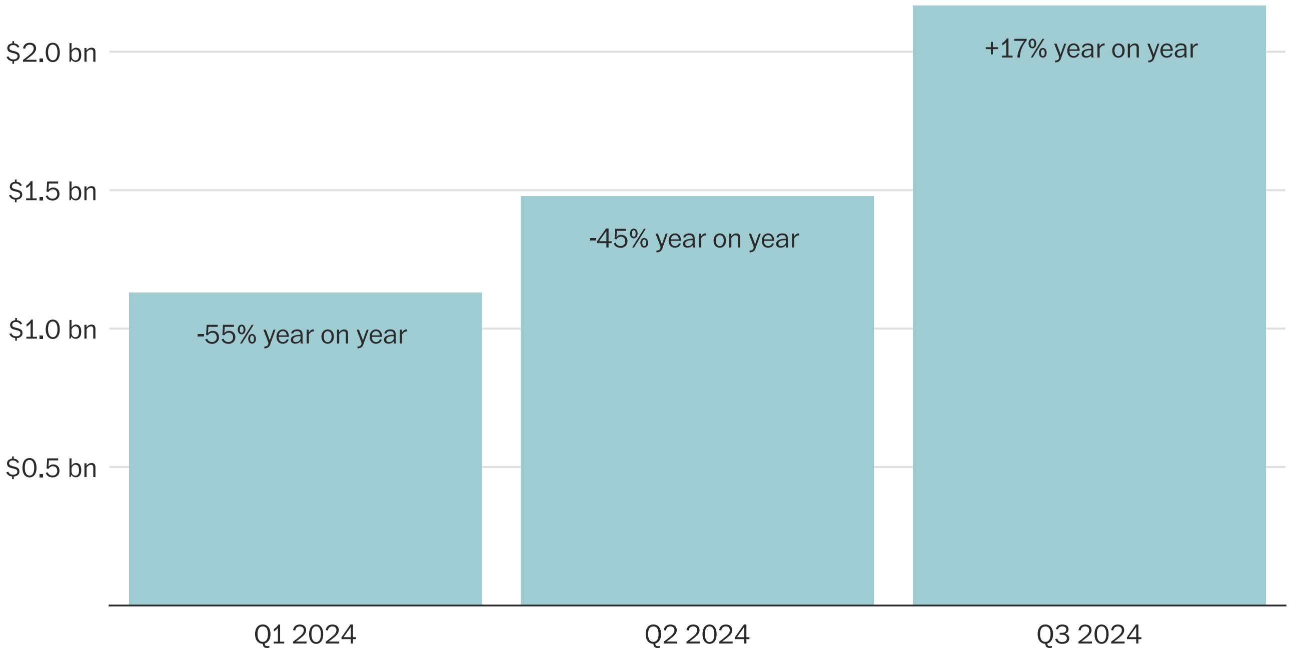
Earlier this month, Tesla reported 462,890 vehicle deliveries for the third quarter, a 6 percent increase from the same period last year. The improvement came after two consecutive quarters of annual delivery declines and as the company offered discounts and incentives to attract a broader market beyond early EV adopters.

Musk said on an investor call Wednesday that Tesla this week reached a total of 7 million vehicles produced over the company's lifetime. The automaker expects to sell more vehicles in 2024 than it did last year, Musk said. That would require Tesla to make record vehicle deliveries in the fourth quarter.

EXHIBIT H

Tesla's profit has started to rebound

The company posted $2.2 billion in profit for the third quarter of 2024, an increase after two quarters of falling net income.



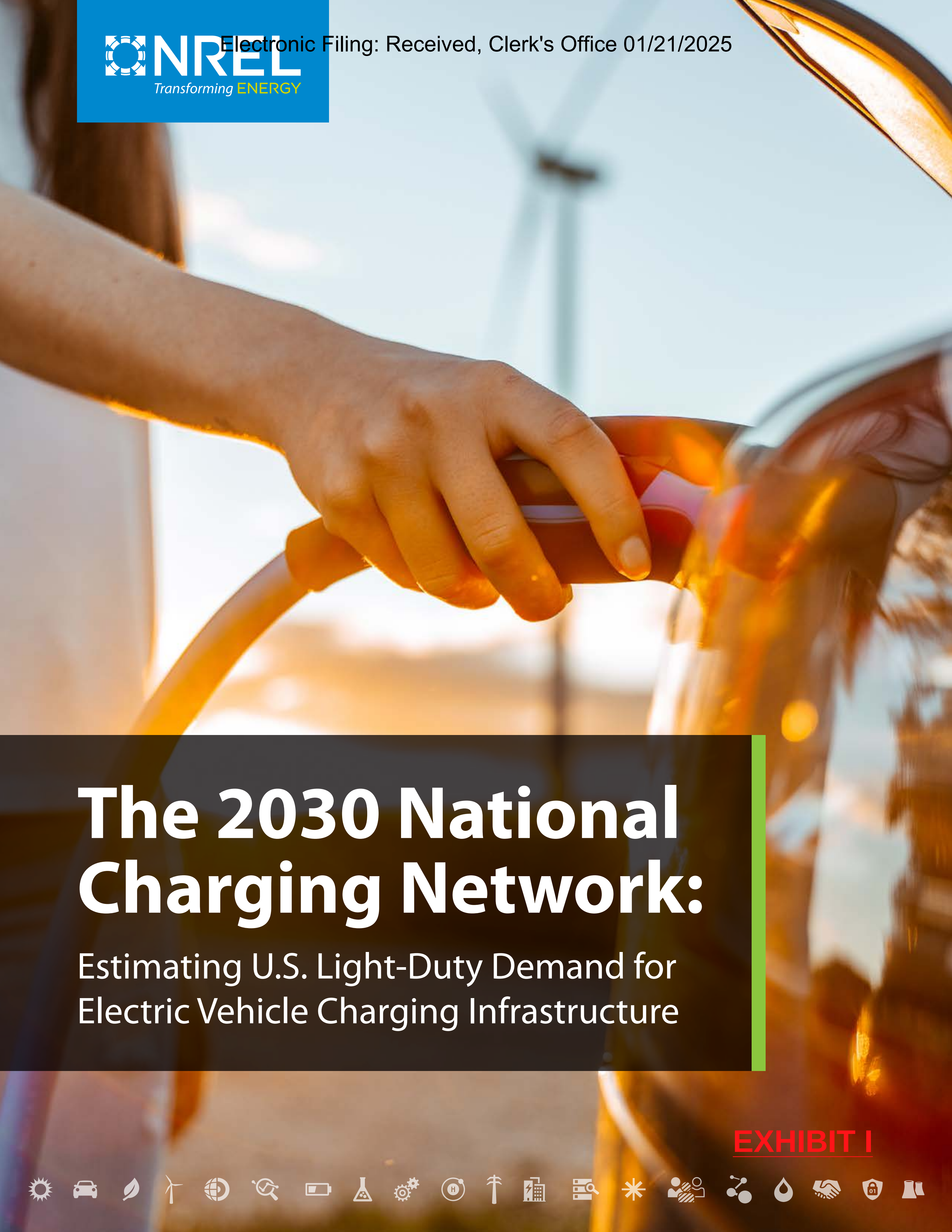
Source: Tesla

Tesla's Cybertruck became the third best-selling EV in the United States during the third quarter, behind Tesla's Model 3 and Model Y, the company said in a shareholder presentation. The distinctive pickup, which has faced a slew of quality issues since its launch last year, "achieved a positive gross margin for the first time" this quarter, Tesla said.

The company also said Wednesday that it is on track to launch more affordable electric vehicle models in the first half of 2025. Musk forecast 20 to 30 percent growth in vehicle sales for next year on the investor call.

Wednesday was Tesla's first earnings report since unveiling its long-anticipated robotaxi, called the Cybercab, this month. Musk made bold predictions for the new product line on the investor call, saying the company is aiming to produce at least 2 million Cybercabs each year and repeating his earlier prediction that production would begin in 2026.

EXHIBIT I



The 2030 National Charging Network:

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

EXHIBIT I

Acknowledgments

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Timely contributions from Atlas Public Policy were necessary to accurately estimate the magnitude of charging infrastructure announcements from the public and private sectors. Thanks to Spencer Burget, Noah Gabriel, and Lucy McKenzie.

Special thanks to external reviewers who provided feedback during various phases of this work. While reviewers were critical to improving the quality of this analysis, the views expressed in this report are not necessarily a reflection of their (or their organization's) opinions. External reviewers included:

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

Jamie Dunckley………………………………………………… Electric Power Research Institute

Paul J. Allen……………………………………………Environmental Resources Management

Colin Murchie and Alex Beaton .... EVgo

Jamie Hall, Alexander Keros, Michael Potter, and Kelly Jezierski........................ General Motors

Brian Wilkie, Christopher Coy, and Ryan Wheeler………………………………… National Grid

Jen Roberton……………………………………… New York State Department of Public Service

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

Erick Karlen…………………………………………………………....Shell Recharge Solutions

Madhur Boloor and Michael Machala…………………………………..Toyota Research Institute

Nikita Demidov……………………………………………………………………… Trillium

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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.

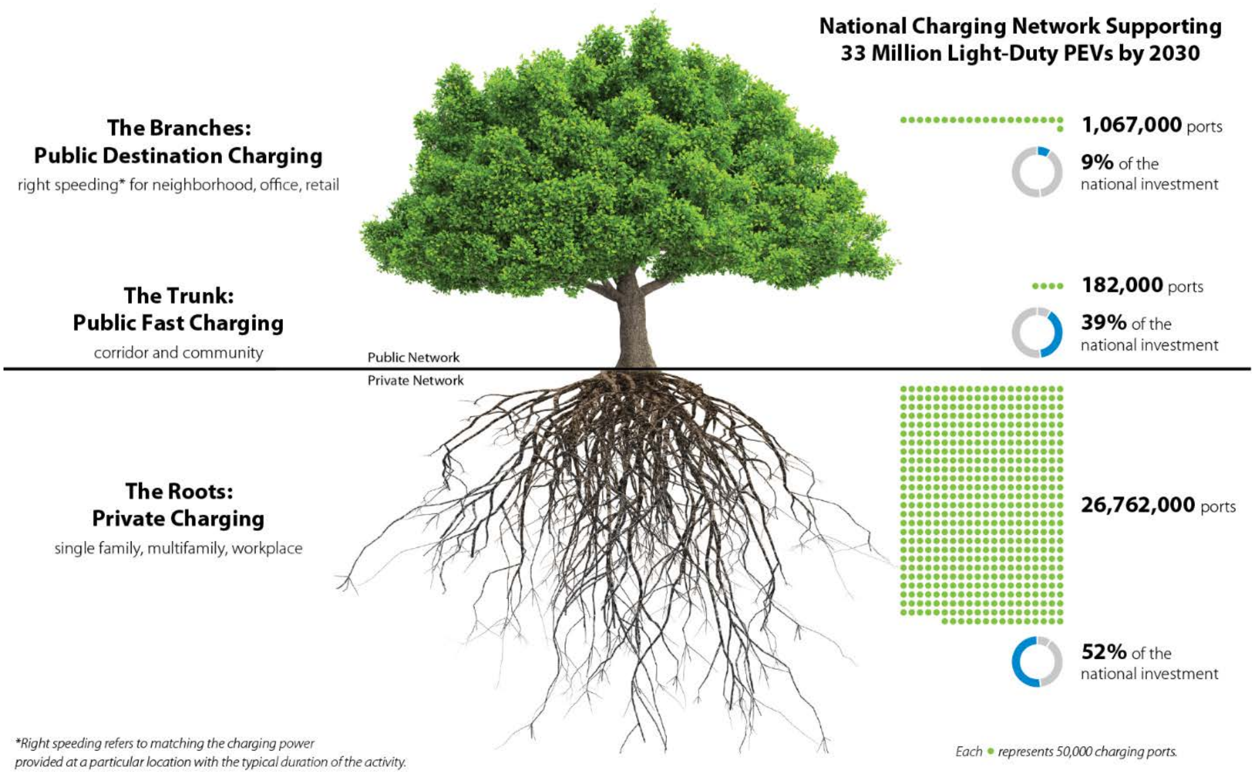

Figure ES-1. Conceptual illustration of national charging infrastructure needs

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.

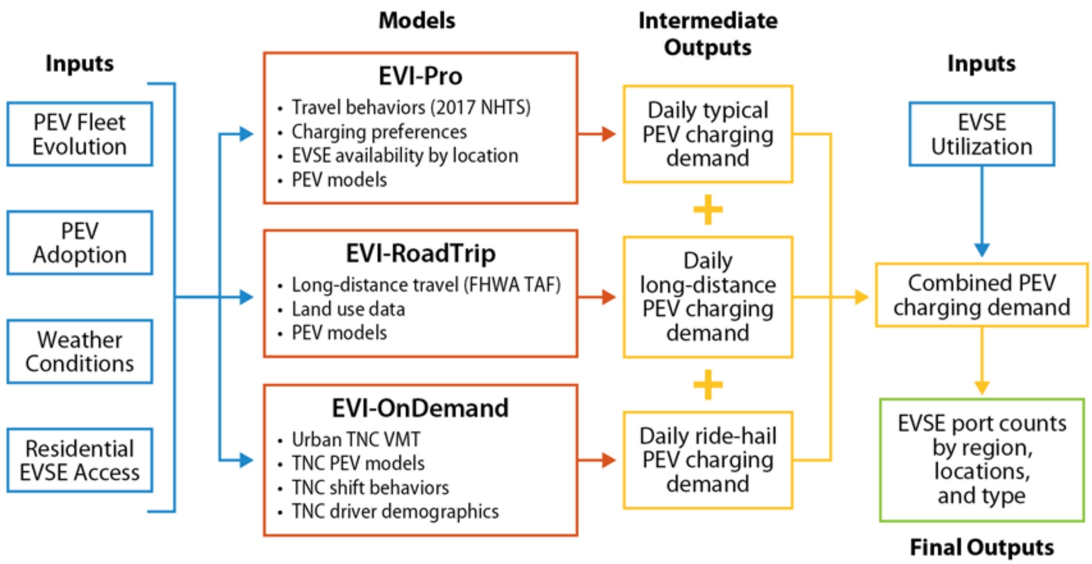

Figure 1. Shared simulation pipeline integrating EVI-Pro, EVI-RoadTrip, and EVI-OnDemand

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).

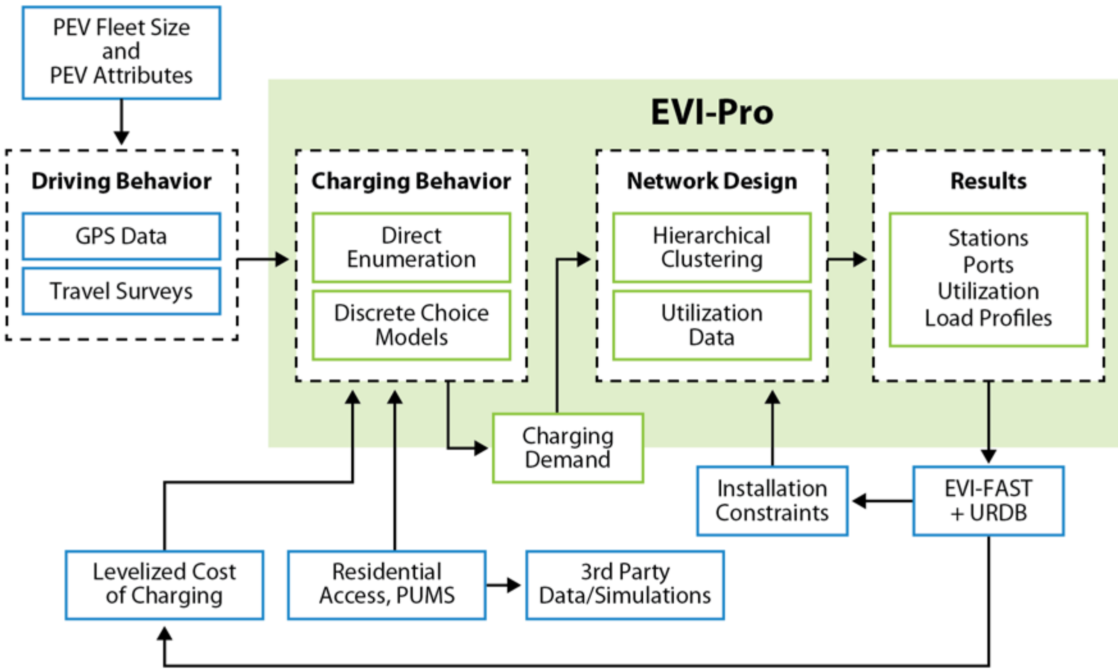

Figure 2. EVI-Pro block diagram for charging behavior simulations and network design

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).

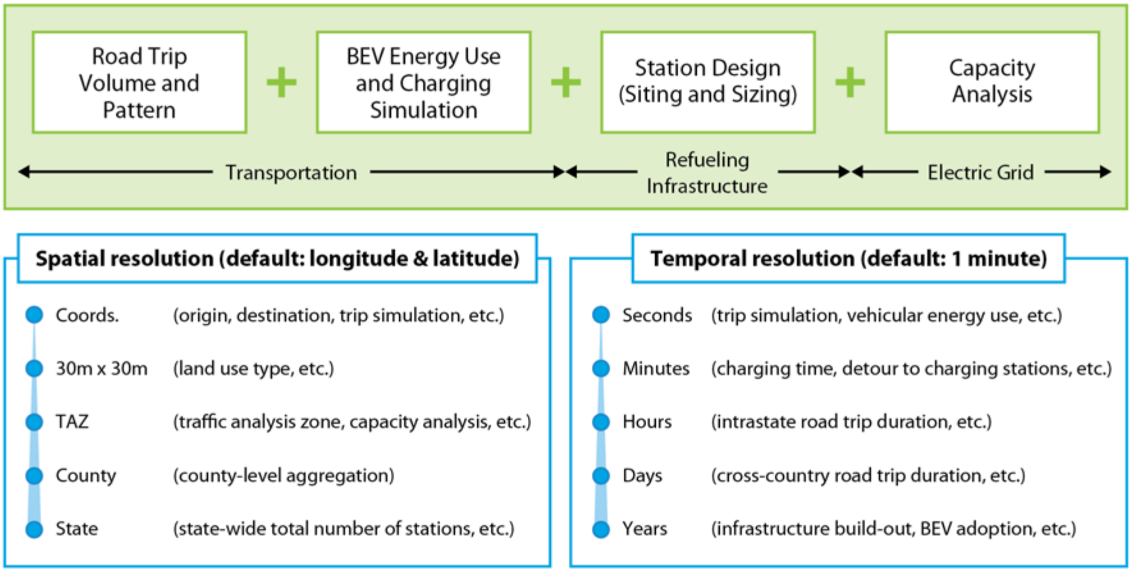

Figure 3. EVI-RoadTrip block diagram for traffic generation, charging behavior simulations, and network design

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.

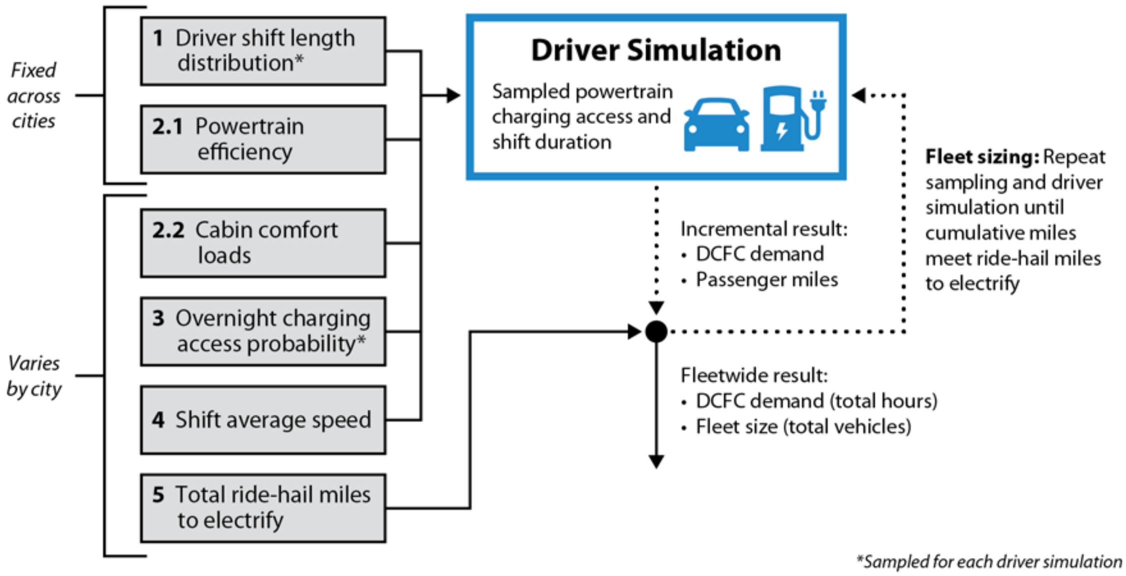

Figure 4. EVI-OnDemand block diagram for driver simulations and related assumptions

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.

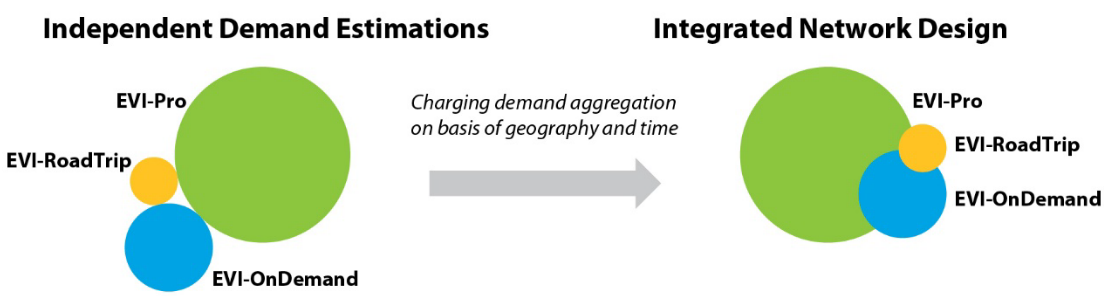

Figure 5. Conceptual diagram illustrating independent demand estimations, demand aggregation, and integrated network design

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.

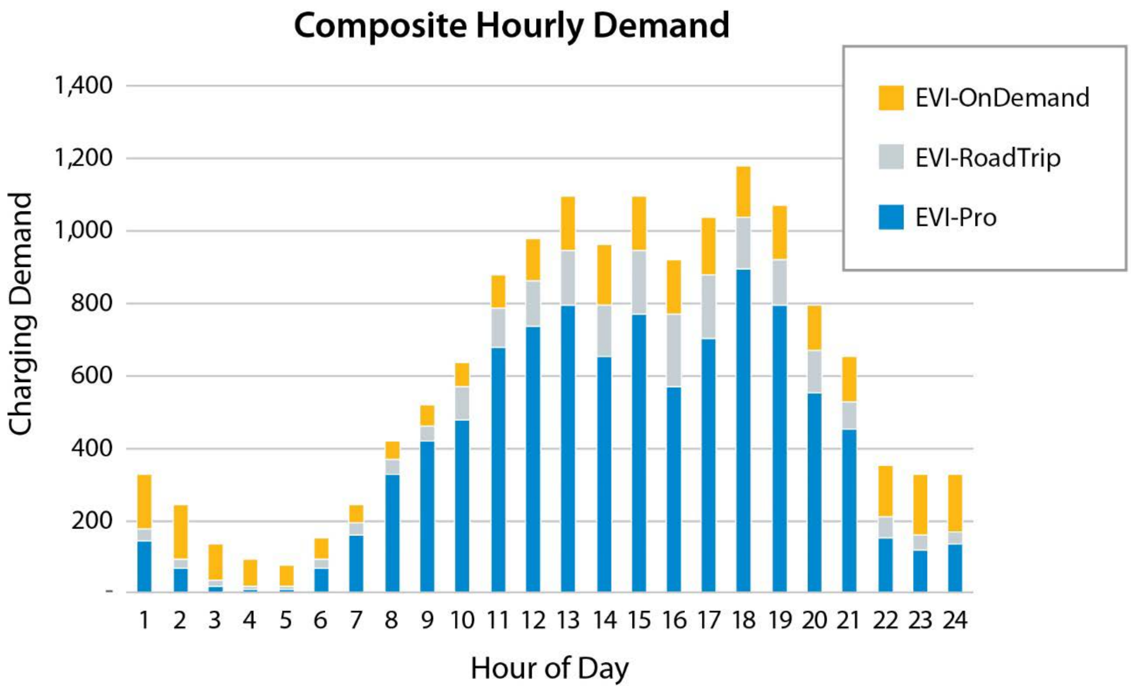

Figure 6. Composite hourly demand for DC charging by use case for an illustrative region

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.

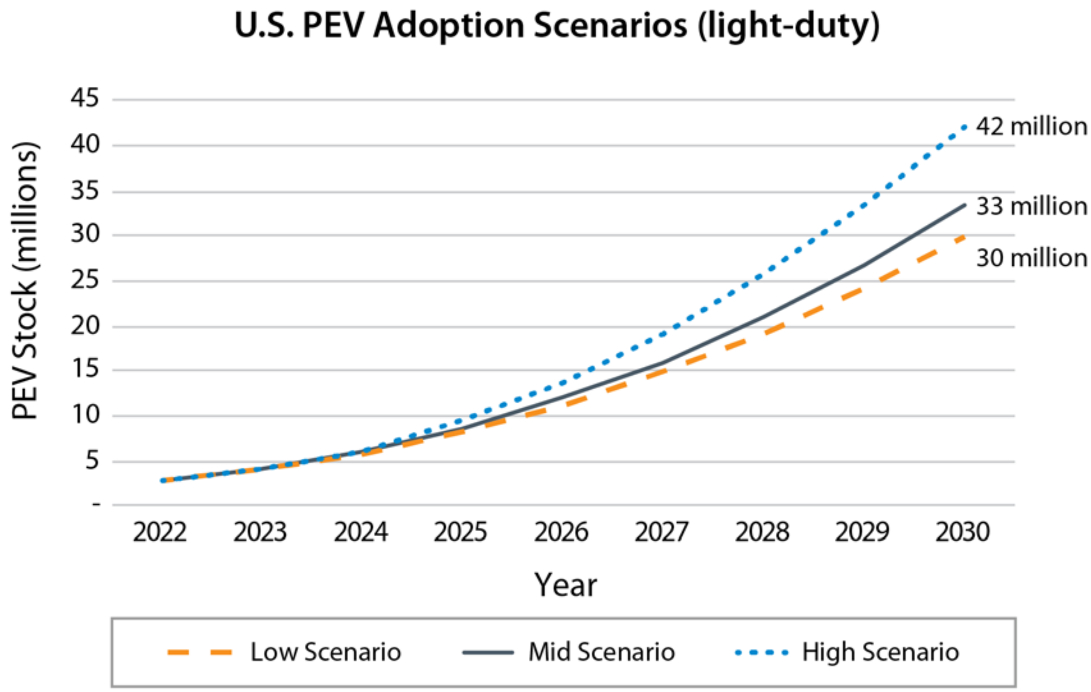

Figure 7. U.S. national light-duty PEV stock under three adoption scenarios

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.

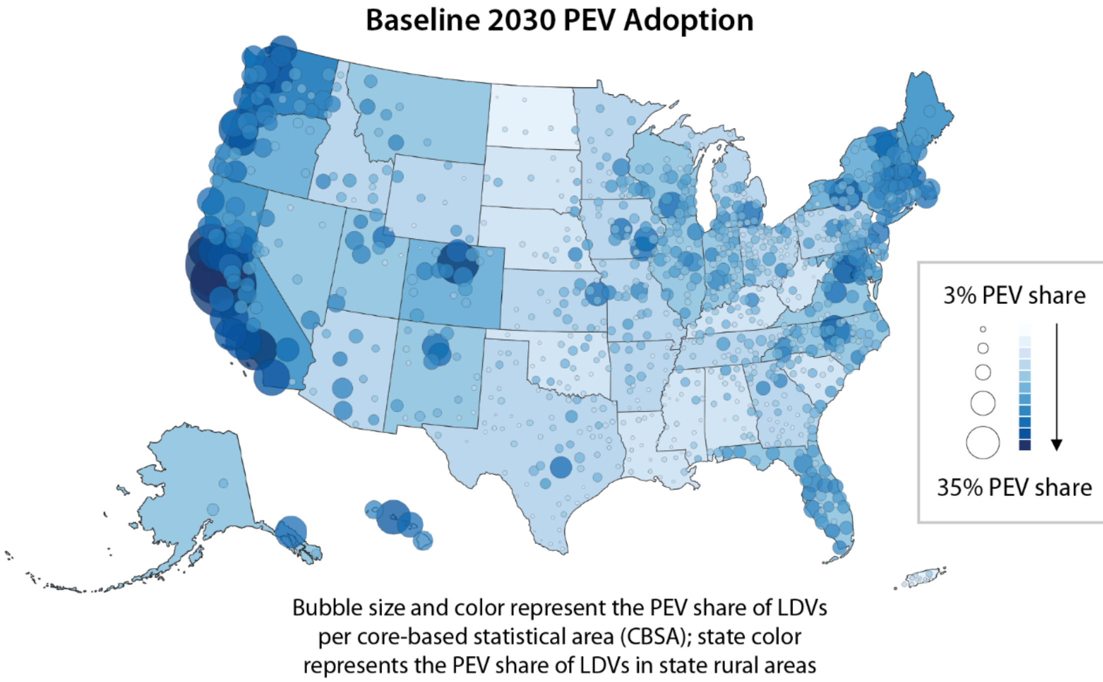

Figure 8. Assumed spatial distribution of 33 million PEVs in 2030 by CBSA and state

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.

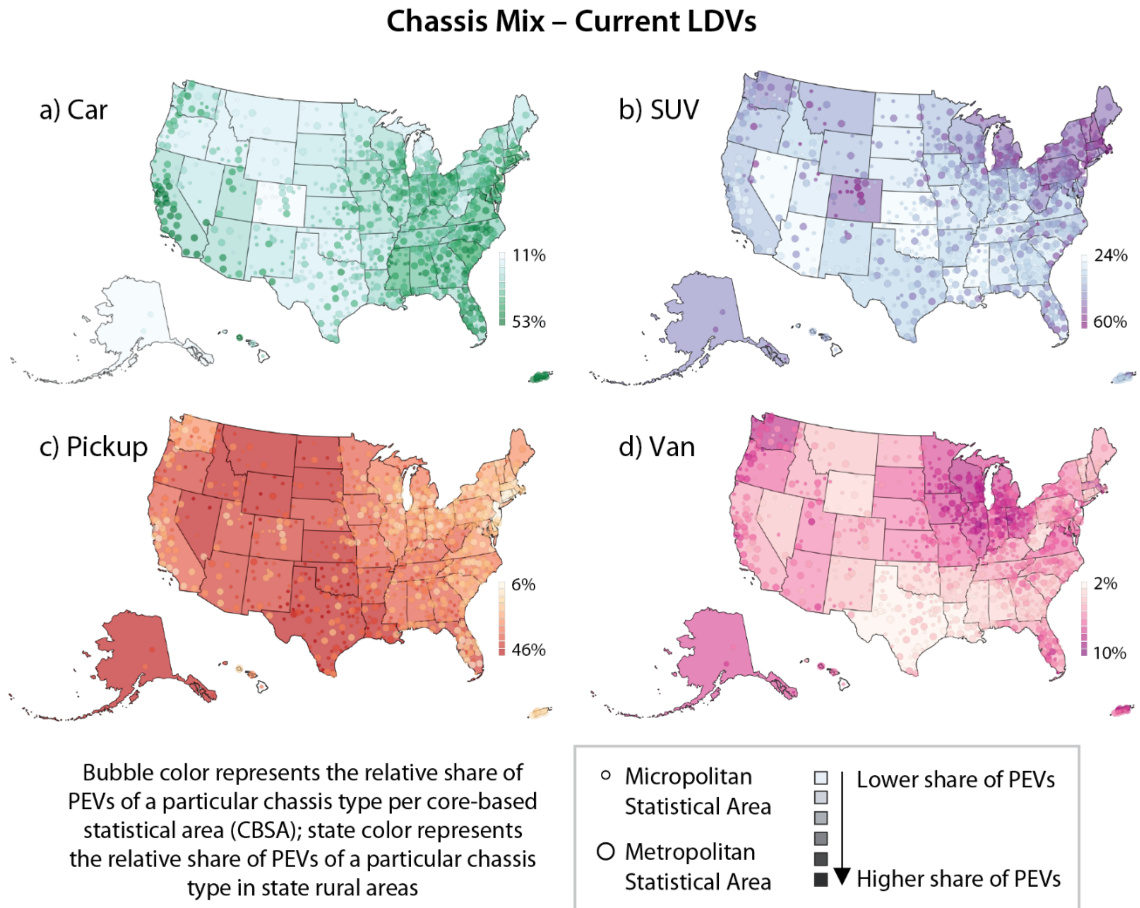

Figure 9. Spatial distribution of new (2019–2022) LDV registrations by body type.

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	320	190	150	26
	2025	300	260	150	24
	2030	300	290	250	20
PHEV sedan	2020	290	45	N/A	N/A
	2025	290	50	N/A	N/A
	2030	290	55	N/A	N/A
BEV C/SUV	2020	390	190	150	30
	2025	430	240	150	30
	2030	420	280	350	20
PHEV C/SUV	2020	370	35	N/A	N/A
	2025	380	40	N/A	N/A
	2030	370	40	N/A	N/A
BEV pickup	2020	–	–	–	–
	2025	570	280	250	24
	2030	500	300	350+	20
PHEV pickup	2020	–	–	–	–
	2025	440	35	N/A	N/A
	2030	420	35	N/A	N/A
BEV van	2020	–	–	–	–
	2025	460	240	150	30
	2030	440	280	350	20
PHEV van	2020	–	–	–	–
	2025	390	35	N/A	N/A
	2030	380	40	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.

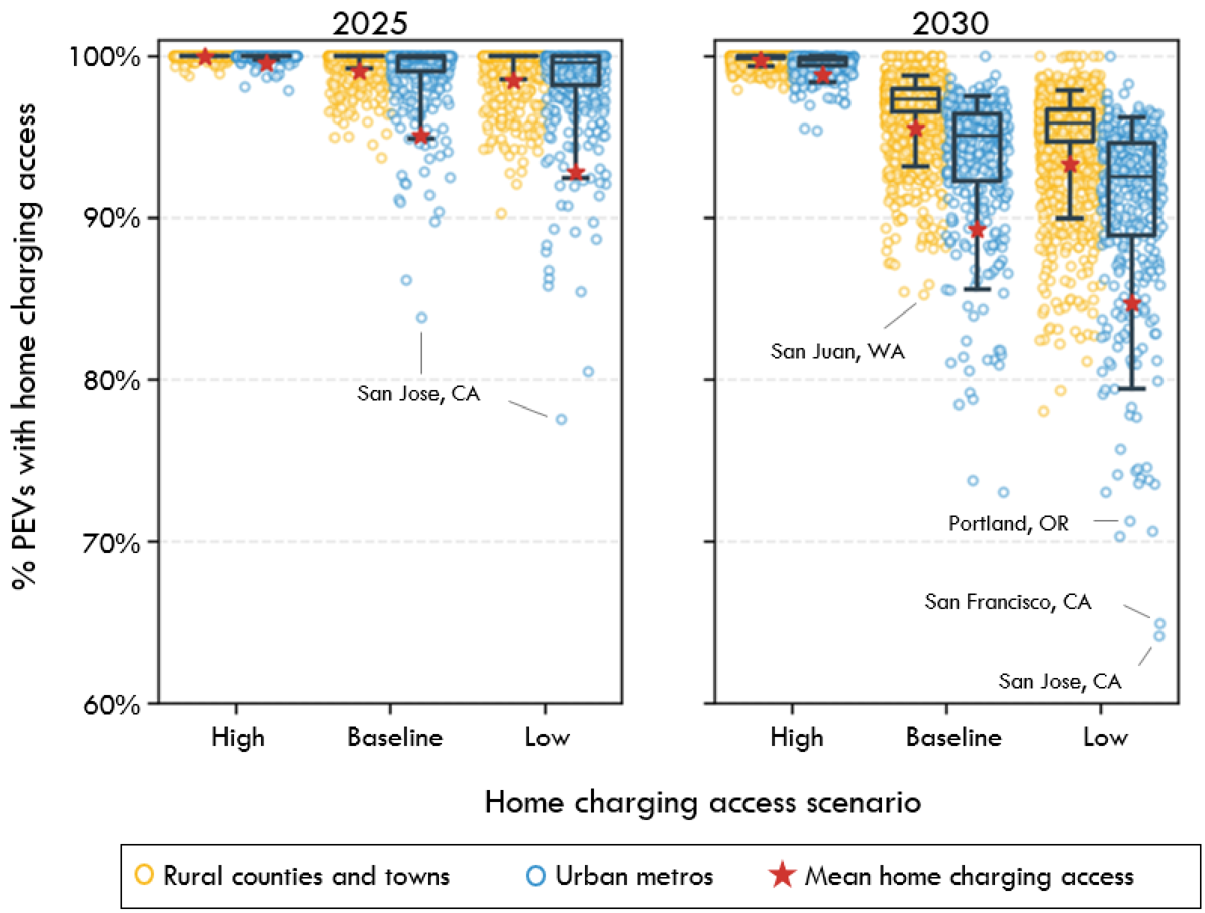

Figure 10. Residential charging accessibility scenarios as a function of PEV stock share. In the boxplot figure, the box reflects the inner quartile range (25%–75%), with the horizontal line reflecting the median value. Whiskers represent the 5th and 95th percentile values, respectively.

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.

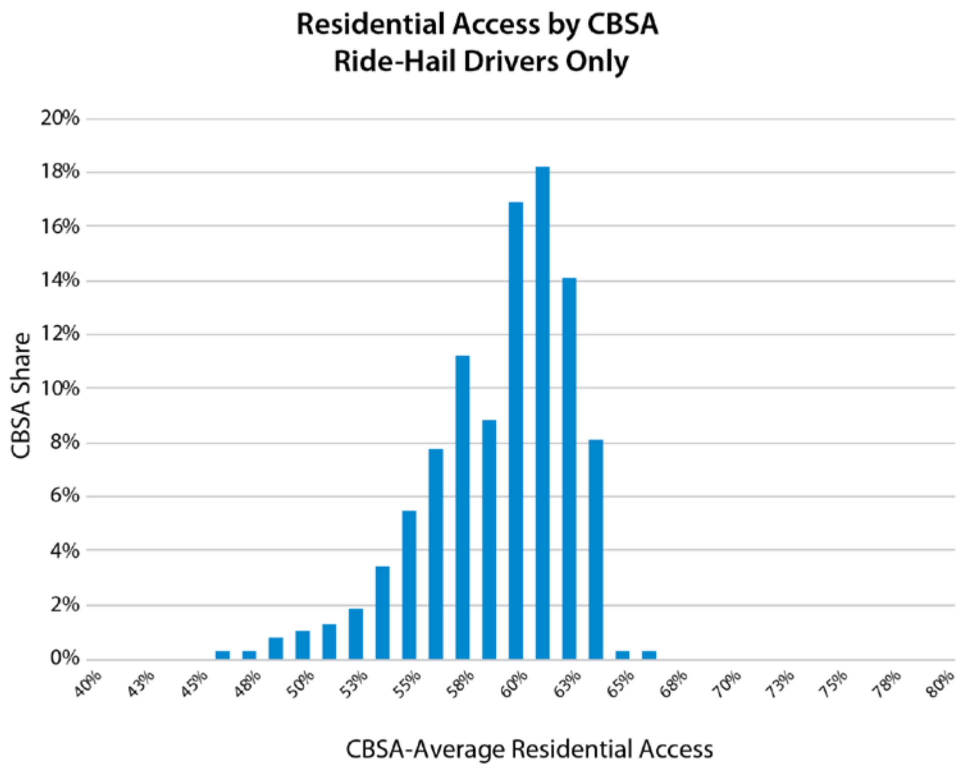

Figure 11. Likelihood of overnight charging access for ride-hailing drivers for the baseline scenario across all metropolitan CBSAs

[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.

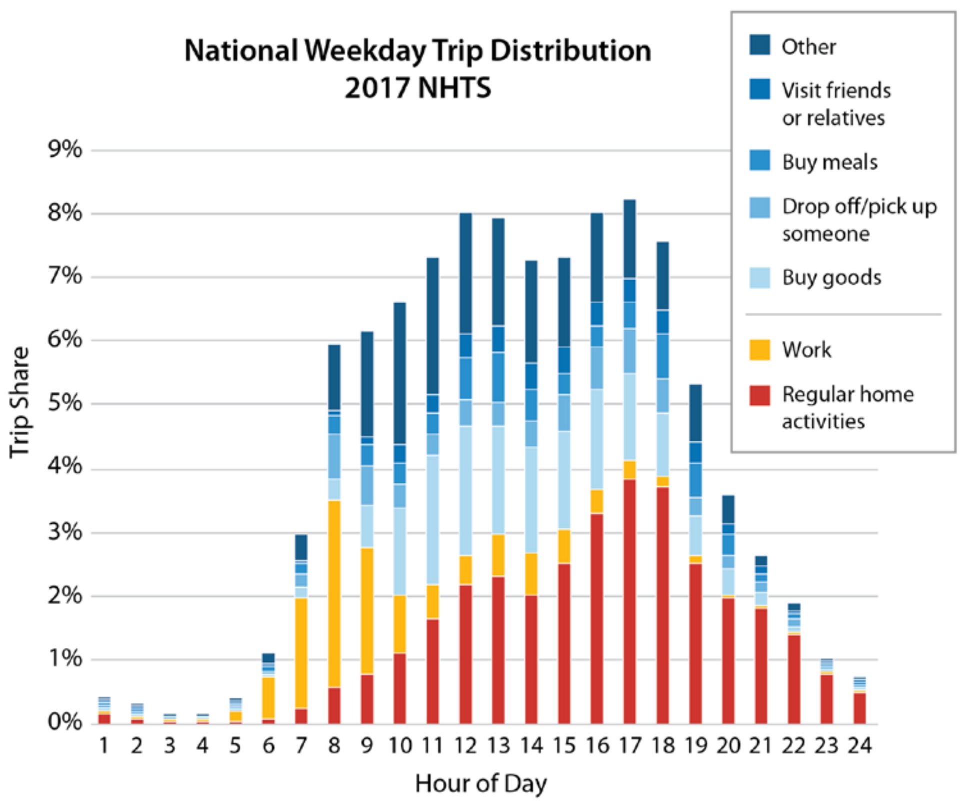

Figure 12. 2017 NHTS auto weekday trip distribution by hour of day and activity type ("other" activities include general errands, buy services, exercise, recreational activities, health care visits, religious or community activities, work-related meetings, volunteer activities, paid work from home, attending 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.

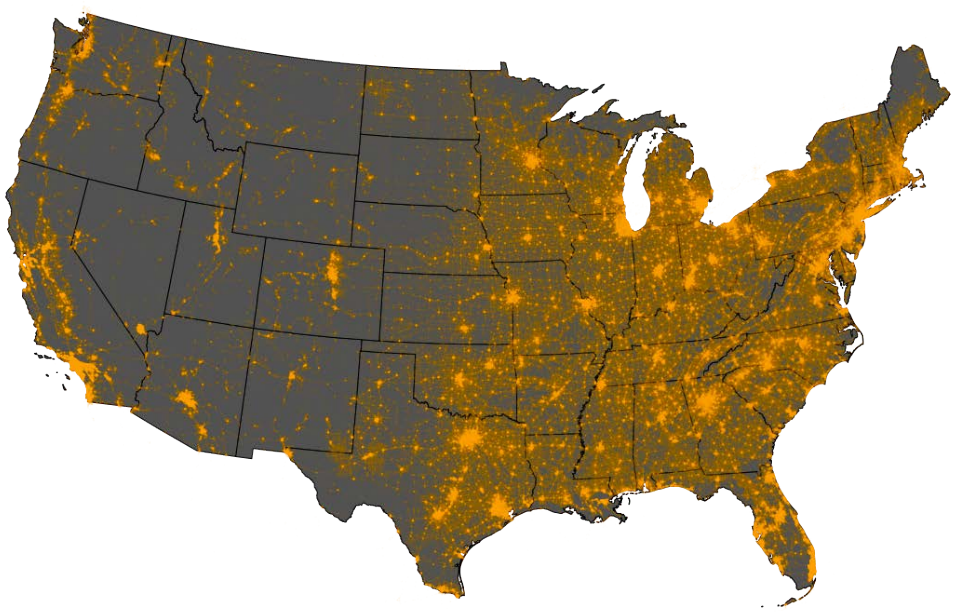

Figure 13. National origin-destination data set from Jan.–Feb. 2020 (licensed from INRIX)

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.

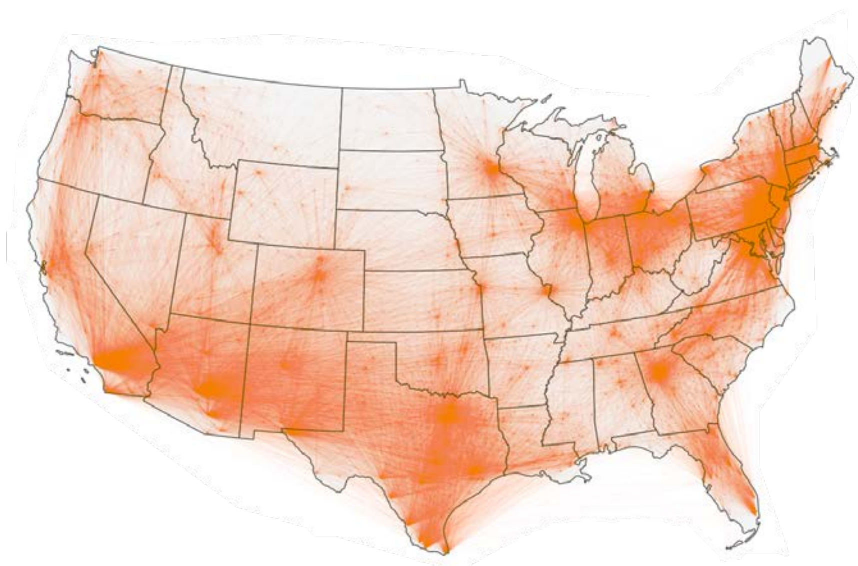

Figure 14. County-to-country origin-destination flows visualized from the FHWA TAF data set

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.

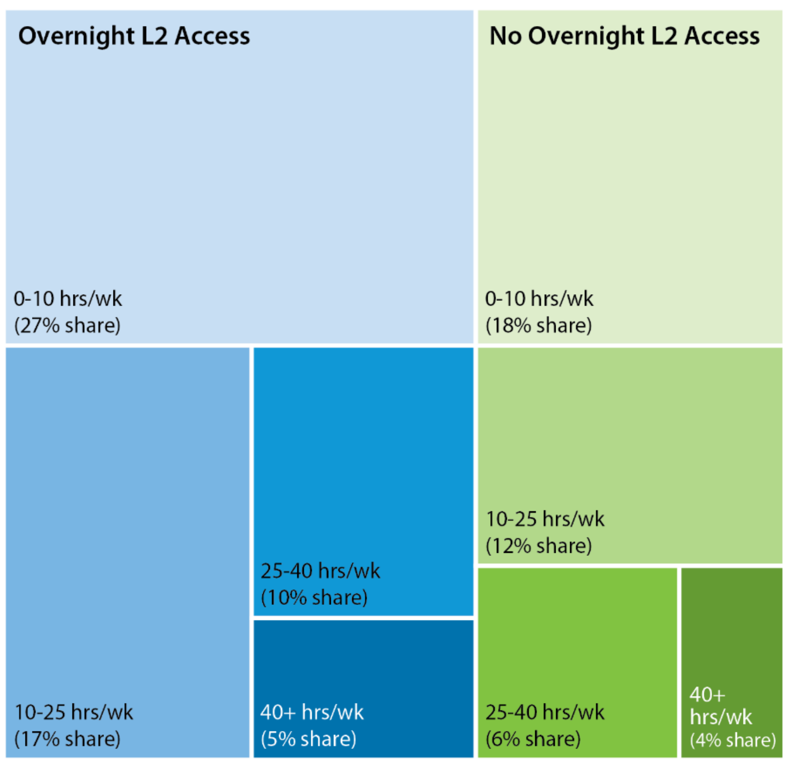

Figure 15. Assumed national composition of ride-hailing drivers by shift type and residential charging access

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]

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[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).

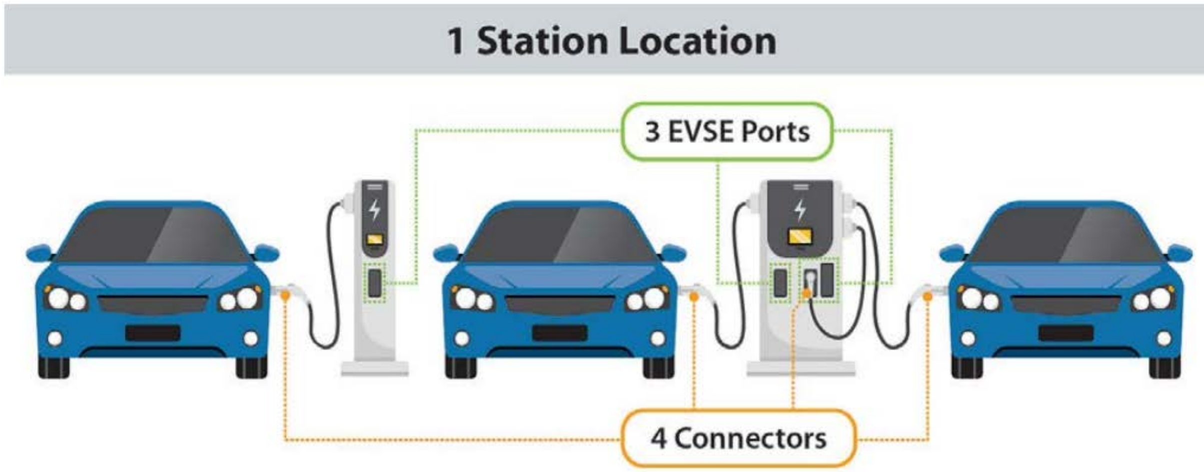

Figure 16. PEV charging infrastructure hierarchy.

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.

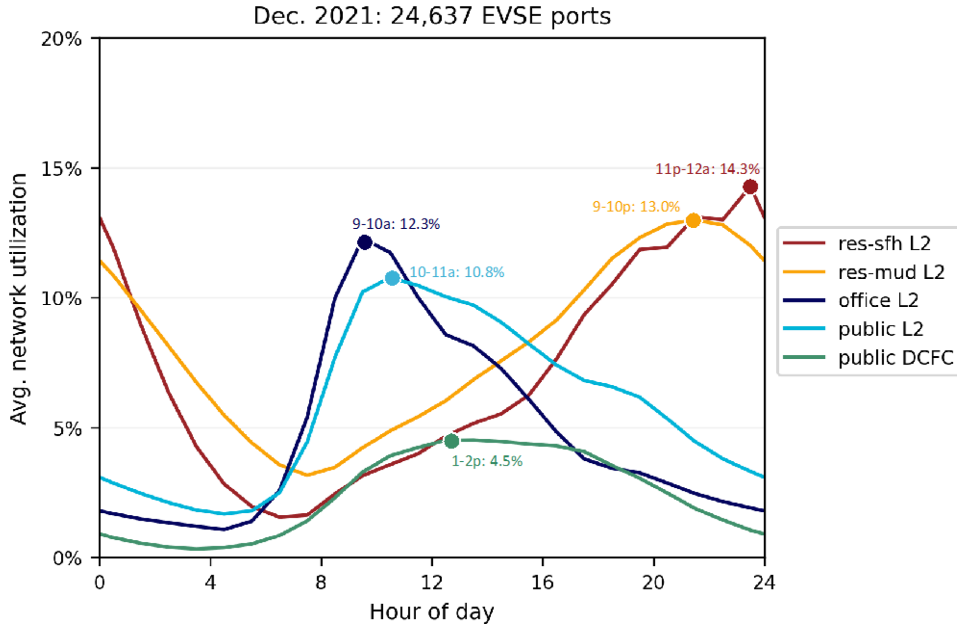

Figure 18. Average network utilization across 24,637 ports from December 2021 by location and EVSE type.

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.

