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April 28, 2022

Chair Liane Randolph
Members of the Air Resources Board
Dr. Richard Corey, Executive Officer
California Air Resources Board
1001 I Street,
Sacramento, CA 95814

Re: EVSE Standards – Technology Review Report to the Board

Dear Chair Randolph, Members of the Board, Dr. Corey, and ARB Staff:

Plug In America works to accelerate the shift to plug-in vehicles powered by clean, affordable, domestic electricity to reduce our nation's dependence on petroleum and improve the global environment. As the organization representing the more than a million California EV drivers and millions of potential future consumers of plug-in hybrids and fully electric vehicles, we strongly support ARB's EVSE regulation, implementing SB 454, the EV Open Access Act.

We applaud that ARB is focused on cleaner air for all California residents and uses science and facts to make their determinations. This is what your excellent staff has done in putting together today's well researched Technology Review. As the sponsor of Senator Corbett's SB 454 (2013), Plug In America's goal was to make charging an EV as simple for a consumer as filling your tank with gasoline. We wish to thank ARB staff and the Board for moving forward the concept of real open access for EV charging to fruition.

Imagine how you would feel if you pulled into a gas station and didn't know how much the fuel costs or if they would accept your money for payment? And then in order to fuel you had to download an app, call an 800 number, find a specific prepaid fuel card, or join a club just to fill your car? SB 454 was created to make sure this *didn't* happen.

Card readers (credit, debit, and prepaid via EMV chips) are the most basic way to solve the issue of never leaving any driver stranded at a public charger. In their recent annual report, Electrify America indicated that 1/3 of their transactions came via cards. Many of the other EVSPs here today can't tell you those facts because they don't have card readers on their products. Consumers will buy more EVs if we eliminate this barrier and fueling is a familiar experience, which is what the regulation provides.

We are responding today to encourage *not* relitigating the important work that ARB staff and this Board has accomplished. Our goals are straightforward:

- 1) First to ensure open and universal access to publicly available charging stations, especially given many of them were deployed with public taxpayer funding.
- 2) And second, to ensure that such open access takes into consideration the needs of Disadvantaged Communities, not all of whom possess smart phones, credit cards, or bank accounts, yet who are considering purchases of EVs to save on their transportation costs. As ARB staff's data shows, these underserved consumers may not have broad access to prepaid contactless cards for a number of years as EMV chip cards are just entering the prepaid market after almost 10 years. As an example - social security payments are now finally being made with prepaid EMV chip cards, not contactless cards.

Disadvantaged communities are disproportionately impacted by the lack of credit/debit/prepaid card readers on EV chargers. According to the FDIC, 25% of all of California households are either unbanked or underbanked. In minority and disadvantaged communities this number rises to 50%.¹

We are just reaching the point where used EVs are becoming affordable for this population and the state is making considerable investments to help make this happen. Prepaid cards widely available at grocery and convenience stores can help mitigate this issue with 26.9% of unbanked households using them for a variety of purchases.² This is why Plug In America believes that EMV card readers on EV chargers are a ubiquitous solution for all EV drivers and why we support the regulation.

It is extremely important to discuss reliability of the EV charging networks in general – Plug In America recently surveyed over 5,500 EV owners and more than 1,400 individuals interested in purchasing an EV (please see attached). The number one concern of EV drivers was broken or non-functional chargers (25% of respondents) – but this wasn't caused by card readers because most of today's chargers don't have them. Information from EVSE hardware vendors points to communications issues, like the recent 3G network shutdowns, which would equally impact tap or app-based payments. We need to have fundamental standards on EV charging reliability if we hope to reach our common EV goals.

The regulation's opponents you'll hear from will want you to believe that the costs to add card readers place an extreme burden on them, but while other fuel options still have card readers, EV charging should provide this basic access feature. Isn't it reasonable to provide real open access meeting the consumers where they are, rather than where the industry says they will be?

¹ Federal Deposit Insurance Corporation, The 2017 National Survey of Unbanked and Underbanked Households, https://economicinclusion.gov/surveys/2017household/documents/tabular-results/2017_banking_status_California.pdf

² Federal Deposit Insurance Corporation, The 2017 National Survey of Unbanked and Underbanked Households, <https://economicinclusion.gov/surveys/2017household/prepaid-cards-findings/>

We appreciate your consideration of our recommendations and are available for further discussions with members of the ARB Board and staff.

Sincerely,

A handwritten signature in blue ink, appearing to read "Jay Friedland".

Jay Friedland
Senior Policy Advisor
Plug In America

cc: Analisa Bevans, California Air Resources Board
Joshua Cunningham, California Air Resources Board
Stephanie Palmer, California Air Resources Board

Plug In America is the leading national consumer voice promoting the use of plug-in electric vehicles in the United States to consumers, policymakers, auto manufacturers and others. Formed as a non-profit in 2008, Plug In America provides practical, objective information collected from our coalition of plug-in vehicle drivers, through public outreach and education, policy work and a range of technical advisory services. Our expertise represents the world's deepest pool of experience of driving and living with plug-in vehicles. www.pluginamerica.org

The Growing EV Market

Observations in a year of growth

February 2022

PUBLISHED BY:
Plug In America
Los Angeles, CA

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EXECUTIVE SUMMARY

Plug In America is the voice of the electric vehicle (EV) consumer; while several groups perform surveys of EV drivers, Plug In America's membership includes EV drivers with years or even decades of experience with the vehicles. In September–December 2021, Plug In America surveyed over 5,500 EV owners and more than 1,400 individuals interested in purchasing an EV.¹ This survey follows our prior survey² and will be an annual series. Similar to last year, the intent of this survey is to understand the current state of EV driving and consideration in the United States, in particular:

- What are the primary motivations for drivers and those considering EVs?
- What are the most valuable sources of information available to EV customers?
- What is the quality of the current EV buying experience for customers?
- Are EV owners content? Why and why not?
- What are the most significant concerns with existing fast-charging networks?
- Where do prospective EV owners converge and diverge from existing owners?

The year 2021 was extraordinary for electric vehicles, with the market nearly doubling year-over-year. Electric vehicles made up approximately 4% of new vehicle sales in 2021, compared to about 2% in 2020.³ Future growth should be strong as new models become available, especially in the popular light truck segment. It will be essential to ensure that the buying, driving, and charging experiences continue to improve.

EV owners are generally satisfied with their purchases; 90% say that it is "likely" or "very likely" that their next vehicle purchase will be an EV. The primary motivation for EV owners to purchase the vehicle was the environment and air quality, with approximately 50% indicating this was their most important consideration, nearly three times the rate of the consideration next most frequently listed as the most important (cost savings, at 18%). A majority of respondents (59%) considered it "vital"

¹ See "Survey Methodology and Response Summary" for more detail.

² See <https://pluginamerica.org/about-us/electric-vehicle-survey/>. [Noah, may want to change the old link?]

³ Argonne National Laboratory, "Light Duty Electric Drive Vehicles Monthly Sales Updates," <https://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates>, accessed January 27, 2022.

or "very important" that EVs charge with renewable energy, which increases the environmental benefits even further.

Over 80% of owners indicate satisfaction with finding the information they needed to buy or lease an EV; the most common detail lacking was cold-weather performance. EV-specific websites such as PlugStar.com were rated as the most valuable EV information source by EV owners and those considering buying an EV. However, owners were left wanting with the experience they received at dealerships, with only 15% considering the salesperson "very high" in knowledge. While EV owners intend to continue EV ownership, they voice frustration with public charging infrastructure, with the most common issues being "broken or nonfunctional chargers" or "too few charging locations." On both topics, 34% of respondents noted this as at least a "moderate concern." However, there was significant variation by charging network, with the Tesla Supercharger network scoring significantly better than its competitors on every metric. Public fast charging has room for improvement.

