Guidehouse INSIGHTS

White Paper

Robust Public Charging Infrastructure Is Essential for EV Adoption

Why Overnight Home Charging Is Not Enough

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Introduction

In the early days of the modern EV era, starting in the late-2000s, driving range on a charge was still generally well under 100 miles for most models. To help make the case to skeptical drivers that they did not actually need a multi-hundred-mile range, EV evangelists promoted the idea that most people do not drive more than 40 miles in a day. By charging each night at home, drivers could start each day with the equivalent of a full tank of energy without ever visiting a gas station. While all of this is indeed true, as is often the case, it fails to tell the full story.

Overnight charging is not an adequate solution if EVs are eventually going to supplant internal combustion engine vehicles entirely

Overnight charging is not an adequate solution if EVs are eventually going to supplant internal combustion engine (ICE) vehicles entirely. The realities of who buys new or used vehicles and where those people live will play a huge role in determining how EVs proliferate throughout the transportation fleet. Expansive and reliable public charging infrastructure will be an essential element of developing a successful e-mobility ecosystem.

Most People Never Buy New Vehicles

Many factors influence the decision to purchase a vehicle. Its price, handling, safety rating, fuel efficiency or range, cargo space, passenger capacity, acceleration, navigation, age, size, condition, and potential resale value are all important considerations that go into making a purchase. However, price, and specifically the monthly payment for financing, ultimately ends up as the deciding factor for most consumers. The importance of price can be seen in the number of new and used vehicles sold.

The cost differential between new and used vehicles is huge, with used vehicles being cheaper than new ones, and representing the majority of sales each year. In 2019, **40.8 million used vehicles** were sold in the US, at an average price of $20,100, compared to **12.8 million new vehicle** sales at an average cost of $38,003. Another **4.2 new vehicles were leased**.[1]

Supply chain issues for microchips and other production disruptions in the wake of the COVID-19 pandemic have resulted in limited supplies of new vehicles. As a result, prices for both new and used vehicles have increased since 2019 while overall sales have dropped. Average transaction prices (ATP) on new vehicles topped $48,000 in mid-2022, with EVs averaging as much as $66,000 at their peak. This was caused, in part, by a spike in prices of critical minerals for battery production following the start of the Ukraine war in March 2022. Prices of both EVs and ICE vehicles have subsided from their mid-2022 peaks but they still remain well above 2019 levels and the cost issues are now exacerbated by high interest rates. The limited supplies of vehicles also caused ATP of used cars to climb to $27,028 in July 2023.[2]

[1] Bureau of Transportation Statistics, “New and Used Passenger Car and Light Truck Sales and Leases,” Accessed November 16, 2023, **https://www.bts.gov/content/new-and-used-passenger-car-sales-and-leases-thousands-vehicles**.

[2] Sean Tucker, “Is Now the Time To Buy, Sell, or Trade-In a Car?,” *Kelley Blue Book*, October 18, 2023, **https://www.kbb.com/car-advice/is-now-the-time-to-buy-sell-or-trade-in-a-used-car/**.

Although EVs are likely to have a lower total cost of ownership compared to ICE vehicles, most consumers remain focused on whether the monthly loan payment can fit their budget. Some estimates suggest that some EVs could reach price parity with ICE vehicles as soon as the end of 2023—with government incentives in place—while others suggest price parity will be achieved sometime before or around 2030. As the price of new EVs continues to fall, the cost differential between EVs and ICE vehicles will become less of a focus for consumers. Like sales of new EVs, sales of used EVs have been increasing—rising 32% in Q1 2023, to an average price of $43,400.[3] The market for used EVs remains small, with most of the EVs in existence having been built in just the past 5 years and representing less than 1% of all the vehicles on the road.

Who Buys EVs?

EV owners have different characteristics from the overall population of vehicle owners. Based on responses to the Guidehouse Insights' *Vehicle Preferences and EV Awareness Consumer Survey,* EV owners tend to be younger, have a 4-year college degree or higher, earn more than $50,000 a year, and live in single-family houses.[4] These characteristics are all consistent with being able to afford more expensive vehicles.