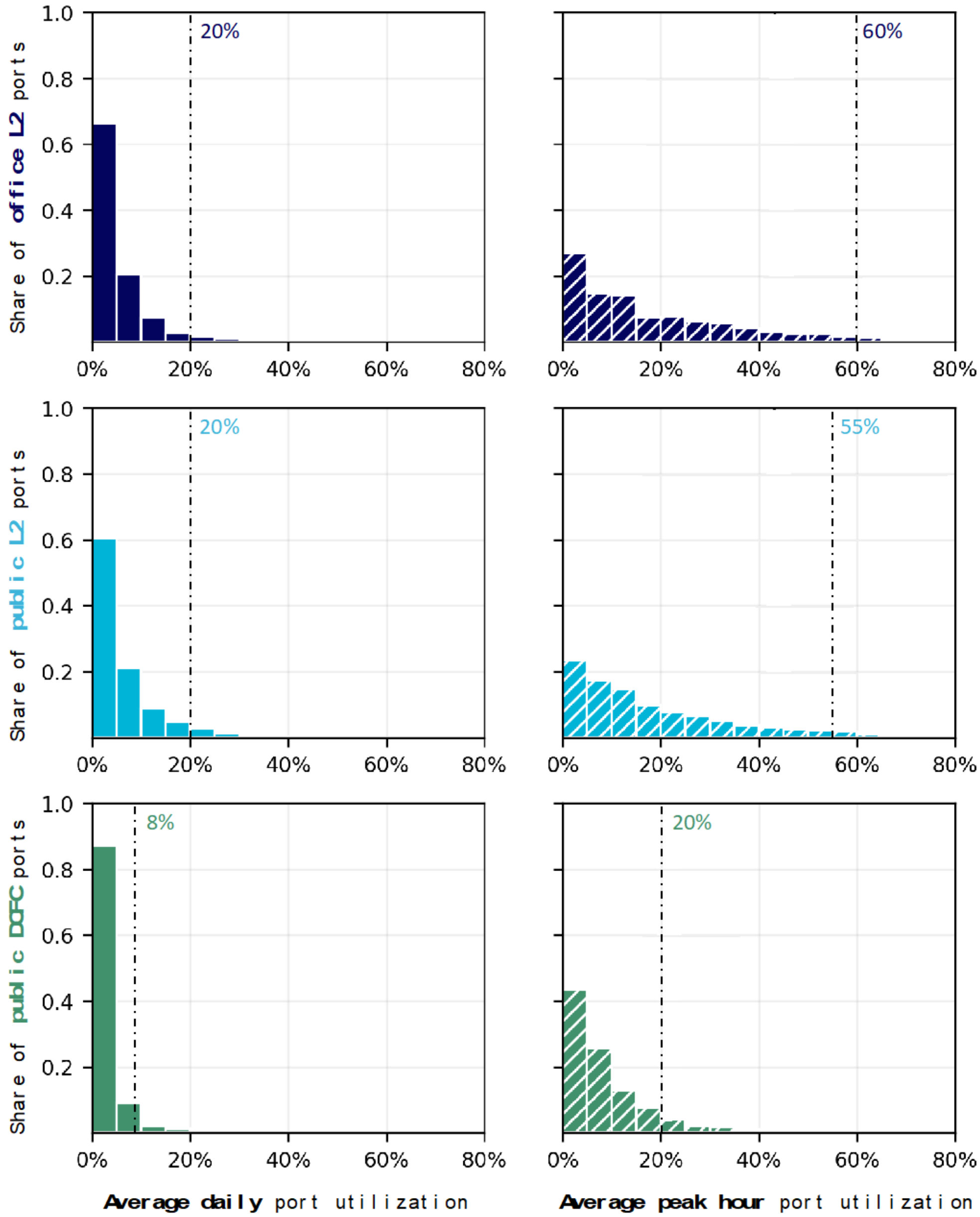

Figure 19. Distribution of average daily port utilization and average peak hour port utilization by location and EVSE type.

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.

Cost (% of total)

Access	Access cost	EVSE cost	Type / Location	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).

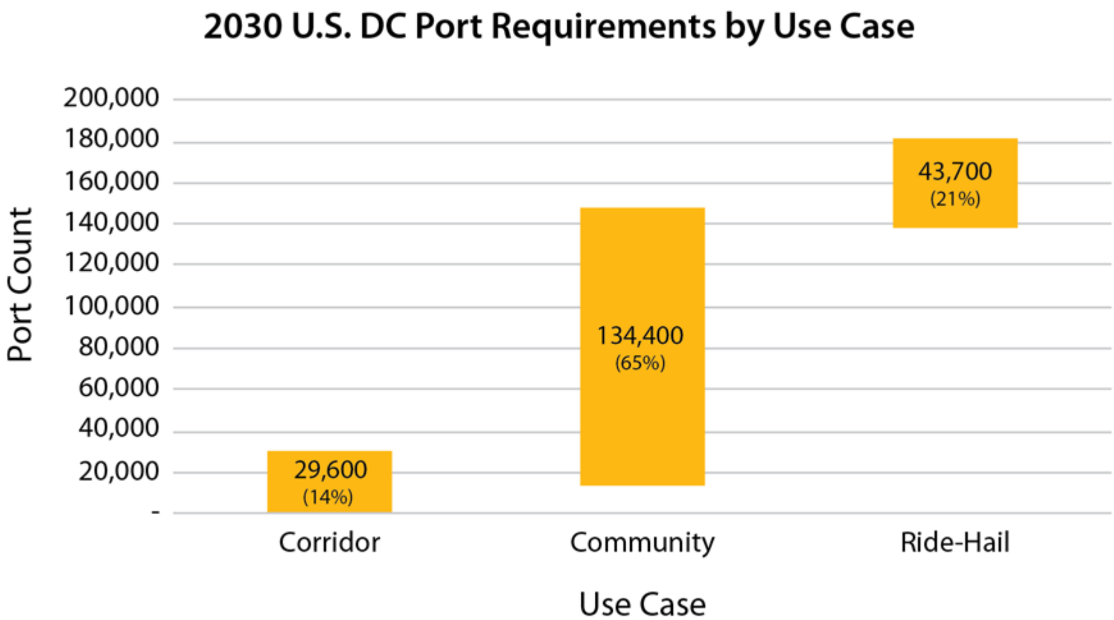

Figure 20. Simulated national DC charging network sized individually by use case and sized by consolidating demand

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.

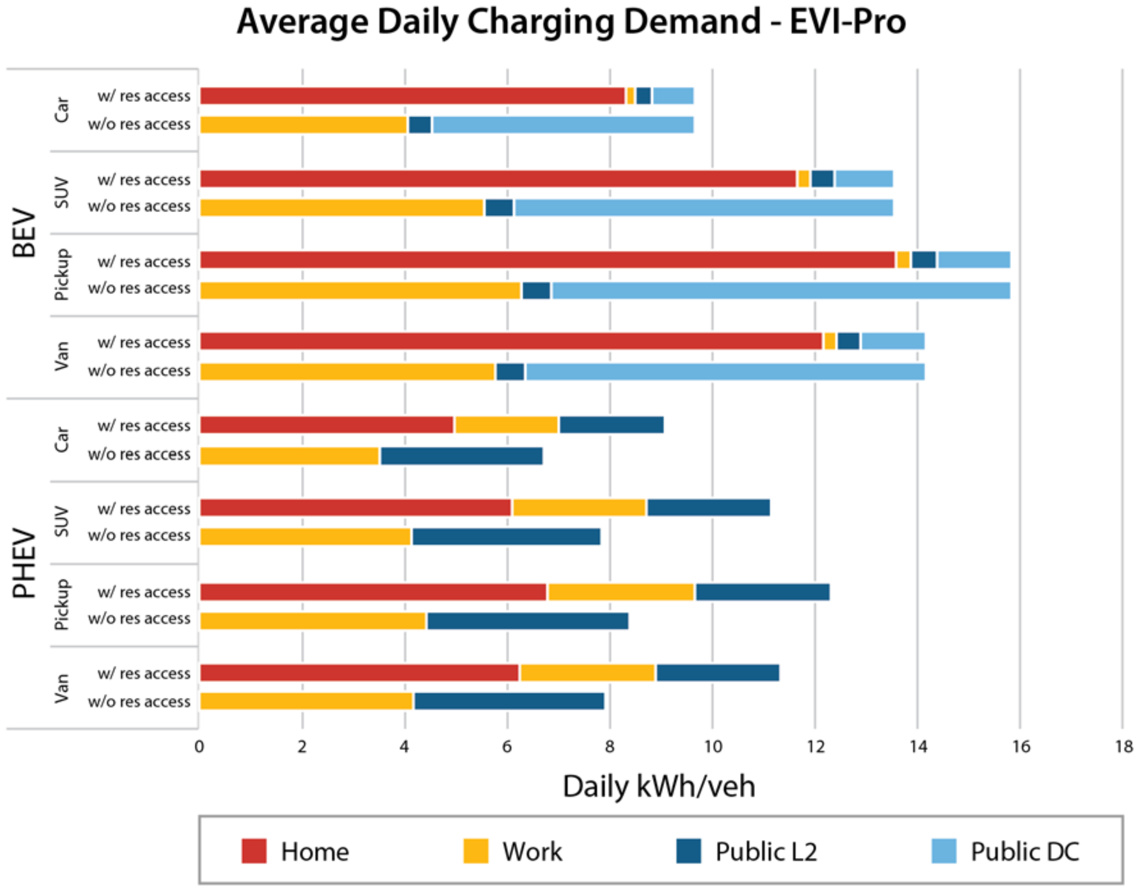

Figure 21. Average daily charging demand simulated by EVI-Pro for typical daily travel, broken out by powertrain type, body style, and residential access

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.

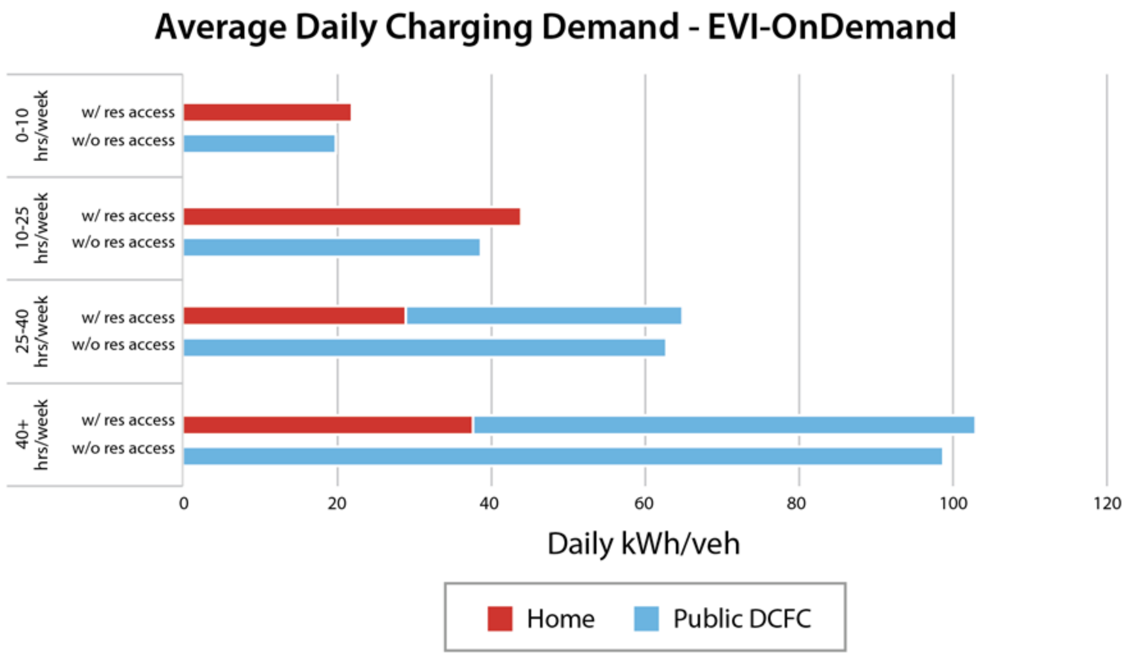

Figure 22. Average daily charging demand simulated by EVI-OnDemand for ride-hailing use cases, broken out by shift duration and residential access

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**

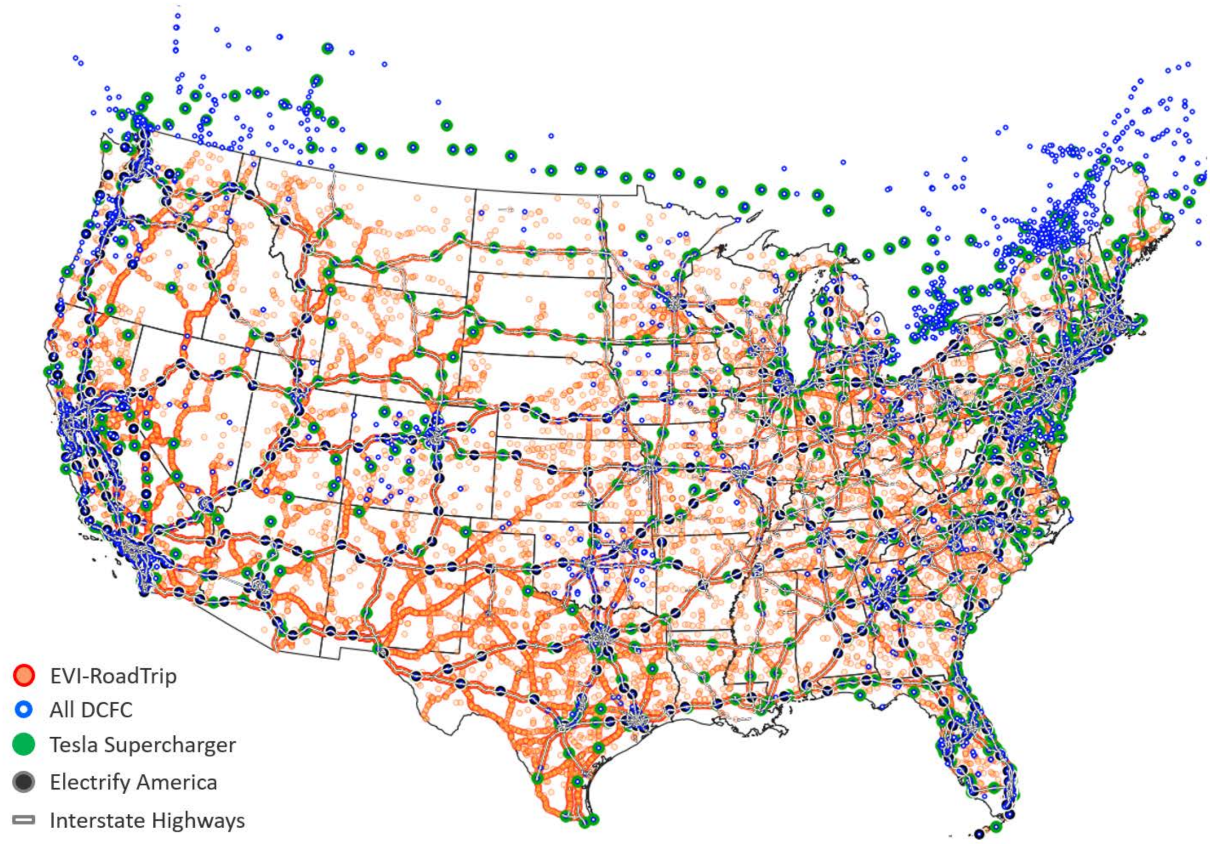

Figure 23. Example charging demand from EVI-RoadTrip overlaid with locations of existing DC stations, including those part of the Tesla Supercharger and Electrify America networks

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.

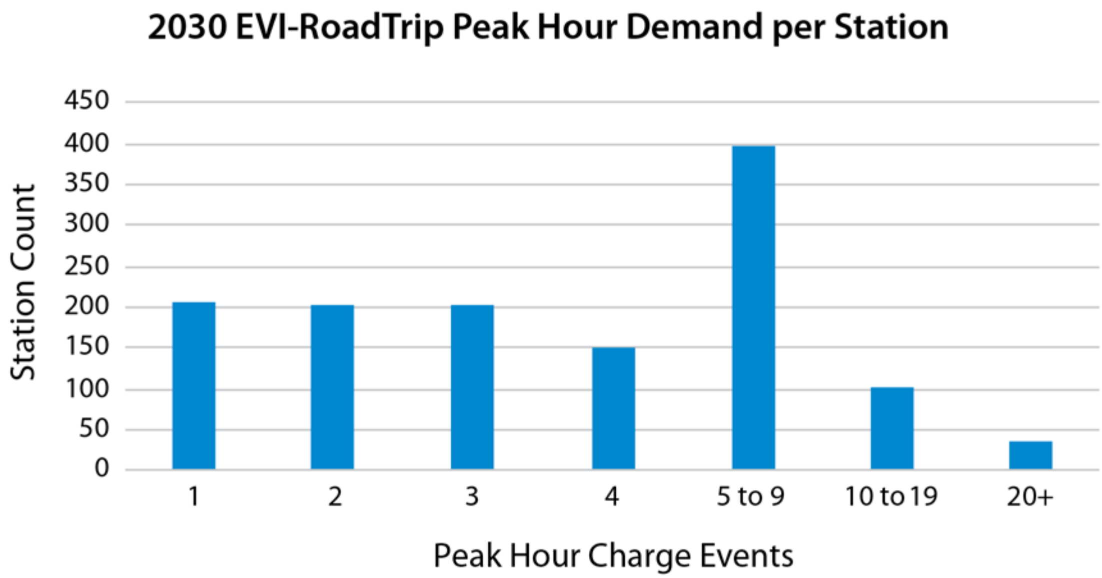

Figure 24. Distribution of peak hourly utilization across corridor stations as simulated by EVI-RoadTrip

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.

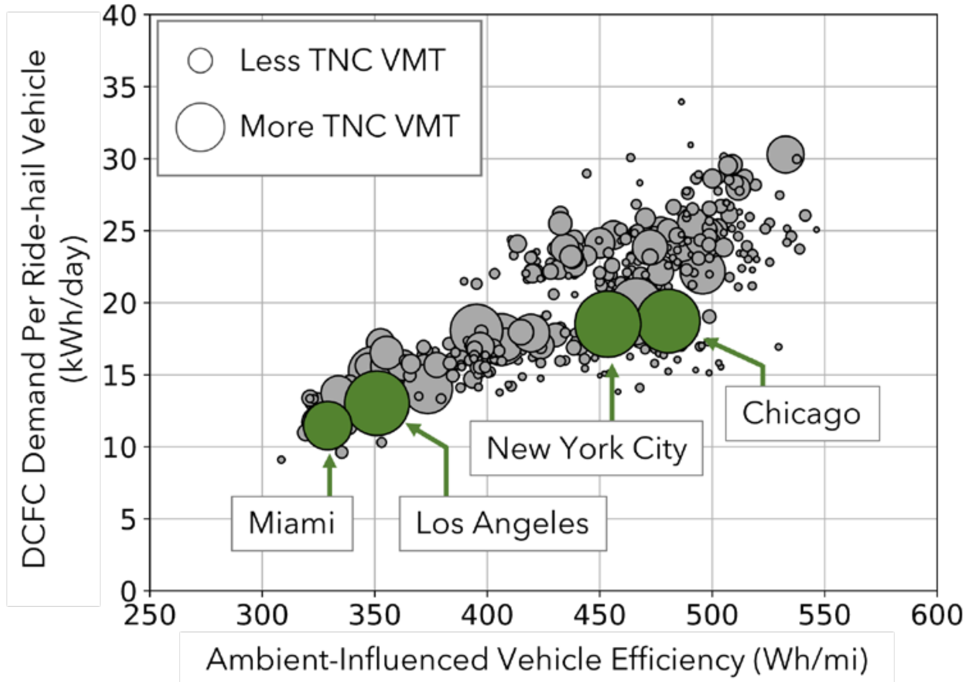

Figure 25. Normalized DC charging demand across CBSAs as a function of worst-case ambient conditions

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).

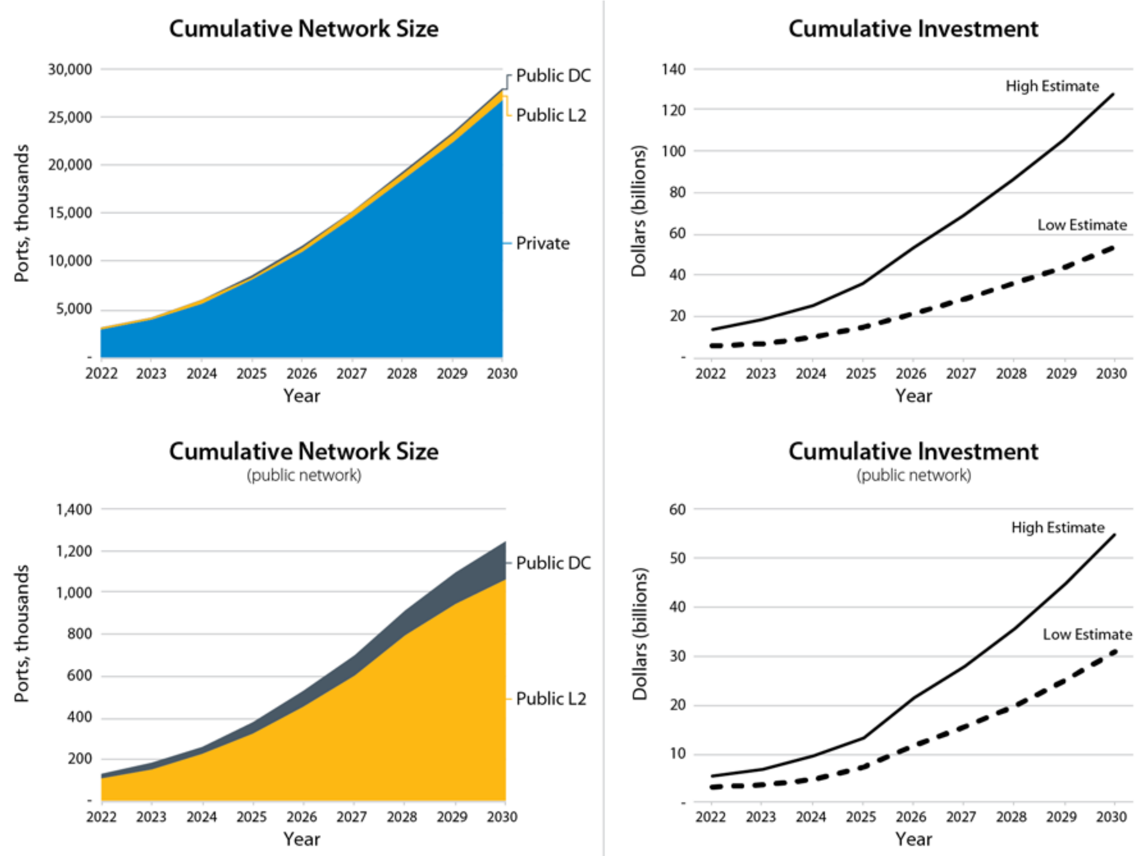

Figure 26. Simulated cumulative network size (left column) and cumulative investment (right column) between 2022 and 2030. Both private and public infrastructure estimates are shown in the top row, while the bottom row isolates the public network result.

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.

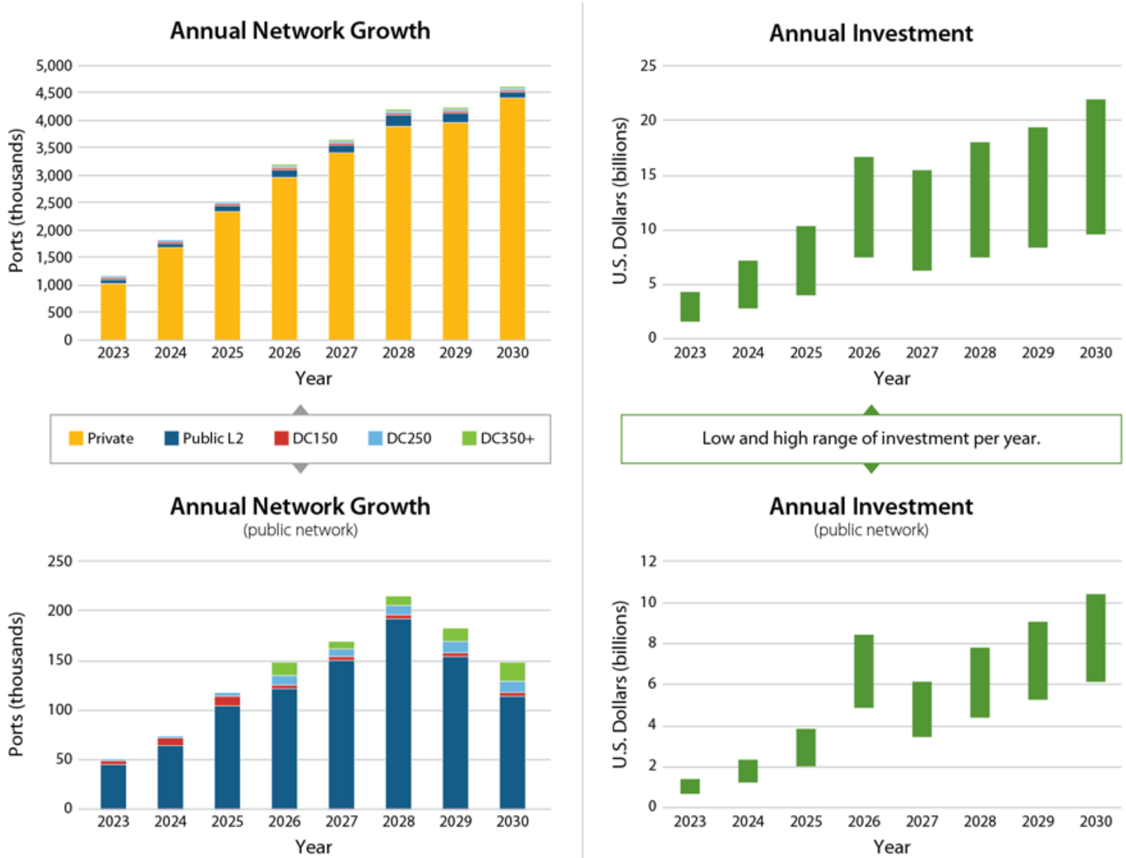

Figure 27. Simulated annual network growth (left column) and investment need (right column) between 2023 and 2030. Both private and public infrastructure estimates are shown in the top row, while the bottom row isolates the public network result.

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).

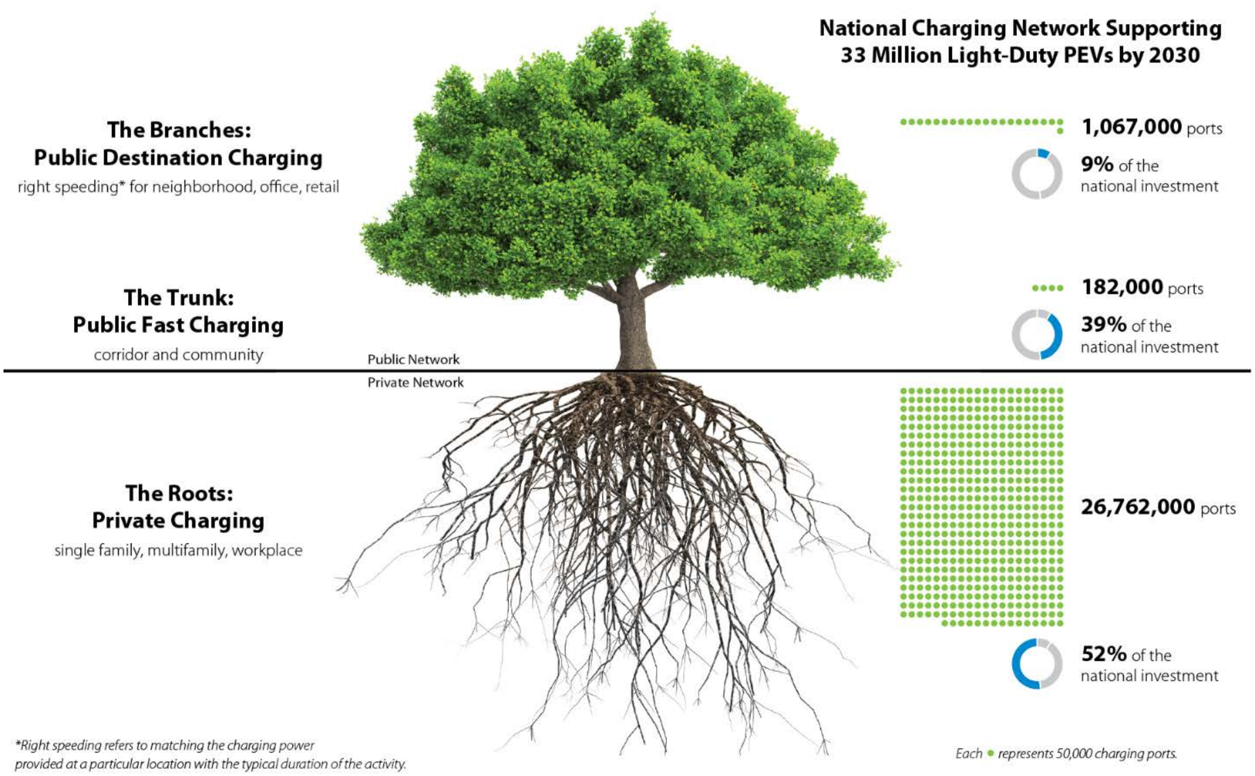

Figure 28. Conceptual illustration of national charging infrastructure needs

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.

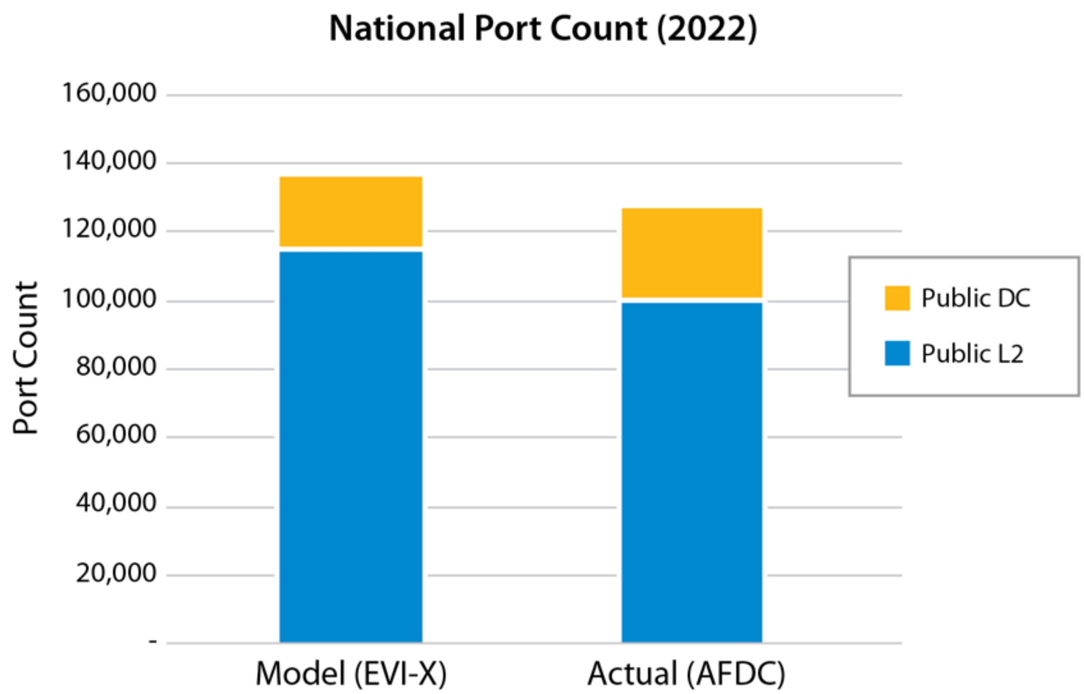

Figure A-1. Size of the 2022 national charging network as simulated in the national pipeline compared to the actual network as measured by the Alternative Fuels Data Center

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EXHIBIT J

MOBILITY

47 states fail to meet the ideal ratio of chargers to EVs, report says

Share

EVs charging at a public station in Ann Arbor, Mich. (PAIGE HODDER)

By: **Hannah Lutz**

September 09, 2024 08:00 AM

Nearly every state fails to meet the optimal ratio of chargers to electric vehicles, according to a new report.

While the optimal number of public electric vehicle chargers varies from one state to the next because of uneven EV adoption nationwide, 47 states fall short of their

EXHIBIT J

target ratios.

Only the District of Columbia and three states — Vermont, Massachusetts and Rhode Island — have the prime ratio of EVs to public chargers, according to the report published Sept. 9 by Here Technologies, a location data and technology platform, and SBD Automotive, a global automotive research firm.

The ideal ratio of registered EVs to public Level 2 and fast chargers across the U.S. is nine to 10 EVs per charging plug on average. But each state has its own target ratio based on road networks, population density, rate of EV adoption and the current fleet of EVs.

Many believe that the number of EVs per public charger should decline as EV volume grows, the groups said. But the number of EVs per public charge point should actually increase as the market matures and chargers improve, they said.

Most states fall short on EV chargers

Just 3 states and the District of Columbia meet an optimal electric vehicle-to-public charger ratio, according to an analysis by Here Technologies and SBD Automotive.

Optimal ratio   Actual ratio

	Optimal ratio	Actual ratio	Difference
Washington, D.C.	6.4	11.1	**+4.7**
Vermont	6.8	8.1	**+1.3**
Massachusetts	8.4	8.7	**+0.3**
Rhode Island	6.5	6.6	**+0.1**
Connecticut	8.2	8	**-0.2**
Maine	6	5.7	**-0.3**
Wyoming	4	3.3	**-0.7**
New York	9.2	7.3	**-1.9**

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	Optimal ratio	Actual ratio	Difference
Kansas	8.1	6.1	**-2**
Missouri	8.1	6	**-2.1**
North Dakota	4.1	1.8	**-2.3**
South Dakota	5.6	3	**-2.6**
West Virginia	5.8	2.6	**-3.2**
Maryland	12.3	9	**-3.3**
Delaware	11.4	8	**-3.4**
Arkansas	7.6	3.8	**-3.8**
Colorado	13.8	9.9	**-3.9**
Iowa	8.8	4.7	**-4.1**
Utah	13.1	8.5	**-4.6**
Nebraska	9.5	4.9	**-4.6**
Mississippi	7.3	2.4	**-4.9**
Montana	10.1	4.8	**-5.3**
North Carolina	13.1	7.6	**-5.5**
Tennessee	12.2	6.5	**-5.7**
Ohio	11.1	5.4	**-5.7**
New Mexico	11.9	6.2	**-5.7**
Alabama	10	4.1	**-5.9**
Minnesota	13	7.1	**-5.9**

	Optimal ratio	Actual ratio	Difference
Georgia	13.8	7.8	**-6**
South Carolina	11.4	5.4	**-6**
Louisiana	9.6	3.3	**-6.3**
Pennsylvania	12.9	6.5	**-6.4**
Michigan	11.9	5.4	**-6.5**
Oregon	16.9	10.3	**-6.6**
Indiana	12.5	5.7	**-6.8**
New Hampshire	13	5.8	**-7.2**
Kentucky	12.4	4.9	**-7.5**
Virginia	16.4	8.9	**-7.5**
Nevada	17.7	10	**-7.7**
Wisconsin	13.6	5.6	**-8**
Idaho	15.5	5.9	**-9.6**
California	22.7	12.7	**-10**
Washington	21.6	11.3	**-10.3**
Texas	19.5	7.4	**-12.1**
Arizona	21.5	9	**-12.5**
Florida	20.6	7.8	**-12.8**
Illinois	23.1	7.9	**-15.2**

	Optimal ratio	Actual ratio	Difference
Alaska	21.2	5.7	-15.5
Oklahoma	19.7	3.7	-16
Hawaii	26.6	9.3	-17.3
New Jersey	28.6	9.8	-18.8

Source: Here Technologies and SBD Automotive

The groups' EV Index is based on the evolution of the market and public charging in Europe, said Robert Fisher, electrification and sustainability principal at SBD Automotive.

"The U.S. is, of course, behind Europe when it comes to maturity of the EV market. So it could be that things evolve a little bit differently in the U.S.," Fisher said.

The U.S. public charging map could differ from Europe in the long run because the states have a wide range of population densities, said Ronak Amin, global product marketing manager at Here Technologies.

"Europe has these rural areas, but not maybe quite like the Wyomings and the South Dakotas of the world. So that ratio could be potentially higher in the U.S.," he said.

The U.S. also will likely have more private chargers than Europe, which would reduce pressure on public charging infrastructure, Fisher said.

The private charging variable and fluctuating EV demand leads to the industry's chicken-and-egg conundrum: build chargers and wait for drivers to come, or sell lots of EVs and then build the charging network?

"When more EVs are being sold, if the charging infrastructure doesn't keep up, then more states will miss their ratio," Fisher said. Inversely, "if more chargers are being installed, but not enough EVs are being sold, then you can overshoot your ratio, and that's a problem as well."

Overshooting the ratio hurts charger operators' bottom lines in an already challenging business.

"We are a little bit concerned in some European countries that they've already overshot, and it's becoming too difficult as a business to be a charge point operator," Fisher said. "In the U.S., we don't have that problem yet, but it could become a problem in the future."

The ranking

The EV-to-charger ratios are part of a broad look at charging across the country. The firms ranked all 50 states and the District of Columbia based on the ratios, along with the distance drivers must travel to find a charger, the speed of charging and the number of EVs on the road compared with gasoline-powered vehicles.

Delaware soared to the top of the overall ranking, up from 15th place a year earlier. Growth in high-power charging and an increase in EV sales drove Delaware's progress, according to the study. Washington, D.C., which was the top scorer last year, moved to second place. Massachusetts and Nevada tied for third.

Idaho, Arkansas and Alaska made up the bottom three.

The EV Index shows both the progress of charging infrastructure and the challenges the EV market continues to face.

The number of public chargers grew by a third since last year's study amid private and public charging infrastructure investments.

Delaware, Tennessee, Louisiana, Texas and Indiana increased their charger count the most on a percentage basis. California added the highest number of chargers, installing more than 6,000 over the last year, Amin said.

The National Electric Vehicle Infrastructure program, which launched more than two years ago, was designed to increase chargers along highways.

The government set aside $5 billion in federal funds to build out a nationwide charging network over five years. The chargers should be installed at least every 50 miles along major interstates and within one mile of highway exits. The stations must be able to charge four EVs at once, and some states require the sites to have certain features, such as 24-hour amenities and pull-through lanes.

The Joint Office of Energy and Transportation said in May that 33 chargers backed by the program were open in six states.

State-by-state coordination and a series of requirements and approvals have contributed to the slow rollout of federally funded chargers. Some charger operators have delayed deployments until they get the funding, Fisher said.

"We could be seeing a sort of unnatural slowdown in charge point deployment currently because of that NEVI program," he said. "But overall, I do think that when we look back on this in, say 2028, we'll say it was foundational to getting the network up to where it needs to be."

Reliability setbacks, charging power lags

The federal program includes strict reliability requirements, but for now, charger reliability remains an issue.

More than 10 percent of the public chargers in Hawaii, Alaska, West Virginia and Washington, D.C. were out of order when Here and SBD Automotive compiled the index. Hawaii's performance was the worst, with more than a fifth of chargers out of service.

Kansas, Massachusetts, Maine and Nebraska had at least 98 percent of chargers online.

States with the most chargers offline typically started installing them several years ago, and some have aged out, Amin said. Weather and limited access to charger technicians also play a role in poor charger performance in states such as Alaska and Hawaii, he said.

Charging speed was an issue in some areas. Michigan, for example, fell in the overall rankings largely because of a decrease in the average charger power there.

The National Electric Vehicle Infrastructure program and other initiatives focus on fast chargers, which can take 20 minutes to restore power to 80 percent and are typically used when a driver is traveling long distances, and the battery is depleted or won't get the car to the destination. It's often a planned charging stop.

But nearly three-quarters of public charging plugs are Level 2, slower chargers, according to the Department of Energy's Alternative Fuels Data Center. Level 2 chargers, which take several hours to power a battery, are typically used at home or work or to top off during daily activities, such as shopping or dining at a restaurant. Level 2 chargers are significantly less expensive for the charger operator and for drivers, Amin said.

"There's this delicate balance of what needs to be deployed out there," he said. Charger operators are "safeguarding their business. They don't want to put out these really expensive chargers and utilization is low. They're trying to understand the calculus behind that."

Featured Stories

EXHIBIT K

ILLINOIS ANSWERS PROJECT
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GOVERNMENT FINANCE & ACCOUNTABILITY

The Feds Are Pushing for Millions More Electric Vehicles on the Road, But Is Illinois Ready?

Gov. J. B. Pritzker's administration says it welcomes the goal of increasing the number of electric vehicles by 2032 but is still examining the implications of a new proposed EPA standard.

EXHIBIT K

by Manny Ramos April 21, 2023

To put more electric vehicles on the road, Illinois will need more charging stations, and it currently lags behind several other states. (Credit: Getty file photo)

Illinois has gotten serious about getting more electric vehicles on its roads, by planning on spending hundreds of millions of dollars in recent years to build more charging stations.

It is part of Gov. J.B. Pritzker's ambitious plan to have 1 million electric vehicles on Illinois roads by 2030 and an important part of the state's goal of reducing emissions caused by gas-powered vehicles.

But are those moves enough, given the latest standard proposed by the U.S. Environmental Protection Agency that would significantly limit tailpipe emissions?

The aggressive proposal from the EPA would mandate two-thirds of new passenger cars and a quarter of new heavy trucks sold in the United States be all-electric by 2032. Last year, **just 5.8% of all vehicles sold were electric**.

Illinois is far behind some other states with the number of charging stations available for electric vehicles but is expected to spend more than $230 million in building out its charging infrastructure. That is still just 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**.

Susan Mudd, senior policy advocate for the Environmental Law and Policy Center, said the state in recent years has done a lot to help transition from gas-powered vehicles, but more will need to be done to meet this proposed EPA standard and address climate change overall.

Mudd also acknowledged this progress can still be thwarted by future state and federal leaders.

"It's hard to predict what the country or the state is going to look like in 10 years," Mudd said. "But there are things the state can do in Illinois to increase the likelihood of that success."

While the proposal would greatly affect automakers, the state will need to be able to support a larger share of electric vehicles on the road.

How can the state better position itself?

Illinois' big spending on EV infrastructure

Alex Gough, a spokesman for the governor, said Pritzker supports a transition to zero-emission vehicles "through a combination of emission standards, vehicle incentives, investment in fueling infrastructure and other policies that support the adoption of zero-emission vehicles."

"The state is still examining the specific impact of the new standards and will be in conversation with automakers, dealers and environmental groups to completely assess the impact," Gough said.

The EPA's proposed rule is a major win for environmentalists as transportation is the largest source of **greenhouse gases in the country**. According to the EPA, transportation makes up 27% of all emissions which is more than electricity (25%), industry (24%) and agriculture (11%).

Vehicles — ranging from small passenger cars to heavy-duty trucks — account for more than 80% of transportation greenhouse gas emissions.

Americans are highly motivated to buy more electric vehicles and cite the environment as a big factor.

A survey conducted by The Associated Press-NORC Center for Public Affairs Research found that only 8% of Americans own an electric vehicle, but 41% said they are **somewhat likely to purchase one as their next car**. The biggest factors for why Americans are interested in buying electric vehicles are so they can save money at the pump and reduce their personal impact on the environment, according to the survey released last week.

While the survey showcases Americans warming up to electric cars, there remains some perceived barriers. For one, about 8 in 10 Americans say they would not purchase an electric vehicle because there aren't enough charging stations. The other is the cost of an electric car which is on average higher than gasoline-powered cars.

Gough said the Pritzker administration is hoping these proposed emission standards would force automakers to "introduce more affordable [electric vehicle] models and reduce the upfront price differential between internal combustion engine and electric car models."

The state has earmarked a windfall of cash to build out the electrification of its infrastructure to support the growing demand of electric vehicles since Pritzker took office. This includes $70 million through Rebuild Illinois; **$84 million from the Volkswagen Settlement funds** will go toward electric transportation and infrastructure, and $149 million from the National Electric Vehicle Infrastructure Formula Program.

The $149 million over five years **would help create a charging network along** I-39, I-55, I-57, I-64, I-74, I-80 and I-90. It would stretch from Huntley in the north to downstate Goreville and from Tinley Park in the east to Galesburg in the west.

There are over 1,200 EV public charging stations across the state that are active which support over 3,000 charging ports, according to the U.S. Department of Energy. Illinois has the 12th most charging stations in the nation, far behind states like California (14,289), New York (3,310), Florida (2,830) and Texas (2,510).

The number of fast-charging ports in the state are even smaller and make up just a quarter (762) of all public ports. These fast chargers are important along heavily-trafficked areas and can have an electric vehicle reach 80% charge between 20 minutes and an hour.

Overall, Illinois' number of charging stations makes up about 2% of the total 52,818 stations nationwide.

Gough said the state welcomes the idea of trucks in Illinois that are zero-emission vehicles but they still need to look "at adoption curves, introduction of new models, costs, battery costs and the supply chain to determine if we can achieve that goal by 2030."

"While we are still waiting on a detailed analysis this summer, we do believe we need a lot more federal dollars to build the infrastructure to support this transition to [zero-emission vehicles]," Gough said.

Rivian is an electric vehicle manufacturer with a plant in downstate Normal that has had a well **documented struggle to get its vehicles out of the assembly line** due to supply constraints. The California-based company, which also announced in February that it would lay off about 6% of its workforce, supports the proposed measure.

Chris Nevers, Rivian's senior director of environmental policy, applauded the newly proposed EPA standard saying in a statement it sets "realistic goals."

"This rulemaking will guide the industry's technological trajectory for decades to come," Nevers said. "We look forward to providing a detailed review of the proposal and will continue to make the case for the strongest possible standards through our products and our advocacy."

There is also a side effect to bolstering the number of electric vehicles in the state that would essentially limit a large tax revenue source. The transition from gasoline-powered vehicles to electric vehicles means a likely reduction in motor fuel taxes.

The state collected over $2.5 billion from this tax in 2022 — a revenue source that has only grown in recent years.

“Currently the state has 65,000 registered EVs and the revenue shortfall is not significant today – [electric vehicle] owners currently pay $100 over the cost of the annual license plate renewal fee,” Gough said.

A necessary challenge

The Environmental Law and Policy Center is one of many groups that have been lobbying the state to take more aggressive positions on lowering emissions and adopting green technology.

“Getting these standards right is a challenge no doubt about it, but it is a necessary challenge,” Mudd said. “The health benefits with a step like this benefits everybody, especially people near highways, it’s huge.”

Mudd said it is hard to know what the world with more electric vehicles will look like, but it is clear that the transition is vital for the environment. She said the state has done a lot in finding funding to support the growing demand in the electric vehicle market, but there are still avenues the state can take to be more proactive.

For one, seeking out more funding from the federal government and doing more to incentivize people to buy electric cars.

Also, concerns over supply issues shouldn’t dictate the state’s direction toward electric vehicles. That is something that ebbs and flows with the years — including charging stations.

"It's not just about public charging stations that will help meet the demand," Mudd said. "We are seeing huge amounts of investments in private charging stations and we see companies like Tesla also opening up its charging networks."

Hertz and BP **announced in February** it planned to invest $1 billion by 2030 into fast charging ports across the country — including in Chicago. The Netherlands-based electric vehicle charging manufacturer **EVBox has also moved its headquarters to Libertyville**.

An area in which the state can be more aggressive to reduce emissions is adopting California's Advanced Clean Trucks rule which would require truck makers to sell an increasing number of zero-emission trucks. Six states — California, New York, Massachusetts, New Jersey, Oregon, Washington — have already adopted the policy.

"Illinois has not yet joined other states in the California clean truck standard … which would help residents and business owners transition to electric vehicles," Mudd said.

EXHIBIT L

CEC Approves $1.4 Billion Plan to Expand Zero-Emission Transportation Infrastructure

For Immediate Release: December 11, 2024

En Español

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EXHIBIT L

California continues to invest an unprecedented amount of funding to build a bigger, better, and more reliable network of electric charging and hydrogen refueling stations, reaffirming the state's status as the country's zero-emission transportation leader.

Media and Public Communications Office
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SACRAMENTO – The California Energy Commission (CEC) today approved a $1.4 billion investment plan that accelerates progress on the state's electric vehicle (EV) charging and hydrogen refueling goals. These investments will help deploy infrastructure for light, medium, and heavy-duty zero-emission vehicles (ZEV) across California, expanding the most extensive charging and hydrogen refueling network in the country.

The plan details how the CEC's Clean Transportation Program will spend $1.4 billion in state funding over the next four years, with at least 50 percent targeted to benefit priority populations. The funding is part of the $48 billion California Climate Commitment, which includes more than $10 billion for ZEVs and ZEV infrastructure. The state has also received billions from the Biden-Harris Administration for clean transportation.

CATEGORIES

Topic
Transportation

Division
Fuels and Transportation

Program
Clean Transportation Program

The funds approved today will result in nearly 17,000 new light-duty chargers statewide. Over [152,000 public and shared private chargers](#) are installed today. Combined with previous investment plans, funding from the federal government, utilities and other programs, the state expects to reach 250,000 chargers in the next few years. In addition to the public network, the state estimates that more than 500,000 private home chargers are installed statewide.

"Today's approval of the investment plan reaffirms California's commitment to funding zero-emission refueling infrastructure," said CEC's Lead Commissioner for Transportation [Patty Monahan](#). "The plan prioritizes clean air benefits in low-income and disadvantaged communities that need it the most. There is no doubt – ZEVs are here to stay in the Golden State."

The funds will become available over the next four years and distributed to projects through competitive grants. Projects include direct incentive and rebate programs for businesses, non-profit organizations, tribes, and public agencies.

Clean Transportation Program Highlights

First created in 2007, the Clean Transportation Program is one of the first transportation-focused funding efforts established to help advance the state's climate change policies. To date, $2.3 billion has been invested in projects supporting ZEV infrastructure, alternative fuels, and advanced vehicle technologies.

- **Community Benefits**: Awarded 63 percent of funding in disadvantaged or low-income communities.
- **Chargers Installed**: Installed or planned nearly 34,700 EV chargers.
- **Hydrogen Stations Opened:** Allocated funding for 96 public hydrogen fueling stations, 44 are open today.
- **Car Charging Incentives**: Created two block grant programs, the California Electric Vehicle Infrastructure Project and Communities in Charge, to provide streamlined incentives for EV chargers.
- **Truck and Bus Incentives**: Awarded $100 million to 120 projects for truck and bus charging and refueling through the Energy

Infrastructure Incentives for Zero-Emission Commercial Vehicles Project.

- **Zero-Emission School Buses:** $500 million to put another 1,000 ZEV school buses on the road.
- **Manufacturing**: Funded 40 ZEV and ZEV-related manufacturing projects that support in-state economic growth.
- **Job Training**: Provided workforce training for more than 32,000 trainees and trainers, helping prepare workers for the clean transportation economy.

California's ZEV Record

California's ZEV record speaks for itself. Since Governor Gavin Newsom's executive order in 2020 calling for a rule to require all new car sales to be zero-emission by 2035, ZEV sales have risen dramatically.

- 26 percent of all new cars sold in California in Q3 of 2024 were ZEVs, according to the CEC
  - 115,897 ZEV sales in Q3 of 2024, an average of 1,300 sold each day
  - 2.1 million total ZEV sales to date
- 30 percent of new ZEVs sold in the U.S. are sold in California, according to the California Air Resources Board
- Thousands of dollars in grants and rebates available for low-income Californians. Learn more

at ClimateAction.ca.gov or ElectricForAll.org

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About the California Energy Commission
The California Energy Commission is the state's primary energy policy and planning agency. It has seven core responsibilities: advancing state energy policy, encouraging energy efficiency, certifying thermal power plants, investing in energy innovation, developing renewable energy, transforming transportation, and preparing for energy emergencies.