<p>90%</p> <p>90% of EV owners are "likely" or "very likely" to purchase an EV as their next vehicle.</p>	<p>83%</p> <p>83% of owners and prospective owners were satisfied with finding the information they needed to buy/lease an EV.</p>	<p>15%</p> <p>Only 15% of EV owners rated dealership salesperson knowledge as "very high." Only 35% rated as "high" or better.</p>	<p>34%</p> <p>34% of those who used DC fast charging noted that broken chargers were at least a "moderate concern;" the same percentage ranked "charging locations are too far apart" similarly.</p>
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Those who do not currently own an EV but are considering purchasing one within the next 12 months share some similarities with current owners, but there are some differences. Like current EV owners, these "intenders" are primarily motivated by environmental and clean air impacts to purchase the vehicle. Still, they are significantly more likely to name cost savings as their most crucial motivating factor (25% do so, versus 18% of EV drivers). They also find EV-specific websites the most valuable source of information on EVs but find less value in EV information resources overall, possibly because they have not yet completed their research. These intenders tended to be older and less likely to earn over \$75,000 per year. Considerers were equally likely as owners to live in a single-family home, with about 85% of respondents falling into this category.

The following report explores these findings in more detail and provides insight into what can be done to encourage further growth in EV adoption.

As a significant motivating factor in EV adoption is air quality and environmental protection, we recommend that this benefit be kept in mind when developing state incentives. Incentives for EVs support a *public good* (cleaner air and a more liveable climate) and do not merely benefit the drivers or owners.

Improving the dealership experience is a key area of Plug In America's expertise, which the report shows is vital to continue expanding our work. We encourage regions and states to implement dealership engagement programs such as PlugStar, which supports, trains, and certifies dealers to sell EVs. This program has proven results in improving customer satisfaction and dealer success in regions where it is implemented.

The most significant problems noted for fast charging networks were broken or nonfunctional chargers (a "major difficulty" or "deal-breaker" for 14% of respondents) and too sparse charging locations (a "major difficulty" or "deal-breaker" for 11% of respondents). These concerns were far less severe among users of the Tesla Supercharger network. Only 3% of Tesla users found broken chargers to be in the two most serious classifications of problems, and only 2% found insufficient charging locations to be of such severity. Publicly-funded charging networks must strive to attain a similar level of driver satisfaction, especially with considerable additional funding for public EV charging in the Infrastructure Investment and Jobs Act.

Overall, the picture is encouraging, with EV drivers very satisfied with their vehicles. While some issues need attention, such as dealership knowledge and public charging reliability, policymakers and industry stakeholders have developed promising solutions to these concerns.

THE STATE OF EV OWNERSHIP

AN EXTRAORDINARY YEAR

The U.S. EV market, including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), doubled in 2022, increasing from around 306,000 vehicles in 2020⁴ to about 607,000 vehicles in 2021.⁵ Market share increased from about 2% of light-duty vehicles in 2020 to about 4% in 2021.

The new models most reported by survey respondents included the Volkswagen ID.4 (131 responses) and the Ford Mustang Mach-E (119 responses). Other new models represented in the survey responses included the Toyota RAV4 Prime, Rivian R1T, Jeep Wrangler 4xE, and Polestar 2.

Notably, EV market share is significantly higher in the car segment, with about 8.5% of new car sales being EVs. But because fewer EV options exist in the much larger light truck segment (minivans, pickup trucks, and SUVs), that segment saw only 3% EV sales. Plug In America expects to see an even broader selection of models in next year's survey, including the light truck segment. Automakers have made numerous commitments to electrification and unveiled plans to produce many new models of electric vehicles. While Plug In America welcomes commitments and plans, we look forward to seeing the actual vehicles on the road.

One of the most anticipated EVs of 2022 will be the Ford F150 Lightning, representing an electric version of the most popular light-duty vehicle in the U.S. market. Assuming Ford can scale up production as it intends, we look forward to seeing many driver perspectives on this vehicle and other new offerings in next year's survey.

MOTIVATION AND INFORMATION

Understanding what motivates EV drivers and where they found value in their EV-buying experience can help refine new offerings and move the market forward.

The motivating factor for current EV owners in purchasing the vehicle is crystal clear—the environment and air quality. Over 50% indicated this was a "most

⁴ Gohlke, D., and Y. Zhou, "Assessment of Light-Duty Plug-in Electric Vehicles in the United States, 2010 – 2020," Argonne National Laboratory, Energy Systems Division, Document ANL/ESD-21/2. June 2021.

⁵ Argonne National Laboratory, Energy Systems Division, "Light Duty Electric Drive Vehicles Monthly Sales Updates," <https://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates>, accessed January 27, 2022.

important" consideration in buying an EV. Figure 1 displays the proportion of owners who indicated that a factor was "most important" to them when considering the purchase of an EV.

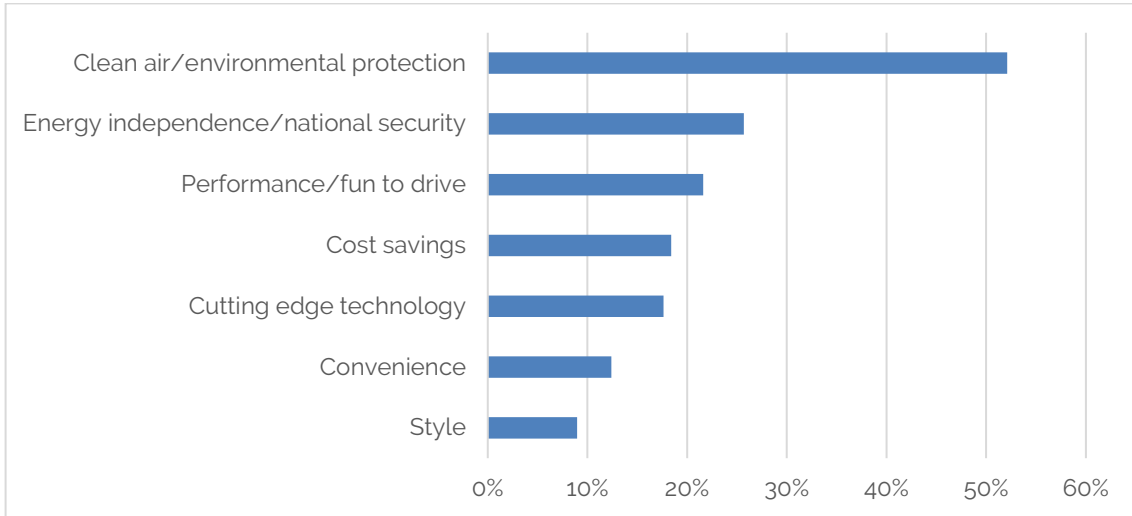


Figure 1: Percentage of EV owners indicating a factor is a "most important" purchase consideration

When asked to select the most important factor, clean air and environmental protection came in first, with cost savings a distant second, as shown in Figure 2.