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EVs have unique features that buyers must consider before making a purchase, including their reliability, range, time it will take to charge, overall purchase cost, and availability of EV charging. Of these features, the availability of EV charging and purchase cost are the most important factors for potential EV owners.[5] Confidence that the necessary charging infrastructure will be built will have an impact on a consumer's decision to purchase an EV. Currently 53% of US adults do not have confidence that the necessary charging infrastructure will be built, and only 17% are extremely/very confident that it will be. Among those who do not believe the necessary infrastructure will be built, only 19% are likely to consider purchasing an EV as their next vehicle, compared to 68% of those who believe the necessary infrastructure will be built.[6]

Building more public charging infrastructure and making it available to those without a dedicated parking space can help shift these numbers if people see the availability of either DC fast chargers that can charge their vehicles quickly, or convenient and cheap AC charging for the long periods when most vehicles sit idle.

Costs were an important consideration for nearly half of the Guidehouse Insights survey respondents, who indicated that they were not willing to pay more to purchase an EV. When asked about federal tax

[3] Ben O'Hare, "Used EV Sales Are Thriving As Prices Continue To Fall," *INSIDEEVs*, April 23, 2023, **https://insideevs.com/news/663689/used-ev-sales-thriving/.**

[4] Guidehouse Insights, *Market Data: EV Consumer Profiles,* 3Q 2020, **https://guidehouseinsights.com/reports/market-data-ev-consumer-profiles**.

[5] Guidehouse Insights, *Market Data: EV Consumer Profiles,* 3Q 2020, **https://guidehouseinsights.com/reports/market-data-ev-consumer-profiles**.

[6] Alison Spencer, Stephanie Ross, and Alec Tyson, "How Americans view electric vehicles," Pew Research Center, July 13, 2023, **https://www.pewresearch.org/short-reads/2023/07/13/how-americans-view-electric-vehicles/#:~:text=Democrats%20and%20Democratic%2Dleaning%20independents,EV%20for%20their%20next%20purchase**.

incentives for purchasing EVs, most respondents were unable to identify the maximum $7,500 federal tax credit correctly. Nearly 30% responded that it was only $2,500, and nearly 25% responded that no federal tax credit was available for EVs.[7]

Where Do Vehicle Buyers Live?

The US has approximately 142.2 million housing units according to the 2021 *American Housing Survey*, with 91.4 million units having a dedicated garage or carport for vehicle parking. Of the estimated 128.5 US households, approximately 63.6% live in detached single-family homes—the most common type of housing unit—while 24.8% live in multi-unit dwellings with two or more units.[8] Of the 88.6 million detached single-family housing units, 72.5 million have dedicated parking. Multi-unit dwellings, or housing structures with two or more housing units, totaled 36.5 million, with only 10.7 million having a garage or carport for vehicle parking.

In 2021, 91.7% of US households had at least one vehicle. The highest vehicle ownership rates were in Idaho and Wyoming, where 96.2% of households owned at least one vehicle. The lowest was in Washington, DC, with 64.3% of households owning at least one vehicle. Nationwide, 32.5% of households owned one vehicle, 37.1% owned two vehicles, and 22.1% owned three or more vehicles. EV ownership is still low, ranging from 1.61% of vehicles registered in California to 0.05% of vehicles in North Dakota and Mississippi.[9]

The Cost of Home Charging

Charging on Level 2 (L2) home chargers is vastly more cost-effective than DC fast charging at the US national average residential electricity rates of about $0.13/kWh. DC fast charging typically costs 3 to 4 times that amount, eating up much of an EV's operating cost advantage.

Even among residents in single-family detached homes, many are either renters or live in older neighborhoods where they rely on curbside parking. Among those that do own homes, many older houses cannot easily support at-home L2 (240 V) charging due to obsolete electric systems or they have a configuration in which the parked vehicle is not in proximity to the electrical service panel. If the home has a 150A to 200A electrical panel near the wall adjacent to parking, installation of a home charger may only cost $750 to $1,000, with chargers costing $300-$500.

For homes with 100A service or less, a panel upgrade is required, and in many cases so is significant rewiring. Even a 150A to 200A panel that is located on the opposite side of the house from the parking area may require expensive wiring changes. These electrical upgrades can easily exceed $10,000 and are unaffordable for lower income residents who also rely on buying cheaper used cars. Property owners in lower income neighborhoods are also less likely, or unlikely to make substantial infrastructure upgrades.

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[7] Guidehouse Insights, *Market Data: EV Consumer Profiles,* 3Q 2020, **https://guidehouseinsights.com/reports/market-data-ev-consumer-profiles**.

[8] *U.S. Census Bureau*, "American Housing Survey (AHS)," Accessed November 16, 2023, **https://www.census.gov/programs-surveys/ahs.html.**

[9] Ashley Tilford and Michelle Megna, "Car Ownership Statistics 2023," *Forbes Advisor*, October 5, 2023, **https://www.forbes.com/advisor/car-insurance/car-ownership-statistics/.**

Is DC Fast Charging Everywhere the Answer to Making Charging Accessible?