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EXHIBIT M

Edison Electric INSTITUTE

Electric Vehicle Sales and the Charging Infrastructure Required Through 2035

October 2024

Edison Electric INSTITUTE

Electric Vehicle Sales and the Charging Infrastructure Required Through 2035

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October 2024

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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

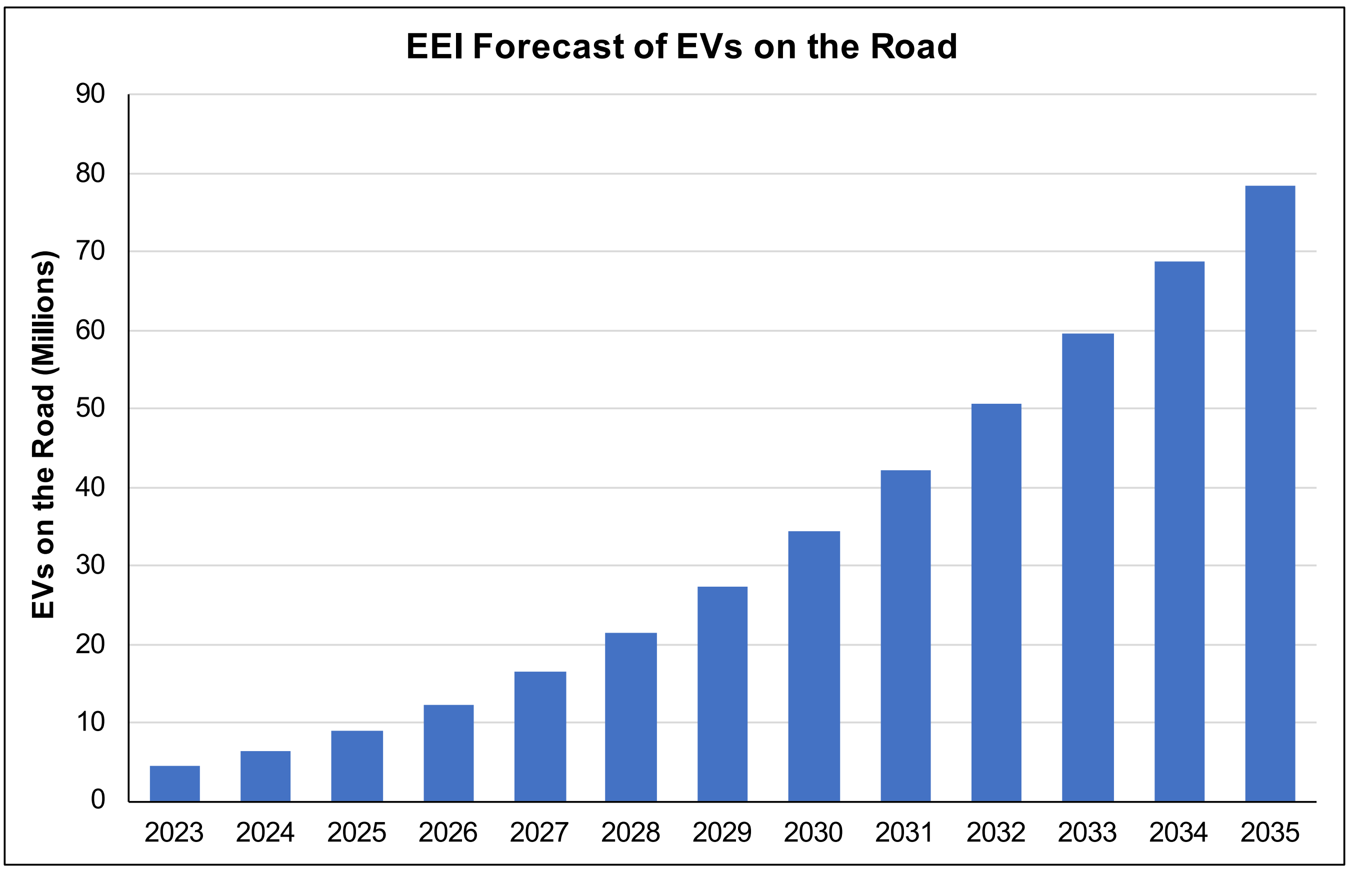
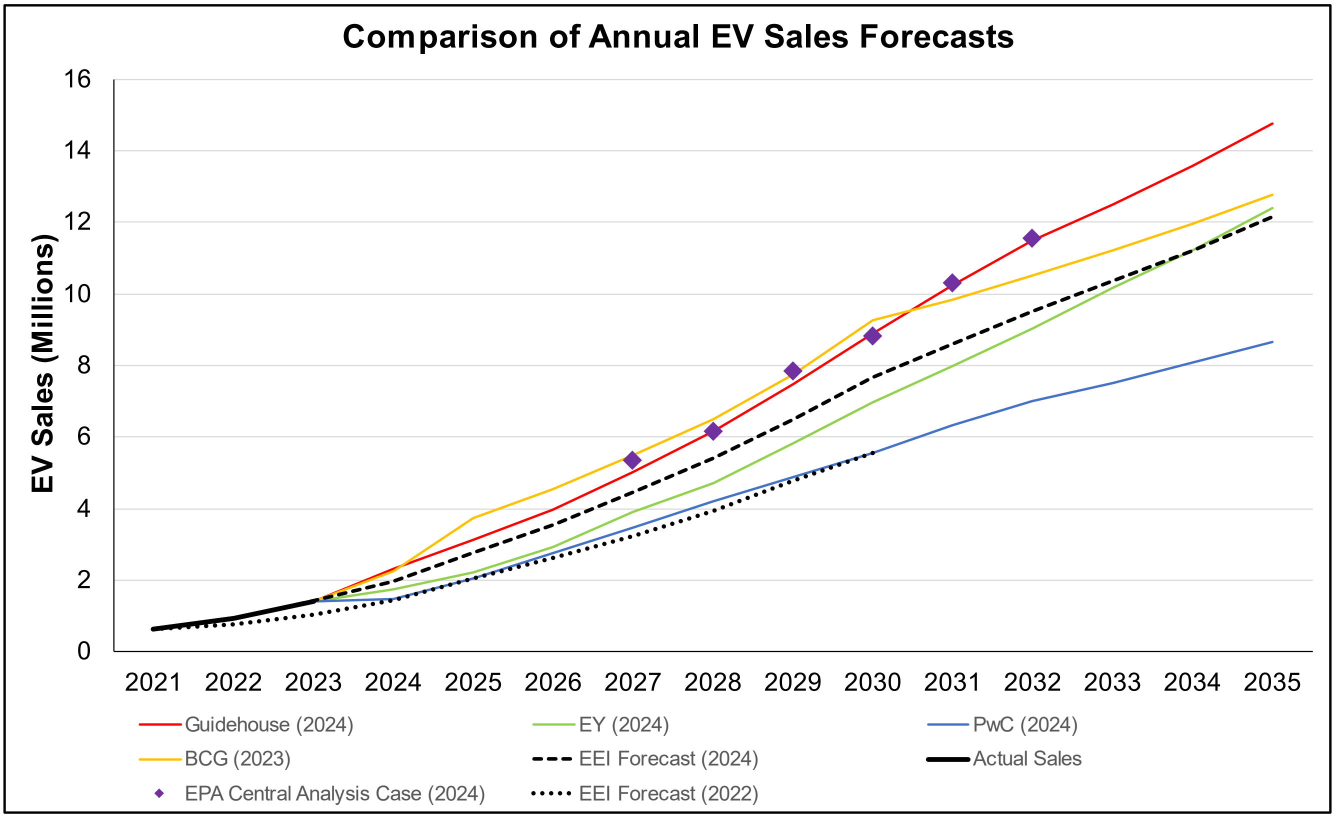


Figure 2. EEI Annual EV Sales Forecast: Nearly 12.2 Million Annual EV Sales in 2035



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]

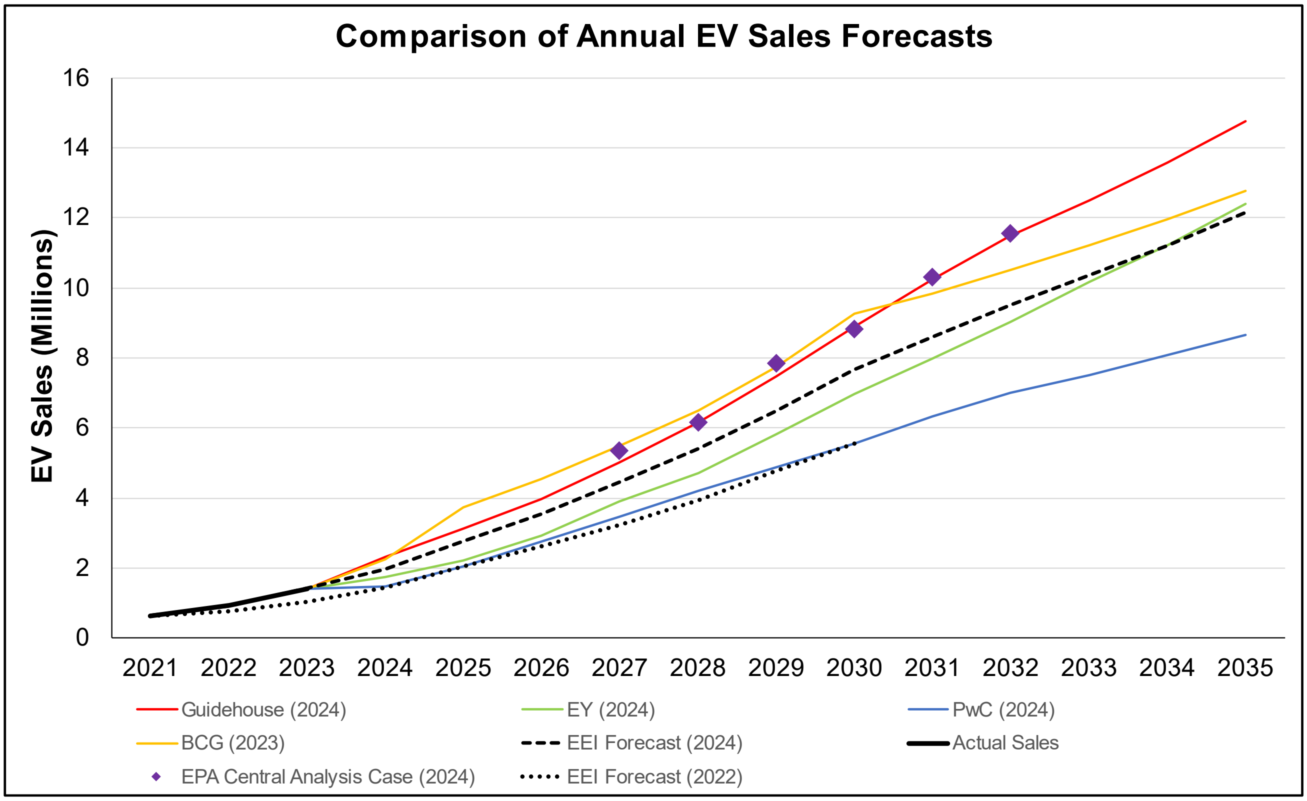
These forecasts were selected because they include three key factors: customer preference models that determine interest in EVs; declining battery costs that influence EV cost competitiveness with ICE vehicles and manufacturer profitability; and fuel efficiency standards and environmental regulations.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

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11. Bloomberg. "Lithium-Ion Battery Pack Prices Hit Record Low of $139/kWh." November 26, 2023, https://about.bnef.com/blog/lithium-ion-battery-pack-prices-hit-record-low-of-139-kwh/
12. International Energy Agency. "Global EV Outlook 2024." April 2024, https://www.iea.org/reports/global-ev-outlook-2024/trends-in-electric-vehicle-batteries
13. Goldman Sachs, "Lower battery prices are expected to eventually boost EV demand." February 29, 2024, https://www.goldmansachs.com/intelligence/pages/even-as-ev-sales-slow-lower-battery-prices-expect.html
14. Mark Crawford. "Solid-State Batteries Drive the Future of the EV Market." The American Society of Mechanical Engineers, February 2022, https://www.asme.org/topics-resources/content/solid-state-batteries-drive-the-future-of-the-ev-market.
15. AAA. "EV Consumer Sentiment Survey." November 20, 2023, https://newsroom.aaa.com/2023/11/annual-electric-vehicle-sentiment-survey/
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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/
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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
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25. USPS. "U.S. Postal Service Unveils First Postal Electric Vehicle Charging Stations and Electric Delivery Vehicles." January 22, 2024, https://about.usps.com/newsroom/national-releases/2024/0122-usps-unveils-first-postal-electric-vehicle-charging-stations-and-electric-delivery-vehicles.htm
26. Amazon. "Everything you need to know about Amazon's electric delivery vans from Rivian." July 10, 2024, https://www.aboutamazon.com/news/transportation/everything-you-need-to-know-about-amazons-electric-delivery-vans-from-rivian
27. Kinshuk Chatterjee. "How Policymakers Can Help Electrify Ride-Hailing Services." Center For Sustainable Energy. April 10, 2024, https://energycenter.org/thought-leadership/blog/how-policymakers-can-help-electrify-ride-hailing-services
28. Uber. "Sustainability." Accessed June 2024, https://www.uber.com/us/en/about/sustainability/?uclick_id=e6da7f2c-77a9-4aa3-947c-22eb87bec76d
29. Tom Vanderbilt. "Inside Lyft's Quest To Get Drivers To Adopt EVs." Lyft. March 27, 2023, https://www.lyft.com/blog/posts/inside-lyfts-quest-to-get-drivers-to-adopt-evs

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

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

Charging Infrastructure Needed to Support EV Market

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

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

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

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

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

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

Table 1. EV Charging Equipment by Location

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

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

Modeling the Charging Infrastructure Needed to Support EV Growth in 2035

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

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

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

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

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

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

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

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

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

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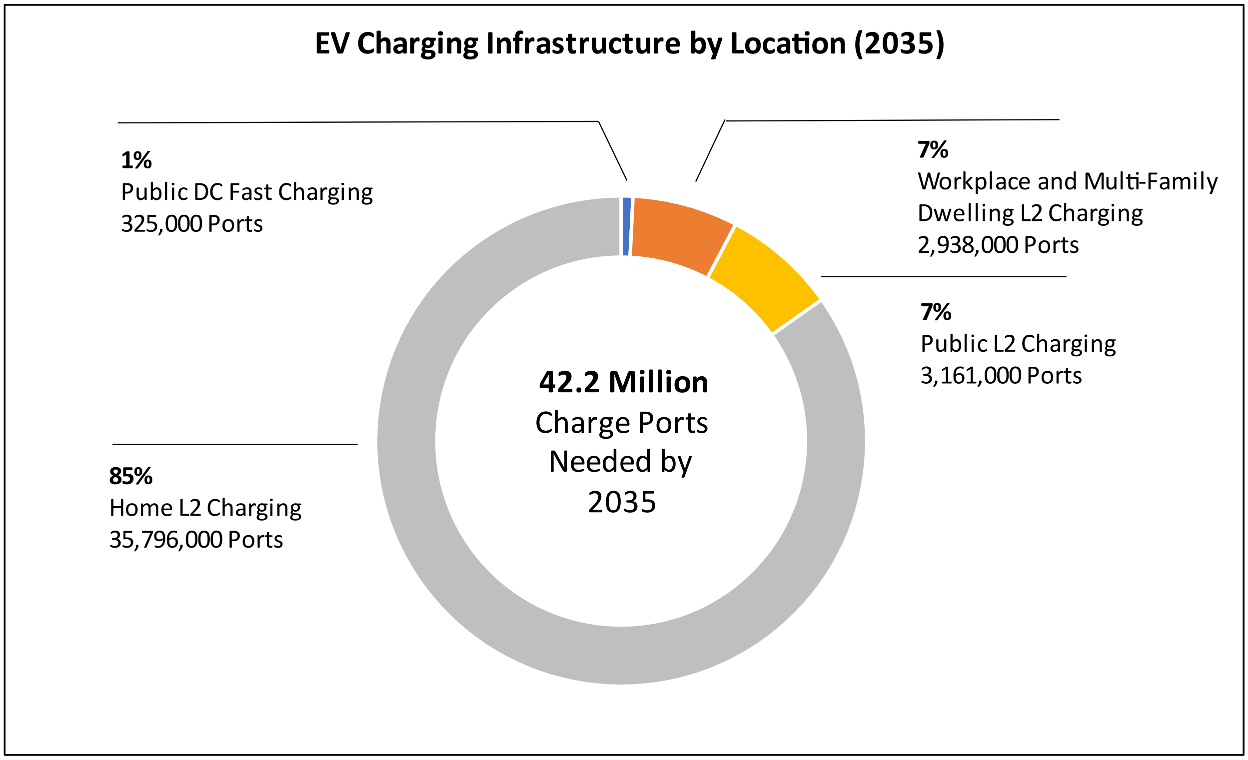
33. Patrick Plotz, et al. "Real World Usage of Plug-In Hybrid Electric Vehicles." ICCT, September 2020, https://theicct.org/wp-content/uploads/2021/06/PHEV-white-paper-sept2020-0.pdf.
34. Yanbo Ge, et al. "There's No Place Like Home: Residential Parking, Electrical Access, and Implications for the Future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

Analysis Results

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

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



Charging Need in 2030 and the Continuing Buildout to 2035

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

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

38. See *Ibid*

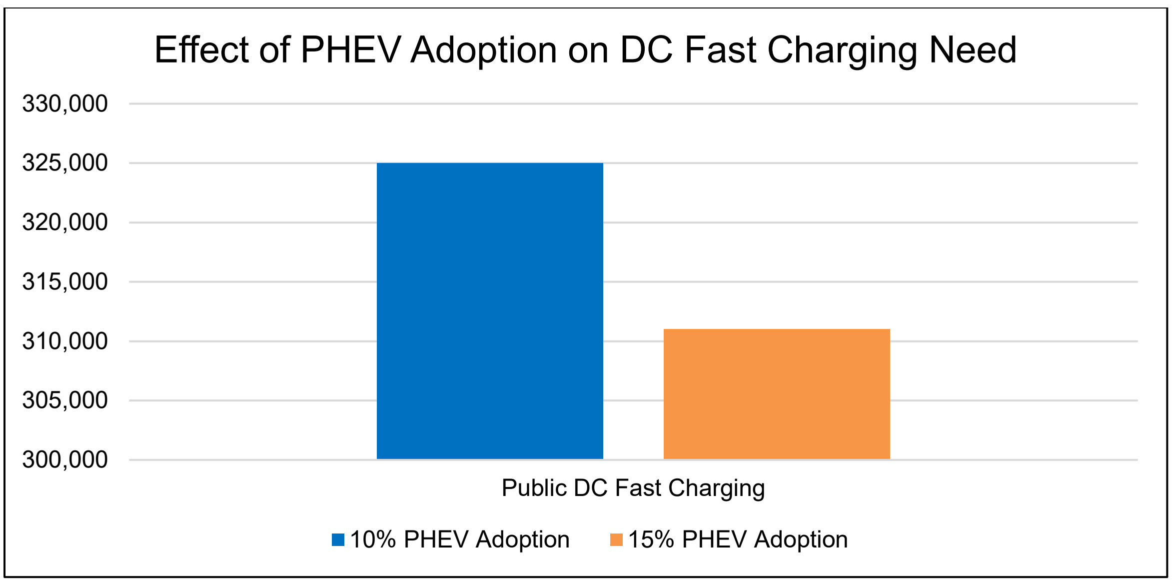
2035, highlighting the critical need to enable the rapid deployment of EV charging infrastructure today to meet the continuing needs of EV drivers through 2035 and beyond.

Impact of PHEV Adoption

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

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

Figure 5. DC Fast Charging Infrastructure Need in 2035



Approaches to Deploying EV Charging Infrastructure

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

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

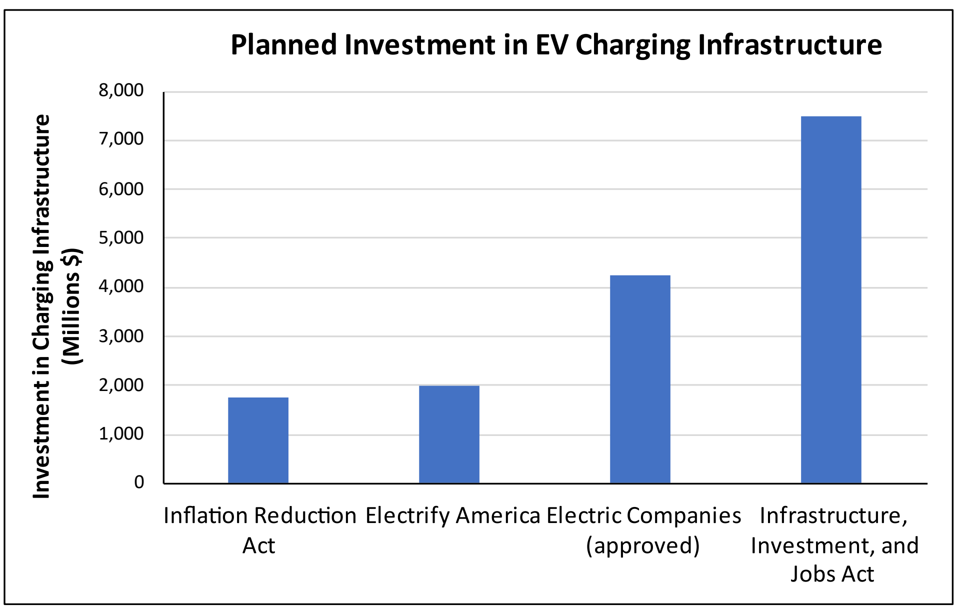
lack of EV charging infrastructure is a primary barrier to EV adoption.[40] The analysis using the EVI-Pro Lite tool in this report estimates the charging infrastructure needed to support a certain level of EVs. In this section, we discuss approaches for deploying EV charging infrastructure.

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

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

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

Figure 6. Planned Investment in EV Charging Infrastructure



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

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

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

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

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

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43. U.S. Department of Transportation Federal Highway Administration. "National Electric Vehicle Infrastructure Formula Program." February 10, 2022, https://www.fhwa.dot.gov/bipartisan-infrastructure-law/nevi_formula_program.cfm.
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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.

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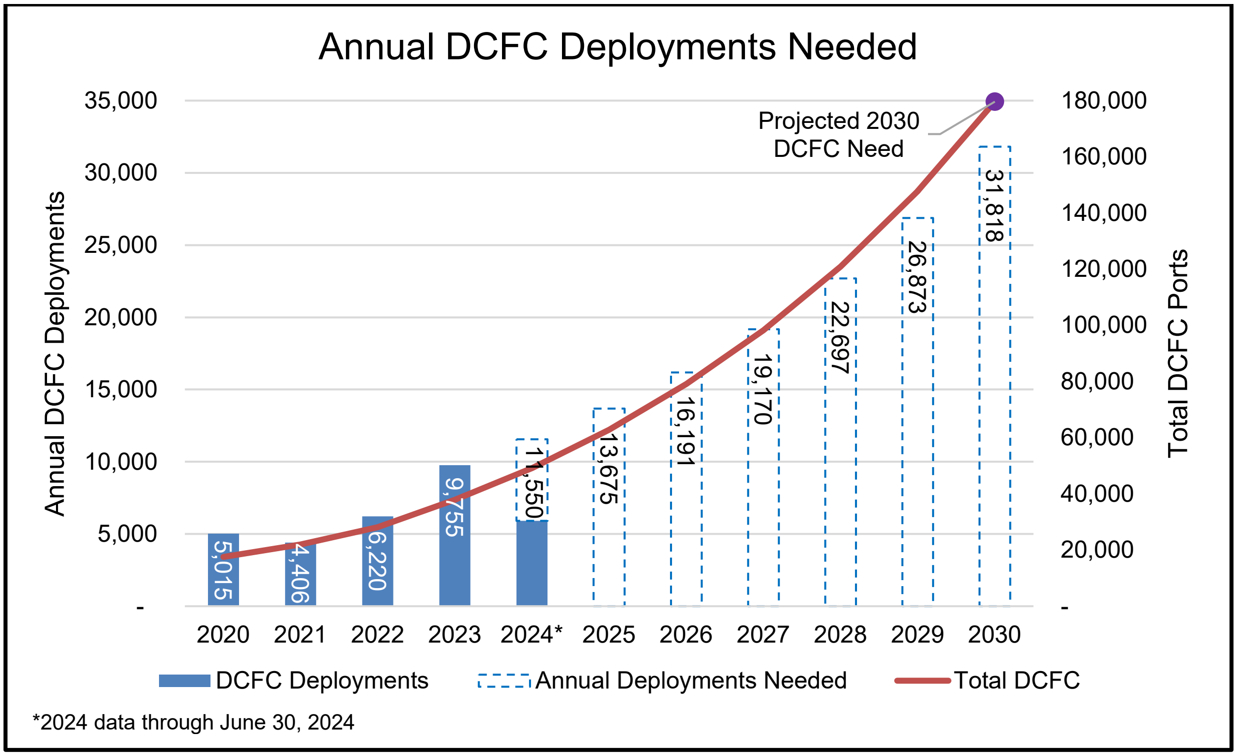
51. EVANNEX. "Tesla Begins Showing Compelling Revenue Outside Its EV Business." *InsideEVs,* April 10, 2023, https://insideevs.com/news/661525/tesla-showing-revenue-outside-electric-car-business/ See also Ryan Fisher, "Tesla Has Built a Charging Business to Be Taken Seriously." *Bloomberg,* April 9,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

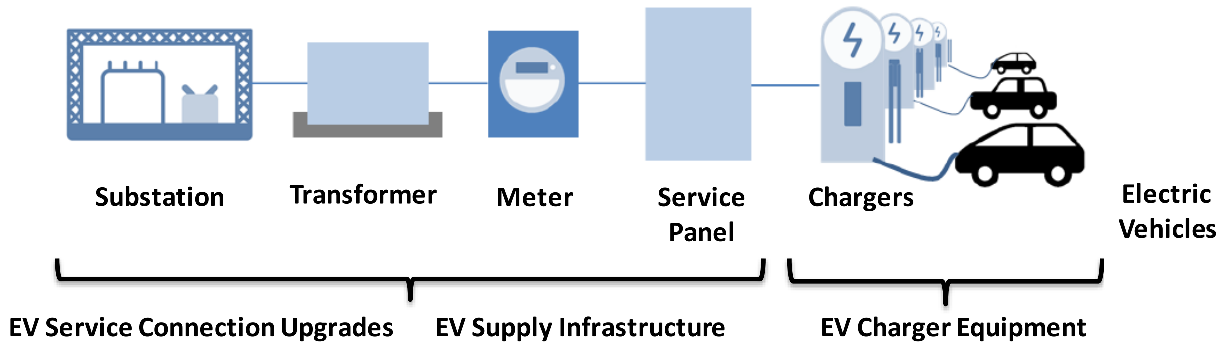
Electric Company Role

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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Washington, DC 20004-2696
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EXHIBIT N

ILLINOIS STATE FACTS

Autos Drive Illinois Forward

Industry Impact

256.8K
256.8 Thousand total auto jobs in Illinois

3.40%
3.40% depend on the auto industry for jobs

EXHIBIT N

$18.33B
Total Labor Income Annually

$41.22B
Total Car Sales in 2022

460.2K
Total New Cars Sold in 2022

Multi-industry contribution analysis of the economic impact of automotive manufacturing, selling, repairing, renting, and additional maintenance modeled using IMPLAN economic analysis data software, 2021 data year; compiled by Alliance for Automotive Innovation with data provided by S&P Global Mobility, sales figures represent new vehicle registrations between January 1, 2022 - December 31, 2022.

Electronic Filing: Received, Clerk's Office 01/21/2025

Tax Revenue

$2.38B
total state tax revenue

4.29%
% of state tax revenue

$1.34B
new vehicle sales taxes

$426.66M
used vehicle sales taxes

$284.37M
sales tax on auto parts and services

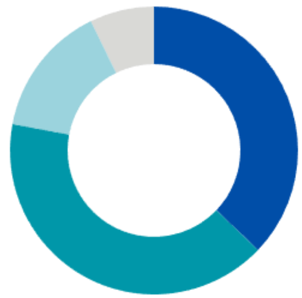
$5.04B
vehicle use taxes (including gas taxes), licenses and fees

$122.26M
corporate profits tax

$412.22M
federal income taxes

Registrations

10.14M
Registered



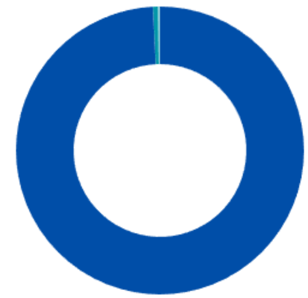
By Body Style

Cars 3,723,392 (36.72%)

UVs 4,085,372 (40.3%)

Pickups 1,485,925 (14.66%)

Vans/Minivans 724,633 (7.15%)



By Powertrain

ICE / Hybrid 10,058,576 (99.21%)

Electric 56,365 (0.56%)

Plug-In Hybrid 23,667 (0.23%)

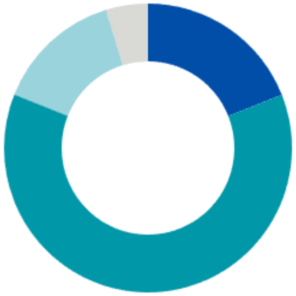
Fuel Cell 2 (0%)

The Illinois average age of vehicles is 11.3 years; The national average is 12.2.

Figures compiled by Powerbase Associates with data provided by S&P Global Mobility as of December 31, 2022.

New Purchases

460.2K
Vehicles Sold



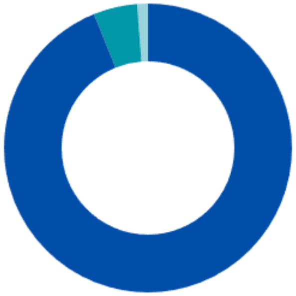
By Body Style

Cars 87,406 (18.99%)

UVs 285,481 (62.04%)

Pickups 65,540 (14.24%)

Vans/Minivans 21,729 (4.72%)



By Powertrain

ICE / Hybrid 432,003 (93.88%)

Electric 22,586 (4.91%)

Plug-In Hybrid 5,567 (1.21%)

Fuel Cell 0 (0%)

Electronic Filing: Received, Clerk's Office 01/21/2025

Auto-related Activity at Ports

Economic Activity From Past Decade

5.69B
5.69 Billion Total Exports

16.09B
16.09 Billion Total Imports

Economic Activity from 2022

833.75M
833.75 Million Total Exports

1.97B
1.97 Billion Total Imports

Compiled by Powerbase Associates with data provided by USA Trade Online, figures represent port activity over the past decade and between January 1, 2022 - December 31, 2022.

Fueling

Gasoline Stations **4,537**

EV Level 2 Charging Stations **996**

EV DC Fast Charging Stations **94**

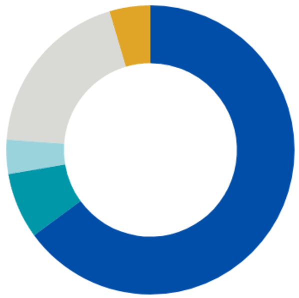
EV Level 2 Charging Ports **2028**

EV DC Fast Charging Ports **227**

Compiled by Alliance for Automotive Innovation with data provided by U.S. Department of Energy's Alternative Fuels Data Center, figures represent fueling data as of January 1, 2023.

Consumers

$72.2K
Median Household Income



Commuting to Work

61.80%
Owner Occupied Housing

- Drive Alone to Work (64.95%)
- Carpool to Work (7.36%)
- Take Public Transportation (3.83%)
- Work From Home (19.26%)
- Other (4.60%)

38.20%
Rental Occupied Housing

Housing Type

88.60%

Owner Occupied Single Family Homes

Single Family Home (49.60%)

1-Unit (6.50%)

2-4 Units (16.50%)

5-9 Units (10.40%)

10-19 Units (4.70%)

20+ Units (11.70%)

Mobile / RV / Boat (0.60%)

Figures compiled by Alliance for Automotive Innovation with data provided U.S. Census Bureau's American Community Survey 2021.

Electronic Filing: Received, Clerk's Office 01/21/2025

Automaker's Facilities

BMW Group	Location	Employees
BMW of North America Regional Parts Distribution Center	Minooka, IL	72
BMW of North America Regional Office	Schaumberg, IL	52

Ford Motor Company	Location	Employees
Chicago Stamping Plant	Chicago Heights, IL	1300
Chicago Assembly Plant	Chicago, IL	4000
Chicago High Velocity Center	Chicago, IL	27
Chicago Regional Office	Downers Grove, IL	75

General Motors	Location	Employees
Customer Care & Aftersales - Parts Distribution Center - Chicago	Bolingbrook, IL	105
GM Financial -- Naperville Branch Office	Naperville, IL	62
Sales, Service and Marketing -- Naperville North Central Regional Office	Naperville, IL	65

Honda	Location	Employees
American Honda Finance Corp. Office	Elgin, IL	
American Honda Motor Co., Inc. Zone Office	Hoffman Estates, IL	

Hyundai/Kia	Location	Employees
Mobis Parts Distribution Center (Hyundai / Kia)	Aurora, IL	

Kia	Location	Employees
Kia Regional Office	Downers Grove, IL	40
Kia Training Center	Lombard, IL	2

Magna	Location	Employees
Magna Operations	IL	291

Magna	Location	Employees
Magna Operations	IL	1234

Mazda	Location	Employees
Mazda Parts Distribution Center	Aurora, IL	3
Mazda Regional Office	Oakbrook Terrace, IL	49

Mercedes-Benz	Location	Employees
Mercedes-Benz USA	Carol Stream, IL	58

Rivian	Location	Employees
Rivian	Normal, IL	3000

Stellantis	Location	Employees
Belvidere Assembly Plant and Belvidere Satellite Stamping Plant	Belvidere, IL	
Chicago Parts Distribution Center	Naperville, IL	100

Subaru of America	Location	Employees
Subaru Service Training Center - Chicago	Elgin, IL	2
Central Region	Itasca, IL	21
Central Region - Zone 1 Chicago (CHI)	Itasca, IL	13

Volkswagen Group of America	Location	Employees
Volkswagen Credit Libertyville	Libertyville, IL	614
Volkswagen Truck and Bus	Lisle, IL	10
Volkswagen Group Mid-West Regional Office	Rosemont, IL	38

Volvo	Location	Employees
Volvo Dealer Training Academy	Naperville, IL	3

EXHIBIT O

Preliminary data release date: June 2022
Final data release date: March 2023

Highlights for appliances in U.S. homes by state, 2020

	Number (million) and percentage of housing units										
		Household has...									
	Total[a]	Electric cooking appliance[b]		Natural gas cooking appliance[c]		Two or more refrigerators		Separate freezer		Clothes washer	
All homes	123.53	83.94	68%	47.10	38%	42.53	34%	41.14	33%	103.96	84%
Alabama	1.90	1.53	81%	0.35	18%	0.69	36%	0.79	41%	1.75	92%
Alaska	0.26	0.17	66%	0.10	38%	0.07	27%	0.15	60%	0.21	84%
Arizona	2.68	1.99	74%	0.80	30%	0.98	37%	0.70	26%	2.43	91%
Arkansas	1.14	0.87	76%	0.34	30%	0.30	26%	0.55	48%	1.06	92%
California	13.18	5.98	45%	9.22	70%	4.18	32%	2.55	19%	10.10	77%
Colorado	2.26	1.70	75%	0.71	31%	0.83	37%	0.72	32%	1.94	86%
Connecticut	1.38	1.00	72%	0.37	27%	0.40	29%	0.35	26%	1.07	77%
Delaware	0.38	0.27	70%	0.10	27%	0.15	39%	0.13	35%	0.34	90%
District of Columbia	0.32	0.16	49%	0.20	62%	0.05	15%	0.04	14%	0.18	58%
Florida	8.06	7.44	92%	0.64	8%	2.62	33%	1.75	22%	7.11	88%
Georgia	3.88	2.87	74%	1.35	35%	1.45	37%	1.36	35%	3.53	91%
Hawaii	0.47	0.40	85%	0.05	11%	0.18	39%	0.15	31%	0.39	83%
Idaho	0.66	0.52	79%	0.18	28%	0.31	47%	0.34	52%	0.61	93%
Illinois	4.90	1.99	41%	3.28	67%	1.65	34%	1.57	32%	3.89	79%
Indiana	2.60	1.58	61%	1.05	40%	1.04	40%	1.15	44%	2.37	91%
Iowa	1.28	0.81	63%	0.42	33%	0.54	42%	0.66	51%	1.17	91%
Kansas	1.13	0.90	80%	0.26	23%	0.43	38%	0.50	44%	0.98	87%
Kentucky	1.74	1.47	84%	0.34	20%	0.62	35%	0.71	41%	1.59	91%
Louisiana	1.73	1.30	75%	0.57	33%	0.61	35%	0.81	47%	1.56	91%
Maine	0.56	0.42	74%	0.04	7%	0.14	25%	0.19	34%	0.48	85%
Maryland	2.28	1.59	70%	0.91	40%	0.78	34%	0.81	36%	1.97	86%
Massachusetts	2.71	1.71	63%	1.20	44%	0.72	27%	0.59	22%	2.04	75%
Michigan	3.92	2.39	61%	1.77	45%	1.43	36%	1.63	42%	3.40	87%
Minnesota	2.23	1.63	73%	0.65	29%	0.86	39%	1.17	52%	1.90	85%
Mississippi	1.08	0.88	81%	0.18	17%	0.36	34%	0.52	48%	0.96	89%
Missouri	2.43	1.88	77%	0.65	27%	0.95	39%	1.17	48%	2.11	87%
Montana	0.43	0.33	77%	0.11	26%	0.15	34%	0.24	56%	0.40	91%
Nebraska	0.77	0.63	83%	0.17	23%	0.30	40%	0.38	50%	0.63	83%
Nevada	1.14	0.55	48%	0.69	60%	0.38	33%	0.25	22%	1.00	88%
New Hampshire	0.54	0.37	69%	0.08	14%	0.19	35%	0.18	34%	0.44	83%
New Jersey	3.39	1.38	41%	2.36	69%	1.32	39%	0.73	22%	2.55	75%
New Mexico	0.79	0.44	55%	0.39	50%	0.25	31%	0.33	42%	0.69	88%
New York	7.52	3.30	44%	4.68	62%	1.94	26%	1.71	23%	4.66	62%
North Carolina	4.01	3.62	90%	0.56	14%	1.32	33%	1.26	31%	3.67	92%
North Dakota	0.32	0.28	89%	0.03	11%	0.13	42%	0.20	64%	0.26	83%

EXHIBIT O

Preliminary data release date: June 2022
Final data release date: March 2023

Highlights for appliances in U.S. homes by state, 2020

	Number (million) and percentage of housing units										
		Household has…									
	Total[a]	Electric cooking appliance[b]		Natural gas cooking appliance[c]		Two or more refrigerators		Separate freezer		Clothes washer	
All homes	123.53	83.94	68%	47.10	38%	42.53	34%	41.14	33%	103.96	84%
Ohio	4.74	3.40	72%	1.63	34%	1.74	37%	1.91	40%	4.02	85%
Oklahoma	1.49	1.01	67%	0.55	37%	0.53	36%	0.66	44%	1.32	88%
Oregon	1.65	1.34	81%	0.41	25%	0.58	35%	0.73	44%	1.49	90%
Pennsylvania	5.13	3.35	65%	1.91	37%	2.02	39%	1.93	38%	4.43	86%
Rhode Island	0.42	0.27	65%	0.15	36%	0.14	33%	0.08	20%	0.32	77%
South Carolina	1.97	1.70	86%	0.35	18%	0.61	31%	0.67	34%	1.80	91%
South Dakota	0.35	0.30	86%	0.05	15%	0.14	41%	0.23	65%	0.30	87%
Tennessee	2.66	2.38	89%	0.38	14%	0.88	33%	1.02	38%	2.41	91%
Texas	10.26	7.58	74%	3.84	37%	3.51	34%	3.14	31%	9.03	88%
Utah	1.04	0.79	76%	0.37	35%	0.41	40%	0.49	48%	0.96	92%
Vermont	0.26	0.17	64%	0.03	11%	0.08	29%	0.12	46%	0.21	80%
Virginia	3.24	2.50	77%	0.88	27%	1.25	39%	1.08	33%	2.90	90%
Washington	2.94	2.48	84%	0.71	24%	1.02	35%	1.09	37%	2.49	85%
West Virginia	0.70	0.51	73%	0.17	25%	0.24	34%	0.29	42%	0.62	89%
Wisconsin	2.39	1.66	69%	0.80	34%	0.97	40%	1.20	50%	2.00	84%
Wyoming	0.23	0.18	79%	0.05	24%	0.09	39%	0.12	55%	0.19	86%

Data source: U.S. Energy Information Administration, Office of Energy Demand and Integrated Statistics, Form EIA-457A of the *2020 Residential Energy Consumption Survey*

Notes: Because of rounding, data may not sum to totals. Percentages are calculated on unrounded numbers. See RECS Terminology for the definitions of terms used in these tables. Differences in characteristics between states may not be statistically significant.

[a] *Total* includes all primary occupied housing units. Vacant housing units, seasonal units, second homes, military houses, and group quarters are excluded.

[b] This estimate includes electric ranges, cooktops, and ovens. Microwave ovens and small kitchen appliances are not included in this estimate.

[c] This estimate includes natural gas ranges, cooktops, and ovens. Natural gas outdoor grills are not included in this estimate.

Q = Data withheld because either the relative standard error (RSE) was greater than 50% or fewer than 10 households were in the reporting sample.

N = No households in reporting sample.

Preliminary data release date: June 2022
Final data release date: March 2023

Relative standards errors (RSEs) for Highlights for appliances in U.S. homes by state, 2020

	RSEs for number and percentage of housing units										
		Household has…									
	Total[a]	Electric cooking appliance[b]		Natural gas cooking appliance[c]		Two or more refrigerators		Separate freezer		Clothes washer	
All homes	0.00	0.51	0.51	0.92	0.92	0.80	0.80	1.18	1.18	0.30	0.30
Alabama	0.00	3.30	3.30	13.92	13.92	9.10	9.10	7.26	7.26	1.92	1.92
Alaska	0.00	3.73	3.73	7.52	7.52	9.98	9.98	5.29	5.29	2.99	2.99
Arizona	0.00	2.30	2.30	6.44	6.44	5.06	5.06	6.75	6.75	1.55	1.55
Arkansas	0.00	3.36	3.36	8.72	8.72	10.26	10.26	6.35	6.35	2.44	2.44
California	0.00	2.68	2.68	1.83	1.83	4.19	4.19	6.14	6.14	1.33	1.33
Colorado	0.00	2.92	2.92	7.69	7.69	6.26	6.26	7.38	7.38	2.17	2.17
Connecticut	0.00	4.26	4.26	11.72	11.72	8.69	8.69	10.61	10.61	3.89	3.89
Delaware	0.00	5.43	5.43	14.02	14.02	11.12	11.12	13.89	13.89	3.36	3.36
District of Columbia	0.00	6.42	6.42	5.55	5.55	15.29	15.29	17.42	17.42	6.18	6.18
Florida	0.00	1.13	1.13	13.13	13.13	5.24	5.24	6.85	6.85	1.69	1.69
Georgia	0.00	3.08	3.08	7.37	7.37	6.94	6.94	5.89	5.89	1.81	1.81
Hawaii	0.00	2.57	2.57	17.26	17.26	7.02	7.02	8.56	8.56	2.76	2.76
Idaho	0.00	2.81	2.81	10.32	10.32	7.26	7.26	5.68	5.68	2.26	2.26
Illinois	0.00	5.28	5.28	3.00	3.00	6.54	6.54	5.18	5.18	2.22	2.22
Indiana	0.00	4.52	4.52	6.29	6.29	6.83	6.83	6.54	6.54	1.82	1.82
Iowa	0.00	4.94	4.94	8.37	8.37	6.35	6.35	5.03	5.03	2.49	2.49
Kansas	0.00	3.71	3.71	13.25	13.25	8.97	8.97	6.92	6.92	2.94	2.94
Kentucky	0.00	2.28	2.28	9.35	9.35	7.16	7.16	6.45	6.45	1.70	1.70
Louisiana	0.00	3.32	3.32	8.60	8.60	8.04	8.04	6.38	6.38	1.84	1.84
Maine	0.00	3.87	3.87	23.92	23.92	11.94	11.94	9.63	9.63	3.28	3.28
Maryland	0.00	3.64	3.64	7.66	7.66	6.50	6.50	8.13	8.13	2.48	2.48
Massachusetts	0.00	3.06	3.06	4.94	4.94	6.32	6.32	7.23	7.23	2.85	2.85
Michigan	0.00	4.25	4.25	5.94	5.94	7.35	7.35	6.71	6.71	2.28	2.28
Minnesota	0.00	3.27	3.27	9.22	9.22	7.82	7.82	5.81	5.81	2.80	2.80
Mississippi	0.00	3.57	3.57	15.64	15.64	10.48	10.48	8.82	8.82	3.23	3.23
Missouri	0.00	3.12	3.12	9.79	9.79	7.14	7.14	6.29	6.29	2.55	2.55
Montana	0.00	4.25	4.25	13.39	13.39	11.26	11.26	7.70	7.70	3.53	3.53
Nebraska	0.00	3.25	3.25	14.25	14.25	8.62	8.62	7.24	7.24	4.10	4.10
Nevada	0.00	7.25	7.25	5.50	5.50	9.92	9.92	12.90	12.90	2.95	2.95
New Hampshire	0.00	5.02	5.02	19.24	19.24	9.46	9.46	10.74	10.74	4.17	4.17
New Jersey	0.00	5.85	5.85	3.08	3.08	5.38	5.38	8.67	8.67	2.85	2.85
New Mexico	0.00	7.40	7.40	8.37	8.37	12.13	12.13	10.01	10.01	3.31	3.31
New York	0.00	3.47	3.47	2.26	2.26	4.40	4.40	5.66	5.66	2.61	2.61
North Carolina	0.00	1.38	1.38	9.68	9.68	6.80	6.80	7.38	7.38	1.48	1.48
North Dakota	0.00	2.13	2.13	15.42	15.42	7.63	7.63	4.71	4.71	3.67	3.67

Preliminary data release date: June 2022
Final data release date: March 2023

Relative standards errors (RSEs) for Highlights for appliances in U.S. homes by state, 2020

	RSEs for number and percentage of housing units										
		Household has…									
	Total[a]	Electric cooking appliance[b]		Natural gas cooking appliance[c]		Two or more refrigerators		Separate freezer		Clothes washer	
All homes	0.00	0.51	0.51	0.92	0.92	0.80	0.80	1.18	1.18	0.30	0.30
Ohio	0.00	3.22	3.22	7.24	7.24	6.53	6.53	6.14	6.14	2.76	2.76
Oklahoma	0.00	5.21	5.21	9.75	9.75	9.66	9.66	9.10	9.10	2.94	2.94
Oregon	0.00	2.40	2.40	9.72	9.72	8.04	8.04	6.86	6.86	2.34	2.34
Pennsylvania	0.00	3.39	3.39	5.65	5.65	5.07	5.07	5.21	5.21	1.66	1.66
Rhode Island	0.00	5.75	5.75	11.57	11.57	11.44	11.44	16.83	16.83	5.27	5.27
South Carolina	0.00	2.01	2.01	12.51	12.51	8.62	8.62	7.75	7.75	1.53	1.53
South Dakota	0.00	2.94	2.94	18.20	18.20	9.04	9.04	5.52	5.52	3.40	3.40
Tennessee	0.00	1.44	1.44	10.27	10.27	6.43	6.43	5.82	5.82	1.63	1.63
Texas	0.00	1.75	1.75	3.98	3.98	3.87	3.87	4.99	4.99	1.17	1.17
Utah	0.00	4.17	4.17	9.52	9.52	9.97	9.97	7.47	7.47	2.73	2.73
Vermont	0.00	4.79	4.79	18.82	18.82	9.83	9.83	7.02	7.02	4.00	4.00
Virginia	0.00	2.50	2.50	8.56	8.56	5.77	5.77	7.16	7.16	1.65	1.65
Washington	0.00	1.77	1.77	7.48	7.48	5.00	5.00	5.80	5.80	2.57	2.57
West Virginia	0.00	4.97	4.97	14.51	14.51	10.43	10.43	9.80	9.80	2.98	2.98
Wisconsin	0.00	3.90	3.90	7.37	7.37	6.01	6.01	4.93	4.93	2.56	2.56
Wyoming	0.00	3.89	3.89	13.46	13.46	7.88	7.88	6.04	6.04	3.29	3.29

Data source: U.S. Energy Information Administration, Office of Energy Demand and Integrated Statistics, Form EIA-457A of the *2020 Residential Energy Consumption Survey*

Notes: See RECS Terminology for the definitions of terms used in these tables. Differences in characteristics between states may not be statistically significant.

[a] *Total* includes all primary occupied housing units. Vacant housing units, seasonal units, second homes, military houses, and group quarters are excluded.

[b] This estimate includes electric ranges, cooktops, and ovens. Microwave ovens and small kitchen appliances are not included in this estimate.

[c] This estimate includes natural gas ranges, cooktops, and ovens. Natural gas outdoor grills are not included in this estimate.

EXHIBIT P

Kelley Blue Book Report: New-Vehicle Prices Climb in November, While Higher Incentives Continue to Entice Buyers

- New-vehicle prices in November were higher year over year for the second straight month, as vehicle costs reached $48,724.
- Incentive spending jumped to 8.0% of the average transaction price in November, an increase from 7.8% in October. Incentive spending has increased for five consecutive months as new-vehicle inventory builds.
- New-vehicle sales surprised to the upside in November, as pent-up demand and improving consumer sentiment drove the market.

ATLANTA, Dec. 11, 2024 /PRNewswire/ -- New-vehicle prices in November climbed higher year over year for the second straight month, according to data from Kelley Blue Book released today. Last month, the average

EXHIBIT P

transaction price (ATP) for a new vehicle was $48,724, an increase of $699, or 1.5%, from November 2023. The November ATP was also higher by $720 compared to the downwardly revised ATP in October of $48,004.

New-vehicle inventory at the start of November was above 3 million units for the first time since 2020, providing new-vehicle shoppers with excellent buying opportunities. And buy they did. Despite higher prices, sales last month topped 1.36 million units, according to Kelley Blue Book, and delivered a seasonally adjusted annual rate (SAAR) of sales of 16.5 million, the best sales pace since the spring of 2021.

"Higher prices were met with higher discounts in November, which has kept the retail business moving," said Cox Automotive Executive Analyst Erin Keating. "Following the national election, pent-up demand and some improvements in consumer confidence seem to be driving the market. And higher incentives are certainly helping as well."

Sales incentives for new vehicles in November averaged 8.0% of ATP, up from 7.8% in October. Incentives have now increased for five straight months. One year ago, in November 2023, incentive spending was equal to 5.3% of ATP. Incentives last month were higher by more than 50% year over year (approximately $1,300), while vehicle prices increased by only 1.5% (approximately $700), helping improve affordability and likely boosting vehicle sales.

Transaction prices in November, at $48,724, were at the highest point of 2024 and are up 2.3% since January. In any given year, vehicle transaction prices typically peak in December. ATPs reached an all-time high of $49,926 in December 2022. Last December, the Kelley Blue Book ATP estimate was $49,023, the highest ATP of 2023.

"The end of the year typically sees an increase in transaction prices, as luxury sales pick up as the year winds down," added Keating. "If sales volumes in November are any indication, we think 2024 will end on a positive note for the auto business. Yes, prices are trending higher year over year, but higher incentives and discounts are bringing in buyers."

New-Vehicle Incentives Vary Widely

While the average new-vehicle incentives in November were equal to 8.0% of the ATP, the amount of discounting in the market varied widely across the many brands, with a majority exceeding the industry average. Of the mainstream brands tracked by Kelley Blue Book, 14 posted incentive spending below the industry average in November, with Porsche, Land Rover, Toyota and GMC continuing to offer some of the lowest incentive levels in the market. Last month, Porsche's incentive spending per vehicle averaged just 2.9% of the vehicle transaction price, which was over $115,000 last month for the German sports car brand.

Meanwhile, 20 brands had above-average incentive spending in November, with 11 of the 20 spending above 10% of ATP. Volkswagen, Ram, Audi and Nissan were a few of the market's most generous brands in terms of incentive spending in November.

Segments with the lowest incentive spending last month were High-Performance Cars, Compact Cars and Small/Midsize Pickups. On the high side, according to the latest Kelley Blue Book report, were Luxury Cars, Full-Size Pickups and Compact SUVs.

The Compact SUVs segment, which accounts for nearly 1-in-5 new-vehicle sales in the U.S. market, continues to be the most popular and competitive segment in the U.S. market. More than 20 excellent models are competing in the segment, and the average price for a new Compact SUV in November was $36,858, higher year over year by 1% but lower than the industry average by more than 30%. Last month, incentive spending in the Compact SUV segment was 10.2% of ATP, a jump from 9.4% in October and an indication of the competitiveness of the popular Compact SUV segment. Only the High-End Luxury Cars segment (BMW 7-Series, Mercedes S-Class, Lexus LS, etc.) had higher incentives, at 11.6% of ATP.

EV Incentive Climb Higher, Prices Fall from October
New electric vehicle sales were also strong in November, with initial estimates suggesting that November volume in the U.S. market was the second-best ever, behind only August 2024. And the story is likely similar to the broader market – higher incentives are helping.

In November, Kelley Blue Book estimates show that the average transaction price for a new EV was $55,105, a decrease of 1.8% from the downwardly revised October price. EV prices last month were lower year over year by 3.8%. Incentive spending on EVs jumped, reaching 14.9% of ATP, the highest level since the pandemic and an increase from the upwardly revised 14.6% in October. At 14.9% of ATP, the typical incentive package last month for a new EV exceeded $8,200, which includes, when applicable, point-of-sale government-backed incentives.

"We have said consistently that 2024 will be the 'Year of More' for electric vehicles," added Keating. "There are certainly more incentives being offered. EVs right now are the best *deals* in the market."

Data tables are available for download.

About Kelley Blue Book
Founded in 1926, Kelley Blue Book, *The Trusted Resource*®, is the vehicle valuation and information source trusted and relied upon by both consumers and the automotive industry for nearly a century. As the industry standard for generations, Kelley Blue Book provides transparent, objective information and data-driven, innovative tools for consumers, automotive dealers and manufacturers. Kelley Blue Book publishes millions of market-reflective values weekly on its top-rated website KBB.com, from its famous Blue Book® Trade-In Values to the Kelley Blue Book® Price Advisor tool, which offers a range for what consumers reasonably can expect to pay for a vehicle in their area. KBB.com editors rate and review hundreds of new vehicles each year to help consumers understand the Best Cars and Best SUVs to meet their needs. Kelley Blue Book℠ Instant Cash Offer provides a redeemable trade-in offer to transaction-ready consumers and conveniently connects them to local participating dealers. Kelley Blue Book's Service Advisor provides guidance on how much to pay for

service and repairs, allowing consumers to schedule service with local dealers on KBB.com. Kelley Blue Book also provides vehicle values to finance and insurance companies as well as governmental agencies. Kelley Blue Book is a Cox Automotive brand.