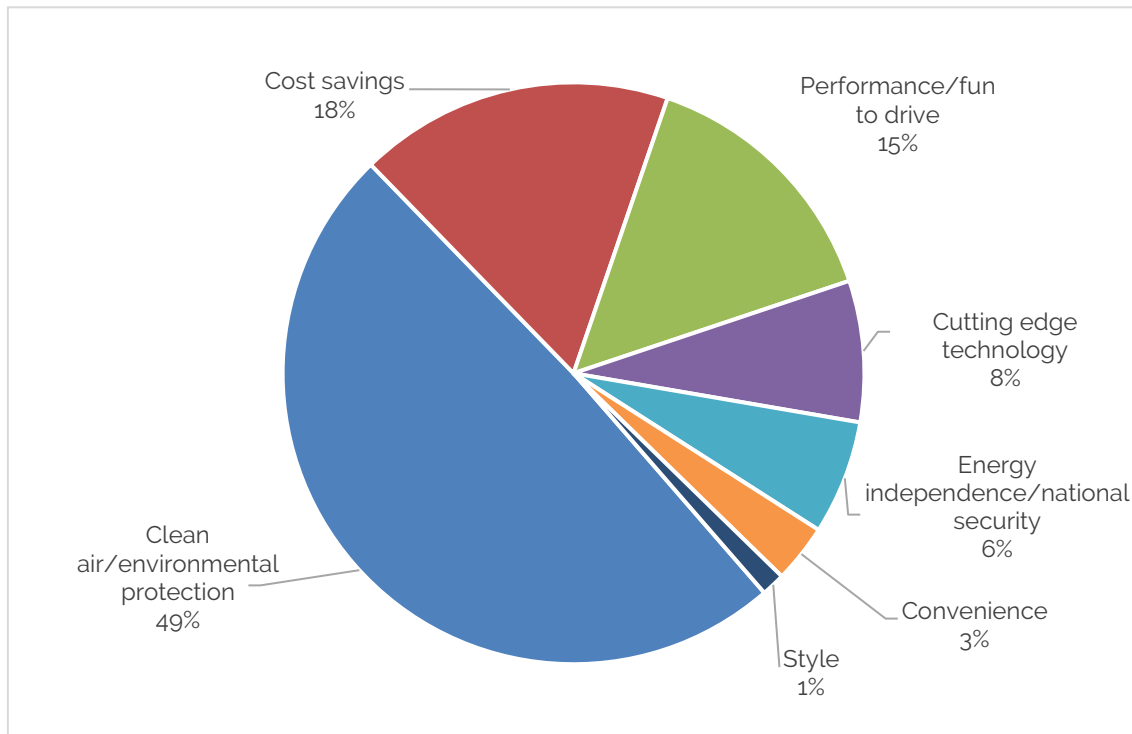


Figure 2: Single most important motivating factor for EV owners

The strong desire for environmental protection also manifests in a preference for charging EVs with renewable energy to achieve even greater emission reductions, as seen in Figure 3.⁶

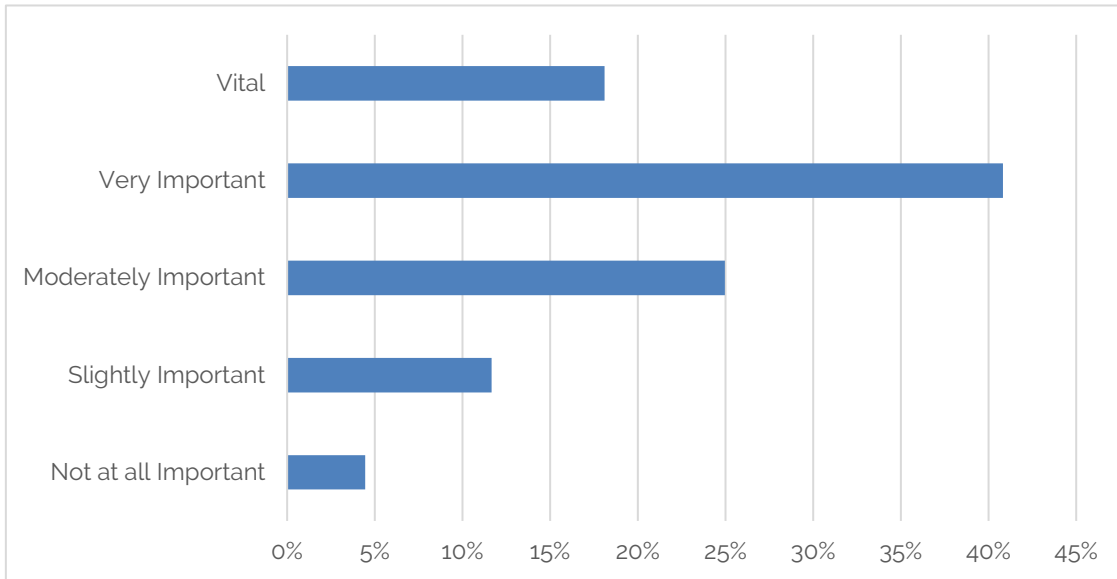


Figure 3: Responses to "How important is it that the electricity used in an EV comes from renewable energy?"

Economic factors were also significant considerations when deciding to purchase an EV; Figure 4 indicates the most influential.

⁶ The vast majority of the country (92%) lives in regions where an EV provides at least a 50% greenhouse gas emission reduction compared to a gasoline vehicle (<https://blog.ucsusa.org/dave-reichmuth/are-electric-vehicles-really-better-for-the-climate-yes-heres-why>) even when charged with grid electricity; purchasing green power achieves even greater emission reductions.

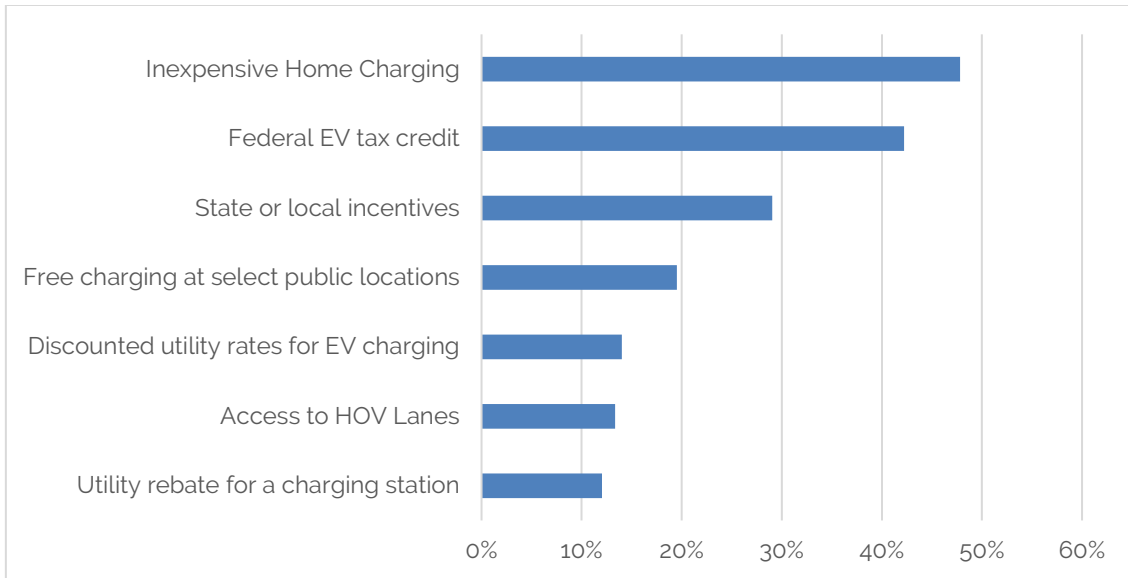


Figure 4: Percentage of EV owners indicating a factor is "critical" or "very influential" on their purchase decision

Access to low-cost home charging was the most significant economic factor in EV adoption. The federal tax credit (for vehicles that are eligible for it) has slightly declined in importance since our prior survey since a smaller fraction of EVs qualified for it. EV drivers who bought Tesla or GM vehicles in 2021 would have designated the federal tax credit as "irrelevant" since they were not eligible. Plug In America is working to restore this tax credit and make it available to more drivers for a longer period of time.