A driver getting into an ICE vehicle typically does so with a high degree of confidence that they can receive the level of fueling needed to reach their destination. While this is usually seen as a given, it is only a reality because of more than a century of fueling infrastructure development—from refineries to pipelines to local fueling stations.

The US has more than 600,00 pumps to refuel ICE vehicles, but only 130,000 EV chargers—and they take four to five times as long to use

The US has 150,000 fueling stations, not counting the number of gas pumps at each station, just how many places sell gasoline. Based on a conservative estimate of four pumps per station, the US has at least 600,000 gas pumps. Each of them can completely refuel a vehicle in about 5 minutes and almost all of them work every time. This is a remarkable feat of automobile-focused infrastructure.

In comparison, the US currently has only 130,000[10] EV chargers, fewer than one-quarter the number of fuel pumps. The fastest DC fast chargers, which represent only a fraction of the total number of public chargers, still require at least 4 to 5 times as long to recharge an EV as filling an ICE vehicle. As noted previously, EV charging at the operator's home is not an option for many drivers. Another issue is that drivers want to know that in an emergency, for example, on a cross-country trip, or just in case they need it, they can have their car ready for a full drive.

If an additional 500,000 chargers were deployed overnight in the same places that fuel pumps are installed, would that solve the problem? Absolutely not, because the charging time issues would still remain.

Highways and major travel nexuses are likely to have some kind of fast charger, but outside of those popular places, many other locations like parking facilities only have L2 chargers that might provide a full charge in 4 to 10 hours. Given that most drivers only use a small fraction of the battery capacity on a daily basis, this is likely to be sufficient to top off the battery while shopping, going to dinner, or parking while at work.

Having direct current fast charging (DCFC) everywhere is not enough for electric chargers. A widespread and diverse mix of L2 and DCFC is needed, combined with driver education about which is the best choice for a given charging session—a change in thinking about how, when, and where to charge. This will require ubiquitous and relatively inexpensive L2 charging at the places where vehicles dwell for long periods. DCFC can be utilized at locations where vehicles might idle for 30 minutes or less.

While DCFC's speed is its primary selling point, advocating for its installation everywhere is not necessarily feasible. By its nature, DCFC needs a lot of input power. A station with ten 350 kW chargers may need up to 3.5 MW if all chargers are utilized simultaneously. This may require substation upgrades that could take years to effect, cost millions of dollars, and put additional strain on the grid. Nonetheless,

[10] The White House, "FACT SHEET: Biden-Harris Administration Announces New Standards and Major Progress for a Made-in-America National Network of Electric Vehicle Chargers," February 15, 2023, **https://www.whitehouse.gov/briefing-room/statements-releases/2023/02/15/fact-sheet-biden-harris-administration-announces-new-standards-and-major-progress-for-a-made-in-america-national-network-of-electric-vehicle-chargers/**.

many drivers' range anxiety issues would be alleviated if, no matter where they park their car, they are 20 minutes away from a full charge.

Could Curbside AC Charging Solve the Accessibility Problem?

As discussed, widespread DCFC is only part of the solution. EVs must also be charged during off-peak periods of electricity demand and when they are parked for hours at a time. Curbside AC charging could be the solution for areas where off-street parking is not an option and the cost of DCFC is not economically viable. A 9.6-kW L2 charger can fill most EVs completely overnight and most would not need a full charge.

Curbside AC charging could be a solution when off-street parking is not available and DCFC is not economically feasible

Some places have already implemented this. Certain areas of the UK moved streetlighting systems to LED bulbs, so the poles could deliver excess capacity. They then built EV charger plugs into the light-poles, allowing urban EV owners to top up their charges while their cars are parked. The company ubitricity, responsible for many of these plugs, claims that this installation takes less than two hours per light pole.

Paris has gone one step further and installed dedicated AC EV chargers along sidewalks where street parking is common. These even have multiple speed options that differ in price. Companies like itselectric[11] are currently producing AC chargers that property owners can install on sidewalks adjacent to their properties. This can enable these charger companies to provide a source of revenue for those property owners from drivers. In all cases, if a driver keeps a charging cord in the vehicle, a charge is never far away. This is essential for the EV transition because range anxiety is a major factor limiting EV adoption—so having the ability to charge a vehicle everywhere is extremely valuable.