About Cox Automotive

Cox Automotive is the world's largest automotive services and technology provider. Fueled by the largest breadth of first-party data fed by 2.3 billion online interactions a year, Cox Automotive tailors leading solutions for car shoppers, auto manufacturers, dealers, lenders and fleets. The company has 29,000+ employees on five continents and a portfolio of industry-leading brands that include Autotrader®, Kelley Blue Book®, Manheim®, vAuto®, Dealertrack®, NextGear Capital™, CentralDispatch® and FleetNet America®. Cox Automotive is a subsidiary of Cox Enterprises Inc., a privately owned, Atlanta-based company with $22 billion in annual revenue. Visit **coxautoinc.com** or connect via **@CoxAutomotive** on X, **CoxAutoInc** on Facebook or **Cox-Automotive-Inc** on LinkedIn.

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EXHIBIT Q

READING THE METER

A look inside a cleaner, safer, smarter auto industry.

ALLIANCE FOR AUTOMOTIVE INNOVATION

Contents – December 5, 2024

EXHIBIT Q

ALLIANCE FOR AUTOMOTIVE INNOVATION
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Forecast Meter

Sales & Production Summary and Forecast (Updated 12/5)

2023-2024 Sales,[1] Extended Sales Forecast[2] and Production Forecasts[3]		
	U.S. Sales & Forecasts	**North American Production**
January '23	1,033,002 (+4.2% YoY)	1,195,548 (+12.9% YoY)
February '23	1,136,332 (+8.7% YoY)	1,257,482 (+15% YoY)
March '23	1,365,966 (+8.6% YoY)	1,442,991 (+6.7% YoY)
April '23	1,347,159 (+13.1% YoY)	1,281,626 (+8.6% YoY)
May '23	1,362,019 (+18.0% YoY)	1,462,273 (+25.5% YoY)
June '23	1,370,976 (+19.9% YoY)	1,387,090 (+13.8% YoY)
July '23	1,299,199 (+19.9% YoY)	1,173,342 (+15.6 YoY)
August '23	1,328,526 (+12.8% YoY)	1,467,284 (+4.5% YoY)
September '23	1,331,952 (+13.9% YoY)	1,353,072 (+7.6% YoY)
October '23	1,200,286 (+5.7% YoY)	1,388,720 (+4.5% YoY)
November '23	1,218,647 (+7.3% YoY)	1,372,253 (+8.1 YoY)
December '23	1,433,266 (+17.3 YoY)	1,082,176 (-2.3% YoY)
January '24	1,076,047 (-1.3% YoY)	1,327,765 (+7.8% YoY)
February '24	1,247,516 (+5.2% YoY)	1,358,836 (+10% YoY)
March '24	1,438,012 (+4.6% YoY)	1,414,502 (-5.7% YoY)
April '24	1,313,512 (+0.6% YoY)	1,473,567 (+15.9% YoY)
May '24	1,429,028 (+0.8% YoY)	1,485,373 (-1.7% YoY)
June '24	1,321,932 (-3.4% YoY)	1,346,584 (-6.1% YoY)
July '24	1,273,115 (-2.0% YoY)	1,117,833 (-4.4% YoY)
August '24	1,419,245 (+3.8% YoY)	1,428,177 (+32.6% YoY)
September '24	1,169,908 (-1.4% YoY)	1,399,608 (+0.8% YoY)
October '24	1,325,263 (+2.4% YoY)	1,506,154 (+7% YoY)
November '24	1,360,060 (+5.8% YoY)	
2023 Full Year	15,457,447 (+12.4% YoY)	16,144,461 (+9.3% YoY) (U.S. 10,611,580)
2024 Estimate	15.9 M	15.77 (U.S. 10.8M)

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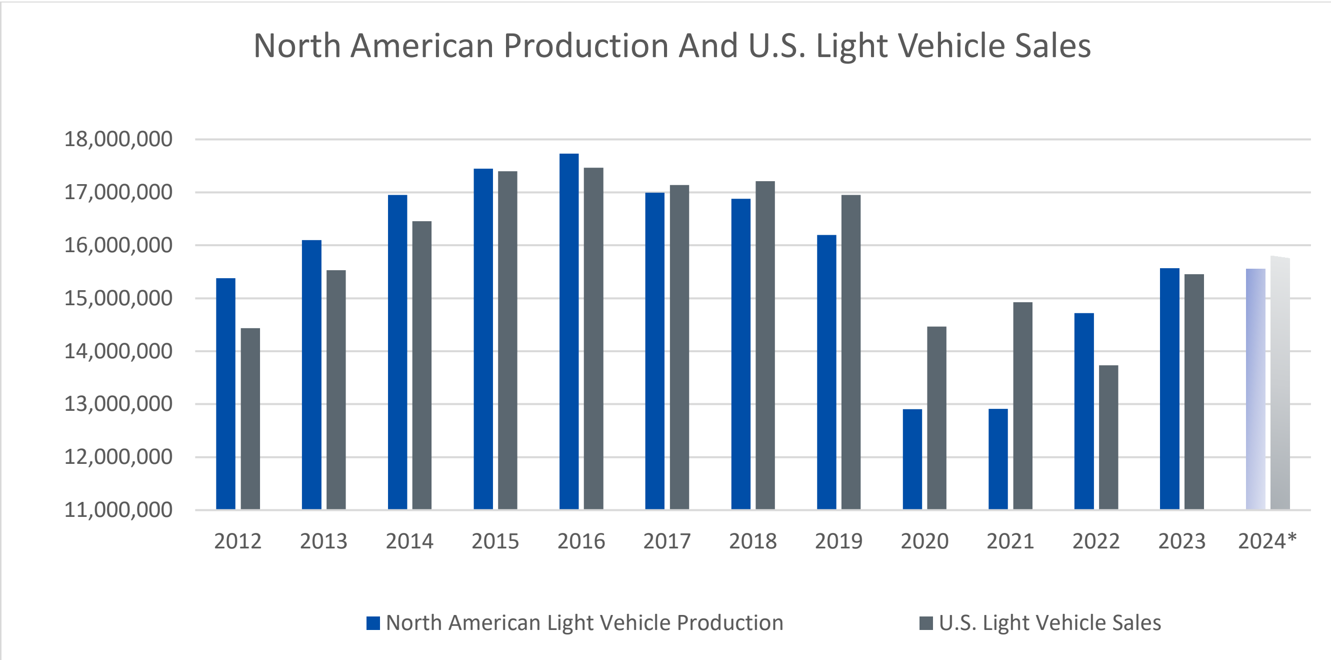
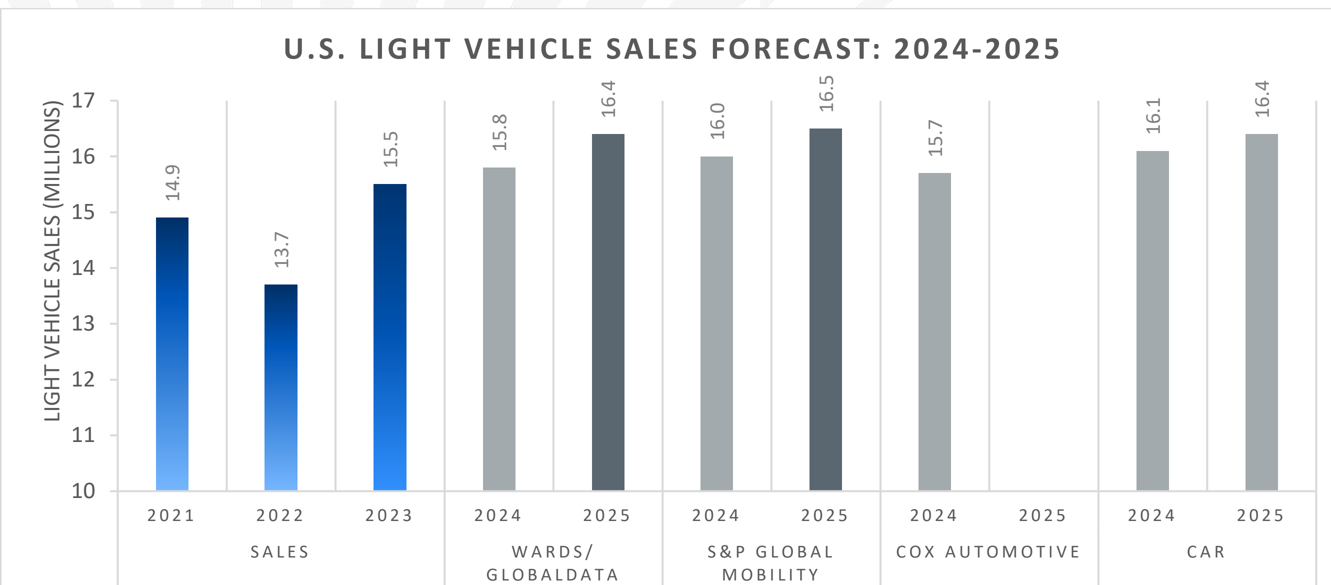


U.S. Light Vehicle Sales Outlook (Updated 12/5)



Wards Intelligence Outlook (12/5)[4]: "Based on an initial look at December putting sales (including imports) at 1.44 million units for a 16.3 million seasonally adjusted annual rate, inventory is projected to decline 4.0% from November to 2.84 million units, 23% above the year-ago total. Excluding imports, North America-built models, because of the production slowdowns, are forecast to decline a bigger 5.5% from November.

"However, there is more upside than downside to the December outlook for demand, meaning dealer lots could be drained more than forecast.

"If the December outlook holds firm, sales in entire 2024 will total 15.83 million units, 2.1% above 2023's 15.50 million. Looking ahead, Wards Intelligence partner GlobalData forecasts sales in 2025 to total 16.1 million and 2026 to total 16.5 million.

North American Production & Inventory Outlook (Updated 12/5)

Wards Intelligence Production Outlook (12/5)[5]: "Production by North America plants, which supply nearly 80% of the U.S. market, declined year-over-year each month from May through September, and, after a 7.6% increase in October, is expected to decline again in November and December.

"The local production slowdowns showed in inventory of North America-built vehicles, which declined 0.8% from October."

Wards Intelligence Inventory Outlook (11/26) [6]: "Inventory is forecast to rise slightly from October, less than 1%, which is lower than the historically typical month-to-month gain in November that averaged roughly 4% to 5%. November's inventory is expected to total 2.95 million units, up from the prior month's 2.94 million and 26.1% above like-2023.

"Days' supply is forecast at 57, down from 60 the prior month, but above year-ago's 47.

"Inventory growth is being slowed by production cuts in response to slow selling vehicles, especially North America-made vehicles, which account for roughly 80% of U.S. sales volume."

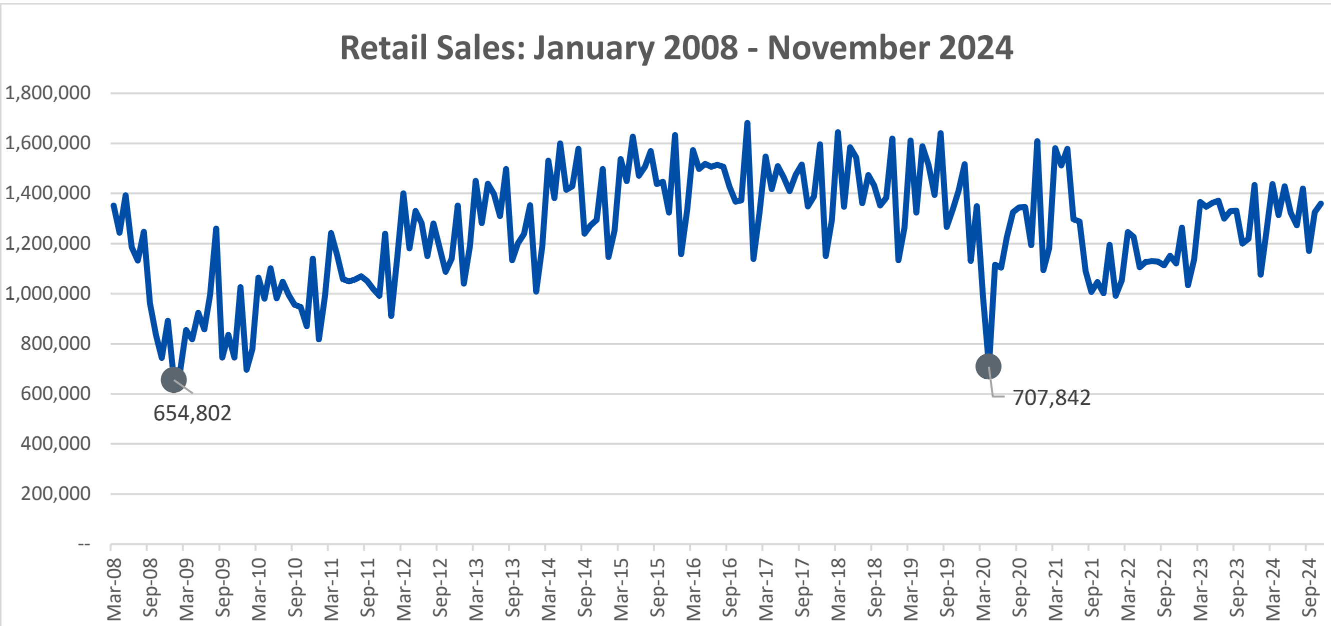
S&P Global Mobility Outlook (11/26)[7]: "North America: The outlook for North America light vehicle production was largely unchanged for the 2024 to 2026 timeframe. The general near-term production outlook for North America continues to reflect the need for further inventory correction. Despite the lack of forecast movement at the macro level, production in 2025 for Ford was revised down by 45,000 units on the need to correct for increasingly excessive inventory which is expected to remain an issue heading into next year. Conversely, Stellantis is moving aggressively to correct inventory with production revised down an additional 48,000 units in 2024 on lower than expected production results in October in addition to downtime extensions centered around the Jeep Grand Cherokee, Gladiator and Wrangler. As a result of the aggressive action from Stellantis, upside potential exists in 2025 which was revised higher by a marginal 6,000 units. Production risk for Stellantis in 2025 moves from excessive production levels to the potential for launch related issues, including delays and/or slower than forecasted launch curves. We continue to evaluate the impacts of the recent US elections with nearly as many questions as answers remaining. Nevertheless, we do expect material reductions in BEV volumes/market share and revisions in electrification mix. These changes are expected to be reflected in future forecast updates.

Market Meter

U.S. Light Vehicle Sales (Updated 12/5)

Monthly Sales (Updated 12/5)

This chart helps to put into context the monthly retail sales due to the COVID pandemic and showing the relative drop in sales compared to the 2008 financial crisis.



November Sales (Updated 12/5)

WardsIntelligence[8]**:** "Improved affordability, and possibly relief from the end of contentious national elections, appeared to bring more consumers into dealer showrooms in November, leading sales to post their biggest year-over-year increase in 2024.

"Demand for U.S. light vehicles surprised on the high side for the second straight month in November, finishing at a 16.5 million-unit seasonally adjusted annual rate, highest since 17.0 million in May 2021.

"The SAAR was well above November 2023's 15.5 million units and the third consecutive sequential increase since August's 15.3 million.

"Raw volume in November totaled 1.360 million units, 10.1% above same-month 2023. The daily selling rate over the month's 26 selling days was 52,310, 5.8% above the year-ago total of 49,423 – 25 selling days.

"Slightly better affordability certainly helped. J.D. Power estimates average transaction prices fell slightly year-over-year in November, while incentive spending rose 42%.

"The estimated retail portion of November's total was 1.19 million units, up 7.4% year-over-year based on DSRs. Fleet volume totaled 173,400, down 3.6% year-over-year."

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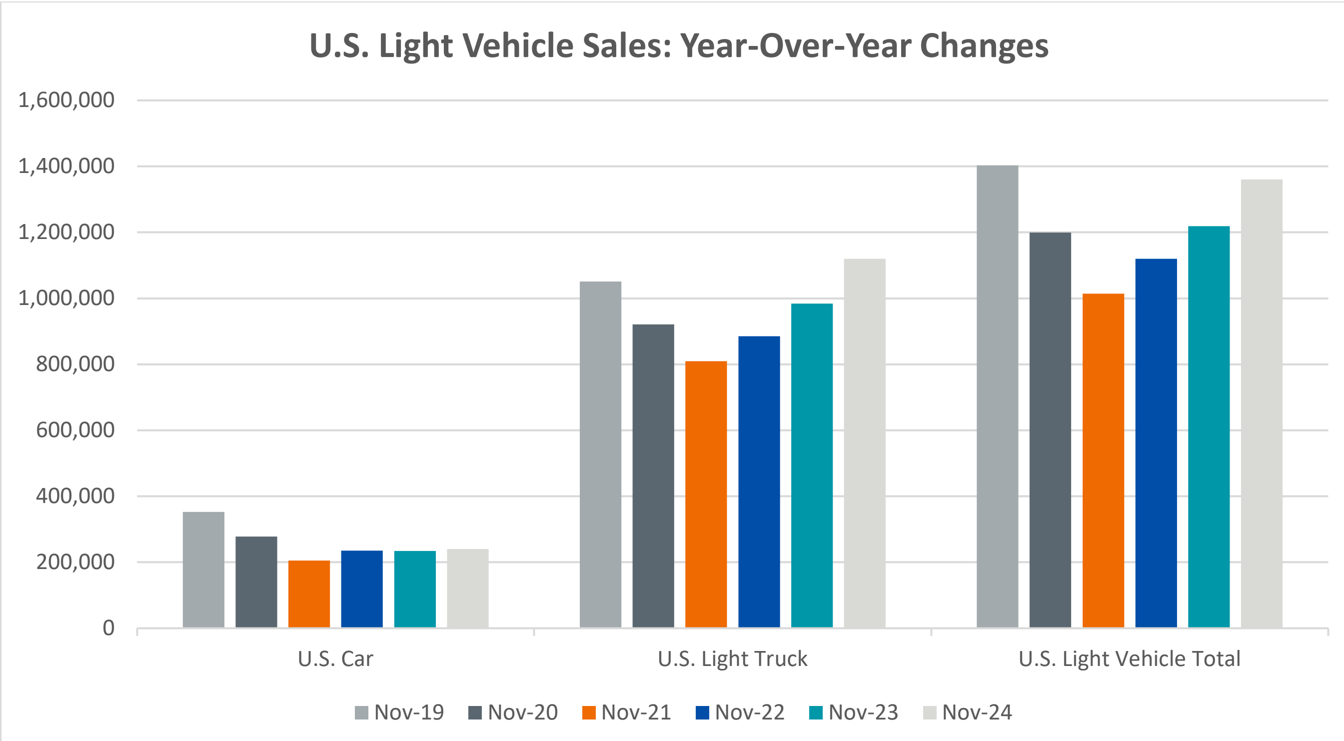
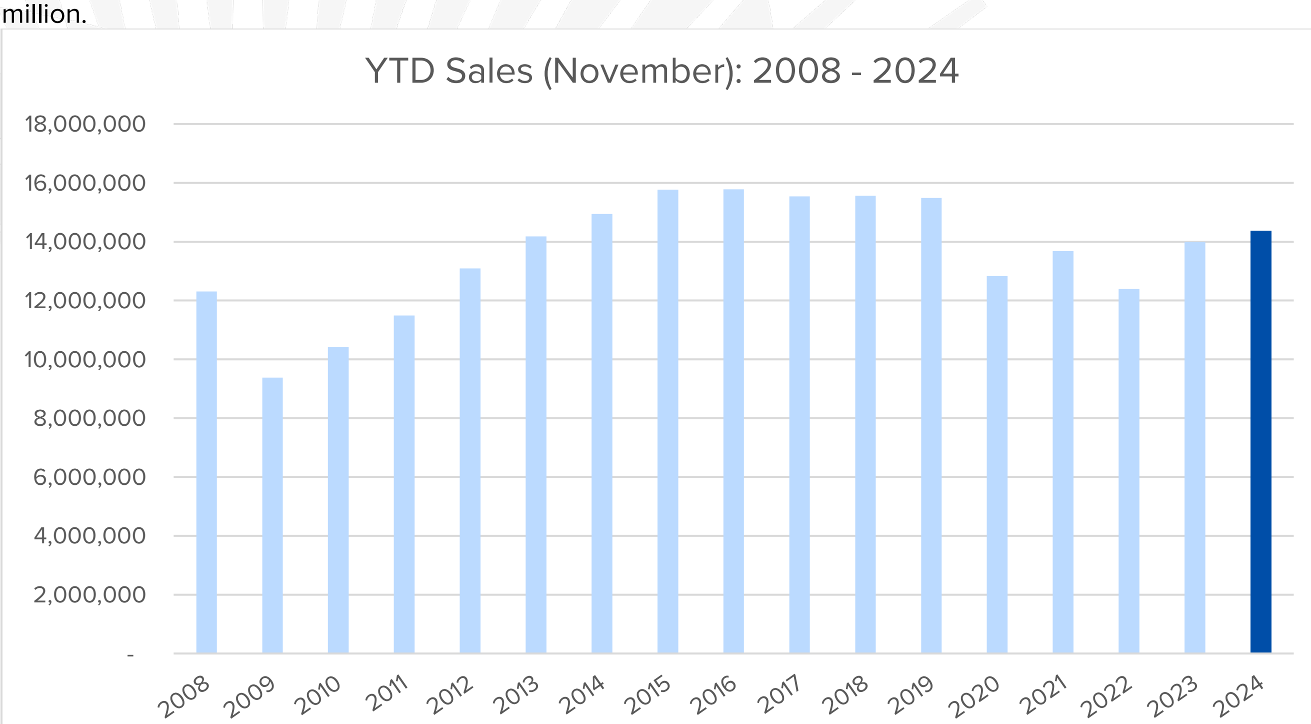


Calendar year-to-date sales through November totaled 14.37 million units, up 2.7 % from like-2023's 13.99 million.



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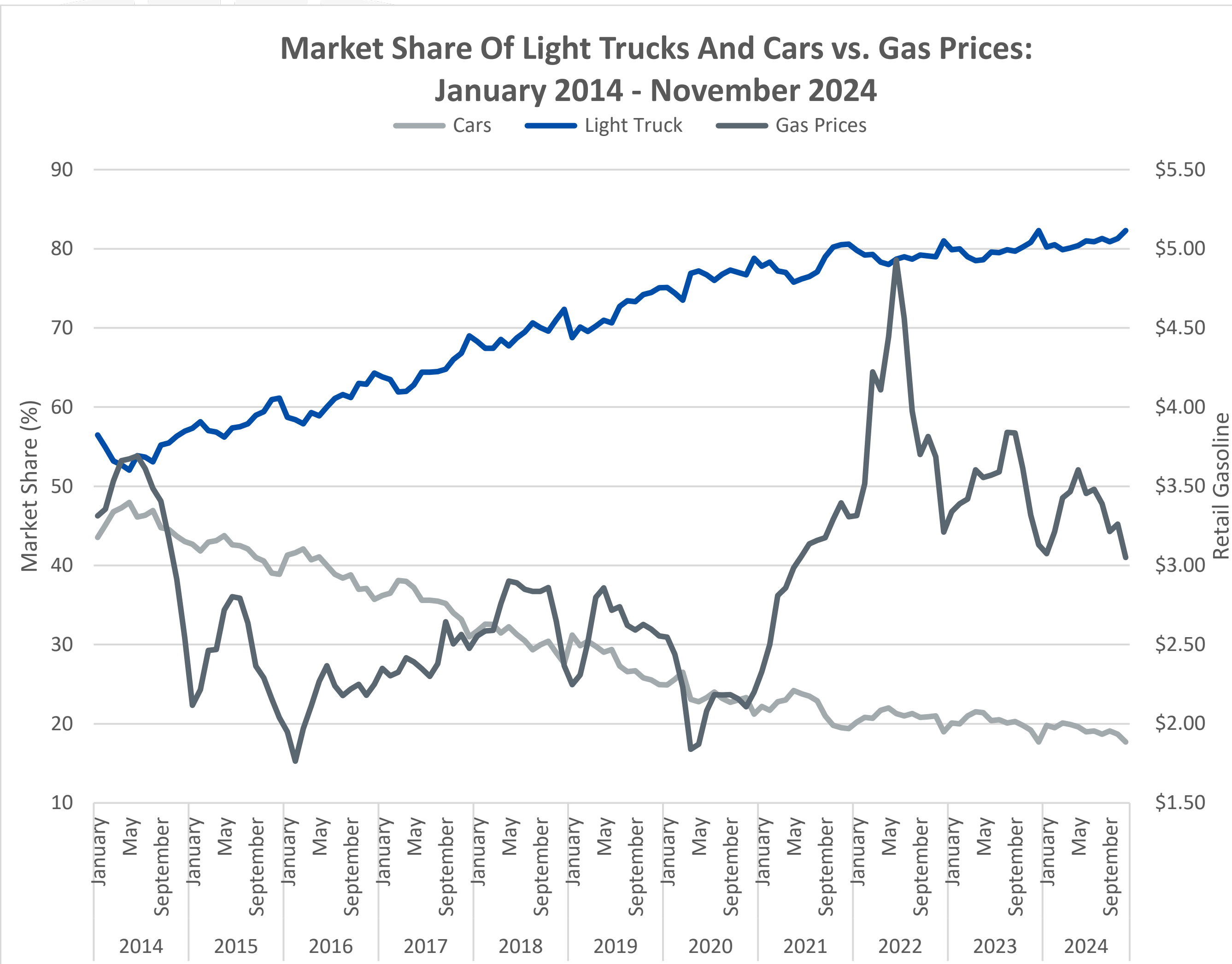
Segments vs. Gas Prices (Updated 12/5)

Monthly Sales For October: Light trucks accounted for 82 percent of sales in November, up nearly 2 percentage points from the market share a year ago. Compared to the same period in 2023, sales of cars are up by 6,367 units, and down more than 111,000 from November 2019, when cars comprised 25% of the market as opposed to the 18 percent of the market passenger cars have now.

Historic Perspective: The upward trend in the popularity of light trucks over cars has been steady since 2013, when only 2% of annual market share separated the two segments.[9] and gas was over $3.00.[10] a gallon. As fuel prices dropped below the $3.00 mark in mid-September 2014, light truck sales began to take off. Gas prices since have averaged only $2.92 a gallon (through July 2024) and when combined with increased fuel economy for light trucks, an increase of 4 mpg since 2013, the perfect conditions existed to continue fueling light truck market growth.[11]



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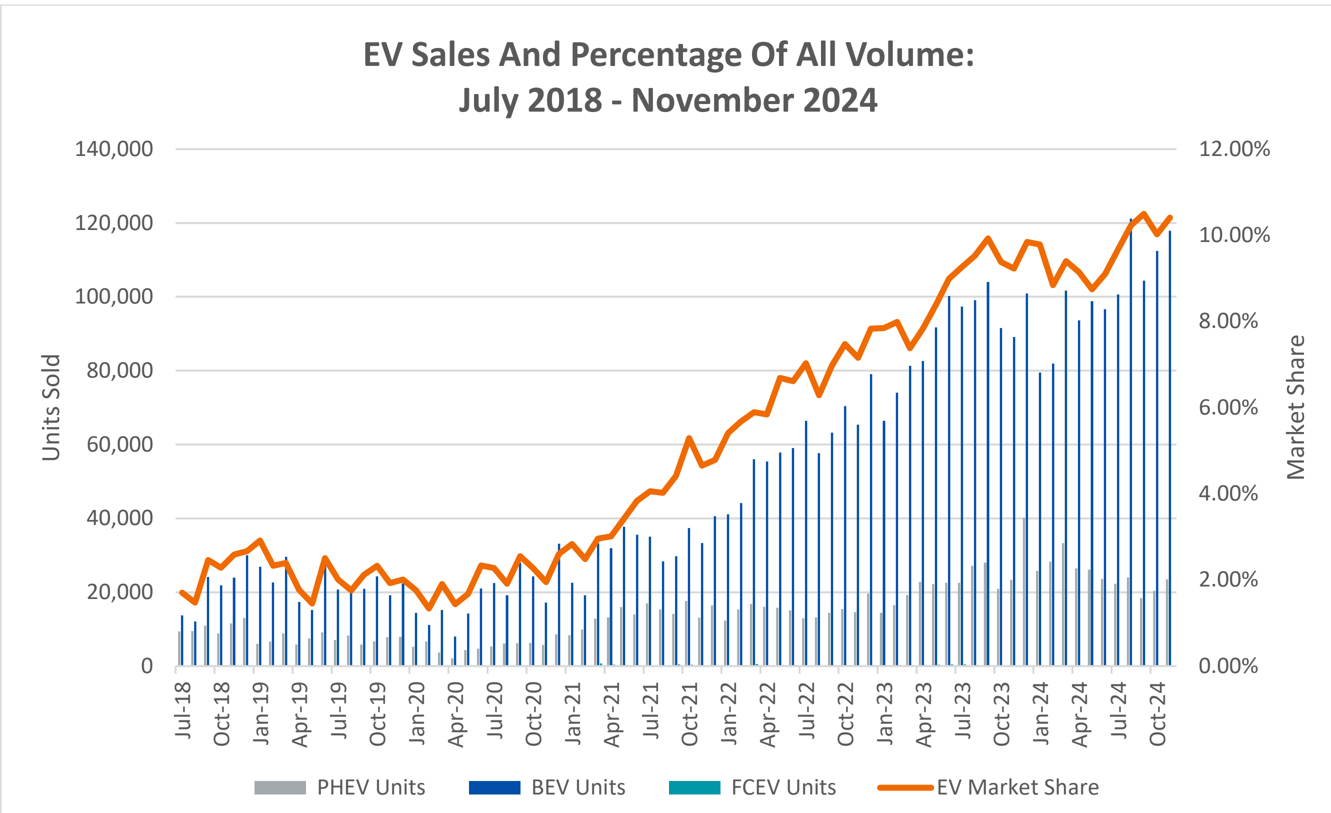
EV Powertrain Sales (Updated 12/5)

Sales of electric vehicles (BEV, PHEV, & Fuel Cell) accounted for 10.4 percent of total vehicle sales in November 2024 (141,539), per Wards estimates. Market share increased 0.48 percentage points (pp) from October 2024. November's EV market share is up 1.2 pp from a year ago. Sales of battery electric vehicles led the way for EVs, accounting for 8.7 percent of total sales, up 1.36 pp from November 2023. Plug-in hybrids accounted for 1.7 percent, down 0.19 pp from the same time last year.[12]



Seasonally Adjusted Annual Rates (Updated 12/5)

WardsIntelligence[13]: "Demand for U.S. light vehicles surprised on the high side for the second straight month in November, finishing at a 16.5 million-unit seasonally adjusted annual rate, highest since 17.0 million in May 2021. The SAAR was well above November 2023's 15.5 million units and the third consecutive sequential increase since August's 15.3 million."

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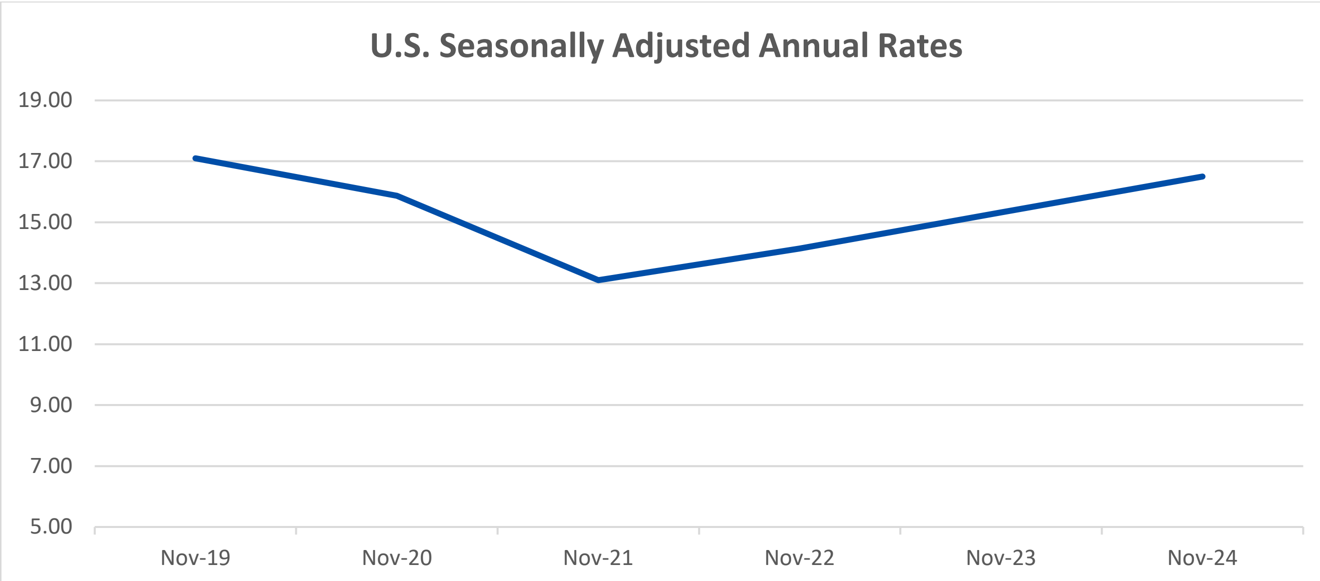

Average Transaction Price (Updated 12/5)

J.D. Power (Updated 12/5)[14]: "The average retail transaction price for new vehicles has decreased slightly from a year ago, driven by higher manufacturer incentives and larger retailer discounts, offset by changes in the mix of vehicles being sold. Transaction prices are trending towards $45,471—down $150 or 0.3%—from November 2023."

Kelley Blue Book (October)[15]: "The average transaction price (ATP) paid for a new vehicle in the U.S. in October was $48,623, according to new data from Kelley Blue Book. Transaction prices last month were higher than the revised September price ($48,423) and higher by 1.7% from year-earlier levels ($47,826). For more than a year now, new-vehicle prices in the U.S. have remained mostly unchanged and near $48,500, as higher inventory levels continue to hold downward pressure on the market.

"New-vehicle sales incentives climbed higher in October, jumping from a revised 7.2% of the ATP in September to 7.7% in October, an increase of more than 6% month over month. Compared to one year ago, new-vehicle incentives have increased more than 60% as automakers compete for sales.

"Electric vehicle ATPs, at $56,902 in October, were lower than the revised September estimate of $57,580. Year over year, EV prices were higher by 0.9%, and compared to the industry average, electric vehicle ATPs in October were higher by just more than 14%, roughly in line with the premium paid one year ago.

EV incentives in October, however, were much higher than one year ago, helping make electric vehicles more affordable for consumers. The average incentive package offered on an EV, including estimates for government incentives when applicable, was 13.7% of ATP, up from a revised 11.6% in September and well more than double the level seen one year ago when incentives were 5.6% of ATP. EV incentives have been elevated throughout 2024, according to Kelley Blue Book data, averaging near 11% of ATP, well above industry average.

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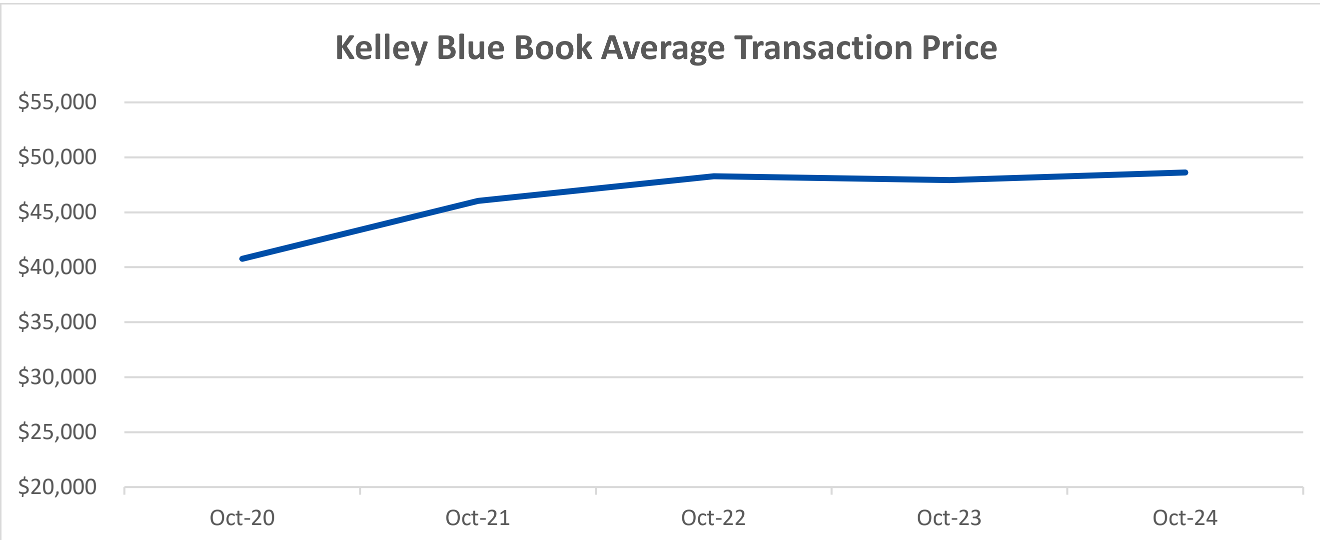
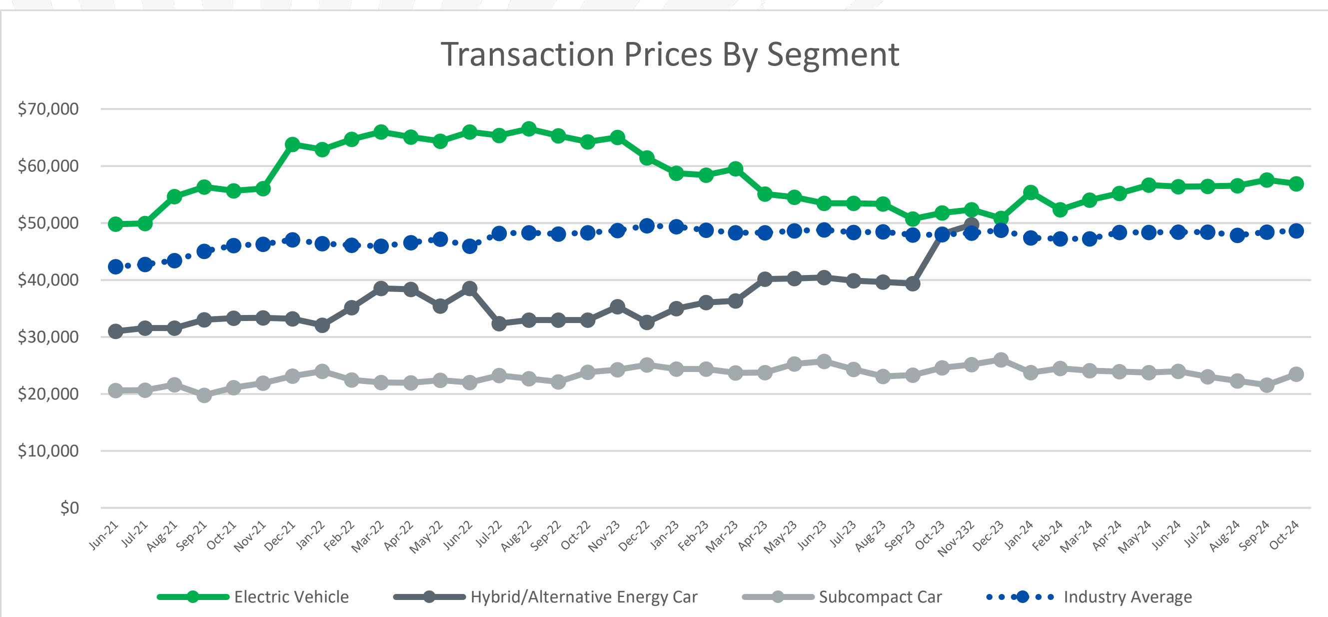
The average transaction price for a new Tesla – the industry's EV leader – declined in October from September to $56,705, according to an initial estimate, but was higher year over year by more than 10%. Lower month-over-month Tesla prices in October were likely influenced by a drop in Cybertruck ATPs, which fell below $100,000 for the first time since launch. In October, the Cybertruck ATP was $98,495. Sales were also lower, dropping to 4,254, the lowest total since June."





Auto Loan Financing (Updated 12/5)

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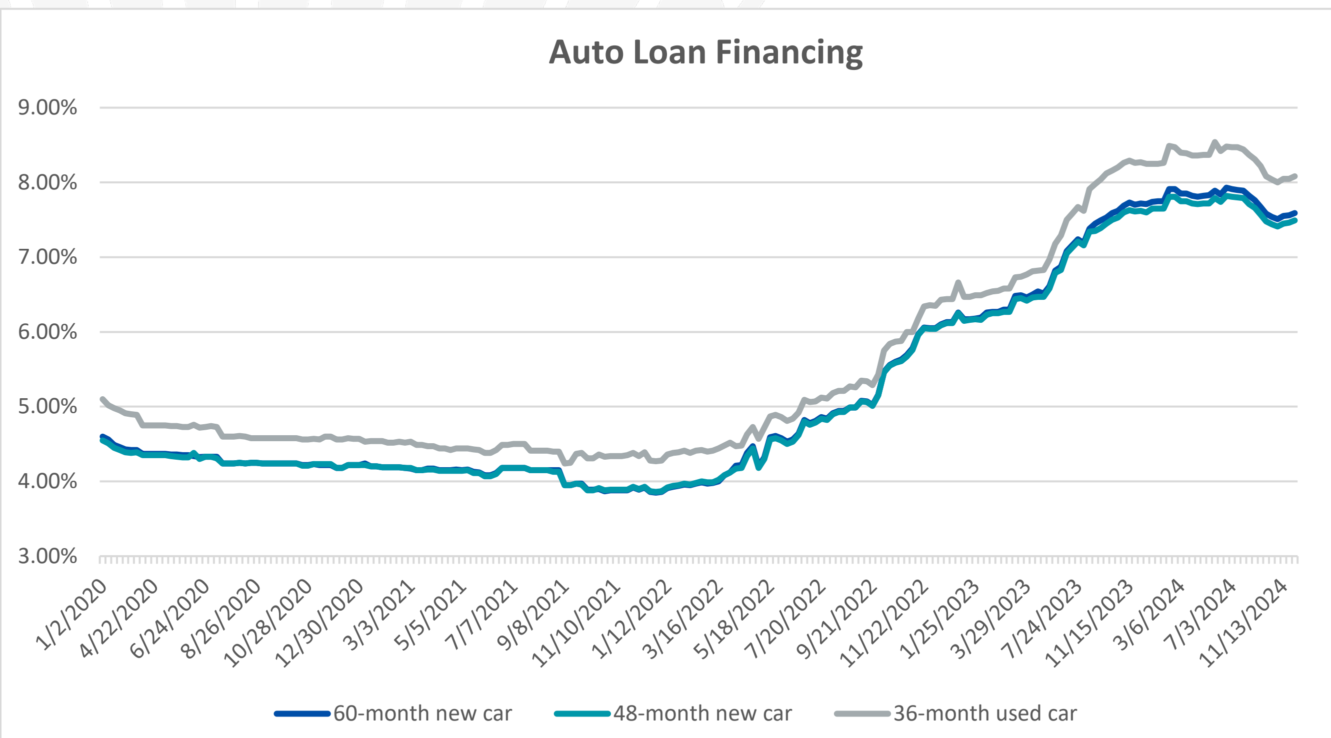
Interest Rates (updated 12/5): Interest rates increased slightly on the 60-month, 48-month and the 36-month used car loans over the past two weeks. Rates now stand at 7.59%, 7.49%, and 8.1%, respectively. Since the beginning of 2020, 60-month rates are up 2.99 pp, and are down 0.13 pp since the same time a year ago.[16]

JD Power (12/5)[17]: "Average monthly finance payments this month are on pace to be $745, up $20 from November 2023. The average interest rate for new-vehicle loans is expected to be 6.45%, down 71 basis points from a year ago. Monthly payments increasing is a result of a drop in trade-in equity, even though transaction prices and interest rates are falling."

Dates	60-month new car	48-month new car	36-month used car
1/2/2020	4.60%	4.55%	5.10%
12/6/2023	7.72%	7.62%	8.27%
11/20/2024	7.56%	7.46%	8.05%
12/4/2024	7.59%	7.49%	8.08%
Two Week Change	0.03%	0.03%	0.03%
Change since 1/3/20	2.99%	2.94%	2.98%
One Year Change	-0.13%	-0.13%	-0.19%



Crude Oil and Gas Prices (Updated 12/5)

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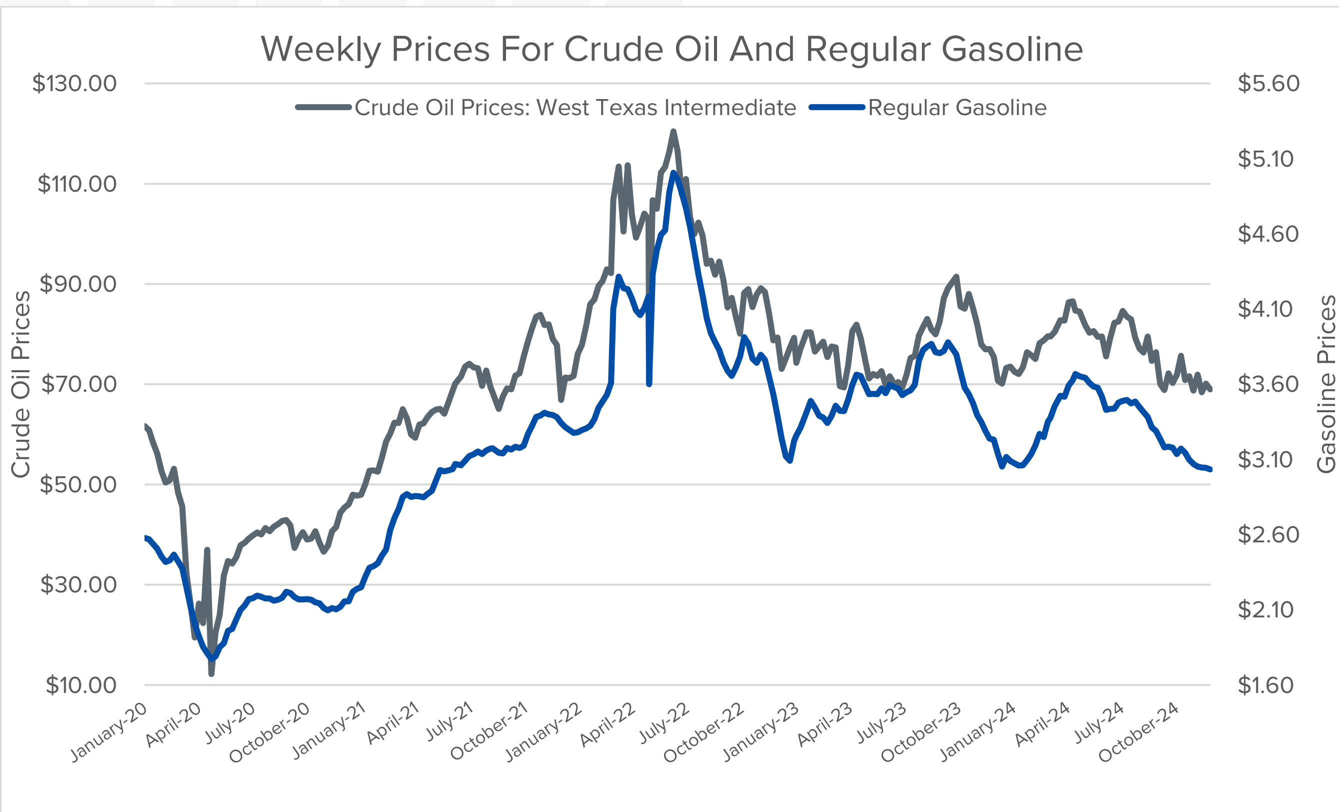
Gas And Oil Remain Elevated (12/5), but Falling: Oil prices, as benchmarked at West Texas Intermediate were $68.94, down $1.17 from the prior week. Since election day 2020, oil prices are $32 a barrel higher. Gas is down slightly from a week ago at $3.03. Gas is 18% higher than the beginning of 2020 and has not been below $3 a gallon since May 2021.[18]

EIA Outlook For Oil (11/6):[19] "We reduced our 2025 forecast for U.S. Lower 48 states (L48) crude oil production in the October STEO from last month by 1% to 11.3 million b/d. This reduction reflects a downward revision to our West Texas Intermediate (WTI) crude oil price forecast. We now expect WTI will average $72/b in 4Q24, about $6/b lower than last month's forecast. Because there is about a six-month lag between price changes and producer activity, the recent price declines will begin reducing U.S. crude oil production in mid-2025. By December 2025, U.S. L48 crude oil production will be 11.4 million b/d, 2% lower than our September STEO forecast."

EIA Outlook For Gasoline (11/6)[20]: "We now expect the U.S. retail gasoline price to average $3.20 per gallon (gal) in 2025, down 10 cents/gal from the September forecast. We also expect the $3.20/gal average next year to be down 10 cents/gal from the 2024 average retail gasoline price.



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Production Meter

U.S. Light Vehicle Inventory and Days' Supply (Updated 12/5)

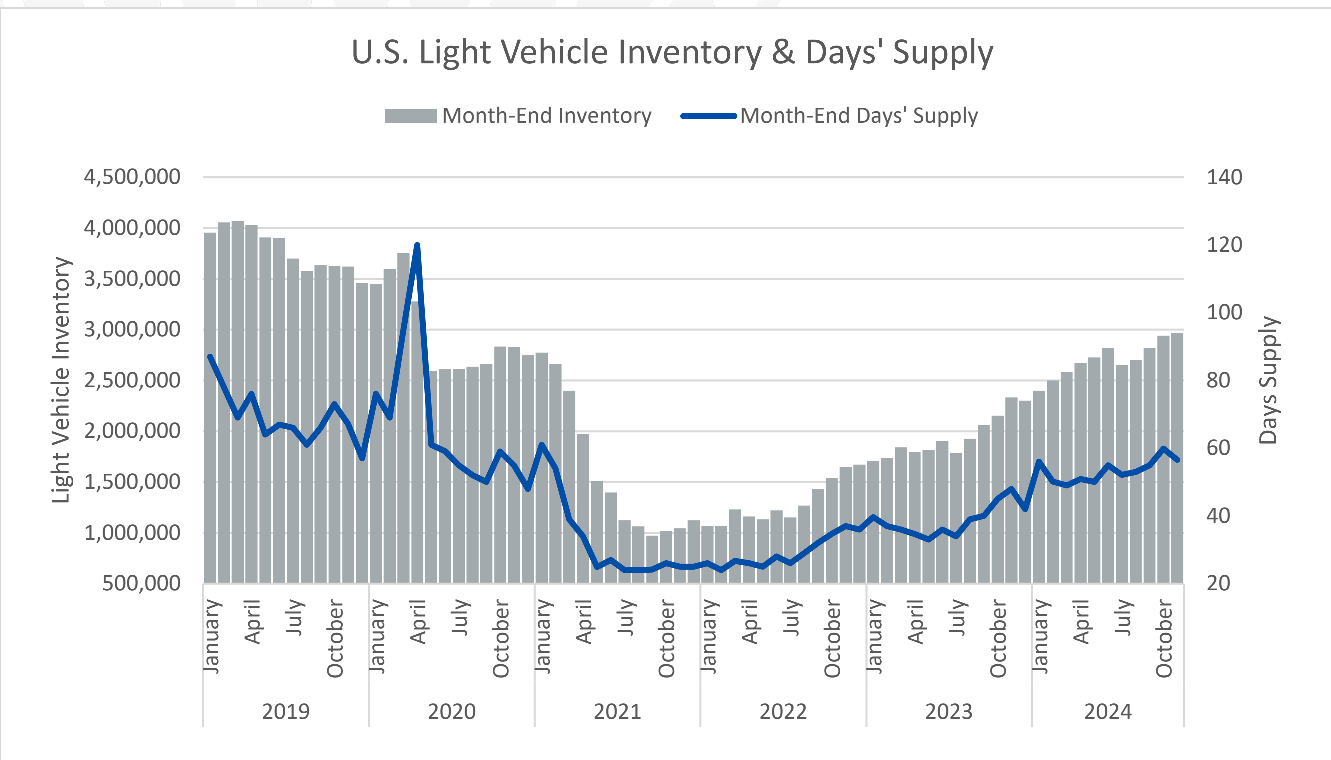
WardsIntelligence Inventory Update (11/6)[21]: "Production slowdowns, as well as slightly stronger demand, curtailed inventory growth in November, as U.S. light-vehicle stocks rose a meager 0.8% from the prior month to 2.966 million units.

"Historically, month-to-month gains of 3% to 4% are normal from October to November.

"In fact, in the past two years, with manufacturers struggling to re-stock dealer lots after global semiconductor shortages starting in 2021 slowed vehicle production which severely slashed inventory levels, month-to-month gains in November spiked to 6.9% in 2022 and 8.3% in 2023.