In addition to motivations for purchasing the vehicle, owners were surveyed regarding the value of varying sources of EV information in making that purchase decision. A similar dominance exists regarding information sources deemed "essential" or "very valuable," with EV-specific websites receiving these ratings for 60% of owners. Online forums and video reviewers, not asked about in our previous survey, proved to be popular sources of information. Ride-and-drive events were also significant sources of information. Plug In America and its national and local partners conduct hundreds of ride-and-drive events across the country during Drive Electric Earth Day and National Drive Electric Week. Figure 5 displays the proportion of owners who indicated that an information source was "essential" or "very valuable" to them.

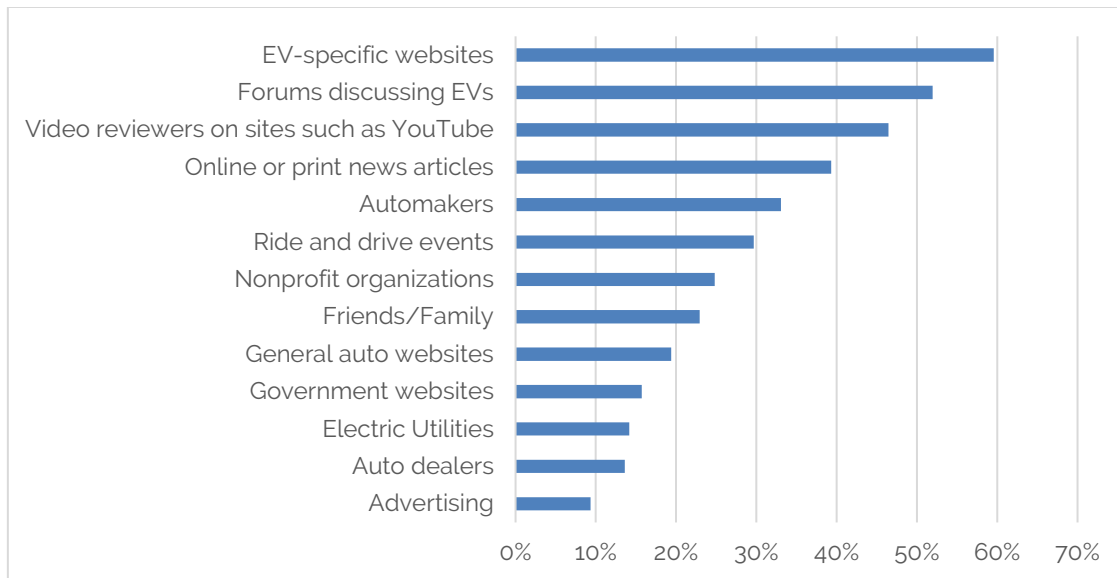


Figure 5: Percentage of EV owners indicating an information source is "essential" or "very valuable"

Continuing analysis of what motivates EV buyers and what they consider the most valuable and trusted information source will be critical to creating and maintaining further momentum in the retail space. Value systems will likely continue to evolve as electric vehicles become more mainstream, appealing to new demographics, and the nature of information access continues to change.

Electric utilities were not highly cited as sources of information on electric vehicles, likely because such entities are only now becoming involved in significant education and outreach efforts.⁷ Many states allow or require electric utilities to provide their customers with information about energy-efficient technologies such as high-efficiency air conditioners or water heaters. It is less common for utilities to promote EVs, even though they are highly efficient and can reduce greenhouse gas emissions and place downward pressure on electricity rates. As EV-specific websites were recognized as a valuable source of information, we note that Plug In America has developed white-labeled utility-specific versions of its PlugStar site to assist utilities in EV education and outreach.

It is also notable that advertising for EVs continues to be virtually non-existent as a source of information, as it was in our previous survey. Only 7% of EV owners and 6% of intenders found advertising a "very valuable" source of information. It is also notable that automakers were trusted to a much greater degree than auto dealerships; 20% of EV owners considered the automaker a "very valuable" source of information, whereas only 9% felt the same about dealerships.

⁷ For more information on utility education and outreach programs, see the Plug In America white paper, *The Missing Piece on Meeting Transportation Electrification Goals: Utility Education and Outreach Programs*, at <https://pluginamerica.org/wp-content/uploads/2020/12/EO-White-Paper.pdf>.

Over 80% of owners indicated that they were *generally* satisfied with finding the information they needed to buy or lease an EV, but only 40% reported that they could find *all* the information they needed without difficulty, as seen in Figure 5. Among the others, the most common information lacking was cold-weather performance, with 26% of respondents noting that information was difficult to find. Respondents generally found ample information on available vehicle models and characteristics; Plug In America offers that information through our PlugStar Shopping Assistant⁸ and our printed Electric Vehicle Guide.⁹ We provide general information on cold-weather EV driving¹⁰ but do not have model-specific information for all EVs. Manufacturers should share information about expected range loss in cold temperatures, as this can vary significantly based on the battery and the vehicle heating system.

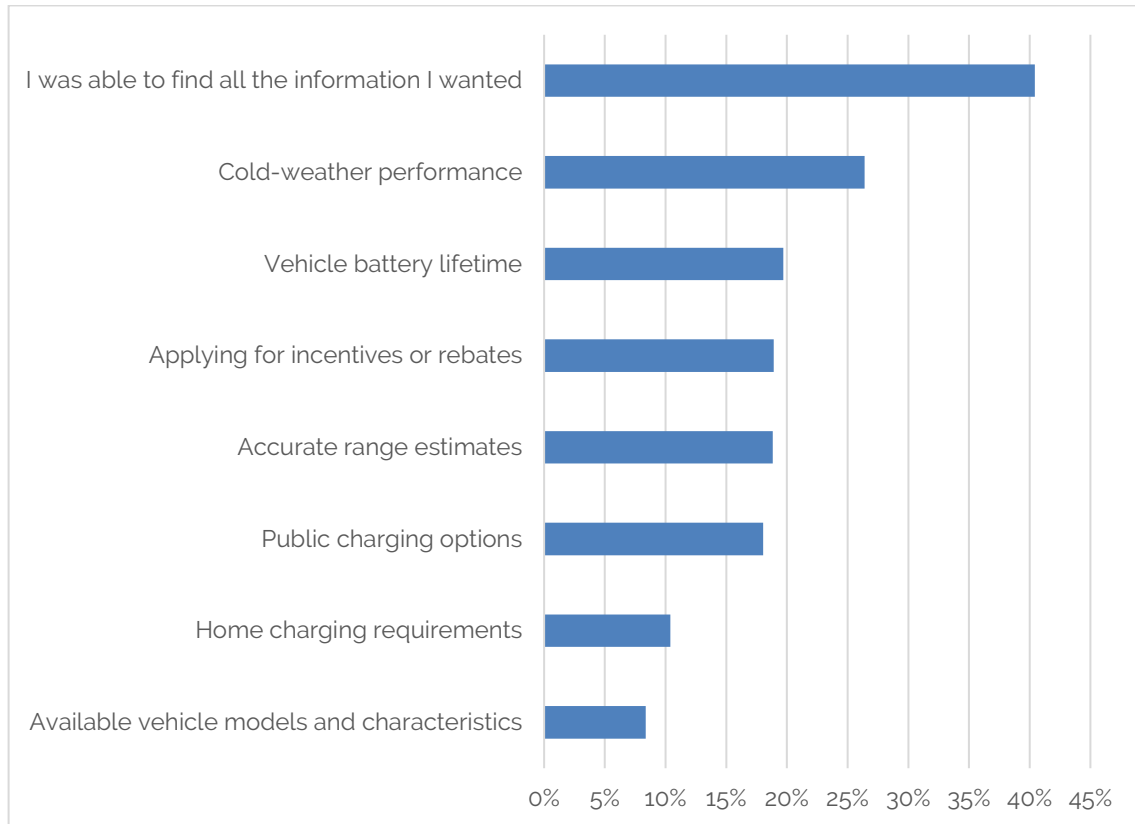


Figure 6: Responses to "What information, if any, did you have difficulty finding?"