Policy Recommendation 1: Subsidize Public Charging Development

EV charging needs the same level of incentives that lawmakers have provided for EV purchases

Over the past decade, incentives for EV adoption in the US, at the federal and state levels, have been largely centered on consumers purchasing new EVs. While this has helped increase the size of the EV fleet, it does not address the other barriers to EV ownership, which primarily revolve around charging. The 2021 Bipartisan Infrastructure Law goes a long way to addressing the charging side of the equation with $7.5 billion targeted at installing new public infrastructure.

However, while providing charging infrastructure in underserved areas is a key focus of the spending, much of it is aimed at installing DCFC. Additional support is needed for deploying more affordable L2 charging in these underserved areas. A robust charging network that provides universal access to both L2 charging and DCFC is essential for enabling mass EV adoption.

For L2, widespread deployment of curbside charging will be essential. To keep costs down, the priority should be systems that provide a simple pedestal with a 240 V outlet that a driver can utilize with a charging cord. This would also reduce the maintenance costs for cords that are damaged when they are

[11] **https://www.itselectric.us/**

left on the ground. It would also provide incentives for charging during off-peak hours, which would reduce the load on a strained grid until it can also be upgraded.

Policy Recommendation 2: Tax Incentives for Workplace Charging?

Employers, business, schools, and other venues where vehicles are parked for hours at a time should also have incentives—from direct subsidies or property tax abatements—to install L2 charging. This would alleviate some of the pressure to build much more costly DCFC. Given the long time frames often required for building power-delivery infrastructure upgrades like substations, incentives for venues where vehicles are parked for hours would also enable a much faster build-out of the charging network.

Policy Recommendation 3: Supporting Charger Installation in Older Homes

The lawmakers and initiative developers who have focused on new homes having EV charger capabilities should also pass laws and regulations to help install L2 EV chargers in older homes. Considering the median age of a home in the US is 40 years, this could be a significant and expensive proposition, but since lawmakers are currently taking the EV transition seriously, it should be possible. Incentives could be in the form of direct subsidies, long-term low interest loans to homeowners that could be rolled into mortgage payments or property tax abatements.

A means of giving property owners incentives to upgrade their properties is also needed. Since the cost of residential electrical upgrades can be significant, property owners who own multiple properties will almost certainly need a major policy push before they spend this amount of money.

Policy Recommendation 4: Utility-Related Policies

As the primary providers of the power used to charge EVs, utilities have a role to play in ensuring that people can charge EVs reliably and cost effectively. One of the major challenges in deploying DCFC is finding locations that have sufficient power to charge multiple vehicles simultaneously. Many of the more desirable locations simply do not have adequate capacity. Substation upgrades could alleviate this problem, but they can cost millions of dollars and take years to implement.

Utilities working with site owners and station operators to coordinate the installation of alternatives such as onsite battery systems could significantly speed up the process of getting new stations online. These alternatives could also save utilities the cost of constructing new substations and help the customer by mitigating demand charges.

Utilities also have a potential role to play in deploying L2 charging through coordination with construction and engineering design firms to ensure reliable power delivery and potential use of onsite storage. In both cases, the onsite storage could be used for load balancing to help reduce strain on the grid during periods of peak demand.

Policy Recommendation 5: Establish Rules for Pricing and Pricing Transparency

Fueling station owners are required to post the prices for fuel so they are clearly visible on the pump. This is rarely the case for EV chargers, especially for L2 equipment. Drivers often must dig through the provider’s app to find the price of a charge. Rules should be established that require the price to be clearly posted before the vehicle is plugged in.

Some states also prohibit electricity from being sold at a retail level on a metered basis per kWh. At these locations, drivers are charged per minute with the actual amount paid per kWh varying depending on the charging speed. All charging should be billed strictly per unit of electricity with no session fees and the taxes should be included in the posted price.

The Need for Charging Equity

Ultimately, the goal is to provide all drivers with equitable access to charging. Whether ICE drivers have a 30-year-old Toyota Corolla or a $400,000 Rolls-Royce, they can pull up to any pump, anywhere in the country, and pay the same price for fuel—in the same amount of time.

As with ICE vehicles, all EV owners should have equal access to convenient and affordable charging

That is not true for EV drivers. Those who can afford to have charging installed at home will pay the least amount to energize their vehicles, and have the most convenient experience.

Getting a home charger installed must be more convenient and affordable for those with single-family homes, whether they own or rent. For everyone else, public charging must be convenient and affordable everywhere, at whatever speed is convenient.

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