"The total was 26.8% above like-2023, but the lowest year-over-year percent gain since August 2022's 18.8%.

"November's 57 days' supply was significantly above same-month 2023's 47 and highest for the month since 67 in 2019 - a 70 days' supply was normal for November in the pre-2020 period."



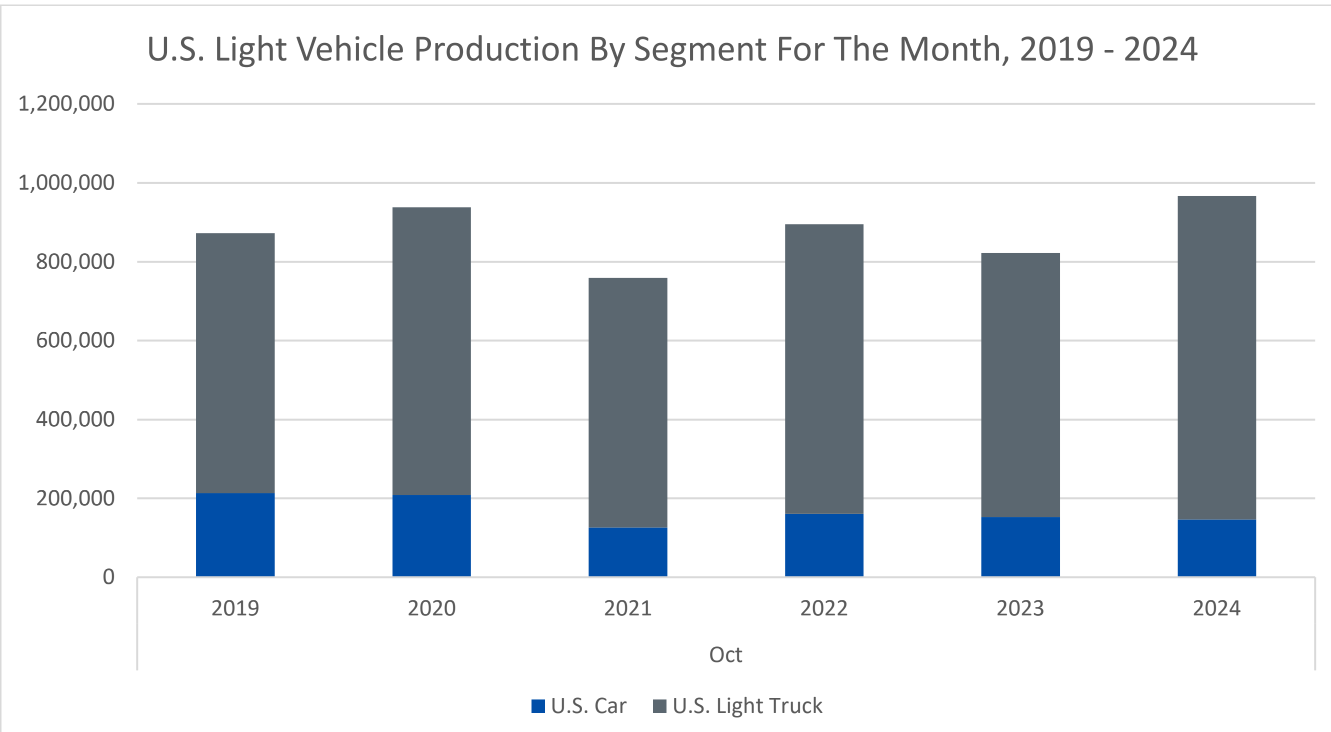
North American Production (Updated 11/26)

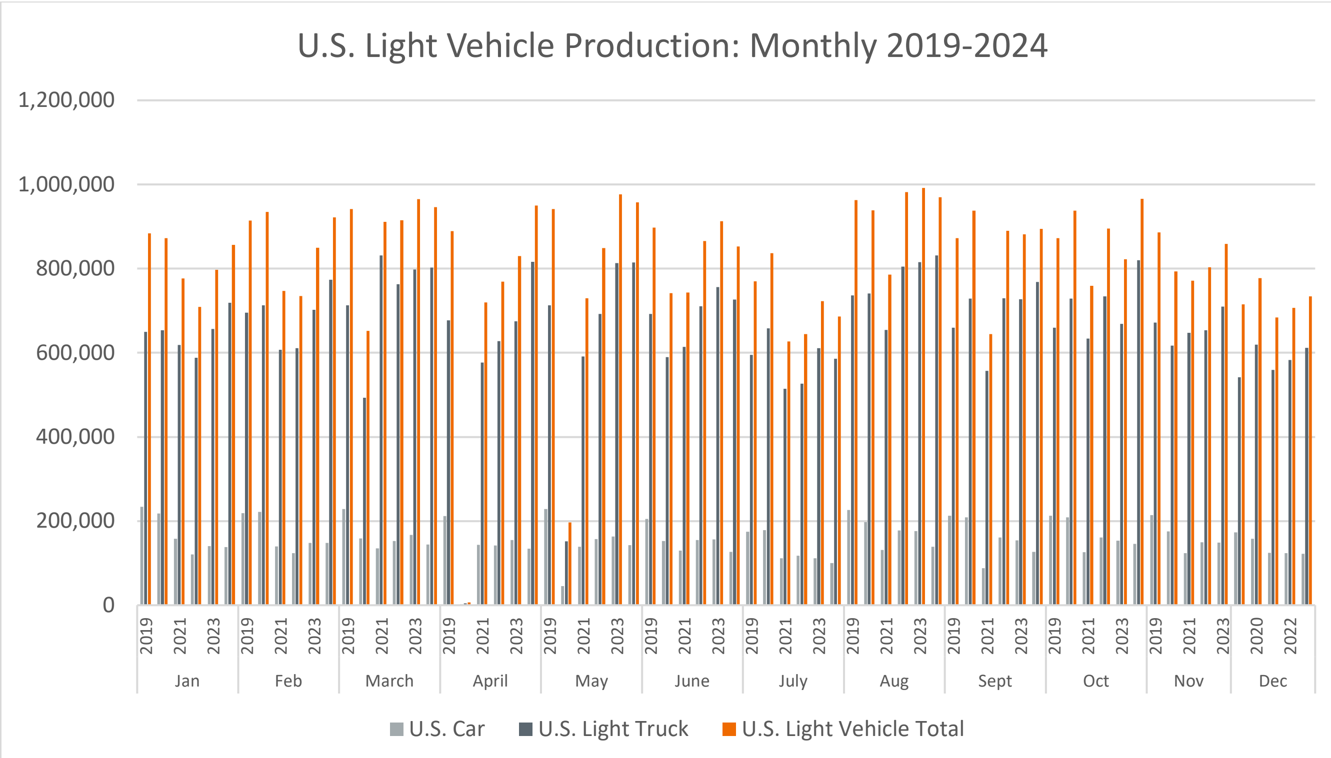
Wards Intelligence[22]: "Production of all vehicles in October totaled 1.506 million units, 7.0% above like-2023, which was hurt by labor-related strikes at Ford, General Motors, Mack and Stellantis. Production in November is tracking to a 5.4% year-over-year drop to 1.299 million and December is pegged to fall 5.8% to 1.031 million."

U.S. Light Vehicle Production (Updated 11/26)

U.S. Monthly Production (Updated 11/26)

U.S. Light vehicle production for October was up 10 percent month-over-month, totaling 894,643 vehicles (146,015 cars, 820,154 light trucks), year-over-year, production is up 14.5 percent from 2023.[23]





Global Meter

Global Light Vehicle Sales (Updated 12/5)

Wards Intelligence[24]: "Global sales of light vehicles and medium-/heavy-duty trucks combined increased 4.3% year-over-year in October to 8.333 million units, based on reported data and estimates by Wards Intelligence.

"The gain reversed a Q3 decline and is expected to continue in the last two months of the year.

"Volume increased in all major regions, with South America surging 12.7% from October 2023, followed by 9.5% in North America, 2.9% in Asia-Pacific and 0.4% in Europe.

"In the AP, however, volume gains mainly were led by the three biggest markets, while deliveries in most of the other countries fell year-over-year.

"China, the by far the biggest market globally, posted a 6.5% gain over the year-ago month and accounted for 68.6% of the region's sales. Excluding China's results, demand in AP fell 4.3% year-over-year – and that includes a 4.0% increase in India, the region's second largest market, and a 9.4% rise in its third biggest market, Japan.

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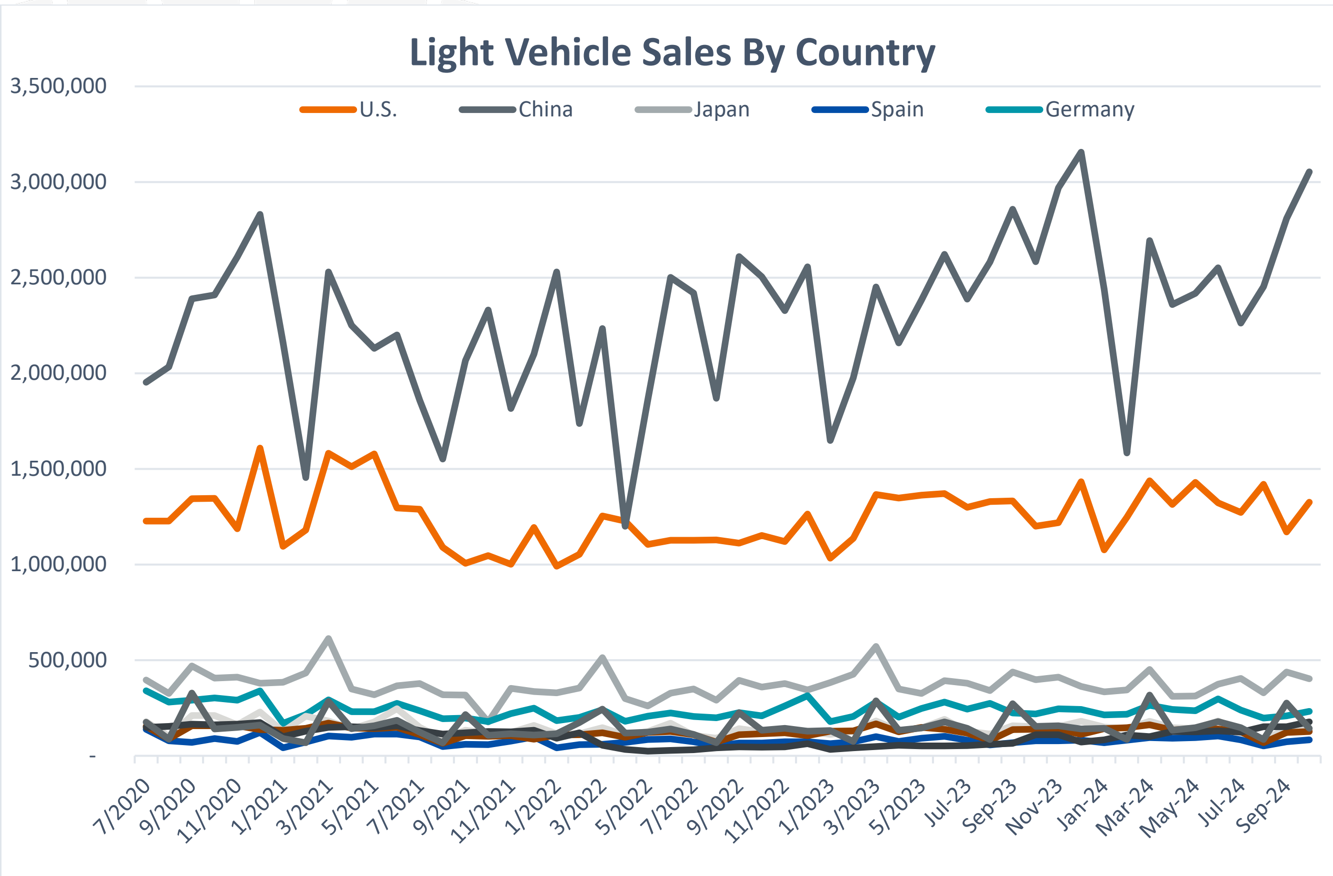
Calendar year-to-date sales through October totaled 77.16 million units, 2.0% above 10-month 2023's 75.62 million.

"Excluding medium-/heavy-duty trucks, light-vehicle sales in October totaled 8.040 million units, up 4.4% from like-2023. Calendar to-date volume was 74.23 million, 2.0% above like-2023's 72.79 million.

"Wards Intelligence partner GlobalData pegged October's annualized rate for light vehicles at 93.0 million units, well above September's 89.0 million. GlobalData expects the global SAAR to range between 90 million and 95 million in November, with raw volume rising year-over-year.

"The forecasting unit expects strong year-over-year growth in November in China – as "scrappage" incentives take hold – North America and South America.

"GlobalData kept its global light-vehicle sales forecast for entire-2024 unchanged at 88.0 million units."



Global Light Vehicle Production (Updated 11/26)

S&P Global Mobility Forecast (11/26)[25]**:** "Light vehicle production remains somewhat challenged across a number of regions as inventory management efforts and mixed demand dynamics influence the near-to-intermediate term forecast. The production outlook reflects these ongoing challenges with this month's forecast update particularly focused on downgrades for Europe and South Asia while a noteworthy upward revision in the extreme near-term for Greater China on stronger output to support more recent improved sales driven by scrappage subsidies results in a modestly stronger overall global production outlook for 2024. We continue to evaluate the impacts of the recent US elections with nearly as many questions as answers remaining. Nevertheless, we do expect material reductions in BEV volumes/market share and revisions in electrification mix. These changes are expected to be reflected in future forecast updates. The November forecast update reflects a mix of upgrades and downgrades of varying magnitudes in the near-to-intermediate term, with adjustments spread across a few regions. China receives a material upgrade for the balance of 2024 to support recent sales strength fueled by government-supported scrappage subsidies. Downward revisions are primarily focused on Europe as well as South Asia, as both markets navigate dynamic demand fundamentals and inventory management, among other factors. The more noteworthy regional adjustments with the latest forecast update are detailed below:

“**Europe:** The outlook for Europe light vehicle production was reduced by 92,000 units and by 170,000 units for 2024 and 2025, respectively (and reduced by 25,000 units for 2026). European regional output was cut again this month. The outlook for 2024 in Western and Central Europe, including Turkey, was revised downward by 104,000 units. This reduction was primarily due to downgrades for Stellantis and Volvo, which were reduced by 33,000 and 38,000 units, respectively. The Stellantis Q4-2024 outlook was particularly impacted, while Volvo reported worse-than-expected Q3-2024 results, with a drop of 29,000 units. Additionally, the production disruption from flooding in Valencia, Spain, led to a general 18,000-unit downgrade for November output in the country. However, a recovery is anticipated in the short-term, with minimal impact on total country volume for 2024. Finally, concerns over potential strikes at Mercedes-Benz and Volkswagen plants in Germany prompted a further reduction of 25,000 units in December output there. Of note, the outlook for the CIS market for 2024 was upgraded modestly by 12,000 units yet failed to offset losses elsewhere in Europe. Looking ahead to 2025, the forecast downgrade was particularly focused in Western and Central Europe, with the outlook for Stellantis becoming notably pessimistic with a reduction of 145,000 units.

“**Greater China:** The outlook for Greater China light vehicle production was increased by 409,000 units and by 51,000 for 2024 and 2025, respectively (and increased by 38,000 units for 2026). The light vehicle market in China continues to recover from the seasonal summer slowdown with October production posting 7% growth year-over-year. During Golden Week holidays, motivated by enhanced scrappage subsidy policies from central and regional governments, passenger vehicle sales have further improved with 16% growth year-over-year according to the CPCA. Despite the sales recovery, given previous high inventory levels and recent production strength, the passenger vehicle inventory index remains elevated at 1.76 for October according to the CDCA. In order to sustain sales activity and support domestic GDP growth, stronger price promotion by most automakers is expected in the coming months. Given recent sales and production strength and an improved very near-term outlook, the forecast for 2024 was revised upward to 29.7 million units, representing 2.4% growth year-over-year. However, with ongoing economic uncertainties, a likely pay-back effect related to the scrapping policy and impacts from the US election, the outlook for 2025 and 2026 was only more modestly revised upwards.

“**Japan/Korea:** Full-year 2025 Japan production was upgraded by 39,000 units relative to last month’s forecast. Toyota is expected to maintain momentum in the first quarter of 2025 to fill the backlog of the Alphard in Japan and to drive ICE exports of the RAV4 and the Land Cruiser. There were no major changes to the long-term forecast relative to last month’s update. South Korea light vehicle production for 2024 was reduced by 12,000 units relative to last month’s forecast. Domestic sales and exports increased in October but fell short of expectations. As a result, production in the extreme near-term was modestly adjusted downward by 0.3% to 4.09 million units. Meanwhile, the production outlook for 2025 and 2026 remained largely unchanged from the previous forecast. In the longer term, production volume from 2030 onwards increased by about 40,000 units or 1.2% per year to address conditions of underbuilding

“**North America:** The outlook for North America light vehicle production was largely unchanged for the 2024 to 2026 timeframe. The general near-term production outlook for North America continues to reflect the need for further inventory correction. Despite the lack of forecast movement at the macro level, production in 2025 for Ford was revised down by 45,000 units on the need to correct for increasingly excessive inventory which is expected to remain an issue heading into next year. Conversely, Stellantis is moving aggressively to correct inventory with production revised down an additional 48,000 units in 2024 on lower than expected production results in October in addition to downtime extensions centered around the Jeep Grand Cherokee, Gladiator and Wrangler. As a result of the aggressive action from Stellantis, upside potential exists in 2025 which was revised higher by a marginal 6,000 units. Production risk for Stellantis in 2025 moves from excessive production levels to the potential for launch related issues, including delays and/or slower than forecasted launch curves. We continue to evaluate the impacts of the recent US elections with nearly as many questions as answers remaining. Nevertheless, we do expect material reductions in BEV volumes/market share and revisions in electrification mix. These changes are expected to be reflected in future forecast updates.

“**South America:** The outlook for South America light vehicle production was increased by 23,000 units and by 4,000 units for 2024 and 2025, respectively (and reduced by 9,000 units for 2026). In the extreme near-term, the outlook has been upgraded due to stronger October production results for Brazil and Argentina coming in 10% and 6% above expectations, respectively. In the absence of a sales forecast update for November, there were no other major changes to the 2024 production outlook for the region. For 2025 and 2026, production volumes remained fairly stable with changes primarily focused on vehicle timing changes, including the delayed renewal of the Toyota Hilux pickup and SUV (delayed by 11 months to 2027 instead of 2026).

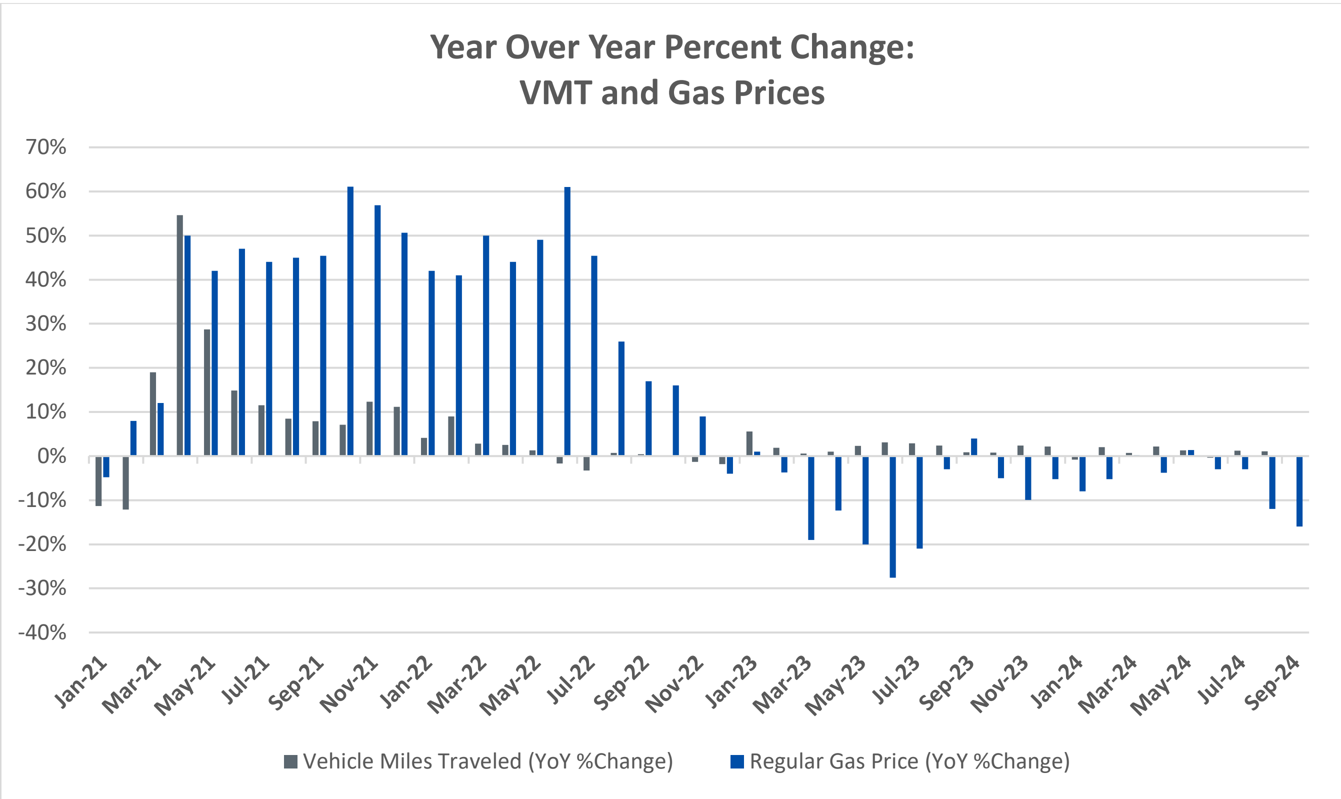
“**South Asia:** The outlook for South Asia light vehicle production was reduced by 63,000 units and by 60,000 units for 2024 and 2025, respectively (and reduced by 97,000 units for 2026). South Asia's light vehicle production forecast update for 2024 was impacted by production weakness associated with the ASEAN market. Weaker recent output for Malaysia accompanied by increased downtime extending further into the fourth quarter was a major driver of the reduced outlook in the extreme near-term. The outlook for 2025 and 2026 in the ASEAN market was revised down by 50,000 units and 55,000 units, respectively, primarily on expectations for softer domestic and export demand for Thailand and Indonesia. Regarding the India market, production was reduced by 24,000 units for 2024 to reflect weaker recent actual production and increased downtime to correct high inventory levels. In spite of recent sales strength, inventory remains elevated, indicating that further corrective actions may be necessary in the coming months. Additional downward revisions, albeit fairly modest, incorporated for India in 2025 and 2026, in part, reflect the ongoing influence of the weaker rupee and elevated interest rates coupled with uncertainty associated with the alliance government and high inventory levels.

Recovery Meter

Roadway Travel (Updated 12/5)

According to the U.S. Department of Transportation, seasonally-adjusted vehicle miles traveled in September increased by 0.7 percent from the same time a year ago. The cumulative travel estimate for 2024 is 2,470 billion vehicle miles.[26]

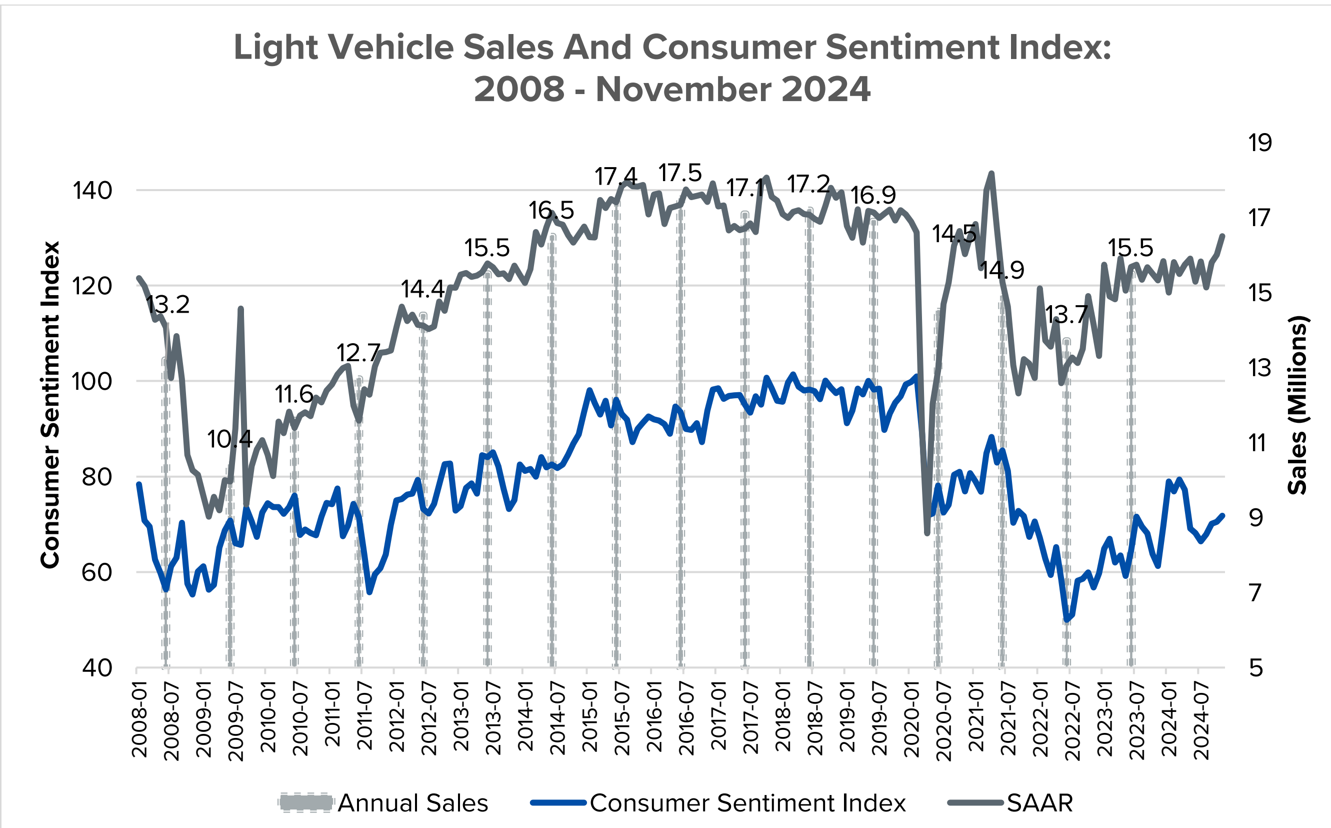
- Travel on all roads and streets changed by -0.1% (-0.2 billion vehicle miles) for September 2024 as compared with September 2023. Travel for the month is estimated to be 277.8 billion vehicle miles.
- The seasonally adjusted vehicle miles traveled for September 2024 is 274.4 billion miles, a +0.7% (1.9 billion vehicle miles) change over September 2023. It also represents a -0.2% change (-0.4 billion vehicle miles) compared with August 2024.
- Cumulative Travel for 2024 changed by +0.8% (+19.7 billion vehicle miles). The cumulative estimate for the year is 2,470.0 billion vehicle miles of travel.



Consumer Confidence and Sales (Updated 12/5)

Surveys of Consumers Director Joanne Hsu[27]: "Consumer sentiment was little changed this month, inching up 1.3 index points from October. In November, sentiment extended a four-month stretch of consecutive incremental increases. Post-election interviews were 1.3 points below the pre-election reading, moderating the improvement seen earlier in the month. Overall, the stability of national sentiment this month obscures discordant partisan patterns. In a mirror image of November 2020 (see chart), the expectations index surged for Republicans and fell for Democrats this month, a reflection of the two groups' incongruous views of how Trump's policies will influence the economy. In contrast, current conditions saw insignificant changes this month across the political spectrum, consistent with the fact that the resolution of the election exerted little immediate impact on the current state of the economy. Ultimately, substantial uncertainty remains over the future implementation of Trump's economic agenda, and consumers will continue to re-calibrate their views in the months ahead.

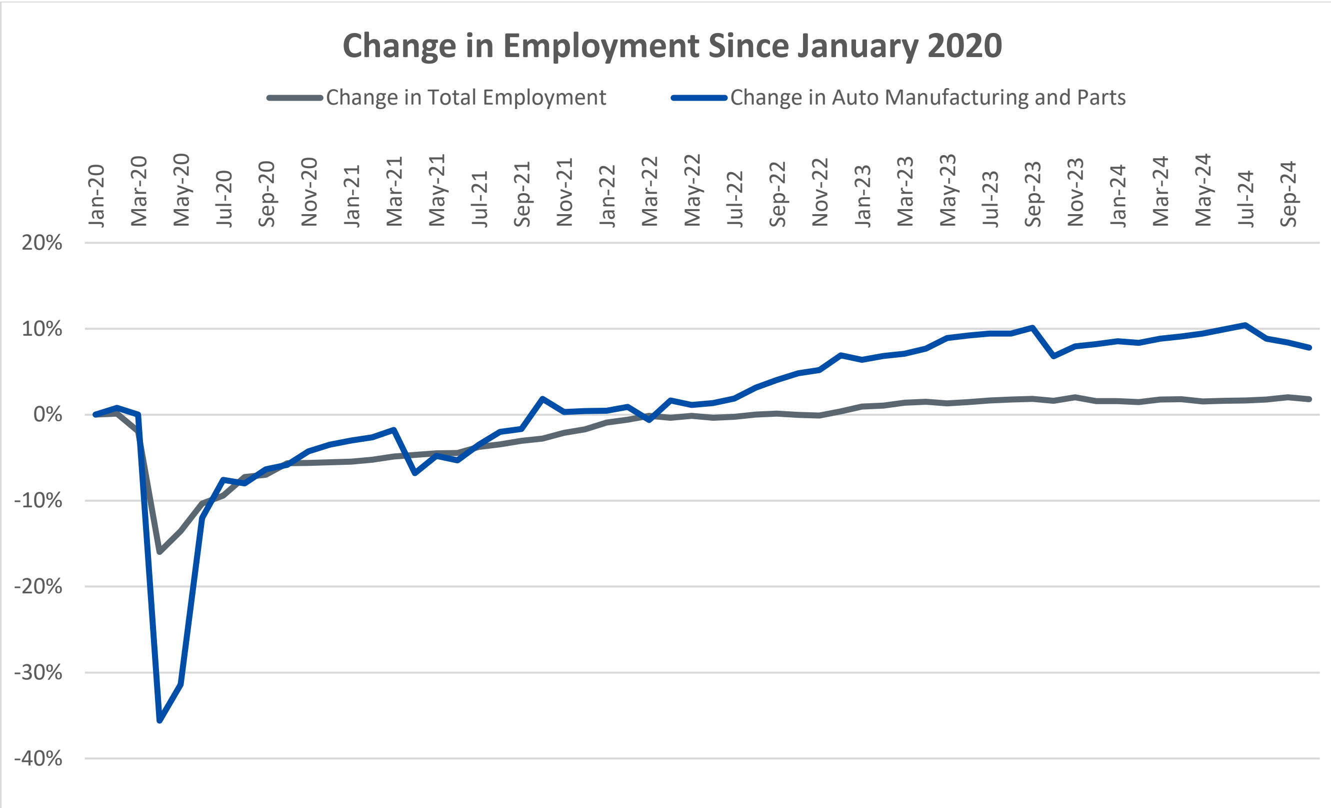
Year-ahead inflation expectations fell slightly from 2.7% last month to 2.6% this month. The current reading is the lowest since December 2020 and sits within the 2.3-3.0% range seen in the two years prior to the pandemic. Long-run inflation expectations rose from 3.0% last month to 3.2% this month; uncertainty over long-run inflation, as measured by the interquartile range of expectations, increased as well."



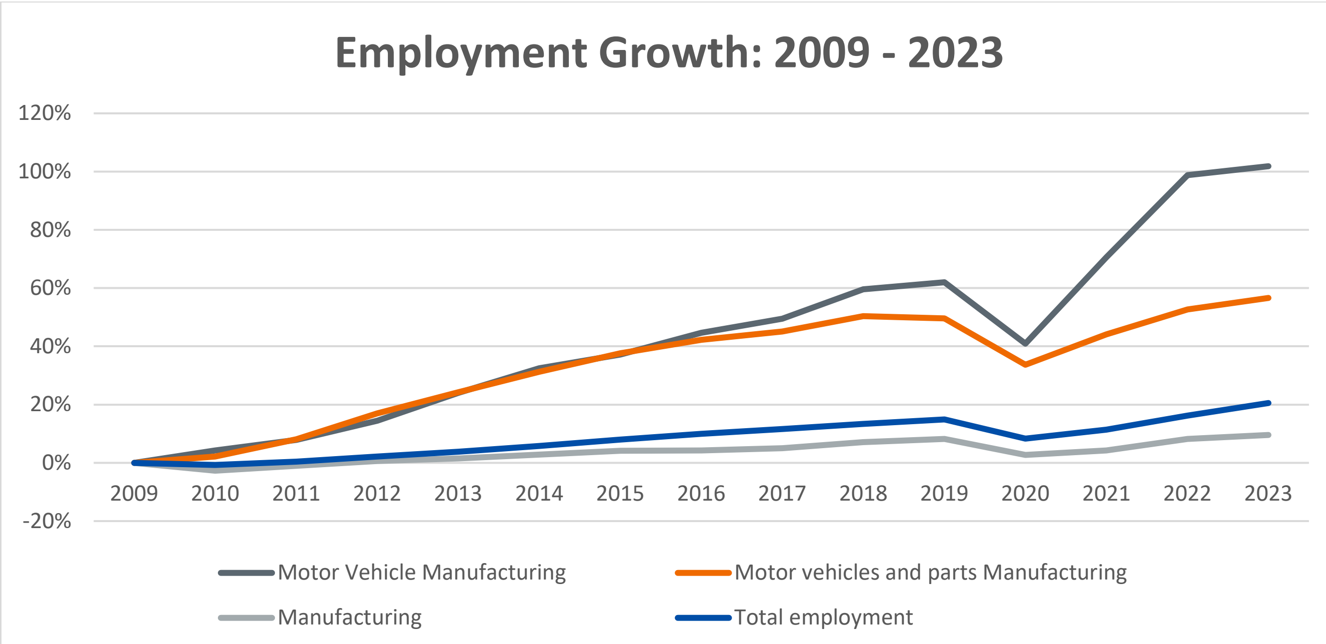
Employment (Updated 11/26)

Motor Vehicle And Parts Manufacturing Lost 6,000 Jobs in October.

After a loss of nearly 350,000 employees (about 35% of the workforce) in the height of the pandemic, employment in the Automobile Manufacturing and Parts sectors raced back but is now fighting losses due to supply chain disruptions with semiconductors.[28]



After the recession in 2009, the auto industry was credited with being on the leading edge of the recovery, which began a ripple effect through other parts of the country.[29] Additionally, the chart below shows how the recovery of jobs in motor vehicle manufacturing alone and motor vehicle and parts manufacturing far outpaced the recovery of manufacturing and total jobs.



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Last updated January, 2025

The average residential electricity rate in the U.S. is 16.94 cents per kilowatt-hour (kWh) The Janaury Choose Energy® Electricity Rates Report shows you just how much energy costs can vary, using the latest electricity prices from the U.S. Energy Information Administration (EIA) in all 50 states. Information on recent rates and fluctuations may help you understand your electricity bill or decide to change your energy plan. Do you live in

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Where you live affects your electricity rate

According to the latest data available from the EIA, the average residential U.S. electricity price is 16.94 cents per kilowatt-hour (kWh). The national average increased 2.8 percent compared with the previous year.

According to the latest data, Utah paid the lowest average residential electricity rates in the country – 11.42 cents per kWh. Hawaii paid the highest electricity rate at 41.27 cents per kWh.

Electricity rates by state

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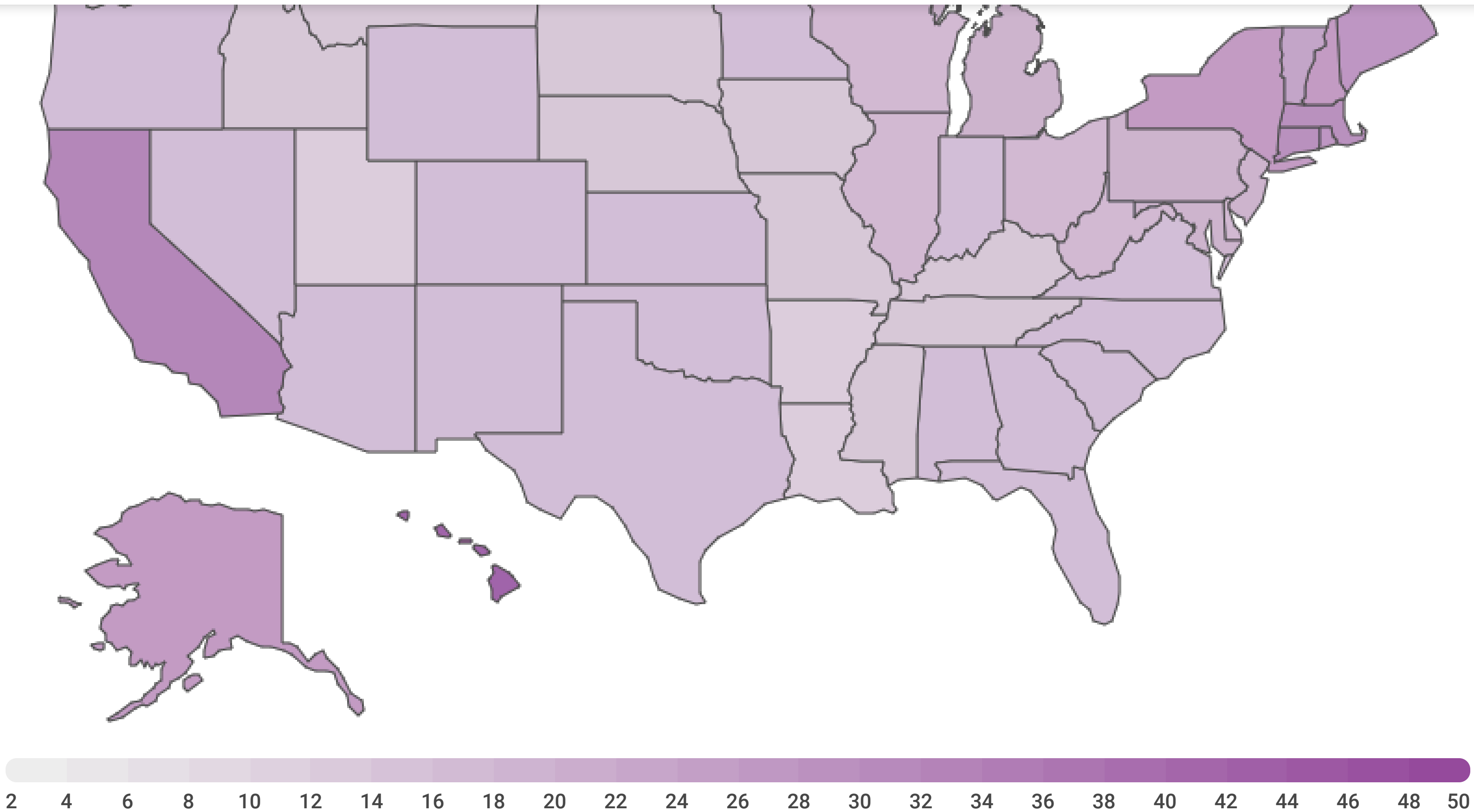

Rate: Average Electric Rate (in ₵/kWh)

Rank: 1=Lowest rate

Change: % Change (from previous month)

Share

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The average home in the U.S. consumes 855 kilowatt-hours (kWh) of electricity per month. Bills vary by state and region, as cost per kWh differs, evidenced by the monthly Choose Energy electricity rates by state report. To estimate average monthly energy bills, multiply the average home's electricity usage (855 kWh) by the cost per kWh in your state for that month.

For example, the average electricity rate in California is 30.22 cents per kWh in this month's report. The state's average residential energy usage is 491 kWh per month. This amounts to an average bill of approximately $148.38 (30.22 cents x 491 kWh) that month. **Find your state in the following table to check the latest average rate (shown in cents per kWh), its rank among other states, and the percentage change from the previous year.**

Residential electricity rates by state

State	Residential electricity rates October 2024	Residential electricity rates October 2023	Annual percentage change	National rank
Alabama	15.54 ¢/kWh	15.08 ¢/kWh	3.1	27
Alaska	25.52 ¢/kWh	24.04 ¢/kWh	6.2	44
Arizona	15.02 ¢/kWh	14.53 ¢/kWh	3.4	22
Arkansas	11.88 ¢/kWh	12.73 ¢/kWh	-6.7	3

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Connecticut	29.96 ¢/kWh	29.01 ¢/kWh	3.3	48
Delaware	17.93 ¢/kWh	17.43 ¢/kWh	2.9	36
Florida	14.2 ¢/kWh	15.45 ¢/kWh	-8.1	18
Georgia	14 ¢/kWh	13.69 ¢/kWh	2.3	15
Hawaii	41.27 ¢/kWh	42.68 ¢/kWh	-3.3	50
Idaho	12.29 ¢/kWh	12.07 ¢/kWh	1.8	6
Illinois	16.58 ¢/kWh	15.75 ¢/kWh	5.3	33
Indiana	15.81 ¢/kWh	15.17 ¢/kWh	4.2	31
Iowa	13.28 ¢/kWh	13.46 ¢/kWh	-1.3	10
Kansas	14.52 ¢/kWh	13.45 ¢/kWh	8.0	20
Kentucky	13.31 ¢/kWh	13.17 ¢/kWh	1.1	11
Louisiana	11.84 ¢/kWh	11.95 ¢/kWh	-0.9	2
Maine	26.22 ¢/kWh	29.06 ¢/kWh	-9.8	45
Maryland	19.21 ¢/kWh	18.38 ¢/kWh	4.5	38

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Minnesota	15.8 ¢/kWh	15.45 ¢/kWh	2.3	30
Mississippi	13.78 ¢/kWh	13.47 ¢/kWh	2.3	13
Missouri	12.58 ¢/kWh	12.2 ¢/kWh	3.1	8
Montana	13.35 ¢/kWh	12.93 ¢/kWh	3.2	12
Nebraska	12.13 ¢/kWh	11.67 ¢/kWh	3.9	5
Nevada	14.61 ¢/kWh	14.63 ¢/kWh	-0.1	21
New Hampshire	24.7 ¢/kWh	25.49 ¢/kWh	-3.1	42
New Jersey	19.58 ¢/kWh	17.46 ¢/kWh	12.1	40
New Mexico	14.23 ¢/kWh	14.12 ¢/kWh	0.8	19
New York	24.98 ¢/kWh	21.99 ¢/kWh	13.6	43
North Carolina	15.52 ¢/kWh	14.4 ¢/kWh	7.8	26
North Dakota	12.08 ¢/kWh	11.71 ¢/kWh	3.2	4
Ohio	16.63 ¢/kWh	15.89 ¢/kWh	4.7	34
Oklahoma	14.08 ¢/kWh	13.04 ¢/kWh	8.0	16

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Rhode Island	27.57 ¢/kWh	30.08 ¢/kWh	-8.3	46
South Carolina	15.74 ¢/kWh	14 ¢/kWh	12.4	29
South Dakota	13.86 ¢/kWh	13.05 ¢/kWh	6.2	14
Tennessee	12.92 ¢/kWh	12.49 ¢/kWh	3.4	9
Texas	15.61 ¢/kWh	14.89 ¢/kWh	4.8	28
Utah	11.42 ¢/kWh	11.23 ¢/kWh	1.7	1
Vermont	23.21 ¢/kWh	22.11 ¢/kWh	5.0	41
Virginia	15.05 ¢/kWh	14.16 ¢/kWh	6.3	23
Washington	12.5 ¢/kWh	11.33 ¢/kWh	10.3	7
West Virginia	16.38 ¢/kWh	15.05 ¢/kWh	8.8	32
Wisconsin	17.14 ¢/kWh	17.14 ¢/kWh	0.0	35
Wyoming	14.08 ¢/kWh	12.49 ¢/kWh	12.7	17
United States	16.94 ¢/kWh	16.48 ¢/kWh	2.8	

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rates

State	Residential electricity rates October 2024	Residential electricity rates October 2023	Annual percentage change
Utah	11.42 ¢/kWh	11.23 ¢/kWh	1.7
Louisiana	11.84 ¢/kWh	11.95 ¢/kWh	-0.9
Arkansas	11.88 ¢/kWh	12.73 ¢/kWh	-6.7
North Dakota	12.08 ¢/kWh	11.71 ¢/kWh	3.2
Nebraska	12.13 ¢/kWh	11.67 ¢/kWh	3.9
Idaho	12.29 ¢/kWh	12.07 ¢/kWh	1.8
Washington	12.5 ¢/kWh	11.33 ¢/kWh	10.3
Missouri	12.58 ¢/kWh	12.2 ¢/kWh	3.1
Tennessee	12.92 ¢/kWh	12.49 ¢/kWh	3.4
Iowa	13.28 ¢/kWh	13.46 ¢/kWh	-1.3

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rates

State	Residential electricity rates October 2024	Residential electricity rates October 2023	Annual percentage change
Hawaii	41.27 ¢/kWh	42.68 ¢/kWh	-3.3
California	30.22 ¢/kWh	31.78 ¢/kWh	-4.9
Connecticut	29.96 ¢/kWh	29.01 ¢/kWh	3.3
Massachusetts	29.23 ¢/kWh	28.19 ¢/kWh	3.7
Rhode Island	27.57 ¢/kWh	30.08 ¢/kWh	-8.3
Maine	26.22 ¢/kWh	29.06 ¢/kWh	-9.8
Alaska	25.52 ¢/kWh	24.04 ¢/kWh	6.2
New York	24.98 ¢/kWh	21.99 ¢/kWh	13.6
New Hampshire	24.7 ¢/kWh	25.49 ¢/kWh	-3.1
Vermont	23.21 ¢/kWh	22.11 ¢/kWh	5.0

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Commercial electricity rates through the year

In many deregulated states, the open energy market is not only for residential customers. Businesses also can take advantage of pricing and plans available through an energy supplier. The average business consumes 6,054 kWh of electricity per month and received a monthly electric bill of about $762.51 in 2023.

Business electricity rates vary greatly by industry and function. Although homes come in all shapes and sizes, businesses have larger variations with diverse needs – from industrial buildings to small businesses. For example, the latest average commercial electricity in Texas was 8.57 cents per kWh. With this number, we can deduce that, on average, companies in the state paid about 518.83 for electricity.

Explore the Choose Energy Business Energy Index for a more in-depth look at commercial and industrial electricity rates.

Business electricity rates by state

State	Commercial electricity rates October 2024	Commercial electricity rates October 2023	Annual percentage change	Commercial rank

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Arizona	12.31 ¢/kWh	11.78 ¢/kWh	4.5	33
Arkansas	10.4 ¢/kWh	10.59 ¢/kWh	-1.8	13
California	27.74 ¢/kWh	24.75 ¢/kWh	12.1	49
Colorado	11.75 ¢/kWh	11.48 ¢/kWh	2.4	27
Connecticut	23.05 ¢/kWh	19.9 ¢/kWh	15.8	48
Delaware	12.77 ¢/kWh	11.88 ¢/kWh	7.5	36
Florida	10.96 ¢/kWh	11.94 ¢/kWh	-8.2	19
Georgia	11.53 ¢/kWh	10.66 ¢/kWh	8.2	24
Hawaii	36.87 ¢/kWh	38.99 ¢/kWh	-5.4	50
Idaho	9.44 ¢/kWh	9.17 ¢/kWh	2.9	6
Illinois	12.35 ¢/kWh	11.12 ¢/kWh	11.1	34
Indiana	12.59 ¢/kWh	12.09 ¢/kWh	4.1	35
Iowa	10.11 ¢/kWh	9.69 ¢/kWh	4.3	11
Kansas	11.14 ¢/kWh	10.7 ¢/kWh	4.1	22

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Maine	18.52 ¢/kWh	17.74 ¢/kWh	4.4	41
Maryland	13.17 ¢/kWh	12.5 ¢/kWh	5.4	37
Massachusetts	20.59 ¢/kWh	19.04 ¢/kWh	8.1	46
Michigan	13.5 ¢/kWh	13.47 ¢/kWh	0.2	38
Minnesota	11.95 ¢/kWh	12.36 ¢/kWh	-3.3	28
Mississippi	12.11 ¢/kWh	12.09 ¢/kWh	0.2	32
Missouri	9.52 ¢/kWh	9.35 ¢/kWh	1.8	7
Montana	12.08 ¢/kWh	12.32 ¢/kWh	-1.9	30
Nebraska	8.35 ¢/kWh	8.57 ¢/kWh	-2.6	3
Nevada	9.64 ¢/kWh	10.55 ¢/kWh	-8.6	8
New Hampshire	19.93 ¢/kWh	19.06 ¢/kWh	4.6	44
New Jersey	14.43 ¢/kWh	13.63 ¢/kWh	5.9	40
New Mexico	10.42 ¢/kWh	10.76 ¢/kWh	-3.2	14
New York	19.1 ¢/kWh	18.84 ¢/kWh	1.4	42

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Ohio	10.94 ¢/kWh	11.06 ¢/kWh	-1.1	17
Oklahoma	9.75 ¢/kWh	9.45 ¢/kWh	3.2	9
Oregon	11.41 ¢/kWh	9.91 ¢/kWh	15.1	23
Pennsylvania	10.95 ¢/kWh	11.19 ¢/kWh	-2.1	18
Rhode Island	20.05 ¢/kWh	19.77 ¢/kWh	1.4	45
South Carolina	11.09 ¢/kWh	10.06 ¢/kWh	10.2	21
South Dakota	10.76 ¢/kWh	10.41 ¢/kWh	3.4	15
Tennessee	12.04 ¢/kWh	11.57 ¢/kWh	4.1	29
Texas	8.57 ¢/kWh	8.82 ¢/kWh	-2.8	4
Utah	8.05 ¢/kWh	8.73 ¢/kWh	-7.8	2
Vermont	19.56 ¢/kWh	18.88 ¢/kWh	3.6	43
Virginia	9.33 ¢/kWh	8.83 ¢/kWh	5.7	5
Washington	10.94 ¢/kWh	10.18 ¢/kWh	7.5	16
West Virginia	11.65 ¢/kWh	11.48 ¢/kWh	1.5	25

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United States	13.20 ¢/kWh	12.73 ¢/kWh	3.7

Due to the volatility of the energy market, energy prices fluctuate throughout the year. From October 2023 to October 2024, Oregon experienced a 14.7% increase, the largest increase in residential electricity prices in the United States. Meanwhile, Maine experienced the largest decrease, with rates dropping 9.8%.

Changes in electricity prices may seem random, but there are a few primary factors that determine how much you pay. These factors are:

- **What time you use energy:** Some energy suppliers offer plans with time-of-use discounts, such as free energy supply from 9 p.m. to 6 a.m.
- **What month you use it:** In warmer states, summer rates can be higher than winter rates due to higher energy demand for cooling.
- **Where you live:** Energy supply rates change from state to state and even among utility areas in the same state, regardless of whether the state has energy choice.

If you are unsure about any of the terms used in this analysis, check out the Choose Energy glossary to learn more.

The future of energy

Energy comes from many sources, including coal, natural gas, nuclear power, and renewables. As nonrenewable sources such as coal diminish, the need for renewable energy sources grows. Some states

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and expects to add another 5,000 megawatts of wind generation capacity from facilities under construction.

- **Solar:** California's solar farms and small-scale solar power systems generated 6,480 thousand megawatt-hours in October 2024 – the most of any state in the country.
- **Hydroelectric:** Washington hydroelectric power produces two-thirds of its net electricity. The largest hydro plant is located at the Grand Coulee Dam in the northern part of the state.

Find out which is the greenest state or learn more about green energy across the country.

Check out real-time energy rates in these locations

The following states and the District of Columbia have deregulated electricity markets, meaning customers can choose the company that provides their electricity from competitive suppliers. Click on the state below to check current electricity rates in your state.

- California
- Connecticut
- Georgia
- Illinois
- Maine

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- New Hampshire
- New Jersey
- New York
- Ohio
- Pennsylvania
- Texas
- Washington, D.C.

Need more information?

Are you a journalist or researcher writing about this topic who needs to know more about historical rates? Send us details about what you need and we'll get back to you with an answer and a relevant quote from one of our rate experts. You should also check out the Choose Energy Data Center for more statistics and analysis centering on energy in the U.S.

Topics in the Data Center include the following:

- The cost of fueling your car with gasoline vs. electricity in your state.
- The **cost of natural gas** in your state.

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- solar, wind, and nuclear energy generation by state.
- The cost of solar panels.

Popular energy reads for you

We aim to empower your energy choice with guidance from our energy experts.

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Your Guide to Choosing an Energy Supplier

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Moving to a deregulated area? Here's what to do about electricity

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Apartment dwellers: here's how to find the best energy plan

Read more →

Ready to choose your energy rate?

Enter your ZIP code to explore plans near you.