⁸ <https://plugstar.com/cars>.

⁹ 2021 guide available at <https://media.ndew.org/r/pia-ev-guide-ndew-2021.pdf>.

¹⁰ See <https://pluginamerica.org/ev-tips-for-winter-weather/>.

We do note that our survey sample is not representative of a cross-section of the *entire* potential car-buying public; it still features a predominance of innovators and early adopters. Subsequent surveys will ask respondents how long they have been driving an EV to ascertain differences in motivating factors and information sources for more recent EV drivers.

THE CONSUMER EXPERIENCE - PURCHASING AND OWNERSHIP

The EV market is full of satisfied owners, with 90% stating that they were "very likely" (77%) or "likely" (13%) to purchase an EV as their next vehicle. BEVs were more common in our survey; 85% of EV owners had at least one BEV, while 28% had at least one PHEV. A full 34% of EV owners did *not* have a conventional internal combustion engine vehicle in their household.

EV owners were somewhat satisfied with the purchasing experience. Only 15% of customers who shopped at a dealership rated the salesperson's knowledge about EVs as "very high." While manufacturers provide informative model-specific training to dealerships, Plug In America has found that dealers often need more tools to answer questions about the entire EV ecosystem, including charging infrastructure, rebates, and policies. Figure 7 displays the proportion of survey responses by the rating of salesperson EV knowledge.

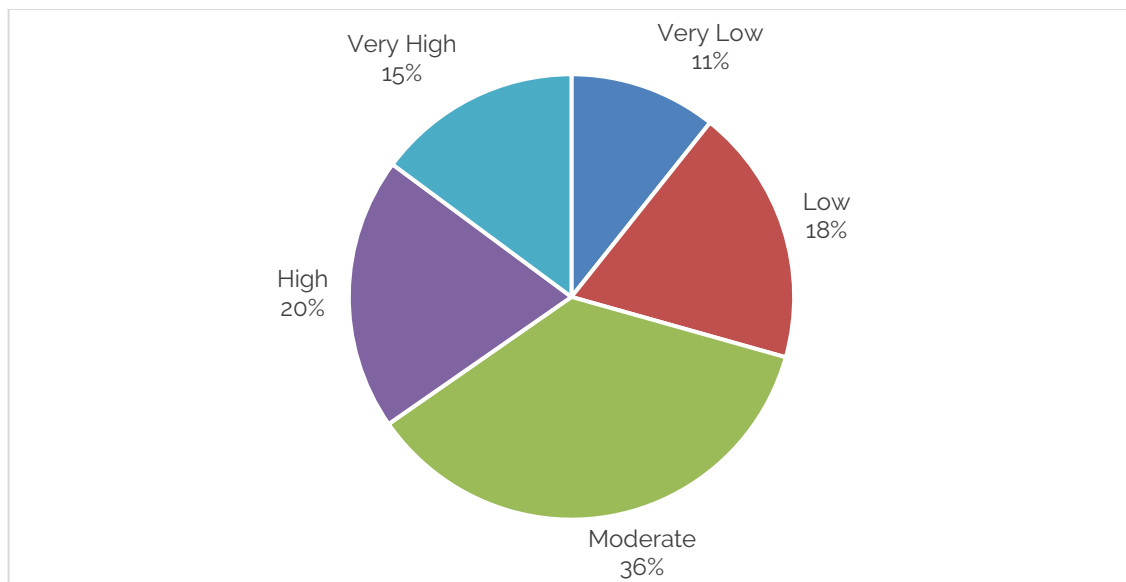


Figure 7: Ratings of salesperson EV knowledge for owners who shopped at dealerships or showrooms

While overall satisfaction with EV ownership is displayed in the intent to remain an EV owner, the process is not without its frustrations. While over 90% of EV owners charge at home daily or weekly, as shown in Figure 8, the majority also charge in public at least occasionally.

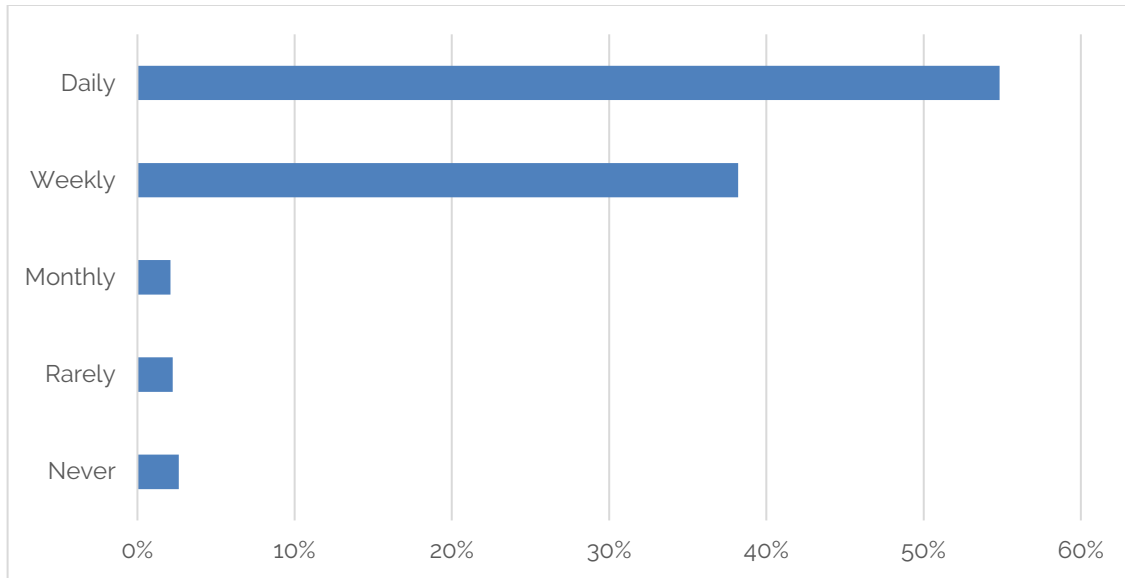


Figure 8: Frequency of home charging among EV owners

Of those respondents who utilized one type of charging location more than any other, home charging was that location for 92%. Another 3% most often used workplace charging, 2% primarily utilized public level 2 chargers, and 2% most often employed fast chargers. About 17% of respondents used multiple locations with equal frequency.

Some 2.6% of EV owners reported *never* charging at home. Of these, 32% reported using workplace charging daily or weekly; 47% reported using public level 2 charging daily or weekly; and 47% reported using DC fast charging daily or weekly.

Level 1 charging remained common for household charging, with about a quarter of EV owners using only 120-V outlets, as seen in Figure 9. These were not only drivers of PHEVs; the five most popular vehicles for drivers with only level 1 charging were the Nissan LEAF, the Chevy Bolt, the Chevy Volt, the Tesla Model 3, and the Toyota Prius Prime. About 30% of LEAF drivers reported using only level 1 charging, as did about 20% of Bolt drivers and 11% of Model 3 drivers.