Enter ZIP code Explore

Are you moving to a new address?

Yes No

States	Cities	Providers	Utilities
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Illinois
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Arlington
Lubbock
Katy
Killeen
See All

Gexa Energy
Green Mountain Energy
Cirro Energy
First Choice Power
Frontier Utilities
Constellation Energy
4Change Energy
Discount Power
Payless Power
Pulse Power
Chariot Energy
TriEagle Energy
Express Energy
See All

TNMP
Duke Energy
PG&E
National Grid
PSEG
Commonwealth Edison
AEP Ohio
Columbia Gas
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See All

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Solar Energy Pros and Cons
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South Carolina Solar Panels

EXHIBIT S

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Stable Insights

EV Charging Pricing Trends

Explore high-quality data on national EV charging station pricing

Overview

Stable Auto has played a pivotal role in evaluating and siting over 16,000 EV charging stations throughout the United States. Through this experience, it's evident that the pricing strategies of EV charging stations significantly influences both the economic sustainability of stations and the satisfaction of EV drivers.

With the anticipated growth in EV ownership, the demand for public charging facilities is set to rise sharply, partly due to limitations of home charging solutions. To prepare for this ...wth, it's important that EV charging station owners and operators adopt strategic pricing

EXHIBIT S

In an effort to shed light on the current state of pricing within the DC fast charging (DCFC) landscape, Stable Auto conducted a comprehensive analysis of the average costs associated with EV charging across the nation, drawing on data from thousands of Level 3 (L3) charging stations under its purview.

Average DCFC charging prices by state (Q2 '24)

The average estimated $/kWh cost for Level 3 (DCFC) charged by stations tracked by Stable Auto

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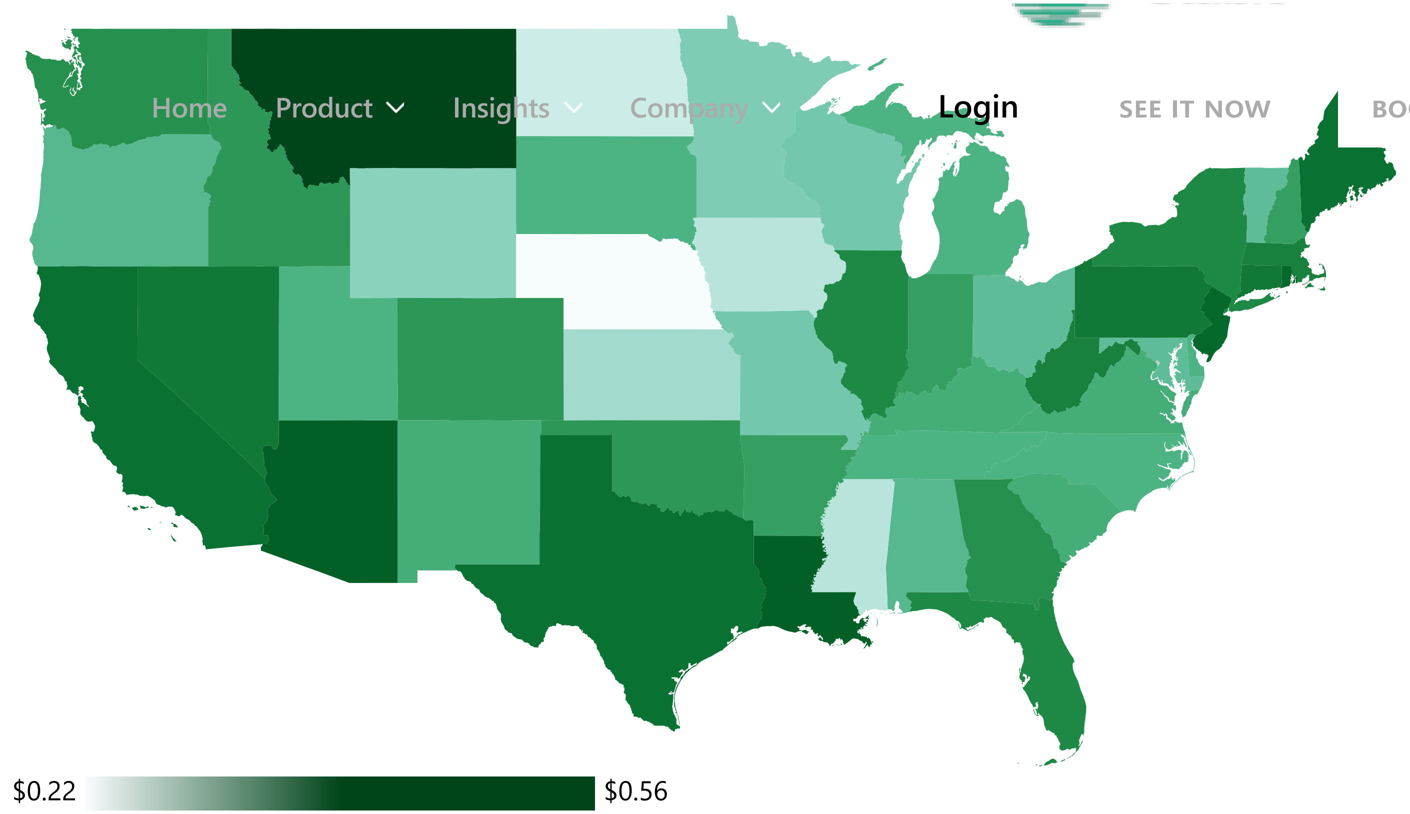

LAST UPDATED AUG 16, 2024

Highlights (Q2 '24)

- Most EV drivers charge their vehicles at home, but those using public DCFCs encounter significantly different prices depending on where they plug in.
- Comparing prices from Q1'24 to Q2'24, the average price remained relatively flat, increasing slightly from $0.45 to $0.46 per kWh.

kWh.

- However, the majority of the Midwest and several states in the South and Southeast experienced lower average charging costs.
- On a state-by-state basis, average prices increased in 36 states and decreased in 12 states, with 7 states experiencing changes greater than 10%. This trend seems driven by a catch-up phenomenon, where prices increased more in areas that started with lower rates. For example, in states where Q1'24 prices were below $0.40, prices rose by an average of 11%, compared to a 1% increase in states where the average price was above $0.40 per kWh.

Using this data

State-by-state view

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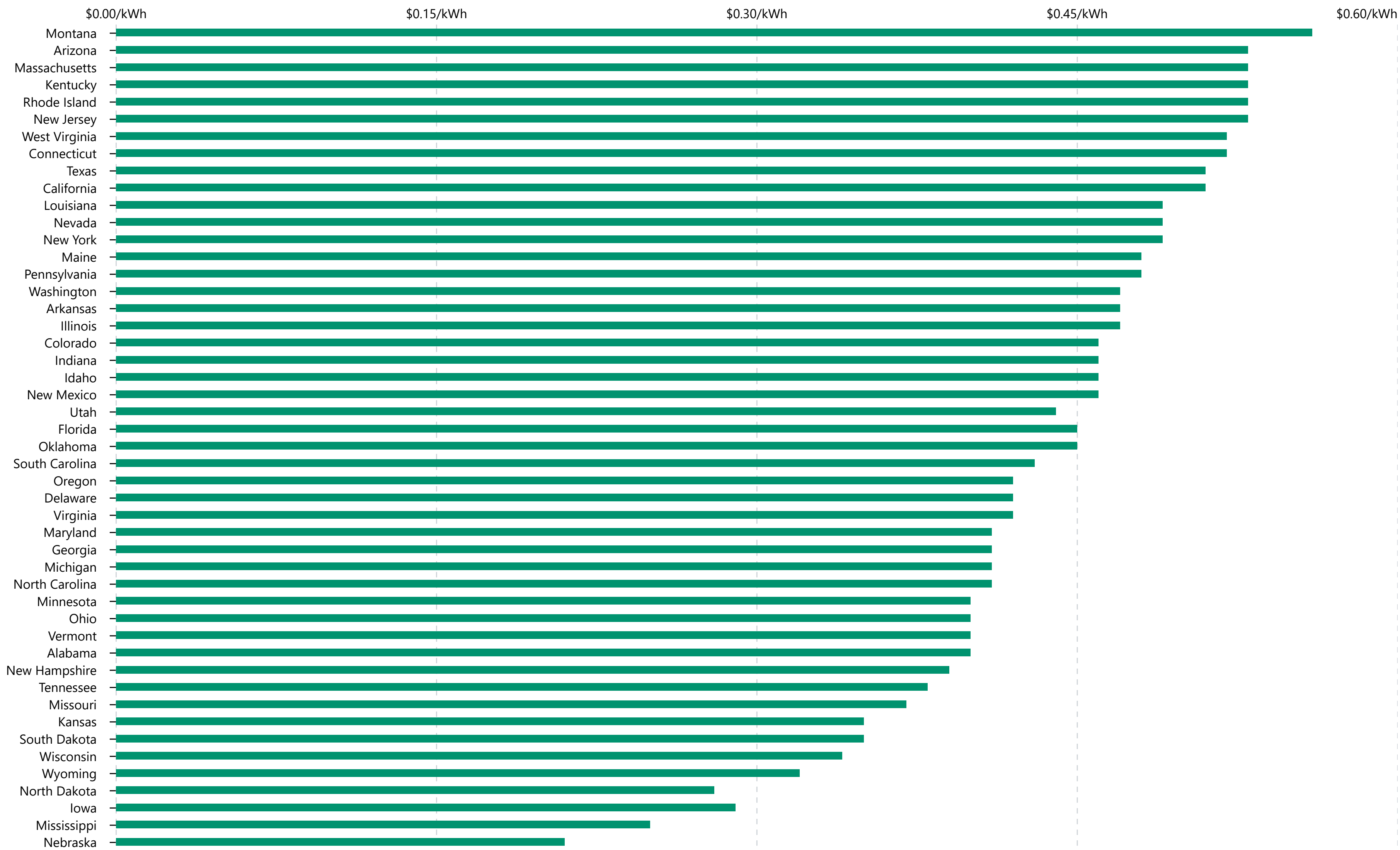

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EXHIBIT T

California Zero-Emission Vehicle Market Development Strategy

February 2021

EXHIBIT T

This document is the result of input and guidance from numerous stakeholders, built on a foundation of decades of ZEV market development experience in California. Market development, by definition, is a work in progress. So is this document and its implementation.

Ideas for improvement are always welcome.

GO-Biz ZEV Team | *zev@gobiz.ca.gov*

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AC TRANSIT
FC4
VANHOOL
AC TRANSIT

Executive Summary

Following a record-setting wildfire season exacerbated by the effects of climate change, Governor Newsom signed Executive Order N-79-20 on September 23, 2020. Executive Order N-79-20 sets ambitious statewide targets to transition California's transportation sector to zero emissions to reduce carbon, smog-forming, and toxic diesel pollution, while retaining and creating jobs and growing the economy.

Increasing and accelerating the shift to a zero-emission transportation system requires an organized, collaborative, and cross-cutting approach. Through this document, the Zero-Emission Vehicle (ZEV) Market Development Strategy, the Governor's Office of Business and Economic Development (GO-Biz) and our partners seek to accelerate large scale, affordable, and equitable ZEV market development.

The following pages purposely afford flexibility for government and stakeholders to innovate, while seeking to ensure transparency and accountability. To accomplish this, the Strategy is centered around the four market pillars: vehicles, infrastructure, end users, and workforce. The pillars must all be fully supported and are built upon a foundation of five core principles: equity in every decision, embracing all zero-emission pathways, collective problem-solving, public actions drive greater private investment, and designing for system resilience and adaptability.

The market pillars and underlying core principles inform the Strategy's roadmap for *who* is focused on *what* — the roles and responsibilities of each public and private market player. The Strategy will be updated at least every three years and each state agency will submit a brief action plan annually, starting March 1, 2021, setting the agency's priorities according to their objectives included herein. All objectives advance the market for one or more of the pillars. Additionally, working with our partners, GO-Biz will develop annual priority summaries for each pillar, along with an equity engagement and implementation strategy and cross-cutting, multi-pillar priority view. These pillar priority documents will focus on harmonizing policy and implementation to get to scale with a target of being posted by March 15th each year.

The Strategy sets the state's high-level course of action. A corresponding public ZEV Strategy website will house the above-mentioned components and track the state's progress towards meeting the Executive Order's targets, agency objectives, and pillar priorities. Progress tracking of diverse market metrics, or market-health indicators, will also facilitate ongoing collaboration and information sharing to refine our understanding of market advancement and inform our course.

A rapid transition to 100 percent zero emissions requires leadership and contributions from many — from industry and political leaders to community members and neighbors. At its core, the ZEV Strategy is a bet on collaboration and constructive competition among these leaders, and those who will come in the future. This document is an initial step on a journey to a complete market transformation; a step only made possible because of the tremendous contributions of a host of visionaries and leaders in all sectors. California continues to lead the way — together.


TRUE ZERO
H35
H70
H2

ZEV Market Development Strategy Overview

On September 23, 2020, Governor Newsom signed Executive Order N-79-20, setting the following zero-emission vehicle targets for California:

- 100% of in-state sales of new passenger cars and light-duty trucks will be zero-emission by 2035,
- 100% zero-emission medium and heavy-duty vehicles in the state by 2045 where feasible and by 2035 for drayage trucks, and
- 100% zero-emission off-road vehicles and equipment operations by 2035, where feasible.

To help meet these targets, Governor Newsom tasked the Governor's Office of Business and Economic Development (GO-Biz) to collaborate with multiple agencies and partners to shepherd the administration's ZEV Market Development Strategy (ZEV Strategy). This document is the first part of the ongoing, purposefully evolving effort to turn California's 100 percent ZEV vision into reality. The ZEV Strategy is structured to break down silos and ensure cross-cutting work throughout the California state government to achieve our ZEV goals.

If we fast forward to 2035 and 2045 and look back at what worked, we can predict one thing with certainty: success will have had many parents. We will have met the challenge with a diverse team of stakeholders from multiple sectors and priority communities[1] who came together to solve problems, create opportunities, and increase equity. And we will meet the challenge through prioritizing the following decision-making principles: equity in every decision, embracing all zero-emission pathways, collective problem solving, public actions drive greater private investment, and designing for system resilience and adaptation.

As such, the purpose behind this ZEV Strategy is to empower stakeholders to work toward generating maximum positive impact on the market. The idea is to set a strong course with the understanding and expectation that conditions are likely to change, often for the better. We firmly know where we need to go, yet we are flexible in how we get there. In a word, the California ZEV Strategy hinges on one of California's most important assets: people.

Current Circumstances

COVID-19 changed the world in 2020. As of this writing, it continues to impact lives, livelihoods, and budgets, and will continue to do so for the foreseeable future. This reality temporarily alters the tools available to build the ZEV market and may affect the pace of change, but it does not change the goal. The crisis has shown Californians how clean the air could be with less combustion and that poor local air quality can worsen the impacts of many diseases, including COVID-19.

Why do we need a ZEV Market Development Strategy?

A robust, competitive, and equitable zero-emission vehicle market is a critical and necessary answer to a series of stubborn problems, including but not limited to: greenhouse gas emissions, toxic air contaminants, and criteria pollutants from California's

1 Priority communities include neighborhoods of California that disproportionately suffer from historic environmental, health, and other social burdens. See glossary for full definition and references to relevant statutes.

more than 30 million vehicles and corresponding fossil-fuel consumption. California has made great strides in cleaning up our air, but the Los Angeles region and the San Joaquin Valley still suffer from the worst air quality in the nation. Greenhouse gas emissions are falling in California as a whole, led by our clean electricity sector, but transportation still accounts for nearly 50 percent of the total. Medium- and heavy-duty trucks are the largest source of vehicle pollution even though they comprise only 2 million of the 30 million registered vehicles in California.[2] Additionally, our past land use development patterns make passenger cars and trucks a necessity in most areas of the state. Safe, affordable, clean transportation and mobility options that reduce reliance on individual cars are not accessible for many communities.

The ZEV Market Development Strategy is meant to help California collectively move from what we know — that California's ZEV market is growing — to what we need — a ZEV market that rapidly scales to deliver the benefits of zero-emission vehicles to all Californians. Moving at the scale and speed we need requires active collaboration and contributions from all market players, both existing and new. It depends on all Californians with a focus on communities most in need, creative problem solving, business model innovation, continued and new investment, regulatory and policy coordination, and consumer support.

California's vehicle regulations, incentives, investments, and sales helped create the zero-emission vehicle market as it stands today. The next step — increasing equitable statewide deployment — requires continuing and expanding creative public-private partnerships[3] to accelerate investment and streamline implementation to expedite a fully self-sustaining, scalable ZEV market.

The ZEV Market Development Strategy focuses on the opportunities and priorities to build the infrastructure network, bring more vehicle types to market in all vehicle classes and applications, increase economic development and high-road jobs,[4] build a skilled workforce, and enable consumers and fleets to adopt ZEVs. We must additionally ensure strategies and programs are developed with consideration of unique local and regional needs and attributes. The Strategy does not create a new layer of government, but instead organizes efforts to work more effectively and efficiently to transition to a self-sustaining ZEV market.

Thankfully, success does *not* depend on technological breakthroughs (although those certainly help). We are working on a human challenge; one only limited by our collective will. This document is written to point all stakeholders in a shared direction, and from there, to unleash the creative and innovative spirit that continues to define California.

Building on California's ZEV Action Plans

The ZEV Market Development Strategy builds on the success and lessons of California's three *ZEV Action Plans* in 2013, 2016, and 2018. Relevant unfinished actions from the latter plans will be carried forward by the responsible agencies. Furthermore, agency actions will continue to build on completed tasks.

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2 *CARB Press Release: California takes bold step to reduce truck pollution*

3 Public-private partnerships include public-private funding and cost share opportunities, such as utility infrastructure programs that leverage ratepayer funding to help pay for some of the fueling infrastructure while fleet entities, such as private companies, transit agencies, school districts, and others pay for part of the infrastructure need and are required to procure eligible ZEVs in order to participate. Likewise, state, regional and local funding, financing, and other programs leverage both public and private capital to move the market forward.

4 High-road jobs are jobs created within a high-road economy, which not only centers on job quality, but also sustainability and equity. A broader term than "high-quality jobs." See glossary for expanded definitions.

The Four Pillars of ZEV Market Development

The primary goal of the ZEV Market Development Strategy is to accelerate large scale, affordable and equitable ZEV market development. **Scale** to bring down the transition cost, accelerate private capital investment, and reduce the need for direct public investment. **Equity** to ensure that communities suffering most from a combination of economic, health, and environmental burdens are actively prioritized and directly benefit from public investment through increased zero-emission mobility options, job opportunities, and cleaner air.

The Strategy should enable outcomes beneficial to California's core health, science, equity, and economic development motivations: improved air quality, reduced greenhouse gas emissions, robust access to and investment in clean transportation, reduced dependence on fossil fuels, preparation for high-road jobs and expanding workforce opportunities for priority communities, and ensuring a clean, reliable, resilient, and affordable energy system.

For purposes of this document, we organize the ZEV market into four pillars: Vehicles, Infrastructure, End Users, and Workforce. All are fundamental to building the market; the system suffers if one pillar falls behind and thrives when the pillars are balanced. These pillars are built on a foundation of core principles, which are described in the following section. The metrics, which will pull from resources presented in Appendix C, will measure our collective success in advancing each of these pillars and toward achieving California's environmental, economic, and equity goals.

Four Pillar Definitions

- **Vehicles:** New and used plug-in electric and hydrogen fuel-cell electric vehicles, including light-, medium-, and heavy-duty vehicles and equipment used for transporting people and freight, as well as for construction, mining, materials handling, industrial operations, agriculture, recreation, and other industries. This also includes zero-emission solutions like ZEV carsharing and micro-mobility options (e.g., e-bicycles, e-scooters). This pillar includes zero-emission high-speed rail, locomotives, marine vessels, and aircraft that transport passengers and freight, as well as the supply chain needed to support all vehicle types.

- **Infrastructure**: Fueling infrastructure needed to support all ZEVs, including electric vehicle charging stations, hydrogen fueling stations, catenary systems and the energy systems that supply them. Vehicle-grid integration (e.g., through battery-electric vehicles), and grid integration of fueling systems (e.g., hydrogen produced through electrolysis) are important components to cost-effectively expand renewable energy penetration, improve resilience, and drive charging and fueling value for end users and the grid. Includes the supply chain to enable infrastructure build out that offers the opportunity to fuel a ZEV at a lower cost than conventional fossil fuels.
- **End Users**: Consumers, riders, fleet operators, transportation network companies, car dealers, drivers, transportation planning agencies, program administrators, ports, regional and local governments and communities, trucking companies, fuel providers, and more.
- **Workforce**: The human workforce, including supply chains, needed to design, manufacture, sell, construct and install, service and maintain ZEVs, ZEV infrastructure, ZEV distribution systems, dealerships, energy systems, networks of charging and fueling stations, and other ZEV-related build. Workforce also includes those at third-party support companies and agencies whose work with ZEV focused institutions is critical to operating and expanding the ZEV market, such as marketing and advertising firms, roadside assistance companies, financial institutions, insurance agencies, and recyclers.

This ZEV Strategy focuses on the who, what, and how of building, maintaining, and balancing these four pillars and uses the construct to identify key market and implementation gaps. Each metric, objective, and collective problem-solving action in the ZEV Strategy maps directly back to at least one of these four pillars, the investments required to build them, and/or outcomes. Each action and decision is rooted in one or more of our core principles.

Core Principles

The following principles serve as the foundation for decision-making throughout the Strategy development and implementation effort:

1. **Equity in every decision**. The people suffering the impacts of social, economic, and environmental burdens are also those closest to the solutions. Continual, meaningful engagement and capacity building within priority communities is key to ensuring that the ZEV market provides direct and assured benefits to those most impacted by poor air quality and lack of access to clean mobility and high-road jobs. We actively look for opportunities to implement community-led ideas and share decision-making power; each decision or action should incorporate priority communities' ideas and direct feedback.
2. **California embraces all zero-emission pathways.** We are technology neutral and actively embrace and support all viable pathways to zero emissions through policymaking, funding, and other state decisions/actions. This includes but is not limited to new and used battery-electric, hydrogen fuel-cell electric, and directly connected electric systems, such as catenary bus lines, and electrified rail including high-speed rail, across all vehicle sizes and classes, and connections to zero-emission transit or other mobility options.
3. **Collective problem-solving**. Success depends on active engagement and collaboration between all levels of government, industry, non-governmental organizations (NGOs), communities, and other engaged stakeholders (e.g., end users).
4. **Public actions drive greater private investment to scale investable markets.** Public and private sector actors have unique, complementary roles to play in scaling the ZEV market. Public policies and actions should help limit market risk and ensure fair and equal access and activate market-based mechanisms; private actions drive scale and provide innovative solutions.
5. **Design for resilience and adaptation.** We are developing the ZEV system holistically, with resilience and adaptation front of mind. ZEVs enable opportunities to stabilize and support our energy system for the benefit of all, including increasing reliability, resilience, and renewable energy penetration.


DRIVE ON SUNSHINE

ZEV Strategy Framework

At the base level, the ZEV Strategy serves as a roadmap for *who* is focused on *what*, within the context of the Four Pillars of ZEV market development. The intended result is for any stakeholder, existing or new, to be able to identify their niche and plug in to the system to contribute to and benefit from ZEV market success and expansion.

To aid and simplify bi-directional communication, the ZEV Strategy is organized around two components: a) this document to set the course based on existing state policies, and b) a website to track progress and facilitate ongoing collaboration and information sharing[5].

ZEV Market Development Strategy Document

Focused on *who* and *what* (updated at least every three years, during which time we will monitor progress and change course if necessary):

1. Establish agreed-upon core principles that guide our ZEV market development quest.
2. Organize collaborative agency and stakeholder efforts around and across building the four pillars of the market: Vehicles, Infrastructure, End Users, and Workforce, with objectives rooted in our core principles (see 'Core Principles' above).
3. Set the direction for metrics targets to measure progress in each of the four pillar areas and in reaching specific goals/objectives.
4. Communicate the roles and top-level objectives of each agency and major stakeholder group in meeting the targets.

ZEV Market Development Website

How and *when* (actively managed):

5. **Outcome Metrics (quarterly updates):** Set up an accessible metrics tracking portal to measure progress relative to California's policy goals.
6. **State Agency Action Plans (annual):** Identify and align regulatory and programmatic (e.g., incentive programs) objectives and processes across agencies.
7. **Pillar Priorities (annual):** Identify topics that need focused, collective action, and set forth plans to address these core issue areas.[6]
8. **Lessons Learned (ongoing):** Ensure lessons learned are easily accessible so that successes can be repeated, and barriers can be overcome in California and throughout the nation.

The ZEV Strategy itself is written from the state government policy and implementation point of view, with a heavy focus on the fundamental roles non-state government actors play. State actions are more detailed, but the ZEV Strategy also establishes guideposts for what our broad community believes is needed from each class of active stakeholder to enable success.[7]

5 *GO-Biz: Zero-Emission Vehicle Market Development Strategy*

6 GO-Biz will introduce an annual stakeholder process to set priorities for the collective action, and ensure each task has a clearly identified lead. Year 1 will rely heavily on feedback collected during the development of this Strategy document.

7 Non-state agency objectives were established with direct and indirect input and will be updated


VOLVO

GO-Biz's Role

GO-Biz serves as the head coach and steward of the ZEV Strategy. The GO-Biz team's role is to actively build constructive connections between stakeholders, work with stakeholders to chart and correct the course of action for collective focus, coordinate state agency actions, and facilitate transparency to keep stakeholders and agencies accountable, including to one another. In short, GO-Biz's job is to put market players in position to win, for the good of the market, for the climate, and for California's air quality. It is important to note that GO-Biz is an amplifier of information, not a funnel. We expect and hope for connections and progress to happen both with and without our active involvement.

Zero-Emission Vehicles in the Broader Context

One of California's priorities is to reduce vehicle miles traveled (VMT) by locating more homes, jobs, services, and education in close proximity to each other so that people can rely less on personal cars and trucks and rely more on transit, biking, walking, and micro-mobility options like e-bikes, e-scooters and ZEV carpools.[8,9] Similarly, California's Sustainable Freight vision is to develop a modern, safe, integrated, and resilient system that continues to support California's economy, jobs, and healthy, livable communities. This includes deploying zero-emission equipment everywhere feasible.[10] The ZEV Market Development Strategy effort focuses on delivering safe, reliable zero-emission answers within the broader VMT reduction and Sustainable Freight framework.

From a macro-level climate and health perspective, California's mobility policies strive to enable the following loading order for residents:

Personal/Shared Mobility*	Freight Movement & Delivery*	Off–Road Applications*
Walk/bike	Bike, walk, drones (last mile delivery)	**Zero-emission vehicles and equipment**
Zero-emission e-bikes, e-scooters, and motorcycles	**Zero-emission vehicles and equipment**	Low emissions where ZEVs infeasible
Public transit	Low emissions where ZEVs infeasible	–
Shared ZEVs (carpooling, carsharing, and ridesharing)	–	–
Single occupant ZEVs	–	–

* The ZEV Strategy focuses on zero-emission solutions for the **bold** entries

Complementary Efforts

Vehicle Miles Traveled Reduction: The California State Transportation Agency (CalSTA) in coordination with Caltrans, the California Transportation Commission, and other partner state agencies, is leading the development of the Climate Action Plan for Transportation Infrastructure (CAPTI) to identify near term actions and investment strategies that help leverage transportation infrastructure investments to reduce our dependence on driving and improve clean and active transportation, sustainable freight, and transit options. This effort will have the practical impact of reducing vehicle miles traveled, as outlined in EO N-79-20 and N-19-19. The ZEV Strategy will not address transportation planning or programming, but rather work to ensure clean transportation and ZEV options are available and deployed within these systems.

Economics & Workforce — Just Transition

Per EO N-79-20, the Labor and Workforce Development Agency and Office of Planning and Research are working with a group of state agencies to design a Just Transition Roadmap, which is an economy-wide strategy to ensure that all Californians benefit from the transition to carbon neutrality, including communities and workers most impacted by climate change and the realignment of fossil fuel industries. The ZEV Strategy will leverage this work, and other related efforts, to ensure California is prepared to meet the needs of the ZEV market.

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8 Additionally, broader work-from-home opportunities help reduce VMT and its associated emissions and other consequences, which has become more apparent in 2020.

9 *CARB: California's 2017 Climate Change Scoping Plan*

10 *CARB: Sustainable Freight Action Plan*

Current Status — Market Snapshot

In addition to the targets in Executive Order N-79-20, California has intermediate goals including 5 million ZEVs on California roads by 2030 and 250,000 public and shared charging stations and 200 hydrogen fueling stations by 2025.[11] As of September 30, 2020, 763,816 passenger ZEVs and more than 3,000 medium- and heavy-duty ZEVs have been sold in California.[12] We have more than 67,343 shared charging stations, including 4,818 direct current (DC) Fast Chargers (as of October 30, 2020), and 44 retail hydrogen stations open to drivers (as of January 15, 2020).[13] Heavy-duty chargers and fueling stations are beginning to proliferate to enable zero-emission medium- and heavy-duty market penetration.

Battery-electric vehicle (BEV) costs continue to decline for vehicles such that market analysts predict battery vehicle cost parity with internal combustion vehicles as soon as 2023 for some sectors of the market, when electric vehicle battery packs are expected to cost $101/kWh.[14] Furthermore, fast charging speed is accelerating, helping to increase vehicle marketability and functionality.

With respect to hydrogen, many of today's stations have multiple dispensers, can dispense four to eight times more hydrogen than those initially deployed just five years ago while being built at half the cost. With supportive policies, experts project that green electrolytic hydrogen and renewable hydrogen produced with organic material feedstock can be cost competitive with gasoline by the mid-2020s.[15] With volume, fuel-cell electric vehicle (FCEV) costs are estimated to rapidly decrease, with high expectations for delivering additional value especially in larger size classes and for drivers with longer daily driving needs.[16,17] This underscores the complementary nature of BEVs and FCEVs, both of which are needed to achieve a 100 percent ZEV future.

CARB's June 2020 adoption of the Advanced Clean Trucks regulation, following the Innovative Clean Transit and Airport Shuttle regulations, will help grow the medium-, heavy-duty, and off-road markets, following years of public and private investment.

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11 *Executive Order B-48-18*

12 Passenger ZEVs: *Zero-Emission Vehicle and Infrastructure Statistics*. Medium-, heavy-duty and off-road ZEV count includes vehicles and equipment funded by the *Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)*, *Clean Off-Road Equipment Voucher Incentive Project (CORE)*, school buses and other vehicles funded by the *Clean Transportation Program*, vehicles and equipment funded by the *Zero-and-Near-Zero Emission Freight Facilities Project*, and estimates of additional vehicles and equipment deployed via *advanced technology demonstration programs* and through other funding sources (zero-emission forklift counts would likely increase this number substantially).

13 *CEC: Zero-Emission Vehicle and Infrastructure Statistics*

14 *BloombergNEF: Battery Pack Prices Cited Below $100/kWh for the First Time in 2020, While Market Average Sits at $137/kWh*

15 Reed et. al. *Roadmap for the Deployment and Buildout of Renewable Hydrogen Production Plants in California*. CEC. Publication Number: CEC-600-2020-002.

16 *Hydrogen Council. Hydrogen Scaling Up: A sustainable pathway for the global energy transition*. November 2017.

17 The International Council on Clean Transportation. *Transitioning to Zero-Emission Heavy-Duty Freight Vehicles*. September 2017.

The light-duty ZEV regulation is set to be updated as well. Through California's suite of public and private complementary regulatory, incentive, and market-enabling actions,[18] manufacturers have clear policy signals to produce ZEVs in all on- and off-road applications.[19]

All this progress has been made through the implementation of multiple critical policies and market signals, including regulations, funding and financing, and education and outreach, coupled with important market development actions and investments by public and private entities. This implementation, and ongoing policy innovation, must continue to reach our intermediate goals and the transformational targets in EO N-79-20, and to guarantee equitable participation and benefits for all Californians.[20]

18 In addition to the regulations noted, incentives funded through the California Climate Investments, Clean Transportation Program, and other sources have played a critical role in California's ZEV market transition to date. Continued public and private funding, financing, investment and other incentives will be essential to accelerating market growth and ensuring access to ZEVs and clean air for all Californians.

19 *CARB Press Release: California takes bold step to reduce truck pollution*

20 People with an income over $150,000/year account for about a third of new vehicle purchases and slightly higher amounts of new electric vehicle and plug-in hybrid purchases. (See, e.g., Clean Vehicle Rebate Project Presentation: *"Growing the Electric Vehicle Market: EV Adopters, 'Rebate Essentials,' and 'EV Converts'"*) Programs making these vehicles more affordable, whether new or used, and marketing them to more Californians are critical to continue to broaden market participation.

Measuring Success (Metrics)

The ZEV Strategy website will house a ZEV metrics portal to clearly display the various tools California has (or will develop) to track progress and diagnose issues. The goal is to provide easily understandable trends and opportunities for stakeholders to go deep into the data. It will also allow for analysis of where there are needs for further investment and focus to meet the State of California's air quality, climate, and equity goals.

The metrics will be organized around the key outcomes (Air Quality, GHGs, Access/Equity, Investment/Jobs) and four pillars (Vehicles, Infrastructure, Workforce, End Users). Each outcome and pillar have a series of targets and/or policy drivers against which progress can be measured. These details and related reports are available in Appendix C.

Table 1 offers a summary of the top-level questions that stakeholders will be able to answer using the ZEV metrics page on the ZEV Market Development Strategy website.[21] Please note that the metrics on the ZEV Strategy website will prioritize simplicity, with direction to help motivated stakeholders dig into more detail.

21 The ZEV Metrics will link to maintained state agency or partners wherever possible.

Table 1: ZEV Metrics Summary - Key Outcome Metrics — Questions to Answer

Air Quality	Greenhouse Gases	Mobility Access*	Jobs/Economic Development*
• Quantity of criteria pollution reduced from transportation sector, with a focus on priority communities	• Quantity of GHG emissions reductions and fossil fuel consumption from transportation sector	• Percent of population and commerce with access to high-quality, clean transportation and mobility options with capabilities comparable to existing equipment. Emphasize priority communities	• Quantification of in-state ZEV-related employers and jobs, with a focus on high-road job access, emphasizing priority communities • In-state ZEV related manufacturing and supply chain footprint

* Note: data collection and analysis processes will be established and refined through ZEV Strategy implementation.

Table 2: Four Pillars Metrics

Vehicles	Infrastructure	End Users	Workforce
• Progress toward CA's LD, MHD, off-road vehicle and equipment targets • New and used vehicle market penetration • Priority community access to ZEVs • Micro-mobility deployment numbers and usage	• Progress toward CA's fueling infrastructure targets for LD, MHD, off-road vehicle and equipment. • Access to charging/ fueling with a focus on priority communities. • ZEV fuel cost competitiveness • Hydrogen production capacity relative to demand • Charging system resilience	• Fleet deployments in or near priority communities • General consumer and fleet awareness and understanding of ZEVs (annual surveys) • Consumer exposure to ZEVs: ZEV carsharing and ridesharing; ride and drive • Consumer and fleet outreach, education awareness campaigns across vehicle classes and vocations (consolidation of annual reports)	• Trained workforce availability • Estimate of ZEV-related high-road jobs in California • Priority community access to high-road jobs • Training programs for electricity and hydrogen
Investment and Financing			
Public and private investment tracking — target increased and accelerated private investment.			

All of the metrics will be designed to help stakeholders quickly answer two fundamental questions: 1) is the market scaling relative to our targets? 2) are priority communities directly and equitably benefiting as the market scales? This will require speaking directly to communities and implementing a bottom-up approach to understanding if we are achieving our goals.

Roles and Responsibilities

One of California's strongest assets is a diverse group of motivated stakeholders that are already playing active roles in developing the ZEV market. Tables 3–12 — "A Tale of Four Pillars" lists stakeholders who play an active role in ZEV market development. Lead and supporting roles are distributed within each stakeholder class, usually with one or more leads per pillar to help establish which group is best positioned to impact the overall success within the pillar.[22]

Readers can view detailed objectives for each agency or stakeholder in *Appendix A* and *Appendix B*. The expectation is for staff and leadership to consider the broader context as they look for gaps in implementation, policy, or participation; ways to innovate; and to streamline and improve processes.

Our hope is that a reader can use these tables to quickly understand the role of any given stakeholder group, and how each entity fits within the context of the greater effort.

Unique Responsibilities of Each Actor

Each agency and stakeholder group has unique contributions to bring to ZEV market development. Appendices A and B establish guiding objectives developed with direct and indirect feedback from each group — with a focus on contribution to the larger ZEV market system.[23] Each objective maps back to at least one of the four pillars of market development, and/or outcomes.

California state agencies have the most detailed objectives. The objectives of non-state government actors hinge on what our leading partners are striving to deliver in the context of state goals. Many objectives necessarily overlap, given the reality that multiple parties are needed to usher in success.

Role of Government in the ZEV Transition

Within the context of developing the ZEV market, the government's role is to develop, implement, and improve policies that enable and encourage investment and market expansion, while increasing access and ensuring that direct benefits reach all communities. Policies must be developed in close collaboration with all of the stakeholder groups included in this document.

Incentives, including direct investments, revenue neutral market-based policies, tax benefits, access to low-interest loans, and a maturing used ZEV marketplace, will continue to play a pivotal role in filling market gaps and creating opportunities to increase access and accelerate the transition to ZEVs. The ZEV Strategy process aims to create a responsive system to focus incentives and related policies around equity and scale, with a goal of leveraging incentives to accelerate private investment.

22 Note: none of the lead or support designations are meant to diminish any group's contributions. Leaders are generally in a prime position to impact outcomes; supporters play crucial roles but generally have slightly less influence on the subject ZEV market development pillar. It is important to acknowledge that success hinges on the system, not any single actor.

23 The ZEV Strategy is designed to be an iterative process; feedback from stakeholder groups will be integrated in ZEV Strategy updates, as appropriate, and throughout implementation.

California Government — State Agencies

The agencies listed in this Strategy have leading and/or supporting roles in building and incentivizing the ZEV market, and we continue to benefit from strong agency leaders and innovative staff throughout state government. *Appendix A* of the Strategy presents each agency's objectives relative to scaling the ZEV market and prioritizing efforts, as well as the key related documents each agency produces, contributes to, or supports.[24] The goal is to empower agency leaders and staff to focus, streamline, and accelerate the administration's market development efforts.

California State Agencies Included in the ZEV Market Development Strategy

California Building Standards Commission (CBSC)
California Air Resources Board
State of California dca Department of Consumer Affairs
Department of Consumer Affairs BAR Bureau of Automotive Repair
CSLB Contractors State License Board
cdfa
California Department of Forestry and Fire Protection (CDF)
CalRecycle
Caltrans
State of California Energy Commission
CalEPA California Environmental Protection Agency
California High-Speed Rail Authority
IBank California Infrastructure and Economic Development Bank
Labor & Workforce Development Agency
Public Utilities Commission State of California
CalSTA
California Transportation Commission
California Workforce Development Board
Department of Finance California
DGS
Housing and Community Development California
State of California DMV Department of Motor Vehicles
Department of Toxic Substances Control
DSA Division of the State Architect Department of General Services
ETP Employment Training Panel
California Governor's Office of Business and Economic Development
Governor's Office of Planning and Research State of California
Office of the State Treasurer California
California Strategic Growth Council

24 State agency objectives are intended to be developed on three-year cycles that coincide with the ZEV Market Development Strategy updates, as outlined in Executive Order N-79-20. However, agencies may review and revise objectives in the interim, as needed, to better support the evolving ZEV market.

Key Stakeholder Groups

Numerous stakeholder groups beyond California state government agencies play key roles in advancing the ZEV market — the state cannot achieve scale alone. *Appendix B* offers an overview of these key groups and their high-level objectives. While comprehensive, it is not all inclusive; as the ZEV market continues to evolve, roles and objectives may change, and new entrants will emerge to respond to the needs of a mature market.

The level of detail provided for these groups is intentionally less than what is outlined for state agencies. The purpose of including key stakeholders in this Strategy is to illuminate the broader ZEV stakeholder landscape, highlight key areas of focus for each group, provide an entry point for those aiming to join the ZEV market development movement, and help identify gaps and areas of overlap so that we can more effectively organize our collective effort.

California ZEV Market Development Stakeholders/Partners

- **California State Agencies (listed on *page 20*)**
- **Local and Regional Government**
  - Air Districts
  - City/County Government
  - Metropolitan Planning Organizations
  - Regional Transportation Planning Agencies
- **Federal and Tribal Governments**
  - Federal Government Agencies and National Labs
  - Tribal Governments
- **Vehicle Manufacturers and Supply Chain**
  - Dealerships (and dealership groups; direct sales)
  - Light-Duty Manufacturers
  - Medium- and Heavy-Duty Manufacturers
  - New Market Entrants
  - Off-Road Vehicles and Equipment Manufacturers
  - Suppliers
- **Grid Operators, Electricity, and Hydrogen Providers**
  - Balancing Authorities
  - Community Choice Aggregators
  - Electric Utilities, Load-Serving Entities
  - Electric Vehicle Charging Station Providers and Installers
  - Gas Utilities
  - Hydrogen Producers
  - Hydrogen Station Developers and Operators
  - Registered Service Agencies
- **Fleets (public and private)**
- **Non-Governmental Organizations**
  - Codes and Standards Bodies
  - Collaboratives
  - Community-Based NGOs
  - Environmental NGOs
  - Equity NGOs
  - Trade Associations
- **Investors/Financing Institutions**
- **Organized Labor**
- **Academia**
  - Community Colleges
  - Universities
- **International Relationships**

The Process

As established in EO N-79-20, the ZEV Market Development Strategy Document will be updated at least every three years. The objectives in the ZEV Strategy (e.g., GO-Biz will lead the development and implementation of the ZEV Strategy) are likely to remain relevant for at least three years. However, the actions and tactics under each objective (e.g., GO-Biz will work with stakeholders to establish clear, agreed upon ZEV metrics that multiple stakeholders can use to diagnose market health) will change more frequently and be adjusted ian response to market conditions.

State Agency Action Plans

Every year, each state agency will submit a brief action plan to GO-Biz, setting the priorities under their ZEV Strategy objectives and communicating key equity strategies the agency is seeking to implement, advance, and/or improve. These plans are designed to be a prioritization exercise that increases transparency and accountability to the objectives detailed in *Appendix A*. GO-Biz will work closely with each agency to help foster alignment and ensure agency actions are coordinated and understood. Stakeholders and partners play a critical role in helping identify areas for improvement and potential policy conflicts.

The first draft action plans are due to GO-Biz by March 1, 2021. The actions are intended to be concise in form, and ambitious in substance. All are aimed at advancing the market in one or more of the four pillars. Agencies will report progress on their actions by January 31, 2022, marking the end of the 2021 cycle, and beginning of the new 2022 cycle.

The action plans and progress/accomplishments will be available on the publicly accessible ZEV Strategy website.[25]

Pillar Priorities

In addition to the agency specific action plans, GO-Biz will publicly post annual priority summaries for each market pillar, along with an equity engagement and implementation strategy and a cross-cutting priority view to connect the pillars together. In all cases, these Pillar Priority documents will focus on policy and implementation harmony across agencies and stakeholders. These six, concise Pillar Priority documents will communicate market development areas and outline the top-level strategies, with a focus on state policy leadership and regional and local opportunities to accelerate implementation.[26] These documents will be posted by March 15 of each year and build off a) issues identified through tracking market metrics, b) stakeholder feedback, and c) agency action plans.[27]

Lessons learned through each year's ZEV Market Development Strategy will inform subsequent policy development.

25 *Zero-Emission Vehicle Market Development Strategy*

26 Six documents: 1: Vehicle Pillar, 2: Infrastructure Pillar, 3: End Users Pillar, 4: Workforce Pillar, 5: Equity Strategy, 6: Cross Cutting Priorities

27 Note: The timing may change as we refine the process based on stakeholder feedback.


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Capturing Lessons Learned

California leaders and stakeholders have learned a tremendous amount since the advent of the ZEV program in the early 1990s. We will continue learning through active collaboration and partnerships that go beyond state and local agencies to include priority communities, project by project, study by study, policy by policy. The ZEV Strategy website aims to consolidate lessons learned in formats that are accessible to multiple stakeholders, inside and outside of California. This includes organizing and directing stakeholders to relevant project summaries, an annual summary of accomplishments and lessons learned for each market pillar with stakeholder input (including equity and cross-cutting issues), and suggestions for improvement to help other jurisdictions learn from California's experience.

Conclusion

There is nothing easy about shifting the entire transportation system from fossil to renewable energy in the timeframe required to meet or exceed California's health and science-based goals. But, with the shared targets outlined in EO N-79-20 and collaboration and contributions from multiple parties, it *is* possible, especially given the gaining momentum in the marketplace. This ZEV Market Development Strategy effort aims to move the transition from *possible* to *inevitable* by creating a framework and process for collaboration and decision-making across multiple stakeholders and partners.

Readers should consider this document and its appendices to be a foundational step in an ongoing effort to accelerate the ZEV market — an effort we all need to continually build upon and improve. There will certainly be challenges on the road to 100 percent ZEVs, but nothing that cannot be overcome by working together.

A Tale of Four Pillars: ZEV Market Development Strategy, Who's Who

Legend

Lead: The group is positioned to take primary responsibility for the given ZEV market pillar (there may be more than one lead per stakeholder class).

Support: The group makes active contributions within the ZEV market pillar in a supporting role.

ZEV Connection: High-level summary that includes statutory and/or administrative direction. Not comprehensive.

Equity Connection: Top-level equity objective for each agency or partner. Designed to be both aspirational and pragmatic.

Goal: Large Scale, Equitable Market Development
Outcomes: Air Quality, GHG Emission Reductions, Equitable Access, Investment/Jobs

Table 3: State Agencies

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Building Standards Commission (BSC)	Building standards that enable ZEV infrastructure	Continue to increase access to infrastructure for all communities through building code updates	–	Support	–	–
California Air Resources Board (CARB)	Health, climate, ZEV regulations and policies; investments and incentives that grow the market equitably; consumer awareness	Improve air quality; vehicle & mobility access for all, metrics development for equity projects	Lead	Support	Lead	Support
California Department of Consumer Affairs (CDCA), Bureau of Automotive Repair (BAR)	Auto repair training, consumer assurance	Protect consumers in used market	–	–	Support	Support
California Department of Consumer Affairs (CDCA), Contractors State License Board (CSLB)	Support and metrics that support implementation of AB 841 and other trades	Data collection and analysis for ZEV infrastructure licensing in CA regions	–	–	–	Support

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
California Department of Food and Agriculture (CDFA), Division of Measurement Standards (DMS)	Device specifications and standards for public stations (consumer and vendor protection)	Ensure fair and accurate transactions	–	Support	–	–
California Department of Forestry and Fire Protection (CAL FIRE)	Fire code adoption and support, & national standard adoption and support. Enforcement of regulations on state property	Broad ZEV infrastructure safety	Support	Support	Support	Support
California Department of Resources Recycling and Recovery (CalRecycle)	Battery & fuel cell recycling, waste to energy	Projects supporting diverse workforce	Support	Support	Support	Support
California Department of Transportation (Caltrans)	ZEV fleet and infrastructure; highway signage for ZEV fueling	Contracting to enable equitable job growth	Support	Support	Support	Support
California Energy Commission (CEC)	ZEV infrastructure investment and analysis, fuel consumption tracking, energy system resilience and forecasting, ZEV technology research and demonstration, ZEV-related manufacturing, workforce training and development	Increase access for and investments in priority communities; support ZEV adoption and access in multi-family housing; pathways to high-road jobs in priority communities; conduct ZEV-related pilot projects in equity communities	Support	Lead	Support	Support
California Environmental Protection Agency (CalEPA)	Battery recycling, waste to hydrogen, electricity	Equity component to all projects	Support	Support	–	–

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
California High-Speed Rail Authority	California's biggest passenger ZEV along with ZEV maintenance equipment and ZEV bus fleet	Progressive contracting, economic development, job training	Lead	Support	Support	Support
California Infrastructure and Economic Development Bank (IBank)	Finance support for ZEV expansion	Lending to enable women and minority owned businesses; lending parameters to ensure equitable access to high-road jobs	Support	Support	–	–
California Labor and Workforce Development Agency	Just transition to carbon-neutral economy	Support development of Just Transition Roadmap	–	–	–	Support
California Public Utilities Commission (CPUC)	Regulate IOU infrastructure investments and ZEV-related programs, rate design to encourage long-term growth, affordable electricity, grid reliability	Equitable investment in and incentives for priority communities, encourage broad employment opportunities, affordable rates for fueling	Support	Lead	Support	Support
California State Transportation Agency (CalSTA)	ZEV based transportation systems	Focus program investments on robust access	Support	Support	Support	–
California Transportation Commission (CTC)	Transportation planning, investment, funding	Plans and project applications describe benefits to priority communities; investment in priority communities	Support	Support	–	–

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
California Workforce Development Board (CWDB)	Workforce development (programs and policy)	Development of high-road training partnerships targeting mission-critical industries, occupations, and communities most in need; collaboration with other agencies to ensure program alignment	–	–	–	Lead
Department of Finance (DOF)	Public investment oversight, public investor guidance	State investments to increase access	Support	Support	Support	Support
Department of General Services (DGS)	Electric vehicle charging stations installation at state properties, ZEV first purchasing, charging accessibility, hydrogen station support.	Contracting to enable equitable growth of high-road jobs	Support	Support	Support	Support
Department of Housing and Community Development (HCD)	Building standards that require ZEV infrastructure and facilitate future charging	Pursue standards that benefit low-income housing	–	Support	–	–
Department of Motor Vehicles (DMV)	ZEV adoption data and registration processes	Ensure DMV customer processes are accessible to all, track ZEV adoption via vehicle registration	Support	–	Support	–
Department of Toxic Substances Control (DTSC)	Battery recycling	Regulations protect vulnerable populations	Support	–	–	–
Division of the State Architect (DSA)	Electric vehicle charging station accessibility regulations and installation at public K-12 schools and community colleges	Ensure access to ZEV fueling for disabled Californians through regulations that are already in effect in the California Building Code	–	Support	Support	–

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Employment Training Panel (ETP)	Job training support for companies expanding their ZEV workforce or retraining	Prioritize investments to underrepresented communities	–	–	–	Support
Governor's Office of Business and Economic Development (GO-Biz)	ZEV Strategy lead, Business support, streamlining	Target economic expansion in underserved communities — focus on minority and small owned businesses/ suppliers	Support	Support	Support	Support
Governor's Office of Planning and Research (OPR)	Just transition to carbon-neutral economy, local government connection	Lead development of Just Transition Roadmap, State, local and regional resilience	–	–	Support	Lead
State Treasurer's Office (STO)	Finance support for ZEV projects including vehicles and charging/fueling infrastructure	Lending to facilitate access to capital for small businesses including supplemental support in priority communities	Support	Support	Support	Support
Strategic Growth Council (SGC)	ZEV enabling investments in communities, community awareness and capacity building	Job development and mobility improvement in priority communities	Support	Support	Support	Support

Table 4: Local and Regional Governments

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Air Districts	Indirect Source Rules requiring ZEVs, incentives and creative market expansion programs; support ZEV Mobile Source Measures and Transportation Control Measures in updates to pollutant plans; evaluate success in reducing emissions in AB 617 Communities	Focus incentives and outreach in priority communities	Lead	Lead	Lead	–
City/County Government	Permitting, weights and measures, zoning, code development and adoption; municipal fleets; planning (e.g., Climate Action Plans and EV Readiness Plans); directional fueling/charging signage; vehicle and infrastructure incentives	Actively engage priority communities	Support	Lead	Support	Support
Metropolitan Planning Organizations (MPOs)	Regional Transportation Plans and Sustainable Communities Strategies focused on maximizing ZEV mobility and infrastructure	Design planning processes to incorporate environmental justice and directly benefit priority communities	Support	Support	Support	Support
Regional Transportation Planning Agencies (RTPAs)	Regional Transportation Plans include regional ZEV goals	Regional Transportation Plans include equity goals	Support	Support	Support	Support

Table 5: Federal and Tribal Governments

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Federal Government Agencies and National Labs	Regulations and policies, research development and deployment, project funding, and broad partnership to scale the ZEV market	Programs explicitly direct resources to priority communities	Lead	Lead	Lead	Lead
Tribal Governments	Pursue ZEV solutions to benefit residents	Collaborate with stakeholders to ensure tribal priorities and needs are addressed	Support	Lead	Lead	Lead

Table 6: Vehicle Manufacturers and Supply Chain

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Dealerships (and dealership groups; direct sales)	Key point of contact for drivers, fleets, and education/marketing	Educate customers on ZEV benefits	Lead	Support	Lead	Support
Light-Duty Manufacturers	Production, advertising, deployment, sale and maintenance of ZEVs	Scale the market for the benefit of all	Lead	Support	Lead	Support
Medium- and Heavy-Duty Manufacturers	Production, deployment, cost reduction, customer assistance, cost of ownership analysis	Scale the market for the benefit of all and concentrate deployments in priority communities	Lead	Support	Lead	Support
New Market Entrants (note: applies to all categories)	Bring new vehicles, infrastructure, software, innovation and human behavior solutions (and attendant data) - challenge the status quo	Create innovative ways to accelerate market access and benefits to priority communities	Lead	Lead	Lead	Lead
Off-Road Vehicles and Equipment Manufacturers	Zero-emission off-road vehicles, equipment, and rail technologies	Target early deployments in segments with the greatest human impact	Lead	Support	Lead	Support

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Suppliers	Produce vehicle and infrastructure components	Create jobs for priority communities	Support	Support	–	Support

Table 7: Fleets

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Fleets (public and private)	Fleet deployments in all applicable use cases	Deploy ZEV fleets in and near priority communities	Lead	Lead	Lead	Support

Table 8: Grid Operators, Electricity and Hydrogen Providers

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Balancing Authorities	Maintain grid reliability and ensure investor/operator confidence	Maintain grid reliability for all communities of California	Support	Lead	Support	Support
Community Choice Aggregators (CCAs)	Reliably provide electricity to customers and their vehicles; support infrastructure, resilience, technical assistance and customer education, ZEV/EVSE incentives (personal vehicles, public/private fleets, e-mobility), innovative pilots (including workforce training, VGI, etc.)	Prioritize light, medium and heavy-duty investments in priority communities through local data driven decision-making, targeted incentive programs, and progressive contracting to deliver maximum community benefit	Support	Lead	Lead	Support
Electric Utilities, Load-Serving Entities	Provide electricity to vehicles and electrolysis safely, reliably, affordably, and in a timely manner; support large-scale infrastructure deployment through investments and rate design, provide customer support and education, and ensure electric rates remain affordable	Fill in market gaps to support infrastructure development in priority communities, contracting to encourage minority and women owned business, equitable cost assignment	Support	Lead	Lead	Support

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Electric Vehicle Charging Station Providers and Installers	EV charging stations enable ZEV adoption at scale, EVCS technology enables grid-beneficial ZEV charging and positive end user charging experience	Hire from, invest in, and deliver charging solutions for priority communities	Support	Lead	Lead	Support
Gas Utilities	Research, test, develop, and if/ when deemed safe, leverage pipeline infrastructure to carry H2 and/or RNG to be converted to H2; develop/support interconnection requirements and tariffs for hydrogen injection into gas system	Invest in priority communities, contracting to encourage minority and women owned business	Support	Lead	Lead	Support
Hydrogen Producers	Produce low-cost carbon-free hydrogen at scale	Hire from priority communities	Support	Lead	Lead	Support
Hydrogen Station Developers and Operators	Develop and maintain reliable hydrogen fueling networks	Hire from, and enable fuel cell travel in and around priority communities	Support	Lead	Lead	Support
Registered Service Agencies	Install, repair, and maintain commercial fueling devices	Ensure safe, reliable, and accurate transactions	Support	Support	Support	Support

Table 9: Non-Governmental Organizations (NGOs)

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Codes and Standards Bodies	Develop and adopt codes, standards and protocols that ensure safety, consumer protection, and enable market scale	Achieve safety, consumer protection for all	Support	Support	Support	–
Collaboratives	Multi-stakeholder collaboration	Connect, synthesize, and apply a diverse set of views	Lead	Lead	Lead	Support
Community-based NGOs	Policy research, analysis, and implementation; ZEV education, awareness, and advocacy; sharing lessons learned; connect priority communities to ZEV benefits and address community-based and specific transportation and mobility needs; solicit resident input and provide expertise on historical community conditions to build workable solutions	Community partnership, engagement, and capacity building	Support	Support	Support	Support
Environmental NGOs		Showcase diverse perspectives; help increase program effectiveness	Support	Support	Support	Support
Equity NGOs		Bring voices and perspective to policy making, represent the underrepresented	Support	Support	Support	Support
Trade Associations	Represent collective business interest to streamline policymaking input; workforce development	Pursue employees from priority communities, bring in minority owned businesses	Support	Support	Support	Support

Table 10: Investors

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Investors/ Financing Institutions	Private capital scales the market	Create broad opportunities	Lead	Lead	Lead	Lead

Table 11: Academia

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Community Colleges	ZEV workforce pipelines and industry partnerships	Create opportunities for priority communities	Support	Support	Support	Lead
Universities	R&D, Analysis, Human capital/workforce development	Create opportunities for priority communities	Support	Support	Support	Lead

Table 12: Organized Labor

ZEV Stakeholder	ZEV Connection	Equity Connection	Vehicles	Infrastr.	End Users	Workforce
Organized Labor	Train and connect ZEV workforce	Create opportunities for priority communities to join the ZEV related workforce	Support	Support	Support	Lead


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Glossary

Battery-Electric Vehicle (BEV): A zero-emission vehicle that uses electricity stored in a battery to power one or more electric motors and can be plugged in at home, work, fleet, or public charging stations.

Core Principles: A set of five principles that provides the foundation for decision-making throughout the Strategy development process and can be adjusted over time as priorities shift and the market advances. The core principles are equity in every decision, embrace all zero-emission pathways, collective problem solving, public-private partnership, resilience and adaptation.

End Users: The pillar of ZEV Market Development that encompasses consumers, riders, fleet operators, transportation network companies, car dealers, drivers, transportation planning agencies, program administrators, ports, regional and local governments and communities, trucking companies, and fuel providers.

Equity: Actively empowering priority communities to thrive and reach their full environmental, economic, and social potential by transforming the behaviors, institutions and systems that are causing disproportionate harm. Decisions and processes that intentionally prioritize equity are inclusive across marginalized groups, increase access to a broad suite of clean transportation and mobility options and other critical resources, and maximize opportunities in priority communities.

Fuel-Cell Electric Vehicle (FCEV): A zero-emission vehicle that is powered by electricity generated by an on-board fuel cell that electrochemically combines hydrogen (from the tank) and oxygen (from the air), with only harmless water vapor created as byproduct. Hydrogen is stored on-board the vehicle as a compressed gas.

High-quality jobs: The ideal job pays a family-sustaining wage, offers comprehensive employer-provided benefits, values worker voice, and provides security, fair scheduling, a safe and healthy work environment, and pathways for career advancement. There is no single standard for a quality jobs across regions and industries. A key element of the broader term "high-road jobs."

High-road jobs: Jobs created within a high-road economy, which not only centers job quality, but also sustainability and equity. In a "high-road" economy, firms compete by capturing the value of innovation, quality, and worker skill, rather than pursuing a "low-road" race to the bottom based on low wages and environmental externalities. The result is family-supporting jobs, with better wages and benefits, opportunities for entry and advancement, and respect for worker voice. A broader term than "high-quality jobs."

Infrastructure: The pillar of ZEV Market Development that encompasses fueling infrastructure needed to support all ZEVs such as electric vehicle charging stations (EVCS), hydrogen fueling stations, catenary systems and the energy systems that supply them, vehicle-grid integration, and the supply chain that enables infrastructure build out that offers the opportunity to fuel a ZEV at a lower cost than conventional fossil fuels.

Light-Duty Vehicles: Have a gross vehicle weight rating of at most 10,000 pounds.

Medium- and heavy-duty vehicles: Have a gross vehicle weight rating above 10,000 pounds. Medium-duty vehicles are between 10,000 and 26,000 pounds while heavy-duty vehicles includes vehicles above 26,000 pounds.

Metrics: Includes quantitative and qualitative indicators of ZEV market growth and health that will be tracked over time on a publicly-accessible website to display progress towards meeting state ZEV targets, filling market gaps, and meeting other key success indicators. Metrics are separated into six sections: Outcomes, Vehicles, Infrastructure, Workforce, End Users, and Investment. Progress will be updated regularly, leveraging existing processes where feasible to facilitate ongoing collaboration and information sharing.

Micro-mobility: Light-weight transportation options optimized to move an individual a short distance. Electronic scooters and bikes, as well as traditional bicycles and scooters are the most prominent examples of micro-mobility technologies.

Objectives: A goal to be achieved or a target to be reached. Meeting ZEV objectives will help grow or scale the ZEV market.

Off-road vehicles and equipment: Vehicles and equipment designed to do work off-road.

Pillars of Market Development: Provide an illustrative and organized focus for the strategy document. There are four pillars: Vehicles; Infrastructure; End Users; Workforce. Each are fundamental to building the market. If one pillar falls behind, the market suffers; if the pillars are balanced, the market thrives.

Pillar Priorities: Concise documents provided annually by GO-Biz that summarize the progress made for each market pillar. The pillar priority documents will communicate market development areas and outline the top-level strategies, with a focus on state policy leadership and regional and local opportunities to accelerate implementation.

Priority Communities: Includes neighborhoods of California that disproportionately suffer from historic environmental, health, and other social burdens. These burdens include, but are not limited to, poverty, high unemployment, inadequate access to educational resources and training opportunities to secure high-road jobs, air and water pollution, presence of hazardous wastes, high incidence of asthma, heart disease, and other chronic illnesses. Due to historic discrimination, these communities often include high levels of residents and households with people of color, low-income status, seniors, people with disabilities, non-English speakers, and those who have limited awareness of or access to clean transportation and mobility options. This definition recognizes the need to be inclusive and deliberate in acknowledging past and current policies resulting in the accrual of these burdens and minimizing further harms as paramount in meeting the State's equity goals and fostering actions that distribute community benefits intentionally and equitably. Priority communities include disadvantaged communities (DACs), low-income communities, and underserved communities, which are specific terms used in many of the statutes and regulations in the Strategy (e.g., Senate Bill 535 (De León, 2012), Senate Bill 350 (De León, 2015), Assembly Bill 1550 (Gomez, 2016), Assembly Bill 841 (Ting, 2020)).

Stakeholder: An individual or group that has a stake or interest in any decision, activity, or enterprise of the ZEV market.

State Agency Action Plans: Brief documents that identify and align regulatory and programmatic objectives, processes, and priorities across agencies. Each plan is connected to at least one of the four pillars of market development helping provide both transparency and accountability.

Vehicles: The pillar of ZEV Market Development that encompasses light-, medium-, and heavy-duty battery-electric vehicles and hydrogen fuel-cell electric vehicles, equipment used for transporting people and freight. This also includes zero-emission solutions like ZEV carsharing, e-bicycles, e-scooters, high-speed rail, locomotives, marine vessels, and aircraft that transport passengers and freight.

Vehicle-grid integration (VGI): Any method of altering the time, charging level, or location at which grid-connected electric vehicles charge or discharge, in a manner that optimizes plug-in electric vehicle interaction with the electrical grid and provides net benefits to ratepayers by doing any of the following: increasing electrical grid asset utilization; avoiding otherwise necessary distribution infrastructure upgrades; integrating renewable energy resources; reducing the cost of electricity supply; offering reliability services consistent with Section 380 or the Independent System Operator tariff. For purposes of the Strategy, we also consider the broader grid integration of fueling systems (e.g., hydrogen produced through electrolysis).

Vehicle Miles Traveled (VMT): The miles traveled by motor vehicles over a specified length of time (e.g., daily, monthly or yearly) or over a specified road or transportation corridor.

Workforce: The pillar of ZEV Market Development that encompasses the human workforce, including supply chains, that is needed to design, manufacture, sell, construct and install, service and maintain ZEVs, ZEV infrastructure, ZEV distribution systems, dealerships, energy systems, networks of charging and fueling stations, and other ZEV-related build. Workforce also includes those at third-party support companies and agencies whose work with ZEV focused institutions.

Zero-Emission Vehicle Action Plans: Reports published in 2013, 2016, and 2018 that offered a roadmap in support of the Governor's goal of getting 1.5 million ZEVs on the road by 2025 (Executive Order B-16-2012). It laid out the state's progress to-date, challenges, high-level goals, and actions for state agencies to take that could accelerate ZEV adoption.


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Appendix A: State Agency Objectives and ZEV-Related Reports

As part of the ZEV Strategy, each agency (or groups of agencies, as indicated below) will work to deliver results under the one or more objectives established in the pages of Appendix A. To focus actions under these objectives, each agency or agency group will submit concise annual agency action plans designed to concentrate efforts on key deliverables or results. These action plans are meant to be prescriptive enough to ensure accountability, yet open enough to encourage innovation.[28] If new data or insights justify a shift in priority, agencies will adjust and share the changes.[29] Agencies are listed alphabetically. Each agency's objectives directly or indirectly relate to one or more market development pillars, as shown in the following tables.

Legend

Direct = Main target of the objective

Indirect = Ancillary benefit of the objective

Building Standards Commission (BSC)

The BSC oversees California's comprehensive building codes. For ZEVs, this means approving forward leaning building codes that significantly reduce the cost of infrastructure, opening opportunities for consumer and fleet adoption.

Equity: Continue to increase access to infrastructure for all communities through building code updates.

Building Standards

Collaborate with regulation-proposing and expert agencies (CARB, HCD, CEC, CPUC, GO-Biz) to advance building standards that prepare California for a 100% ZEV fleet.

BSC ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Building Standards: Collaborate with regulation-proposing and expert agencies (CARB, HCD, CEC, CPUC, GO-Biz) to advance building standards that prepare California for a 100% ZEV fleet.	–	Direct	Direct	–

28 Annual updates are envisioned, starting with March 1, 2021. Action plans will be housed on the ZEV market development website (GOBiz will create the website). GO-Biz envisions these plans to be 1-5 pages and will work with each agency to minimize the administrative burden, maximize the impact and transparency.

29 A note on data: State agencies will strive to align data requests to minimize administrative costs for companies working to build the ZEV market.

California Air Resources Board (CARB)

CARB serves as the foundational agency for ZEV market development. Their regulations and incentive programs, both developed with active agency and stakeholder engagement, set the market development floor. CARB is responsible for promoting and protecting public health, air quality, and reducing the impacts from climate change by reducing criteria pollutants, toxic air contaminants, and greenhouse gas emissions.

Equity: Improve air quality, particularly in communities disproportionately impacted by pollution; increase clean vehicle and mobility awareness, affordability, and access for priority communities; collect quantitative and qualitative data and develop metrics to measure progress and impact over time.

CARB ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Analysis: Maintain shared analytical understanding of the role of transportation in air quality/toxic and climate emissions.	Direct	Direct	Indirect	–
Regulation: Develop and implement regulations to require investment into production, sale and use of zero-emission vehicles/transportation and mobility, freight, and off-road equipment considering needs identified by communities most impacted by poor air quality. Propose building standards that prepare California for a 100% ZEV fleet (coordinate with BSC, HCD, CEC, CPUC, GO-Biz).	Direct	Direct	Indirect	Indirect
Incentives: Create and implement incentive systems that build awareness and market demand, facilitate market expansion — with a focus on meeting unique community transportation and mobility needs, and share lessons learned to replicate or expand creative projects and approaches where feasible. Ensure that all incentives support state's high-road workforce goals as well and encourage high-road market expansion and improved job quality for CA workers.	Direct	Indirect	Direct	Direct
ZEV Market Development: Expand new and used markets and programs, consumer education and awareness, and increase access to clean mobility. Lead H2 infrastructure analysis, support EVSE analysis (in collaboration with CEC, CPUC and GO-Biz).	Direct	Direct	Direct	Direct
Mobility and Technology Advancement: Invest in research, development, and demonstration to advance clean mobility and ZEV technology, including opening/enabling new markets.	Direct	Direct	Direct	Indirect
Information Sharing: Feed aggregated OEM and market data into agency policymaking processes.	Direct	Direct	Indirect	Direct
External Market Development: Leadership/collaboration with other states, nations, federal government, local government and community-based organizations, etc.	Direct	Direct	Direct	–
Consumer and Worker Awareness: Strengthen and expand ZEV related education and outreach, and tailor to unique needs of impacted communities, to ensure all Californians understand how to transition to cleaner mobility options.	–	–	Direct	Direct

Key CARB Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Climate Change Scoping Plan: 1) Transportation's contribution to GHG emissions, 2) ZEV penetration required to reach GHG targets.	Lead Agency, Ongoing
Mobile Source Strategy: 1) Overall strategy to decrease emissions from mobile sources, 2) major milestones that inform regulatory and incentive strategy.	Lead Agency, Ongoing
State Strategy for the State Implementation Plan: Determine the role ZEVs play in achieving the existing National Ambient Air Quality Standards (NAAQS) and how the state can speed up the timeline for NAAQS attainment.	Lead Agency, Ongoing
Funding Plan for Clean Transportation: Funding strategy - which sectors and communities need pilot project funding, rebate style funding, or subsidized financing. Equitable ZEV deployment, ZEV manufacturing, ZEV replacement, aligning vehicle purchase incentives, reduced risk of purchasing ZEV, outreach plans and strategies, community transportation needs assessments, light-duty ZEV market findings, and long-term heavy-duty investment strategy (see below).	Lead Agency, Ongoing
Heavy-Duty Investment Strategy: (appendix to Funding Plan for Clean Transportation Incentives). Strategy to move technologies through the commercialization process. Seek to provide funding assistance that supports the technology advancement partnerships needed to achieve MHD ZEV deployment targets. Collaborate with CTC.	Lead Agency, Ongoing
Carl Moyer Program Guidelines: Incentive funding opportunities for on-road and off-road equipment.	Lead Agency, Ongoing
Cap-and-Trade Auction Proceeds Investments Plan: 1) Funding priorities relative to all climate sectors, connection to relevant implementing agencies.	Lead Agency, Ongoing
Evaluation of Fuel-Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development — AB 8: 1) CARB's analysis of current status and near-term projections of FCEV deployment and station network development, 2) actions necessary to maintain progress and continued future expansion, 3) recommendations to CEC on future station development co-funding through AB 8, 4) technical recommendations.	Lead Agency, Ongoing
Community Air Protection Incentive Guidelines: ZEV role in addressing disproportionate air quality burdens on the most impacted communities.	Lead Agency, Ongoing
California's Sustainable Communities and Climate Protection Act Progress Reports — SB 150: Updated every four years; ZEV component measures progress on transportation improvements.	Lead Agency, Ongoing
Low Carbon Fuel Standard Guidance Documents: How to leverage the LCFS to generate revenue for ZEV infrastructure.	Lead Agency, Ongoing
SB 498 ZEV Report Policy recommendations for increasing ZEV use.	Lead Agency, One-Time
SB 350 Low-Income Barriers Study, Part B) Overcoming Barriers to Clean Transportation Access for Low-Income Residents (CARB, CEC, CPUC, Caltrans, others): Identify barriers for priority communities to access clean transportation options, mobility, and new and used ZEVs. Implement strategies to address these barriers.	Coauthor, Supporting Agency
Hydrogen Station Network Self-Sufficiency Analysis per Assembly Bill 8: 1) Potential scenarios by which to eliminate state support and estimated self-sufficiency date, 2) Impact of factors that drive hydrogen station economics, 3) Most effective cost reduction opportunities, 4) Benefits to the consumer through reduced price at the pump.	Coauthor, Supporting Agency

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
SB 100 (CEC, CPUC and CARB): ZEV role in meeting 100% zero carbon by 2045 requirement.	Coauthor, Supporting Agency
SB 1000 (CEC, CPUC and CARB): Ensure chargers are equitably deployed and vehicles are integrated into the grid.	Coauthor, Supporting Agency
Sustainable Freight Action Plan (CTC, CARB, CEC, CPUC, Caltrans, CalSTA, GO-Biz): Actions each agency can take to 1) achieve California's vision of a modern, safe, integrated, and resilient freight system that continues to support California's economy, jobs, and healthy, livable communities and 2) reach the Plan's targets for freight system efficiency, transitioning to zero-emission technologies, increased competitiveness and economic growth.	Coauthor, Supporting Agency
Vehicle-Grid Integration Roadmap (CEC, CAISO, CPUC, CARB): Actions state can take to advance VGI, accelerate development and deployment.	Coauthor, Supporting Agency
Electric Vehicle Charging Infrastructure Assessment — AB 2127 (CEC, CARB, CPUC): Amount/locations of chargers needed to end the need for combustion.	Coauthor, Supporting Agency
AB 74 Carbon Neutrality Studies (CalEPA, CEC, CARB, GO-Biz, OPR, CalSTA, Labor and Workforce Development Agency, Natural Resources Agency): 1) Identify strategies to significantly reduce vehicle emissions and achieve carbon neutrality. 2) Identify strategies to decrease demand and supply of fossil fuels, while managing the decline of fossil fuel use.	Coauthor, Supporting Agency
AB 8 Time and Cost to 100 Hydrogen Stations (CEC, CARB, with support from GO-Biz): Status and impact of public and private investment; station development timelines.	Coauthor, Supporting Agency
Electrify America Investment Plans: How Electrify America invests VW settlement money into California's ZEV market.	Approving Agency

California Department of Consumer Affairs, Bureau of Automotive Repair (BAR)

The BAR offers various programs and resources for consumers that can be applied to ZEVs to help consumers navigate and grow confidence in the technology.

Equity: Protect consumers in the secondhand market.

BAR ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Consumer Confidence: Establish systems that give consumers confidence that used PHEVs, BEVs, and FCEVs will serve their needs for multiple years.	Direct	–	Direct	–
Maintenance and Repairs: Automotive technicians are trained to service ZEV platforms.	–	–	–	Direct
Data: Build on existing data sharing practices to help inform collective understanding of market health and consumer response.	Indirect	–	–	Direct

California Department of Consumer Affairs, Contractors State License Board (CSLB)

The CSLB supports implementation of AB 841 and protects California consumers by licensing and regulating the state's construction industry.

Equity: Collect data and perform analysis to ensure sufficient ZEV infrastructure licensing in priority communities across the state.

CSLB ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Consumer Protection: Establish/enforce licensing procedures that ensure a well trained workforce and meet market needs.	–	–	–	Indirect
Data: Build on existing data sharing practices to help inform collective understanding of market health.	–	–	–	Indirect

California Department of Food and Agriculture, Division of Measurement Standards (DMS)

The DMS promotes accuracy in metering technology and other related fields in weights and measures for both electricity and hydrogen. They work within the national system, and often blaze the trail for other states and the nation to follow.

Equity: Ensure fair and accurate transactions.

DMS ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Consumer/Vendor Protection: Establish/enforce fuel quality and weights and measures laws and regulations that meet market needs and ensure accurate pricing and marketplace transparency.	–	Direct	–	–
Workforce Training: Put systems in place to help ensure weights and measures testing does not become a bottleneck in the system.	–	Direct	–	Indirect

California Department of Forestry and Fire Protection (CAL FIRE)

CAL FIRE streamlines and adopts fire codes relevant to ZEVs, implements training, and educates communities on fire safety.

Equity: Promote ZEV infrastructure safety across California, making sure priority communities are proactively addressed.

CAL FIRE ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Fire Codes: Adopt fire codes & standards, interpret, and streamline codes for ZEV infrastructure that reflect the latest science and technology. Assist local fire marshals on code interpretation. Enforce the regulations in state buildings.	Indirect	Indirect	–	–
Enforcement Regulations on State Property: Plan review, construction inspections and approval of projects including the High-Speed Rail.	Indirect	Indirect	–	–
Training: Identify and integrate opportunities for ZEV related fire training in existing and new courses.	Indirect	Indirect	–	–

California Department of Transportation (Caltrans)

Caltrans operates a large fleet of vehicles, manages land, and implements projects, including rail and transit, that can all push the market toward zero emissions.

Equity: Prioritize ZEV deployment and investments in priority communities while facilitating Federal and State funding sources to assist our partners in zero-emission vehicle, bus, and rail replacement, procurement, and deployment.

Caltrans ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Green Fleet: Create and promote the greenest fleet in the US.	Direct	Direct	–	–
Rights of Way: Leverage Caltrans' assets and corridor plans to open access to the ZEV market.	–	–	–	–
A: Fill gaps in DCFC and hydrogen fueling networks where feasible.	Indirect	Direct	Direct	Direct
B: Strategically open state land to public and private ZEV infrastructure development.	Indirect	Direct	Direct	Direct
C: Zero-emission lanes or other strategies to incent zero-emission freight. Make ZEVs integral to freight approaches.	Direct	Direct	Direct	Direct
D: Create opportunities for zero-emission rail.	Direct	Direct	Direct	Direct
Dig Once: Make future infrastructure installations easy.	–	–	–	–
A: Develop plan for future line pulls and pipelines.	–	Direct	–	Indirect
B: Develop plan for broadband access.	–	Direct	–	Indirect
C: Develop plan for data hubs for connected and autonomous vehicles.	–	Direct	–	Indirect
Bike/Walk Integration: Integrate biking/walking thoroughfares in road projects.	–	Direct	Direct	Indirect
Research and Development: Focus R&D on ZEV market deployment where feasible.	Direct	Direct	Direct	Indirect
ZEV Infrastructure Signage: Lead efforts to raise awareness with robust signage.	Indirect	Direct	Direct	Indirect

Key Caltrans Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Low Carbon Transit Operations Program (LCTOP) Guidelines: Assist transit providers with funding for the purchase of zero-emission buses and rail, along with the accompanying infrastructure.	Lead Agency, Ongoing
California State Rail Plan: Provide framework for California's rail network, set the stage for cleaner and better rail and community connections.	Lead Agency, Ongoing
The California Fleet Management Plan	Lead Agency, Ongoing
Sustainable Freight Action Plan (CTC, CARB, CEC, CPUC, Caltrans, CalSTA, GO-Biz): Actions each agency can take to 1) achieve California's vision of a modern, safe, integrated, and resilient freight system that continues to support California's economy, jobs, and healthy, livable communities and 2) reach the Plan's targets for freight system efficiency, transitioning to zero-emission technologies, increased competitiveness and economic growth.	Coauthor, Supporting Agency
California Transportation Plan (CTP) (Office of State Planning, Caltrans): Common framework to guide transportation decisions and investments by all levels of government and private sector. Analysis and recommendations regarding current transportation issues and future trends.	Coauthor, Supporting Agency

California Energy Commission (CEC)

The CEC sets the pace for California's multi-agency ZEV infrastructure deployment and ZEV-related manufacturing efforts. This includes efforts to expand charging and hydrogen fueling, vehicle-grid integration, and planning for resilient transportation systems powered by renewable energy. This also includes funding research, development, and deployment of next generation ZEV technologies and investments in ZEV related manufacturing.

Equity: In priority communities: increase access and investments, support ZEV adoption and access in multi-family housing, support ZEV focused pathways to high-road jobs, and conduct ZEV-related, community supported pilot projects.

CEC ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Analysis: Develop and maintain analysis on ZEV infrastructure needs and progress as well as data and shared analytical understanding of the integration of transportation into the energy system, in collaboration with CARB, CPUC, GO-Biz, and other agencies. Forecast transportation energy demand for all vehicles, including ZEVs. Maintain database of California's ZEV-related manufacturing companies.	Direct	Direct	Direct	Indirect

Objectives	Vehicles	Infrastr.	End User	Workforce
Infrastructure Development: Catalyze the development and deployment of economically and environmentally sustainable ZEV infrastructure, with focus on gaps in access for California's most impacted communities. Enable public and private sector investment in ZEV infrastructure, with focus on freight transport given disproportionate and growing pollution burden. Oversee publicly-owned utilities' electricity resource planning, including plans for transportation electrification through investments and rates.	Indirect	Direct	Indirect	Direct
Research, Development & Demonstration: Support wide range of innovative technologies to accelerate deployment of ZEV infrastructure, vehicle-grid integration, and increase benefits for all residents and markets.	Direct	Direct	Direct	Indirect
Infrastructure Resilience: Support energy storage as feasible, vehicle-grid integration, hydrogen supply, grid and fueling infrastructure reliability, workforce adequacy, on-site generation, etc.	Direct	Direct	Indirect	Indirect
Special Projects, Lithium Valley: Work with multiple stakeholders to develop and implement recommendations for lithium extraction in California, per AB 1657 (2020), as well as through other CEC efforts to facilitate a California-based lithium industry.	Direct	Indirect	Indirect	Direct

Key CEC Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Integrated Energy Policy Report (CEC, CAISO, CARB, CPUC): Analyze ZEV infrastructure needs, grid impacts, vehicle-grid integration (VGI) opportunities to reach 100% ZEVs. Forecast ZEVs and associated energy demand to inform utility planning, based on current policies.	Lead Agency, Ongoing
Clean Transportation Program Investment Plan: Determine ZEV sectors, community priorities, and market segments in need of funding for pilot projects, rebates, and subsidized financing.	Lead Agency, Ongoing
EPIC Investment Plan: Fund needed ZEV technology innovations such as smart charging, VGI, bi-directional charging, EV battery reuse and recycling, and distributed energy resources for resiliency.	Lead Agency, Ongoing
Electric Vehicle Charging Infrastructure Assessment — AB 2127 (CEC, CARB, CPUC): Amount and regional need of chargers to serve light-duty, medium-duty, and heavy-duty battery-electric and plug-in hybrid electric vehicles envisioned in California's policy goals.	Lead Agency, Ongoing
AB 8 Time and Cost to 100 Hydrogen Stations (CEC, CARB, with support from GO-Biz): Status and impact of public and private investment; station development timelines.	Lead Agency, Ongoing
Vehicle-Grid Integration Roadmap (CEC, CAISO, CPUC, CARB): Actions state can take to advance VGI, accelerate development and deployment.	Lead Agency, Ongoing
SB 1000 (CEC, CPUC and CARB): Ensure chargers are equitably deployed.	Lead Agency, Ongoing
Lithium Valley Commission Report: Recommendations for developing and expanding in-state lithium production, per AB 1657 (2020). Due on or before October 22, 2022.	Lead Agency, One-Time

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
SB 100 (CEC, CPUC and CARB): ZEV role in meeting 100% zero carbon by 2045 requirement.	Coauthor, Supporting Agency
Sustainable Freight Action Plan (CTC, CARB, CEC, CPUC, Caltrans, CalSTA, GO-Biz): Actions each agency can take to 1) achieve California's vision of a modern, safe, integrated, and resilient freight system that continues to support California's economy, jobs, and healthy, livable communities and 2) reach the Plan's targets for freight system efficiency, transitioning to zero-emission technologies, increased competitiveness and economic growth.	Coauthor, Supporting Agency
SB 350 Low-Income Barriers Study, Part B: Overcoming Barriers to Clean Transportation Access for Low-Income Residents (CARB, CEC, CPUC, CalTrans, others): Identify barriers for low-income and priority communities and low-income households to access clean transportation options, enhanced mobility, and new and used ZEVs. Implement strategies to address these barriers.	Coauthor, Supporting Agency
AB 74/Carbon Neutrality Studies (CalEPA, CEC, CARB, GO-Biz, OPR, CalSTA, Labor and Workforce Development Agency, Natural Resources Agency): 1) Identify strategies to significantly reduce vehicle emissions and achieve carbon neutrality. 2) Identify strategies to decrease demand and supply of fossil fuels, while managing the decline of fossil fuel use.	Coauthor, Supporting Agency
VGI Working Group Report (CPUC, CEC, CARB, CAISO): Determine and enable opportunities to realize VGI benefits, responsibly accelerate ZEV market and achieve grid reliability and resiliency.	Coauthor, Supporting Agency
Integrated Resource Plan (POUs): Ensure that electricity sector contributes to California's economy-wide ZEV and GHG emissions reductions goals.	Receiving Agency
Evaluation of Fuel-Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development — AB 8: 1) CARB's analysis of current status and near-term projections of FCEV deployment and station network development, 2) actions necessary to maintain progress and continued future expansion, 3) recommendations to CEC on future station development co-funding through AB 8, 4) technical recommendations.	Receiving Agency

California Environmental Protection Agency (CalEPA)

CalEPA oversees a variety of agencies, including CARB, that work to restore, protect and enhance California's environment. This table focuses on non-CARB related work.

Equity: Leverage analysis tools and outreach to strategically focus agency actions on high-impact projects and policies.

CalEPA ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Battery Recycling Coordination: Convene the Lithium-ion Car Battery Recycling Advisory Group in collaboration with CalRecycle and the Department of Toxic Substances Control (DTSC).	Direct	–	Direct	Direct
Disadvantaged Communities Identification: Determine the state's disadvantaged communities using the California Communities Environmental Health Screening Tool (CalEnviroScreen).	Indirect	Indirect	Indirect	Indirect

Objectives	Vehicles	Infrastr.	End User	Workforce
California Department of Resources Recycling and Recovery (CalRecycle)	–	–	–	–
A: Recycling: Promote and set up systems for battery and fuel cell reuse and recycling.	–	–	Direct	Direct
B: Second Life of Batteries: Classification, transportation, disposal of used batteries.	–	Direct	–	Direct
C: Biomass and Organics to Hydrogen or Electricity: Develop systems to promote and enable the connection of waste resources to California's energy system, including in alignment with States Low Carbon Fuel Standard regulation.	–	Direct	–	–
Department of Toxic Substances Control (DTSC)	–	–	–	–
A: Second Life of Batteries: Classification, transportation, disposal of used batteries. Second Life of Batteries. Classification, transportation, disposal of used batteries.	Indirect	–	–	Indirect

Key CalEPA Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
AB 74/Carbon Neutrality Studies (CalEPA, CEC, CARB, GO-Biz, OPR, CalSTA, Labor and Workforce Development Agency, Natural Resources Agency): 1) Identify strategies to significantly reduce vehicle emissions and achieve carbon neutrality. 2) Identify strategies to decrease demand and supply of fossil fuels, while managing the decline of fossil fuel use.	Lead Agency, Ongoing
Lithium-ion Car Battery Recycling Advisory Group Recommendations (CalEPA, DTSC, CalRecycle): Determine policies for the recovery, repurposing, and recycling of lithium-ion vehicle batteries sold with motor vehicles of in all classes.	Lead Agency, Ongoing

California High-Speed Rail Authority (HSR)

High-Speed Rail will become the state's largest zero-emission vehicle, with feeder bus service provided by ZEVs, ZEV on-rail and on-road maintenance fleets, and its stations will serve as ZEV mobility hubs.

Equity: Develop contracts, economic development plans, and job training programs in a manner that benefits priority communities and leads to more, new high-road jobs.

HSR ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
ZEV Mobility Hubs: Integrate multi-modal ZEV transitions at stations.	Direct	Direct	Direct	Direct
System Resilience: Establish world-class resilience for California's rail system.	Direct	Direct	Direct	Indirect
ZEV Fleet: Link the rail journey with ZEV bus fleets, incentivize ZEV on-rail maintenance fleets and work with partners to develop a workforce that can operate and maintain the system and fleet.	Direct	Direct	Indirect	Direct

Objectives	Vehicles	Infrastr.	End User	Workforce
ZEV Contract Requirements: Reinforce regulation and policy by requiring ZEV across multiple classes for construction and operation.	Indirect	Indirect	Indirect	Indirect

Key HSR Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
High Speed Rail Business Plan (every other year): The plan for the project's implementation, including type of service, proposed construction timeline, alternative financial scenarios for different levels of service, forecasts of ridership and costs, and risks and mitigation measures.	Lead Agency, Ongoing
High-Speed Rail Sustainability Report (every year): The progress the Authority is making in fulfilling environmental, economic, and cultural sustainability commitments, including its work on stations as multimodal hubs, charging infrastructure work, and renewable energy planning.	Lead Agency, Ongoing

California Infrastructure and Economic Development Bank (IBank)

IBank has broad authority to enable financing of ZEV related projects.

Equity: Lend to enable growth and expansion of women and minority owned businesses and ensure equitable access to high-road jobs across the state.

IBank ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
ZEV Project Finance: Increase financing opportunities for ZEV projects and bring more private capital into the market.	Indirect	Indirect	Indirect	Indirect

Key IBank Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Climate Catalyst Fund (in development): Issue loans and other financial products to the full range of potential borrowers — private, nonprofit, tribal and public actors, creating a truly full-service "green bank" functionality for the state.	Lead Agency, Ongoing
Infrastructure State Revolving Fund (ISRF): Provides low-cost public financing to state and local government entities, including Municipalities, Universities, Schools and Hospitals (MUSH borrowers) and to nonprofit organizations sponsored by public agencies for a wide variety of public infrastructure and economic expansion projects.	Lead Agency, Ongoing
California Lending for Environmental Needs (CLEEN) Program: Offers financing for a broad range of technologies and projects, including ZEVs and infrastructure.	Lead Agency, Ongoing

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Conduit Bonds **A: Industrial Development Bonds (IDBs):** Tax-exempt financing for qualified manufacturing and processing companies, including those involved in ZEVs. **B: 501(c)3 Bonds:** Tax-exempt financing to eligible nonprofit public benefit corporations for the acquisition and/or improvement of facilities and capital assets. **C: Exempt Facility Bonds (EFBs):** Tax-exempt financing for projects that are government-owned or consist of private improvements within publicly-owned facilities. **D: Public Agency Revenue Bonds (PARBs):** Bond financings for various state entities' economic or public development projects and programs.	Lead Agency, Ongoing
Small Business Finance Center — Loan Guarantee Programs: Features a loan guarantee program designed to assist small businesses that experience capital access barriers. **A: Climate Tech Finance Program:** Provides focused capital support for innovative projects in the climate solutions sector.	Lead Agency, Ongoing

California Labor & Workforce Development Agency (LWDA)

The LWDA leads California's efforts to protect and improve our current and future workforce. They play a pivotal role in ensuring our labor pool is prepared to meet the demands of a rapidly expanding ZEV market.

Equity: Collaborate with OPR to develop and implement the "Just Transition Roadmap".

LWDA ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Just Transition: As specified in EO N-79-20, work with the Office of Planning and Research to establish a Just Transition Roadmap for workers and communities impacted by the transition to carbon-neutrality.	–	–	–	Direct

California Public Utilities Commission (CPUC)

The CPUC oversees investor owned utility investments in ZEV infrastructure and the development and affordability of rates, rebates, and other ZEV customer-facing programs with a focus on accelerating the ZEV market and maximizing ratepayer benefits.

Equity: Investment in and incentives for priority communities, encourage broad employment opportunities, pursue affordable rates for fueling, minimize and equitably distribute costs for ZEV infrastructure.

CPUC ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Utility Investment: Enable widespread, safe ZEV adoption via utility investments on infrastructure, with a focus on investing in priority communities. Includes implementation of AB 841(2020) to develop and implement new rules or tariffs to support charging infrastructure.	–	Direct	Direct	Indirect
Electricity Rates that are aligned with the CPUC principles of rate design, promote VGI and electrolytic hydrogen fuel production at times that are beneficial for the electric grid over the long term, while also protecting ratepayers and ensuring rates remain affordable.	Direct	Direct	Direct	Indirect
Private Investment: Enable and encourage aggressive private investment in ZEV infrastructure, such as through existing programs that require site host cost-sharing and procurement of vehicles as precursor to participation and working with utilities to accelerate the interconnection process.	Indirect	Direct	Direct	Indirect
Vehicle-Grid Integration: Promote cost-effective VGI to minimize impacts and maximize benefits of ZEV deployment on the electric grid, improve resilience and enable ZEV market opportunities.	Direct	Direct	Direct	Indirect
Hydrogen in Pipelines: Work with gas utilities to understand both the potential and constraints to integrating hydrogen into existing or new pipeline networks; develop implementation strategies as appropriate.	–	Direct	Direct	Indirect
Education and outreach around ratepayer funded ZEV programs, electric rates, charging behavior and fueling from the grid.	Indirect	Direct	Direct	Indirect

Key CPUC Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Transportation Electrification Framework: Define role, guidelines, and requirements of IOUs for reaching the state's transportation electrification goals.	Lead Agency, Ongoing
VGI Working Group Report (CPUC, CEC, CARB, CAISO): Determine and enable opportunities to realize VGI benefits, responsibly accelerate ZEV market and achieve grid reliability and resiliency.	Lead Agency, Ongoing
SB 100 (CEC, CPUC and CARB): ZEV role in meeting 100% zero carbon by 2045 requirement.	Coauthor, Supporting Agency
SB 1000 (CEC, CPUC and CARB): Ensure chargers are equitably deployed and vehicles are integrated into the grid.	Coauthor, Supporting Agency
Sustainable Freight Action Plan (CTC, CARB, CEC, CPUC, Caltrans, CalSTA, GO-Biz): Actions each agency can take to 1) achieve California's vision of a modern, safe, integrated, and resilient freight system that continues to support California's economy, jobs, and healthy, livable communities and 2) reach the Plan's targets for freight system efficiency, transitioning to zero-emission technologies, increased competitiveness and economic growth.	Coauthor, Supporting Agency

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Low-Income Barriers Study, Part B (CARB, CEC, CPUC): Identify barriers for lower income communities to access enhanced mobility and ZEV market. Determine and implement strategies to address these barriers.	Coauthor, Supporting Agency
Electric Vehicle Charging Infrastructure Assessment - AB 2127 (CEC, CARB, CPUC): Amount/locations of chargers needed to serve the populations of battery-electric and plug-in hybrid electric vehicles envisioned in California's policy goals.	Coauthor, Supporting Agency
Vehicle-Grid Integration Roadmap (CEC, CAISO, CPUC, CARB): Actions state can take to advance VGI, accelerate development and deployment.	Coauthor, Supporting Agency
Integrated Resource Plans (IOUs): Ensure that electricity sector contributes to California's economy-wide ZEV adoption and GHG emissions reductions goals.	Receiving Agency

California State Transportation Agency (CalSTA)

CalSTA oversees California's transportation departments and can steer programs to emit zero emissions, where applicable.

Equity: Focus program investments on robust clean mobility access.

CalSTA ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Planning: Ensure state transportation planning prioritizes zero-emission mobility and freight movement, sustainable transportation, and mobility access. Focus on communities most in need.	Direct	Direct	Direct	Direct
Funding: Increase funding opportunities in ZEV fueling and charging infrastructure and ZEV fleet implementation funding programs.	Direct	Direct	Indirect	–
Equity and Sustainability: Make transportation systems more inclusive and sustainable (active transportation, integrated travel project, complete streets, VMT reduction).	–	Direct	Direct	Direct

Key CalSTA Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
California Transportation Plan: 1) CalSTA and state's transportation agencies view of VMT and ZEV's as compatible and complementary, 2) How California can build a more efficient and more environmentally friendly transportation system through VMT and GHG reductions.	Lead Agency, Ongoing
Transit and Intercity Rail Capital Program: 1) Funding assistance for transit providers for the purchase of zero-emission buses and rail, along with the accompanying infrastructure 2) the role ZEBus and ZETrain play in the larger transit picture, 3) Methodologies to determine the funding for these technologies.	Lead Agency, Ongoing
Climate Action Plan for Transportation Infrastructure: How to leverage state funding programs where the State of California plays a role in scoping, recommending or selecting specific projects to further the implementation of the transportation vision.	Lead Agency, One-Time

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
AB 74/Carbon Neutrality Studies (CalEPA, CEC, CARB, GO-Biz, OPR, CalSTA, Labor and Workforce Development Agency, Natural Resources Agency): 1) Identify strategies to significantly reduce vehicle emissions and achieve carbon neutrality. 2) Identify strategies to decrease demand and supply of fossil fuels, while managing the decline of fossil fuel use.	Coauthor, Supporting Agency
Sustainable Freight Action Plan (CTC, CARB, CEC, CPUC, Caltrans, CalSTA, GO-Biz): Actions each agency can take to 1) achieve California's vision of a modern, safe, integrated, and resilient freight system that continues to support California's economy, jobs, and healthy, livable communities and 2) reach the Plan's targets for freight system efficiency, transitioning to zero-emission technologies, increased competitiveness and economic growth.	Coauthor, Supporting Agency

California Transportation Commission (CTC)

The CTC oversees funding programs with some opportunities to fund ZEV related projects.

Equity: Craft project applications that describe and highlight potential benefits of investing in priority communities.

CTC ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Align Funding: Prioritize ZEV investments, and align funding with sister agencies, where feasible.	Direct	Direct	Direct	–
Road Funding: Develop equitable strategies to ensure roads continue to be maintained as revenue generated from gasoline and diesel declines.	–	Direct	Direct	–
Regional Level Transportation Planning: Collaborate with regional transportation planning agencies to incorporate zero-emission infrastructure into transportation planning where feasible.	Indirect	Direct	Direct	Indirect

Key CTC Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Active Transportation Program (ATP) Guidelines: Funds expansion of non-motorized infrastructure to increase walking and bicycling, such as walkways, bike lanes, and bike-share.	Lead Agency, Ongoing
Regional Transportation Planning Guidelines: Guides regional planning for Metropolitan Planning Organizations and Regional Transportation Planning Agencies, with opportunities to guide analysis and prioritization of ZEV related projects.	Lead Agency, Ongoing
Local Partnership Program (LPP) Guidelines: Funds road maintenance, other transportation infrastructure improvements, and transit vehicle acquisition.	Lead Agency, Ongoing
Trade Corridor Enhancement Program (TCEP) Guidelines: Funds infrastructure improvements on trade corridors, including limited freight rail and port investments.	Lead Agency, Ongoing
Solutions for Congested Corridors Program (SCCP) Guidelines: Funds multi-modal improvements along the state's most congested corridors.	Lead Agency, Ongoing

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Local Streets and Roads Program (LSRP) Guidelines: Sets rules for formulaic investment in local roadway maintenance — tangential opportunities to support ZEVs.	Lead Agency, Ongoing
California Transportation Plan (CTP) Guidelines: Provides guidance for the development of the CTP, which describes goals and objectives for the State's transportation system.	Lead Agency, Ongoing
Multimodal Corridor Planning Guidelines: Provides guidance for eligible programs that can receive funding through the Congested Corridors Program.	Lead Agency, Ongoing Coauthor, Supporting Agency
Sustainable Freight Action Plan (CTC, CARB, CEC, CPUC, Caltrans, CalSTA, GO-Biz): Actions each agency can take to 1) achieve California's vision of a modern, safe, integrated, and resilient freight system that continues to support California's economy, jobs, and healthy, livable communities and 2) reach the Plan's targets for freight system efficiency, transitioning to zero-emission technologies, increased competitiveness and economic growth.	Coauthor, Supporting Agency
State Highway Operation and Protection Program Guidelines (SHOPP): Funds capital improvements relative to the maintenance, safety, operation, and rehabilitation of the state highway system.	Coauthor, Supporting Agency
State Transportation Improvement Program (STIP): Funds state highway improvements, intercity rail, and regional highway and transit improvements.	Coauthor, Supporting Agency

California Workforce Development Board (CWDB):

CWDB is uniquely positioned to facilitate relevant high-road job training and transition partnerships, with a focus on quality jobs and broader access to them, as well as related policy development and implementation.

Equity: Continue to focus programmatic and policy work directly on building economic opportunity and mobility for those who have been marginalized, disadvantaged, and/or denied opportunity.

CWDB ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Program Development and Administration: Invest in high-road workforce development projects in both private and public sectors that support State of California ZEV mandates and goals, including vehicle deployment, charging/refueling infrastructure installation, and vehicle operations and maintenance.	Indirect	Indirect	Indirect	Direct
Policy and Program Alignment: Provide state and local agencies with guidance to address job quality and job access in ZEV-related investments, and develop shared understanding of California's labor and workforce development systems as they relate to high-road ZEV market development (present and future).	Indirect	Indirect	Indirect	Direct
Local Guidance: Provide guidance to local workforce boards to support State of California ZEV mandates and goals. (Note: focus on areas with existing industry clusters — i.e., LA Basin and Bay Area).	Indirect	Indirect	Indirect	Direct

Key CWDB Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
AB 398 (2017) Climate and Labor Report: Establish vision for ensuring major climate policies and programs support high-road jobs with accessible training pathways, particularly for disadvantaged Californians.	Lead Agency, Ongoing
High Road Training Partnership (HRTP): Invest in and assist local industry-based partnerships of high-road employers, workers and their representatives, and other entities that deliver economic equity, job quality, and sustainability for the ZEV market.	Lead Agency, Ongoing
High Road Construction Careers (HRCC): Invest in and assist local partnerships that link local building and construction trades councils to workforce boards, community colleges, and community-based organizations, creating structured pathways to state-certified apprenticeships relevant to the ZEV market.	Lead Agency, Ongoing
AB 74/Carbon Neutrality Studies (CalEPA, CEC, CARB, GO-Biz, OPR, CalSTA, Labor and Workforce Development Agency, Natural Resources Agency): 1) Identify strategies to significantly reduce vehicle emissions and achieve carbon neutrality. 2) Identify strategies to decrease demand and supply of fossil fuels, while managing the decline of fossil fuel use.	Coauthor, Supporting Agency
Sustainable Freight Action Plan (CTC, CARB, CEC, CPUC, Caltrans, CalSTA, GO-Biz): Actions each agency can take to 1) achieve California's vision of a modern, safe, integrated, and resilient freight system that continues to support California's economy, jobs, and healthy, livable communities and 2) reach the Plan's targets for freight system efficiency, transitioning to zero-emission technologies, increased competitiveness and economic growth.	Coauthor, Supporting Agency

Department of Finance (DOF)

DOF plays a pivotal role in budget development, which has a direct impact on ZEV related programs.

Equity: Promote long-term economic sustainability of all communities while recognizing the particular needs of priority communities.

DOF ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Public Investment: Steward budget process to support ZEV market development.	Indirect	Indirect	Indirect	Indirect

Key DOF Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
California Climate Investment Framework: Strategy for the state's pension funds, with recommendations for making climate conscious decisions.	Lead Agency, Ongoing

Department of General Services (DGS)

DGS leads state agency procurement and ZEV adoption and integration into the State of California fleets, and enables municipal fleet adoption through contracting.

Equity: Leverage contracting to expand the ZEV market and enable equitable growth of high-road jobs.

DGS ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Procurement Policies: Implement vehicle and infrastructure procurement policies to exceed the timelines outlined in EO N-79-20.	Direct	–	Direct	–
Petroleum Reduction: Pursue strategies to reduce the state fleet's petroleum consumption by 50% (from 2015 levels) by 2030.	Direct	Direct	Direct	–
ZEV Procurement and Distribution: Enable non-state public entities to leverage state contracts to purchase ZEVs and supporting equipment and develop policies to encourage ZEVs retired from the state fleet directly benefit communities most in need.	Direct	Direct	Direct	–
Fleet and Workplace Infrastructure: Lead state government efforts to install fleet charging to enable accelerated fleet electrification; identify opportunities and encourage use of public hydrogen stations. Develop new strategy to address post-pandemic workplace charging needs in anticipation of accelerated EV adoption in California. (Partners: CEC, CPUC, CARB, Caltrans, CDCR, EDD, Fish & Wildlife; agencies with fleets).	Indirect	Direct	Indirect	Direct
Public EV Charging and Hydrogen Station Infrastructure: Encourage development of new stations by leasing out surplus property, when feasible.	Indirect	Direct	Indirect	Direct
VMT Reduction: Develop and maintain programs to reduce state worker vehicle miles traveled and/or enable shifts to less impactful travel modes. (Partner: CalHR, all agencies)	–	–	Direct	–
ZEVs on Rental Car Contracts: Make it easier to implement now that BEVs commonly have more than 200 miles of range, and FCEV market is expanding.	Direct	–	Direct	–
Division of the State Architect	–	–	–	–
Accessibility Regulations: Electric vehicle charging stations are completely integrated into California's building standards for commercial and public facilities. Collaborate with the Building Standards Commission to advance building standards for EV charging at public K-12 schools and community colleges.	–	Direct	–	–

Key DGS Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
ZEV First Purchasing Policy Management Memos: How to leverage the state fleet to support ZEV adoption.	Lead Agency, Ongoing

Department of Housing and Community Development (HCD)

HCD develops building standards for private residences, including multifamily buildings, enabling cost effective home charging.

Equity: Pursue standards that preserve and expand safe and affordable housing opportunities, benefiting priority communities.

HCD ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Building Standards: Collaborate with expert agencies (CARB, BSC, CEC, CPUC, GO-Biz) to ensure ZEVs are adequately integrated into California's residential building standards.	–	Direct	Direct	–

Department of Motor Vehicles (DMV)

DMV handles registrations and ownership transactions. DMV also provides Motor Carrier permits (MCP), clean air decals (CAD), international registration plan (IRP) and other registration products/services that are essential to intrastate and interstate commerce.

Equity: Ensure that DMV customer processes are accessible to all. Track market data to enable assessment of market access to the new and used ZEV market.

DMV ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Data: Collect, maintain, and share ZEV registration and odometer data to enable robust market analysis, while protecting consumer privacy.	Indirect	Indirect	Indirect	Indirect
Market Access: Clearly delineate processes to enable new technology to be tested in real world settings, create opportunities for OEMs and fleets to work together to build market confidence.	Direct	–	Direct	–
Education: Increase awareness of ZEVs through various touchpoints (e.g., driver tests, DMV materials, mailers, etc.).	–	–	Direct	–

Employment Training Panel (ETP)

ETP specializes in employee training programs. These can be leveraged to introduce and improve ZEV related job skills and increase compensation and retention.

Equity: Prioritize investments and programs that serve priority communities.

ETP ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Training: Ensure California-based companies and public agencies can easily train current and future employees on ZEV related systems.	–	–	–	Direct

Governor's Office of Business and Economic Development (GO-Biz)

GO-Biz leads the ZEV Market Development Strategy and serves as the first point of contact for ZEV related businesses to engage with state government.

Equity: Facilitate economic expansion in underserved communities and integrate minority and small owned businesses/suppliers into the growing ZEV market. Ensure program wide robust outreach and engagement with priority communities.