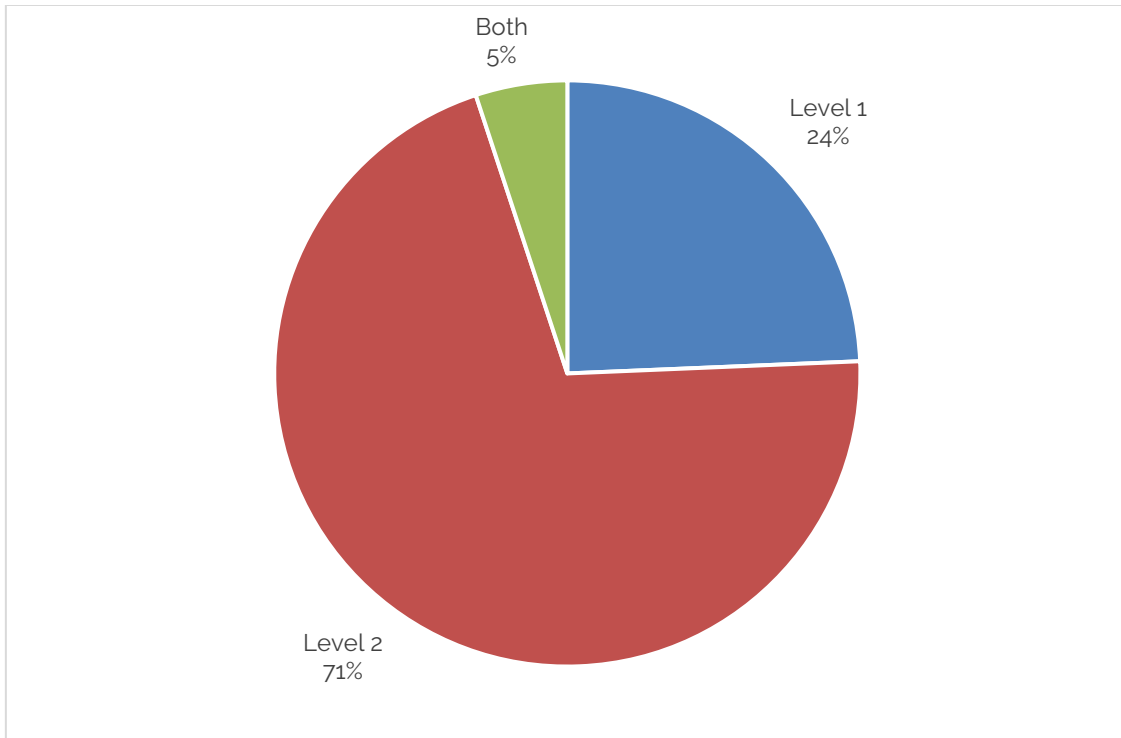


Figure 9: Home Charging Options

Workplace charging was frequently utilized by EV owners who have such charging available to them. Over a quarter of such respondents reported using it weekly, and nearly another quarter reported using it daily, as seen in Figure 10.

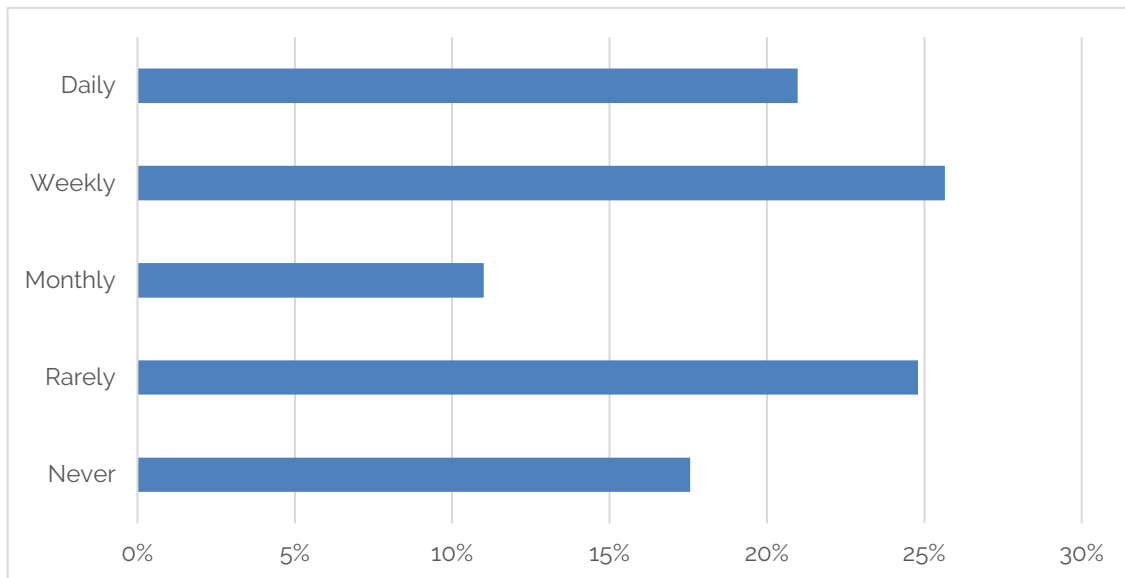


Figure 10: Frequency of workplace charging among EV owners with access to it

The Public Charging Experience

From our prior survey, we changed our question about difficulties with public charging networks to specifically address charging experiences within the past year. Going forward, this will allow us to assess the improvement in such networks. Drivers noted a range of difficulties. These are shown in Figure 11 and are aggregated across all networks.

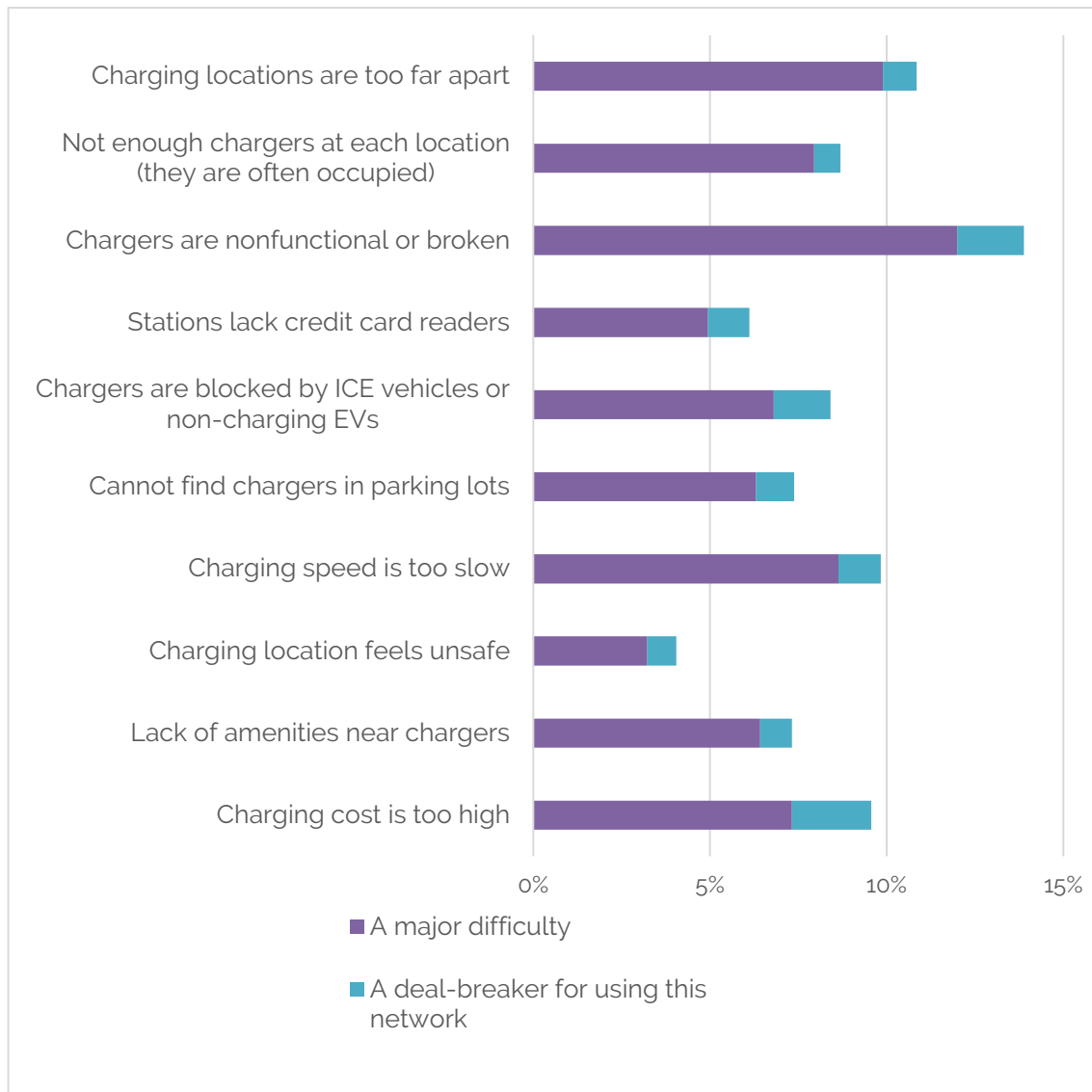


Figure 11: Challenges with DC fast charging

However, the charging experience varies considerably by network. Figure 12 and Figure 13 compare the Tesla Supercharger network to the other major U.S. fast-charging networks. Tesla drivers have access to a proprietary charging network

that differs in several key respects from other networks, and users of that network reported far fewer difficulties.

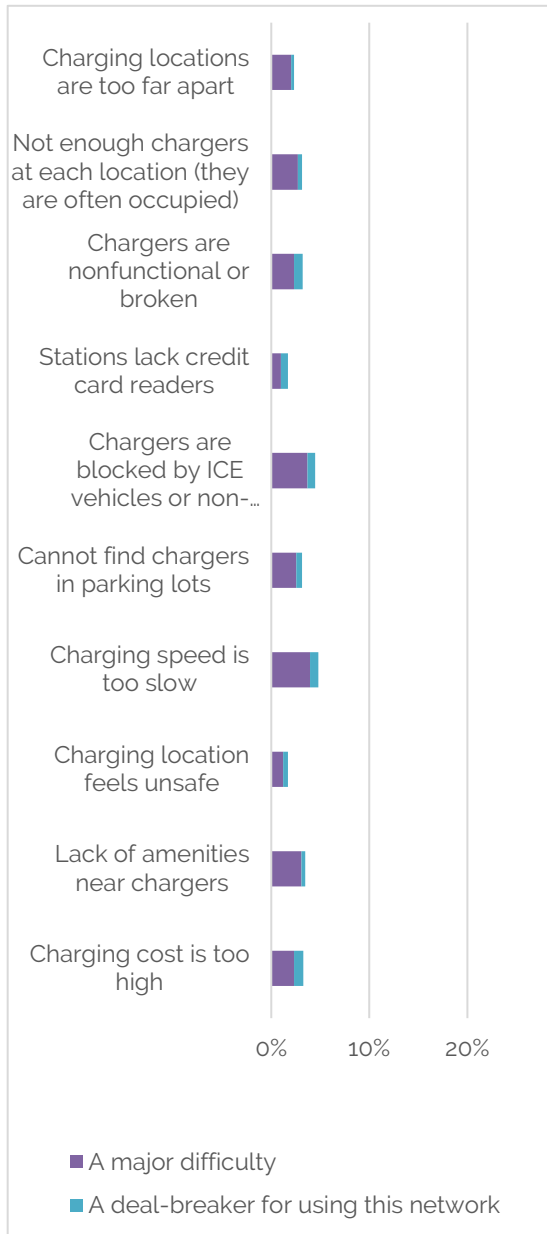


Figure 13: Tesla Supercharger network

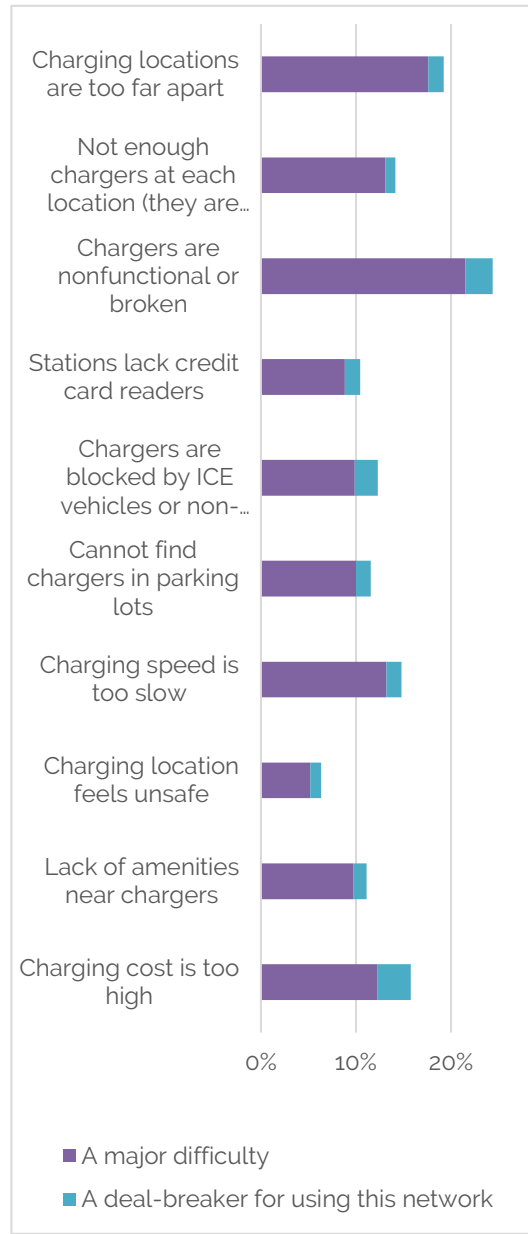


Figure 12: Other major DCFC networks

The problem most often ranked as "a major difficulty" or "a deal-breaker for using this network" was chargers being broken or nonfunctional. At best, this is a nuisance or inconvenience. At worst, an EV driver could be stranded. Negative

experiences caused by nonfunctional charging stations would adversely affect the EV market.

Table 1 shows the most common issues by fast charging network. As can be seen, the non-Tesla networks had similar prevalence of broken chargers, with around a quarter of respondents noting that it was at least a major difficulty.