GO-Biz ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
ZEV Strategy: Organize and lead the development and implementation of the ZEV Market Development Strategy.	Direct	Direct	Direct	Direct
Infrastructure Permitting: Streamline ZEV infrastructure development.	–	Direct	–	–
Market Development Growth: Actively support clean mobility business development and work with industry, labor agencies and stakeholders to enable equitable job growth (leverage Business Investment Services, Cal Competes, and the Office of the Small Business Advocate).	Indirect	Indirect	–	Direct
Incorporate Industry Voice: Feed business perspective into agency decision-making and regulatory processes–strategic problem solving, market enabler.	Indirect	Indirect	Indirect	Indirect
Market Innovation: Enable and catalyze innovation within California (innovation hubs).	Indirect	Indirect	Indirect	Indirect
International Business: Attract foreign direct investment, assist companies in gaining access to new markets (e.g. through iZEV Desk and iZEV Market Place), share lessons learned with, and learn from, global partners.	Indirect	Indirect	Indirect	Indirect
ZEV Advertisement: Utilize ZEVs when feasible in Visit California and related marketing campaigns.	–	–	Indirect	–

Key GO-Biz Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
ZEV Market Development Strategy: 1) Articulate core principles for collective ZEV action, 2) Identify ZEV targets, 3) Establish roles and objectives of agencies and stakeholder groups, 4) Organize collective problem-solving, 5) Ensure lessons learned are captured and incorporated.	Lead Agency, Ongoing
Electric Vehicle Charging Station Permitting Guidebook: 1) Current plug-in electric vehicle (PEV) landscape in California, 2) Station development phases, process, best practices and pitfalls, 3) Future market perspectives.	Lead Agency, Ongoing
Hydrogen Station Permitting Guidebook: 1) Hydrogen and fuel-cell electric vehicles (FCEV) ecosystem and current landscape in California, 2) Hydrogen station development phases, process, best practices and pitfalls, 3) Future market perspectives.	Lead Agency, Ongoing
Sustainable Freight Action Plan (CTC, CARB, CEC, CPUC, Caltrans, CalSTA, GO-Biz): Actions each agency can take to 1) achieve California's vision of a modern, safe, integrated, and resilient freight system that continues to support California's economy, jobs, and healthy, livable communities and 2) reach the Plan's targets for freight system efficiency, transitioning to zero-emission technologies, increased competitiveness and economic growth.	Coauthor, Supporting Agency
Evaluation of Fuel-Cell Electric Vehicle Deployment & Hydrogen Fuel Station Network Development — AB 8 (CARB, CEC, GO-Biz): 1) CARB's analysis of current status and near-term projections of FCEV deployment and station network development, 2) actions necessary to maintain progress and continued future expansion, 3) recommendations to CEC on future station development co-funding through AB 8.	Coauthor, Supporting Agency
Electric Vehicle Charging Infrastructure Assessment — AB 2127 (CEC, CARB, CPUC, GO-Biz): Amount/locations of chargers needed to serve the populations of battery-electric and plug-in hybrid electric vehicles envisioned in California's policy goals.	Coauthor, Supporting Agency
AB 74/Carbon Neutrality Studies (CalEPA, CEC, CARB, GO-Biz, OPR, CalSTA, Labor and Workforce Development Agency, Natural Resources Agency): 1) Identify strategies to significantly reduce vehicle emissions and achieve carbon neutrality. 2) Identify strategies to decrease demand and supply of fossil fuels, while managing the decline of fossil fuel use.	Coauthor, Supporting Agency
Agency Action Plans — ZEV Market Development Strategy: Actions each agency will take to achieve their ZEV Market Development Strategy objectives.	Receiving Agency

Governor's Office of Planning and Research (OPR)

OPR serves as California's comprehensive state planning agency — driving land use, economic development and workforce insights and guidance that directly impact the ZEV market.

Equity: Lead the development and implementation of the "Just Transition Roadmap" and support local and regional resilience planning and implementation through the Integrated Climate Adaptation and Resiliency Program.

OPR ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Land Use Synergies with ZEV: Support cross-sectoral and interagency conversations that bring priorities together, including around land use planning and guidance, implementation of SB 743, transportation, housing and development, freight and logistics, etc.	–	–	Direct	Direct
Just Transition: As specified in EO N-79-20, work with the Labor Agency to establish a Just Transition Roadmap for workers and communities impacted by the transition to carbon-neutrality.	–	–	–	Direct

State Treasurer's Office (STO)

The Treasurer's Office has broad authority to finance, provide tax relief, and invest in ZEV related projects.

Equity: Increase knowledge of and access to capital for small and minority owned businesses and manufacturers.

STO ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Finance ZEV Projects: Identify and implement creative approaches to financing ZEV related projects. Coordinate with federal Green Bank Accelerator initiatives to provide a variety of financial incentives and support to public and private projects.	Indirect	Indirect	Indirect	Indirect
Tax Exclusions: Identify and implement creative approaches to support alternative energy and advanced transportation manufacturing.	Indirect	Indirect	–	–

Key STO Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
California Capital Access Program for Small Business (CalCAP): Loan loss reserve program that encourages banks and other financial institutions to make loans to small businesses that have difficulty obtaining financing, particularly women, minority, veteran and LMI communities.	Lead Agency, Ongoing
A: CalCAP/California Air Resources Board Truck Loan Assistance Program: Provides financing opportunities to qualified small-business owners to purchase cleaner and zero-emission heavy-duty vehicles.	Lead Agency, Ongoing
B: CalCAP/EVCS Financing Program: Provides small-business borrowers and lenders with incentives to finance electric vehicle charging station equipment acquisition and installation at businesses and multi-unit dwellings.	Lead Agency, Ongoing
Sales and Use Tax Exclusion Program: Provides a sales and use tax exclusion to manufacturers that promote advanced transportation, renewable fuels, alternative energy, and recycling.	Lead Agency, Ongoing
Industrial Development Bonds: Low-cost financing for businesses that feature a manufacturing component related to pollution control, including ZEV related projects.	Lead Agency, Ongoing
Tax Exempt Bonds: Tax-exempt financing for projects that purchase clean-air vehicles for solid and water waste facilities and recycling facilities, with additional incentives for small businesses.	Lead Agency, Ongoing
Green Bonds: Financial instruments issued by the public sector, private sector, and multilateral institutions specifically to finance climate and environmentally-friendly projects.	Lead Agency, Ongoing

Strategic Growth Council (SGC)

SGC invests in communities, creating opportunities to enable ZEV adoption.

Equity: Support job development and mobility improvement in priority communities.

SGC ZEV Market Development Objectives

Objectives	Vehicles	Infrastr.	End User	Workforce
Incentivize ZEVs in All Programs: Infrastructure and planning grant programs incorporate ZEV and ZEV infrastructure incentives and funding in their sustainable community development strategies.	Indirect	Indirect	Direct	Direct
Update Guidelines with ZEVs in Mind: ZEV deployment and infrastructure incentives/guidelines in SGC grant programs are continually updated to reflect State of California priorities, including proactive support for small minority owned businesses.	Indirect	Indirect	Direct	Direct

Key SGC Documents Related to ZEV Market Development

Report & Key ZEV Market Related Questions Addressed	Role & Frequency
Affordable Housing and Sustainable Communities (AHSC) Program Guidelines: Supports opportunities to fund ZEVs and ZEV infrastructure in AHSC projects.	Lead Agency, Ongoing
Transformative Climate Communities (TCC) Program Guidelines: Supports opportunities to fund ZEVs and ZEV infrastructure in TCC projects.	Lead Agency, Ongoing

Appendix B: Key Stakeholder Groups and High-Level Objectives

Numerous stakeholder groups beyond California State Government Agencies play key roles in advancing the ZEV market — the state cannot achieve scale alone. This section offers an overview of these key groups and their high-level objectives. While comprehensive, it is not all inclusive; as the ZEV market continues to evolve, roles and objectives may change, and new entrants will emerge to respond to the needs of a mature market.

The level of detail provided for these groups is intentionally less than what is outlined for state agencies. The purpose of including key stakeholders in this Strategy is to illuminate the broader ZEV stakeholder landscape, highlight key areas of focus for each group, provide an entry point for those aiming to join the ZEV market development movement, and help identify gaps and areas of overlap so that we can more effectively organize our collective effort.

Governor's Office and California Legislature

The Governor's Office and California Legislature set the vision for the state. The Governor's Office establishes budget priorities with the legislature and helps focus the state agencies' collective effort on targets to achieve California's environmental, economic, and social goals.

The Legislature plays a foundational role in building the ZEV market by setting aggressive targets and passing permit streamlining laws, working with the Governor's Office to establish budget priorities, and raising awareness of critical challenges and solutions.

Local and Regional Government

Local and regional governments serve pivotal roles in ZEV market development. From permitting to building standards, transportation planning to investments, we rely on local leaders and policies to hasten the transition to zero emissions for all Californians.

California has 482 cities, 58 counties, 35 air districts, 18 metropolitan planning organizations, and 26 regional transportation agencies, each with different realities and constituencies. The following objectives are high-level and directional — their application will vary across the state.

Local and Regional Government

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Air Districts	California's 35 air districts play varying roles in ZEV market development depending on district size, population, air quality, and other local factors. They lead and collaborate with regional stakeholders to broaden and promote ZEV adoption and innovative clean mobility and administer rebate programs like Clean Cars 4 All.	• Shared understanding of local air quality • Enable and fund, as appropriate, broad ZEV adoption and innovative clean mobility • Push the technology/deployment envelope • Support ZEV infrastructure networks • Tailor local education, outreach, and incentives to the needs of community • Develop strategies to increase ZEV adoption, as appropriate • Measure impacts of strategies in reducing air pollution regionally and in AB 617 communities • Manage settlement programs • Adoption of local facility based mobile source rules that require ZEVs at commercial airports, warehouse distribution centers, seaports, and railyards	Lead	Lead	Lead	–

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
City/County Government	Local governments approve and oversee ZEV infrastructure permitting, zoning building code, certify weights and measures, operate their own fleets, lead land use planning, and implement policies that directly impact ZEV deployment.	• Reduce car dependence in communities, including transit and micro-mobility • Streamline permitting for ZEV infrastructure • Develop of City or Regional ZEV Readiness Plans or Roadmaps • Adopt aggressive building standards that facilitate the transition to ZEVs, micro-mobility, and reduced car dependence; and ensure new construction can meet future demand to avoid unnecessary retrofitting costs • Direct investment in ZEV infrastructure in well-attended, frequently used and municipally-owned property; and deploy and/or create concessions to encourage private investment • Explore reduced parking requirements in exchange for charging infrastructure installation • Support consumer awareness programs such as ride-and-drives and targeted outreach • Engage large employers and property owners to encourage ZEV infrastructure deployment • Create emissions-free zones • Prioritize ZEV deployment in fleets and procurement decisions (leading by example) • Create or facilitate ZEV programs that focus investment in priority communities	Support	Support	Support	Support
Metropolitan Planning Organizations (MPOs)	MPOs lead regional transportation planning. They play a pivotal role in getting people out of cars, optimizing freight corridors, and deploying strategies to encourage ZEV adoption.	• Develop and implement Sustainable Community Strategies and Regional Transportation Plans that incorporates ZEV related policies • Implement projects that support the Sustainable Freight Action Plan • Permit streamlining outreach and support • Apply for and implement state and federal funding that encourages ZEV adoption • Develop regional ZEV readiness plans, tools, and studies	Support	Support	Support	Support

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Regional Transportation Planning Agencies (RTPAs)	RTPAs serve a role very similar to MPOs, but for rural regions. They develop long range planning to ensure their region's vision and goals are clearly identified, and effective decisions are made to reach those goals. These plans should support the state's ZEV goals.	• Develop and implement strategies to integrate ZEVs into Regional Transportation Plans • Identify and communicate ZEV related opportunities and barriers; work with stakeholders to implement solutions • Permit streamlining outreach and support • Apply for and implement funding that encourages ZEV adoption • Develop regional ZEV readiness plans, tools, and studies	Support	Support	Support	Support

Federal and Tribal Governments

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Federal Government Agencies and National Labs	Through policy priorities and funding decisions, the federal government plays a key role in how quickly we can accelerate the ZEV market throughout the country. Federal environmental, energy and transportation agencies and national labs set vehicle emission standards, provide funding and thought partnership for early stage R&D, data collection and analysis, and facilitate stakeholder collaboration.	• Set policies and provide incentives to encourage development and deployment of ZEV technologies by OEMs and fuel providers, and that support workforce development to support the ZEV market • Set policies and provide incentives that enable broader access and greater uptake of ZEVs among end users • Invest in ZEV related R&D and technology advancement, leveraging national labs and other resources • Collaborate with key stakeholder groups to identify ZEV market barriers and potential solutions • Continue, expand, or create tax related opportunities to encourage investment in renewable generation, storage and ZEV infrastructure • Pursue ZEV advancements and deployment with the US military	Lead	Lead	Lead	Lead
Tribal Governments	California is home to 109 sovereign Tribes. Engagement by and with tribal leaders can help ensure equitable transportation solutions and ZEV access to tribal communities.	• Work with state agencies and tribal associations to identify areas of mutual concern and strengthen partnerships to implement solutions • Work with stakeholders to ensure infrastructure planning is inclusive of tribal communities • Collaborate with outreach and educational entities to ensure messaging and outreach efforts reflect tribal community perspectives and needs	Support	Lead	Lead	Lead

Vehicle Manufacturers and Supply Chain

Delivering zero emissions to all is only a dream without vehicle manufacturer investment in, and commitment to zero-emission technologies. Success hinges on automaker ability to deliver products that meet and exceed customer expectations across all vehicle classes. Further, California will need vehicle manufacturers to market their ZEVs more prominently to build consumer awareness and demand.

California has a long history of working constructively with automakers to develop policies and incentives to seed the ZEV market. This work will be leveraged and expanded in working with other vehicle and infrastructure manufacturers, with an aggressive eye toward scale.

The following are some of the components of various supply chains in automobile and rail industries that could grow in California.

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Dealerships (and dealership groups; direct sales)	Auto dealerships are on the front line of customer and fleet engagement. They can encourage ZEV adoption and grow consumer and fleet confidence in ZEV technology. Dealers are often the first place for consumers to have questions answered about ZEV infrastructure. It is critical that agencies work with dealerships (including used car dealerships) to understand consumer ZEV needs and preferences and provide information on critical incentives and low-cost financing.	• Stage new and used ZEVs on the lot in visible locations • Train sales and service people with continuous training programs • Provide marketing and education materials to trainees and customers for more informed car buying choices • Facilitate transparency in ZEV ownership, including helping customers understand total cost of ownership • Partner with ZEV education and outreach organizations • Pursue opportunities to support and enable charging and fueling infrastructure	Lead	Support	Lead	Support

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Light-Duty Manufacturers	With nearly 30 million passenger vehicles on California roads, this market segment plays a key role in the development and cost reduction of components. Cars are also important in raising the awareness and visibility of ZEVs among the public.	• Develop desirable products in all vehicle classes and platforms • Increase number of affordable models • Create ZEV platforms that perform well in various use cases • Develop used vehicle market • Increase awareness and excitement for ZEVs through diverse marketing and advertising • Infrastructure needs identification and deployment support	Lead	Support	Lead	Support
Medium- and Heavy-Duty Manufacturers	The largest contributor to GHG emissions and air pollutants. Many priority communities disproportionately suffer from medium- and heavy-duty truck emissions.	• Products that meet various needs of fleet owners and operators • Continued product improvement and cost reduction • Operations and maintenance training for fleet operators • Early customer assistance and total cost of ownership analysis • Insights on ZEV and infrastructure experience • Input into infrastructure planning, timing, and scaling help coordinating with local utilities to ensure grid planning begins prior to vehicle arrival • Network development for service, repairs, parts	Lead	Support	Lead	Support
New Market Entrants (note: applies to all categories)	New market entrants challenge the status quo by bringing new vehicles, infrastructure, components, software, innovation and human behavior solutions (and attendant data). Applies to multiple categories (but only included here).	• Introduce disruptive technologies and business models • Increase access to priority communities	Lead	Lead	Lead	Lead

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Off-Road Vehicles and Equipment Manufacturers	Forklifts, farm and construction equipment, rail, aviation, etc.	• Zero-emission technology development and deployment • Input into infrastructure planning, timing, and scaling, including connections between on-road and off-road vehicles • State-of-the-art verified[30] and certified vehicles and equipment[31] that meet performance and operational requirements • Robust supply chain • Input into co-locating ZEV infrastructure • Early customer hand-holding • Operation/maintenance training and workforce development	Lead	Support	Lead	Support
Suppliers	Robust, local supply chains can bring down cost, reduce emissions, and increase resilience.	• Create components that improve ZEV and ZEV infrastructure processes and opportunities	Support	Support	–	Support

30 *CARB: Locomotive Emission Verifications, Technology Demonstrations, and Incentives*

31 *CARB: Certified Vehicle and Engines*

Fleets

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Fleets (public and private)	(e.g., Local and regional public fleets, transit agencies, freight and logistics, ports, airports, warehouses, Transportation Network Companies, vehicle and equipment rental companies, corporate fleets, etc.) Fleets represent unique opportunities to scale the market, especially for fleets that "return to base" regularly to recharge or refuel. ZEV adoption in fleets can drive down costs, create market opportunities, and facilitate rapid learning. Fleet operators' understanding of total cost of ownership introduces opportunities that can help scale vehicle production. Entities that enable fleet adoption, but may not own all vehicles on location, play a pivotal role as well, such as airports, ports, warehouses, etc.	• ZEV adoption in increasing amounts over time; share lessons learned • Evaluate routes and duty cycles to determine operational feasibility of BEVs and/or FCEVs, as well as needed infrastructure locations and throughput capacity to support • Direct communication and collaboration with automakers, fueling providers, and ZEV car sharing/rental companies • Quantified shift to eVMT, including for both passenger and freight • Larger fleets help pave the way for smaller fleets • Case studies, best practice sharing and pros and cons assessments - private or public infrastructure, upfront cost/ funding challenges • Assess utilization gains of fleet chargers to inform future programs • Workforce development and training • Infrastructure deployment	Lead	Lead	Support	–

Grid Operators, Electricity and Hydrogen Providers

Electricity and hydrogen providers are keystone players in the market. Reliable, affordable, renewable energy delivery systems will serve to expand the market.

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Balancing Authorities	Balancing authorities, such as the California Independent System Operator, maintain reliability on the grid and operate transparent, wholesale energy markets. Both components are core to end user and investor/operator confidence.	• Ensure electricity is available when needed • Optimize the connection of renewable electricity • Support multi-stakeholder efforts to enable robust vehicle grid integration • Develop opportunities to accelerate renewable electricity-based production of hydrogen as a strategy to increase grid resilience, and increase renewable energy utilization and production	Support	Lead	Support	Support
Community Choice Aggregators (CCAs)	CCAs serve as a backbone of transportation electrification in the communities they serve, from procuring renewable resources, designing rates, expanding storage and ensuring resilience, to interfacing with customers through their electricity account and customer-facing programs that help facilitate the transition to ZEVs. CCAs are uniquely positioned to work with their local government partners to leverage local data to make strategic investments that maximize community benefit and streamline local process.	• Develop ZEV enabling rates • Support local permit streamlining and reach building code adoption • Innovate ways to enable transportation electrification • Incentives for drivers, fleets, new mobility and charging infrastructure • Deploy charging infrastructure in underserved communities • Build support to increase ZEV resilience, including storage • Consumer adoption/education/technical assistance • Vehicle-Grid Integration pilots and programs • Invest in system reliability and resilience	Support	Lead	Lead	Support

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Electric Utilities, Load-Serving Entities	Public- and investor-owned electric utilities serve as a backbone of transportation electrification, including installing ZEV charging infrastructure, procuring renewable resources, providing long-term rate options, managing the grid, timely interconnecting new ZEV loads, expanding DERs including storage and renewables, and ensuring resilience, to interfacing with and educating customers, as well as providing customer-facing transportation electrification programs.	• Encourage investments in and enable charging infrastructure and ZEVs broadly, at scale, and with prioritization of underserved communities; such as through incentives for charging infrastructure and ZEVs (e.g., Clean Fuel Reward program) • Long-term ZEV-enabling rate design (charging and hydrogen production) and affordable, equitable rates for all ratepayers • Fast and safe interconnection and energization through streamlined process • Identify available capacity for ideal interconnection locations to provide grid benefits at lower cost for charging infrastructure and electrolytic hydrogen production, and refueling facilities • Deploy distribution level power systems for electrolytic hydrogen production and refueling in underserved communities • Provide an environment to beta test emerging ZEV technologies • Build grid infrastructure to support increase in ZEVs, including grid-scale storage and onsite clean power generation • Appropriately targeted consumer outreach and education • Vehicle-Grid Integration pilots and programs • Reliability and resilience of grid and ZEV-fueling infrastructure	Support	Lead	Lead	Support

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Electric Vehicle Charging Station Providers and Installers	Electric Vehicle Charging Stations (EVCS) and their providers are cornerstones of the ZEV market — charging stations enable electric vehicle adoption. Positive charging experiences facilitate market growth and beneficial charging supports grid integration and state energy goals. Charging options are rapidly increasing, from an expanding network of public DC charging stations to mobile solutions for charging flexibility.	• Network and market expansion, sustainability, reliability, and resilience, and expansion • Inform policy, regulation, and incentive design • Grid integration and customer experience support • Charging strategy development and education • Network and cybersecurity • Charging standards and protocol development and implementation • Enable technology development • Workforce development • Share permit and interconnection experience to identify streamlining opportunities	Lead	Support	-	-
Gas Utilities	Gas utilities can leverage their systems safely to enable an increase in the production and distribution of renewable natural gas and hydrogen, both of which can serve as electrification feedstocks.[32]	• Develop strategies for natural gas pipelines to become hydrogen carriers, as feasible, such as: accelerated interconnection process for hydrogen injection into the gas grid, including permit streamlining • Identify ideal interconnection locations to enable green hydrogen injection from electrolytic hydrogen production facilities • Develop strategies to enable hydrogen supply and hydrogen station expansion	Lead	Support	-	-

32 RNG can be used to create electricity or hydrogen. Hydrogen is used to create electrons, either in stationary applications or onboard fuel-cell electric vehicles.

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Hydrogen Producers	Hydrogen has been used at scale in industrial applications for decades — success hinges on scaling a dedicated hydrogen production stream to support the retail and commercial vehicle markets. Producers will also need to continue to innovate and develop decarbonized production technologies that drive down costs.	• Advance innovative business models to drive down the cost of hydrogen • Cost reduction to be competitive with gasoline and diesel • Cross sector connection • Establish a reliable renewable hydrogen supply chain, including feedstock and renewable electricity sources • Distribution of molecules reliably, safely, and efficiently with competitive options • Technology advancement for decarbonized or renewable production • Active engagement in codes and standards development	Lead	Support	-	-
Hydrogen Station Developers and Operators	Station developers and operators are crucial to the consumer and fleet facing side of the hydrogen marketplace — hydrogen stations enable the adoption of fuel-cell electric cars, trucks, and buses. Success hinges on deploying a sufficient number of stations to get broad geographic coverage to support the consumer and commercial vehicle adoption.	• Market and network expansion • Station locations to leverage wide geographic distribution while serving demand near our urban cores, suburban and rural destinations • Partner with existing gas/diesel fueling operators to provide an opportunity to transition these small businesses	Lead	Support	-	-
Registered Service Agencies	RSAs install, repair and service commercial fueling devices to ensure they dispense accurate quantities of electricity or hydrogen.	• Keep training up to date so that metrology does not become a station opening bottleneck	Support	Support	-	-

Non-Governmental Organizations (NGOs)

NGO's serve critical broad ranging functions throughout the ZEV market. They use their insights to improve policymaking, conduct education and outreach, bring parties together, employ experts who help push the boundaries of what the collective believes is possible. From a state perspective, we need environmental, equity, and community-based NGOs to hold us all accountable to our goals, help us identify blind spots, particularly when it comes to ensuring we are building a diverse, inclusive market.

We have grouped NGOs by primary purpose below (the grouping is imperfect).

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Codes and Standards Bodies	Groups such as the American Society for Testing and Materials (ASTM) International, National Fire Protection Association (NFPA), National Institute of Standards and Technology (NIST), Society of Automotive Engineers (SAE) International set model codes, standards and protocols that facilitate safe operation and enable scale by organizing industry around shared standards.	• Align stakeholders around shared charging and fueling standards • Maximize safety and consumer protection for charging and fueling stations and within vehicles • Enable market innovation	Support	Support	Support	-

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Collaboratives	Various state agencies are members of, or partners with the following collaboratives that bring multiple stakeholders together to problem solve and create opportunity (alphabetical order): the California Electric Transportation Coalition, California Fuel Cell Partnership, California Hydrogen Business Council, CALSTART, Coast to Coast Smart eMobility, Electric Vehicle Charging Association, Electric Vehicle and Hydrogen Infrastructure Strike Forces, International ZEV Alliance, National Governors Association, Pacific Coast Collaborative, Regional ZEV Collaboratives (e.g., Sacramento PEV Collaborative, Bay Area EV Council, LAEDC E4 Mobility Alliance, Los Angeles Transportation Electrification Partnership, San Diego Regional Accelerate to Zero Emissions Collaboration), Clean Cities Coalitions, U.S. Climate Alliance, Under2° Coalition, Transportation Decarbonization Alliance, Western Governors Association, and Veloz.	• Education and awareness • Multi-stakeholder problem solving, setting forward-leaning agendas • Cross-sector relationship building • Collaborative vision setting • Thought partnership • Implementation	Lead	Lead	Lead	Support

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Community-based NGOs	NGOs across sectors — whether focused on environmental, social, or economic outcomes — play a key role in raising core issues at the local, state, and national levels, ensuring agency accountably, and providing results from research and studies to help inform ZEV policy and market development. They can also serve as a trusted resource for public outreach and education and can mobilize their constituents to help advance goals.	• Bring in localized voices and expertise • Inform policy, regulation, and incentive design • Help design transportation systems that can meet unique community needs • Build capacity and community awareness • Workforce development	Support	Support	Support	Support
Environmental NGOs		• Provide policy recommendations based on research and analysis • Encourage and enable policy, regulatory, and incentive design innovation • Hold agencies accountable • Implementation of programs	Support	Support	Support	Support
Equity NGOs		• Bring in new voices and expertise • Represent the underrepresented • Help design transportation systems that can address multiple barriers, while also meeting unique community needs • Advise on equity pilots and programs • Collaborate on equity and mobility metrics for success • Build capacity and community awareness • Hold agencies and programs accountable — and enable opportunities to better reach priority communities	Support	Support	Support	Support

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Trade Associations	Trade associations serve to advance the specific needs of their members in advancing the ZEV market. They can also serve to convene stakeholders for collaboration and information sharing, research and analysis, and development of advocacy materials.	• Work with stakeholders across sectors to determine, amplify, and advocate for policies and legislation that will accelerate the ZEV market • Provide consolidated feedback representative of the specific industry group	Support	Support	Support	Support

Investors

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Investors/ Financing Institutions	Private investment, and a robust private market, plays a pivotal role in getting to 100% ZEV sales. The system works equitably if investors (broadly defined) make money selling or operating ZEV mobility at prices that welcome the entire market. Getting there requires active and ongoing collaboration between investors and the public sector.	• Thought partnership on how to bring in more private capital • Forward-looking investment to help accelerate technology development and ZEV utilization • Communicate investment priorities	Lead	Lead	Lead	Lead

Academia

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Community Colleges	Community colleges play a fundamental role in training California's workforce, exposing students to new technology, establishing training partnerships with ZEV companies, and more.	• Build robust ZEV related training programs that build transferable skills and are connected to both current and future jobs • Maintain close connection with industry partners to ensure students are trained for what the marketplace needs • Pilot programs such ZEV carsharing, e-bike sharing, and EV charging	Support	Support	Support	Lead
Universities (University of California, California State Universities, Private Universities)	Universities serve a key role in educating students and the future workforce, as well as producing primary research and analyses from a trusted third-party source.	• Create future employees for ZEV companies, government and local agencies/groups • Research, internships, and development/innovation • Pipelines to bring innovations to market • Pilot programs such ZEV carsharing, e-bike sharing, and EV charging • Enable ideas to move from bench to market	Support	Support	Support	Lead

Organized Labor

Stakeholder Group	ZEV Connection	Objectives	Vehicles	Infrastr.	End Users	Workforce
Organized Labor	Labor unions both train and represent workers. They can deliver the job quality essential to a high-road ZEV industry, and the skilled workforce needed to build it.	• Promote high-quality jobs for ZEV workers • Deliver highly skilled workers across ZEV industries and occupations • Generate equity and opportunity in the ZEV labor market through industry partnerships that join business, labor, education, community, and social services	Support	Support	Support	Lead

International Relationships

California is a global hub for ZEV deployment and remains invested in success - our international efforts underscore our commitment to the success of the ZEV market in California, other states, and nations. Our international cooperation includes information-sharing and engaging in policy dialogue with our overseas partners, recognizing that California plays an outsized role as a subnation in helping advance the global ZEV market. We also help California ZEV companies gain access to new markets through export development programs and trade missions. Additionally, our foreign direct investment efforts aim to attract international ZEV companies that will bring high-road jobs to our state directly and through the diverse supplier networks they support, while also maintaining California's position as the epicenter of innovation. "California ZEV" is a brand with enormous international recognition and influence and we engage internationally because we know that each ZEV that replaces an internal combustion engine makes the world incrementally better.

Appendix C: Measuring Success

California has a series of targets, reports, and tools to pull from to measure ZEV market success. The following sections organize these targets and resources around six sections: Outcomes, Vehicles, Infrastructure, End Users, Workforce, and Investment. The ZEV Market Development Strategy website will pull from these sources to help stakeholders easily assess ZEV market health and outcomes. It will point to existing tools, such as the CEC's ZEV stats website, whenever possible.

Developing the metrics for the website will be an iterative process and rely heavily on stakeholder input. The website will be adjusted over time to include additional or refined metrics to better capture progress towards meeting our targets. For reference, Table 1 in the main report summarizes the key questions the ZEV Strategy website will help stakeholders answer.

1. **Air quality** improvement, including criteria pollutant and toxic emissions reductions, throughout California with focus on achieving attainment of air-quality standards and particularly in vulnerable communities.

Air Quality Improvements

Target	Target Date	Policy Driver	Measurement Resource
Reduction of specified pollutants, including PM10 and PM2.5, Ozone, Nitrogen Dioxide, and others	Ongoing	California Ambient Air Quality Standards (CAAQS)	Compliance with CARB *California Ambient Air Quality Standards*
8-hour Ozone Standard of 80 parts per billion (ppb) for South Coast and San Joaquin Valley	2023	U.S. EPA standard	Compliance with *2016 Mobile Source Strategy* and *Revised 2016 State Implementation Plan*; 2016 *South Coast* and *San Joaquin Valley* Air Quality Management Plans.
70% reduction in NO_x from 2016 levels	2023	CARB 2016 Mobile Source Strategy, necessary to achieve ozone and PM2.5 standards	
AB 617 Localized Community Emission Reductions	2024	AB 617 (2017), Community Air Protection Program	CARB *Community Air Protection Blueprint* and Local *Community Emission Reduction Plans*
Micrograms per cubic meter (µg/m^3) annual PM 2.5 standard for South Coast, San Joaquin Valley, Imperial County, City of Portola in Plumas County	2025	U.S. EPA standard	Compliance with *2016 Mobile Source Strategy* and *Revised 2016 State Implementation Plan*; corresponding local air quality management plans

Target	Target Date	Policy Driver	Measurement Resource
75 ppb ozone standard for South Coast and San Joaquin Valley 80% reduction in NO_x from 2016 levels	2031	U.S. EPA standard CARB Mobile Source Strategy, necessary to achieve ozone and PM2.5 standards	Compliance with *2016 Mobile Source Strategy* and *Revised 2016 State Implementation Plan*; corresponding local air quality management plans In development: CARB *2020 Mobile Source Strategy* and corresponding regional air quality management plans
70 ppb ozone standard for South Coast and San Joaquin Valley	2037	U.S. EPA standard	

2. GHG emissions from transportation decline over time to meet overall state GHG emissions reduction targets.

GHG Emissions Reductions

Target	Target Date	Policy Driver	Measurement Resource
GHG emissions 40% below 1990 levels	2030	SB 32 (2016)	Compliance with CARB *2017 Climate Change Scoping Plan, Low Carbon Fuel Standard (LCFS)*
Carbon neutrality	2045	Executive Order B-55-18	In development: CARB *Achieving Carbon Neutrality in California*
GHG emissions 80% below 1990 levels	2050	Executive Order B-16-2012	Compliance with CARB *2017 Climate Change Scoping Plan* and future Climate Change Scoping Plans; LCFS
Reduction of fossil fuel consumption in transportation sector	Ongoing	Executive Order N-79-20	California Retail Fuel Outlet *Annual Reporting (CEC-A15) Results*
Reduction of greenhouse gas (GHG) emissions from transportation network companies (TNCs)	GHG reduction targets beginning in 2023	*Clean Miles Standard Regulation* SB 1014 (2018)	CARB and CPUC *regulatory implementation tracking* of TNC progress to reduce GHGs

3. Access to high-quality clean transportation and mobility options for all Californians, with focus on ensuring the state's most vulnerable communities are prioritized and have more equitable access to and experience direct benefits of clean mobility.

Equitable Priority Community Access

Target	Target Date	Policy Driver	Measurement Resource
Projects funded with Community Air Protection Incentives achieve measurable emissions reductions in communities	Ongoing	AB 617 (2017) and CARB Community Air Protection Incentives	CARB project tracking and reporting for *funded projects* CARB *Community Air Grants*

Target	Target Date	Policy Driver	Measurement Resource
Increased transportation equity and quality in priority communities	Ongoing	CARB Sustainable Transportation Equity Project (STEP) CARB Clean Mobility Options Voucher Pilot Program SB 1275 (2014)	CARB project tracking and reporting for funded projects, *STEP, Clean Mobility Options Voucher Pilot Program* and *community transportation needs assessments*, Clean Cars 4 All. CVRP low- and moderator-income increased rebate, *Other light-duty equity projects*, *Medium- and heavy-duty projects*, *SB 150 Report*, *CCI Reporting Metrics*, Access Clean California "equity metrics" developed by The Greenlining Institute and Grid Alternatives, Greenlining *Mobility Equity Framework*, *Diversity Inclusion Framework*, and *Making Equity Real in Research*
At least 25% of Cap-and-Trade revenues allocated to projects in disadvantaged communities	Ongoing	AB 1550 (2016) and precursor SB 535 (2012)	CARB *Low Carbon Transportation Program* project outcome tracking through *Moving California* and *California Climate Investments Outcomes*
At least 35% of CPUC-approved IOU investments allocated to programs and projects in underserved communities	Ongoing	AB 841 (2020)	*CPUC tracking of IOU investments*
Implement priority recommendations of SB 350 Study Part B: Overcoming Barriers to Clean Transportation Access for Low-Income Residents	Ongoing	SB 350 (2015) and CARB/ CEC SB 350 Barriers Reports	CEC *Energy Equity Indicators*, and CARB *Accessible Clean Transportation Options SB 350* CARB *SB 350 Strategic Outreach Roadmap*, CARB *SB 150 Report*, Access Clean California "equity metrics" being developed by The Greenlining Institute and Grid Alternatives
Equitable statewide deployment and access to charging stations	Ongoing	SB 1000 (2018)	CEC *SB 1000 process* within *Clean Transportation Program*

Target	Target Date	Policy Driver	Measurement Resource
Increasing community ZEV readiness (light-, medium-, and heavy-duty), prioritizing vulnerable communities	Ongoing	CEC community ZEV readiness grants CEC mobility and access grants	California Climate Investments CARB *Low Carbon and Air Quality Improvement Program* CEC *Clean Transportation Program* outcomes *San Bernardino ZEV Readiness Efforts* Draft Assessment of CARB's Zero-Emission Vehicle Programs, *SB 498* GO-Biz Streamlining (*EVCS* and *H_2 Permitting, Building Standards*)
Leverage local clean transportation funding to enhance equity	Ongoing	SB 2297 (1988) SB 98 (1999)	*Mobile Source Air Pollution Reduction* and *Air Quality Management District* outcomes

4. **Economic Development and Job Creation**: Increasing the number of in-state **ZEV-related employers and high-road jobs** will maximize economic opportunities, increase participation in equity communities, and accrue the benefits associated with the transition to zero-emission transportation.

ZEV Employers and Jobs

Target	Target Date	Policy Driver	Measurement Resource
Increasing number of in-state ZEV employers	Ongoing, annual	Executive Order B-48-18, Executive Order N-79-20, AB 398 (2017), AB 841 (2020)	Tracking by Labor Agency (including Workforce Development Board and Employment Training Panel), CEC, Office of Planning & Research; tracking by local economic development entities; CPUC tracking of IOU investments
In-state growth in high-road jobs in ZEV sector			
Increasing diversity of ZEV workforce and prioritizing opportunities for priority communities		Executive Order B-48-18, Executive Order N-79-20, AB 398 (2017), SB 350 Studies	

Vehicle Metrics

1. The following metrics track progress toward the state's **medium- and heavy-duty and off-road vehicles and equipment**.

Light-Duty Vehicles

Target	Target Date	Policy Driver	Measurement Resource
1.5 million ZEVs	2025	Executive Order B-16-12, CARB Advanced Clean Cars	CEC Data Portal: Vehicle *Sales* and *On-Road* Tracking, compared to overall vehicle market
5 million ZEVs	2030	Executive Order B-48-18, CARB Advanced Clean Cars	
100% of new car sales	2035	Executive Order N-79-20, CARB Advanced Clean Cars	
DGS ZEV Fleet Purchases: at least 50% of the light-duty vehicles purchased for state fleet each year are zero-emission	2024-25 and annual, ongoing	Executive Order B-16-12, SB 498 (2017), *Green Fleet Initiative*	Compliance with *Zero-Emission Purchasing Mandate*
Regional and local public fleet ZEV purchases	Ongoing	Executive Order N-79-20	Work with local governments for data, capture to extent feasible
Increased zero-emission micro-mobility options and usage	Ongoing	Executive Order N-79-20; California Climate Investments	Tracking of funded projects and deployments of zero-emission micro-mobility options, usage

Medium- and Heavy-Duty and Off-Road Vehicles and Equipment

Target	Target Date	Policy Driver	Measurement Resource
100% of new transit bus purchases are zero-emission 100% of on-road transit buses are zero-emission	2029 2040	Innovative Clean Transit Rule	Reporting for CARB *Innovative Clean Transit*
100% of on-road airport shuttles are zero-emission	2035	Zero-Emission Airport Shuttle Rule	Reporting for CARB *Zero-Emission Airport Shuttle*
100% of in-use drayage trucks are zero-emission	2035	Executive Order N-79-20, Advanced Clean Trucks Rule	In development: reporting for CARB *Advanced Clean Trucks and in-development Advanced Clean Fleets* rules
100% of in-use off-road vehicles and equipment are zero-emission where feasible	2035	Executive Order N-79-20	In development: reporting for CARB rules like *Transport Refrigeration Unit, Locomotives* and *Zero-Emission Forklift* (under development)

Target	Target Date	Policy Driver	Measurement Resource
100% of on-road medium- and heavy-duty vehicles are zero-emission where feasible	2045	Executive Order N-79-20, Advanced Clean Trucks Rule	In development: reporting for CARB *Advanced Clean Fleets* rule (under development)
DGS ZEV Fleet Purchases: at least 15% of newly purchased vehicles with gross vehicle weight rating 19,000+ pounds for the state fleet shall be zero-emission	2025 and annual, ongoing	AB 739 (2017)	Tracking of *ZEV & Hybrid First Purchasing Mandate for Medium- and Heavy-Duty Vehicles*
DGS ZEV Fleet Purchases: at least 30% of newly purchased vehicles with gross vehicle weight rating 19,000+ pounds for the state fleet shall be zero-emission	2030 and annual, ongoing	AB 739 (2017)	
Regional and local public fleet ZEV purchases	Ongoing	Executive Order N-79-20	Work with local governments for data, capture to extent feasible

2. In addition to the state's vehicle targets, **market expansion capability** is an important metric to show whether we are achieving adequate technology advancement and market transformation within vehicle classes to scale the ZEV market in all sectors and more broadly meet the needs of underserved communities.

Vehicle Market Expansion Capability

Target	Target Date	Policy Driver	Measurement Resource
100% with increasing number of **light-duty** models for sale (used and new) in variety of vehicle classes	Annual increases until 100% in 2035	Executive Order N-79-20, ZEV Regulation	Annual number of announced vehicle models Annual number of available vehicle models, *Veloz Dashboard* Annual number of available models by vehicle type (e.g., compact, sedan, sport, CUV, SUV, van, pickup)

Target	Target Date	Policy Driver	Measurement Resource
100% where feasible with increasing number of **medium- and heavy-duty** models for sale in all 2b-8 vehicle classes	Annual increases until 2045 Annual increases until 2035 for drayage	Executive Order N-79-20, Innovative Clean Transit Rule, Zero-emission Airport Shuttle Rule, Advanced Clean Trucks Rule	Annual number of announced vehicle models Annual number of available models reported for CARB *Advanced Clean Trucks* manufacturer rule and Advanced Clean Fleets rule (under development) Annual number of available models by vehicle type (e.g., heavy tractor: day cab & line-haul, bus: shuttle, school & transit, step van, straight truck: hauler & power take off, box truck, refuse truck, fire engine, ambulance, etc.)
100%, where feasible, with increasing number of **off-road** models for sale in all vehicle and equipment classes	Annual increases until 2035	Executive Order N-79-20, Zero-Emission Forklift and Transport Refrigeration Unit Rules	Annual number of announced vehicle and equipment models Annual number of available models by equipment type (e.g., yard tractor, wheel loader, backhoe loader, excavator, skid steer, forklift, gantry crane, reach stacker, transport refrigeration units, locomotives, harbor craft, etc.)
ZEV lifecycle sustainability and end of life strategy clear and implemented	Ongoing	Executive Order N-79-20	Lithium-ion Car Battery Recycling Advisory Group and related efforts

Infrastructure Metrics

The following metrics track progress toward the state's **fueling targets for light-duty vehicles, medium- and heavy-duty vehicles, and off-road equipment**.

Light-Duty Vehicle Fueling

Target	Target Date	Policy Driver	Measurement Resource
200 hydrogen stations	2025	Executive Order B-48-18	CEC Data Portal: *Hydrogen Stations*
250,000 shared chargers, including 10,000 DCFC			CEC Data Portal: *EV Chargers*
Timely deployment of hydrogen stations (and supply) to support at least 5 million ZEVs	2030	Executive Order B-48-18, AB 8 (2013) hydrogen reports	CEC Data Portal: *Hydrogen Stations*
Timely deployment of charging stations to support at least 5 million ZEVs		Executive Order B-48-18, CEC IEPR/AB 2127 (2018) process	CEC Data Portal: *EV Chargers*
Timely deployment of charging and hydrogen stations to support 100% zero-emission new sales of passenger cars and trucks (Targets under development)[33]	2035	Executive Order N-79-20	CEC Data Portal: *Hydrogen Stations* *EV Chargers*
Customers can access ZEV fuels that are cleaner and less costly than fossil fuels	Ongoing	Executive Order N-79-20, SB 350 (2015), CPUC Transportation Electrification Framework; and CARB LCFS program	CEC, CPUC, CARB tracking
Develop strategies to further enable VGI and increase renewable electricity penetration	2030	SB 676 (2018)	CPUC

33 The California Energy Commission is assessing the fueling infrastructure needed to support the vehicle targets in Executive Orders B-48-18 and N-79-20. The CEC's *AB 2127* once finalized, will provide the targets for charging infrastructure.

Medium- and Heavy-Duty and Off-Road Vehicle and Equipment Fueling

Target	Target Date	Policy Driver	Measurement Resource
Timely deployment of charging and fueling infrastructure to support medium-, heavy-duty, and off-road vehicle and equipment targets	Ongoing	Executive Order N-79-20, Executive Order B-48-18, AB 2127 (2018), and CARB LCFS program	CEC *Integrated Energy Policy Report* and CARB *Clean Transportation and Air Quality Improvement Program* analyses CARB tracking of regulatory progress, LCFS *Data Dashboard* and *Quarterly Summaries*
Customers can access ZEV fuels that are cleaner and less costly than fossil fuels	Ongoing	Executive Order N-79-20, SB 350 (2015), CPUC Transportation Electrification Framework, and CARB LCFS program	CEC, CPUC, CARB tracking
Develop strategies to further enable VGI and increase renewable electricity penetration	2030	SB 676 (2018)	CPUC

End User Metrics

Consumer and fleet awareness of light-, medium-, heavy-duty, and off-road ZEVs must continue to expand to achieve market-advancing levels of consumer and fleet demand for ZEVs.

End User Awareness, Understanding, and Demand

Target	Target Date	Policy Driver	Measurement Resource
Increasing general consumer and fleet **awareness and understanding** of ZEVs Consumer **exposure** to ZEVs: ZEV carsharing and ridesharing; ride and drive (statistics) Consumer and fleet **outreach, education awareness campaigns** across vehicle classes and vocations Emphasis on **engagement with priority communities** in all of the above	Ongoing, Annual	Executive Order B-48-18, Executive Order N-79-20	Tracking of Veloz *Electric for All* campaign *Tracking of Electrify America consumer awareness campaign* CEC *Clean Transportation Program* and CARB *Low Carbon Transportation Program* tracking UC Davis Institute of Transportation Studies *Surveys and Analysis (particularly for used ZEV market)* *CARB Access Clean California* *SB 350 Outreach Strategic Roadmap, technical assistance and capacity building efforts*
Increasing consumer and fleet **demand/purchase** of ZEVs	Ongoing, Annual		CEC Data Portal *Vehicle Population* and *New ZEV Sales* CEC *Clean Transportation Program* and CARB *Low Carbon Transportation and Air Quality Improvement Program* tracking *Clean Vehicle Rebate Project Statistics*

Workforce Metrics

A trained and sufficient **workforce** is fundamental to boost the California economy and scale the ZEV market. This set of metrics focuses on workforce as an input. Job growth is captured as an outcome earlier in the document.

Workforce Sufficiency

Target	Target Date	Policy Driver	Measurement Resource
In-state ZEV-related manufacturing and supply chain footprint, jobs	Ongoing	Executive Orders N-79-20, B-48-18	Quantity of in-state ZEV-related manufacturers, supply chain and other companies and corresponding jobs
Workforce that can meet timing, scale needs	Ongoing	Executive Order N-79-20	TBD — Industry Surveys Access to career technical education, training, and apprenticeship programs
Certified electricians that can facilitate state's ZEV infrastructure goals	Ongoing	AB 841 (Ting, 2020)	Number of *Electric Vehicle Infrastructure Training Program (EVITP) certified electricians*

Investment Metrics

Investment in ZEV manufacturing, consumer and fleet purchases, and fueling infrastructure must continue to rise and state investments should consider market readiness to appropriately leverage private investment.

Tracking Private Investment

Target	Target Date	Policy Driver	Measurement Resource
Increasing private investment in ZEV-fueling infrastructure	Ongoing, annual	Executive Order B-48-18, Executive Order N-79-20, LCFS ZEV Infrastructure Crediting	CEC *Data Portal*, *Clean Transportation Program* CARB LCFS *Data Dashboard* and *Quarterly Summaries* CARB funding, or directed funding (e.g., settlement funds) for infrastructure *CPUC R.20-08.022 and Transportation Electrification Framework*
Increasing private investment in ZEV research and development, manufacturing and production	Ongoing, annual	Executive Order B-48-18, Executive Order N-79-20	GO-Biz Investment tracking (TBD) CARB *Advanced Clean Cars*, *Advanced Clean Trucks* (manufacturer and fleet rules) CEC *Clean Transportation Program* and CARB *Low Carbon Transportation and Air Quality Improvement Program* tracking
Increasing private investment in ZEV procurement by consumers and fleets	Ongoing, annual	Executive Order B-48-18, Executive Order N-79-20	

EXHIBIT U

Agency ZEV Action Plans

The state agency ZEV action plans on this page communicate ZEV priorities and objectives that the agency is seeking to implement, advance, and/or improve. Each agency action plan also provides an opportunity to track progress and accomplishments, and to record lessons learned that will help grow the ZEV market.

Current state agency ZEV action plans and reports are available as PDFs by clicking on the links under the agency's name and logo. State agency ZEV action plans and reports from previous years are available by clicking on the Agency ZEV Action Plan Archives link at the bottom of the page.

Bureau of Automotive Repair (BAR)

- 2024 Action Plan

California Air Resources Board (CARB)

- 2024 Action Plan

California Building Standards Commission (CBSC)

Please see DGS's ZEV Action Plan

California Department of Transportation (Caltrans)

- 2024 Action Plan

California Dept. of Forestry and Fire Protection (CAL FIRE)

- 2023 Action Plan
- 2022 Report

EXHIBIT U

Department of Resources Recycling and Recovery (CalRecycle)

Please see CalEPA's ZEV Action Plan

California Energy Commission (CEC)

- 2024 Action Plan

California Environmental Protection Agency (CalEPA)

- 2024 Action Plan

California Public Utilities Commission (CPUC)

- 2024 Action Plan

California State Transportation Agency (CalSTA)

- 2024 Action Plan

California Transportation Commission (CTC)

- 2024 Action Plan

California Workforce Development Board (CWDB)

Please see LWDA's ZEV Action Plan

Contractors State License Board (CSLB)

- 2023 Action Plan

Department of Consumer Affairs (DCA)

Please see BAR's ZEV Action Plan
and CSLB's ZEV Action Plan

Department of Housing and Community Development (HCD)

- 2024 Action Plan

Department of Motor Vehicles (DMV)

Department of General Services (DGS)

- 2024 Action Plan

Division of Measurement Standards (DMS)

- 2023 Action Plan

Department of Toxic Substances Control (DTSC)

Please see CalEPA's ZEV Action Plan

Division of the State Architect (DSA)

Please see DGS's ZEV Action Plan

Employment Training Panel (ETP)

Please see LWDA's ZEV Action Plan

Governor's Office of Business and Economic Development (GO-Biz)

- 2024 Action Plan

Governor's Office of Planning and Research (OPR)

- 2024 Action Plan

High-Speed Rail Authority (HSR)

- 2024 Action Plan

Infrastructure and Economic Development Bank (IBank)

- 2024 Action Plan

Labor & Workforce Development Agency (LWDA)

- 2024 Action Plan

State Treasurer's Office (STO)

- 2024 Action Plan

Strategic Growth Council (SGC)

Agency ZEV Action Plan Archives

EXHIBIT V

Zero-Emission Vehicle Market Development Strategy

The ZEV Market Development Strategy, as called for in Executive Order N-79-20, is meant to help California collectively move forward and deliver zero-emission benefits to all Californians. It outlines how state agencies and stakeholder groups key to our transition can move together with the scale and speed required to reach the state's ZEV targets. The primary goal of the ZEV Market Development Strategy is to accelerate large scale, affordable and equitable ZEV market development. This strategy is a living document that will adapt over time based on feedback and lessons learned. If you have questions or feedback, please contact us.

View Market Development Strategy

ZEV Market Metrics

ZEV Market Metrics provide a quick overview of targets and progress in each of the Pillars and Outcomes areas of the ZEV Strategy. Click the tiles for more information, including one-page Metrics Snapshots with links to data sources.

Pillars

EXHIBIT V

ZEV Strategy Documents

The first ZEV Market Development Strategy was published in 2021, with new editions anticipated every three years. The forthcoming 2024 ZEV Market Development Strategy will be posted here.

To implement the ZEV Strategy, interagency collaboration and alignment are key. Not only do many agencies contribute to the ZEV Strategy itself, but they also develop ZEV Action Plans that are shared with GO-Biz each year.

Additional strategy-related documents published since 2021 include the Equity Engagement & Implementation Plan (December 2021) and ZEV Pillar Priorities Document (October 2022). While the publication of additional Pillar Priorities documents is not anticipated, a ZEV Equity Action Plan is planned for 2024.

2021 Strategy

2024 Strategy (Coming Soon)

State Agency Action Plans

EO N-79-20

ZEV Equity

Equity in every decision is the first principle of the ZEV Market Development Strategy. The first ZEV Equity Action Plan will be published in 2024 with robust engagement and input from community-based organizations and leaders, environmental justice groups, and other key equity stakeholders. The ZEV Equity Action Plan will build on the Equity Engagement and Implementation Plan that GO-Biz published in 2021, which provided a ZEV Equity lay of the land, inventory of existing engagement on equity in the ZEV space, and priorities for state agency improvement. The new Equity Action Plan is part of the ZEV Strategy, but will be published separately.

Equity Engagement & Implementation Plan

ZEV Equity Action Plan Input Form

Zero-Emission Vehicles Over the Years

California has been a leader in the transition to clean mobility for decades and continues to set ambitious goals for the future. View our Zero Emissions Vehicles Over the Years timeline to learn about the technological. regulatory, policy, and market developments that have helped us to get where we are, and see the goals we're striving to achieve by 2045.

Learn More

Keep in Touch

ZEV Strategy Implementation Updates

GO-Biz ZEV Newsletter: The Plug and Nozzle

Hydrogen (H2) Strategy Implementation Updates