Network	Most Significant Issue	"A major difficulty" or "A deal-breaker for using this network"
Blink	Chargers are nonfunctional or broken	24%
ChargePoint	Chargers are nonfunctional or broken	25%
Electrify America	Chargers are nonfunctional or broken	26%
EVgo	Chargers are nonfunctional or broken	21%
Tesla Supercharger	Chargers are blocked by ICE vehicles or non-charging EVs	4%

Table 1: Most prevalent issues with fast charging networks

Many public chargers are funded through grant programs. Such programs can impose reliability requirements on stations receiving funding; these may include:

- requirements for redundancy (multiple chargers at a given charging location),
- uptime (establishing a minimum percent of the hours in year that each charger must be functional), and
- maintenance and repair (stipulating a time to initiate repairs from the notification of a charger being nonfunctional).¹¹

Additionally, some state programs offer grants for replacement of existing charging stations, which will be increasingly necessary as early generations of electric vehicle supply equipment (EVSE) reach the end of their service life.

The second most common concern was charging stations being too far apart. This should improve both as additional stations are built, and vehicle range improves.

¹¹ The Northeast States for Coordinated Air Use Management (NESCAUM) recommends that charging supported with public funds be required to maintain a 99% uptime (for DCFC), that there should be multiple chargers at each site to provide redundancy (whether DCFC or level 2), and that any necessary repair efforts should be initiated within 24 hours of a notice of malfunction. See <http://www.nescaum.org/documents/model-contract-provisions-for-public-evse-5-24-19.pdf/download>.

A majority of respondents indicated that the charging speed of their usual network was either "not at all a problem" (44% of respondents) or only "a minor inconvenience" (27%). And when asked about their vehicles, 91% of respondents reported that charging speed was "satisfactory" (71%) or "exceptional" (20%).

Vehicle Characteristics

Acknowledging that many respondents had multiple EVs, respondents were asked about the EV they drove most often. The Tesla Model 3 was the most frequently cited vehicle, accounting for 18% of responses. The next most common EVs were the Nissan LEAF and the Chevy Bolt. The responses are shown in Figure 14, noting all models with 100 responses or more.

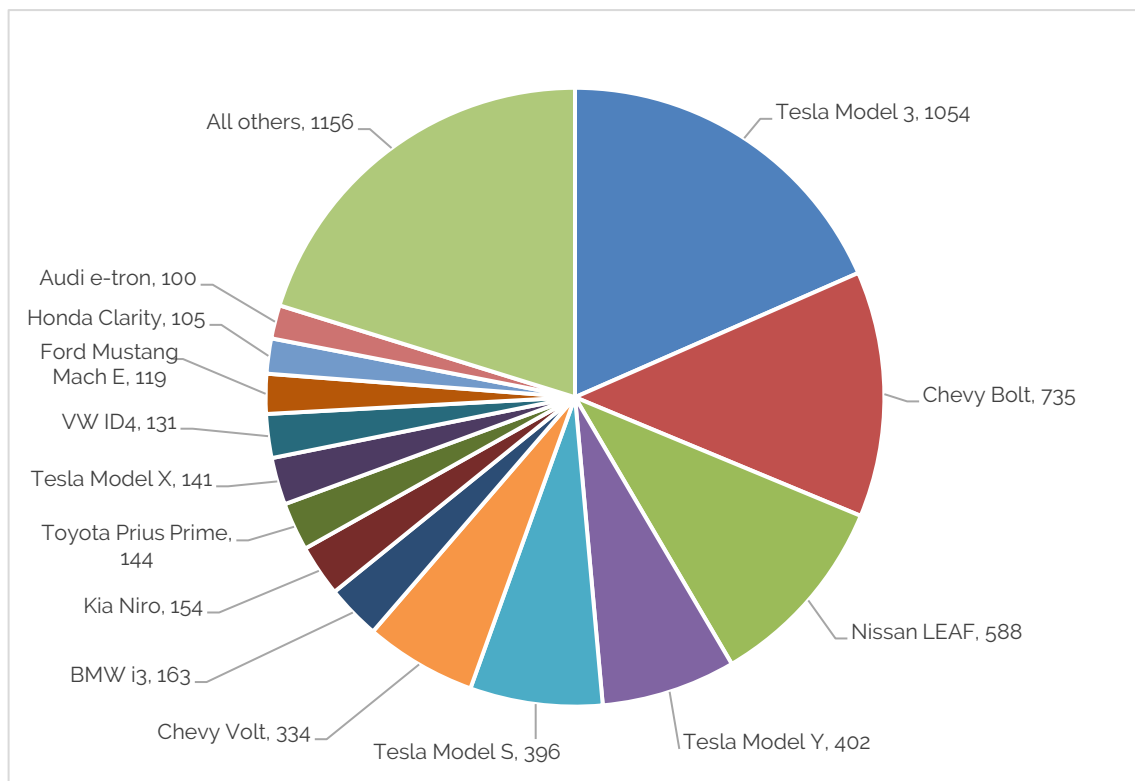


Figure 14: Primary EV of survey respondents

The Ford Mustang Mach-E and the Volkswagen ID.4 saw their first U.S. sales in 2022 and represented the survey's 11th-most and 12th-most common EVs.

A wide range of vehicles constituted the "All others" category, including electric motorcycles, conversions of internal combustion engine vehicles, and small-volume production EVs.

Of those who purchased their EVs (as opposed to building or converting), 80% reported purchasing them new, while 20% bought them used.

Overall, respondents were generally satisfied with their EVs' characteristics, as shown in Figure 15. Note that these are drivers' perceptions and not objective quantifications. For example, the Tesla Model X has more cargo space than the smaller Model Y, but Model Y drivers reported greater satisfaction with their vehicle's cargo space, perhaps due to different expectations.

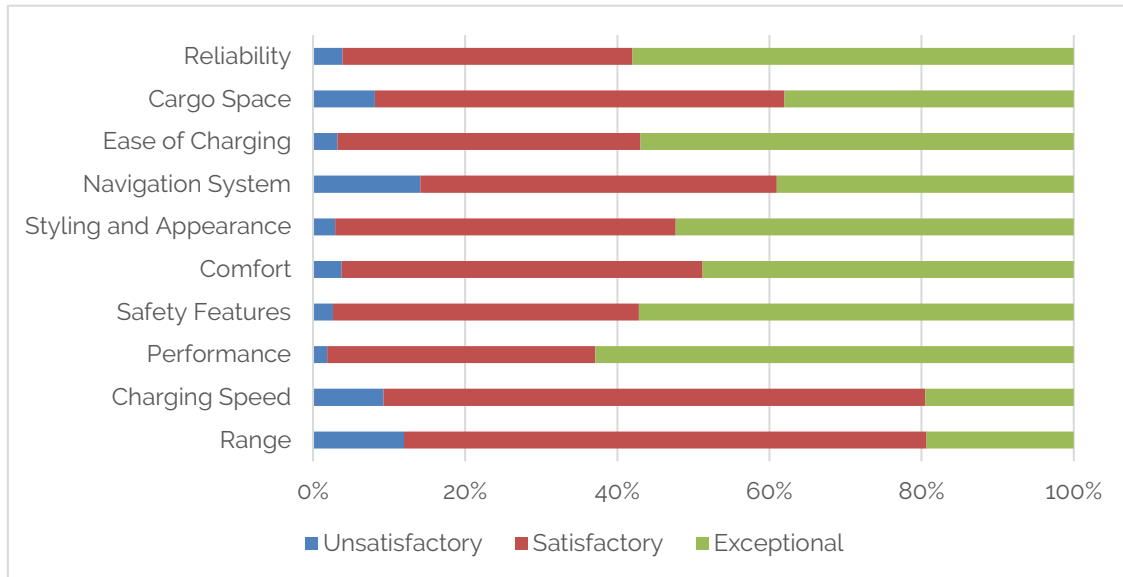


Figure 15: Overall driver satisfaction with EVs

The Tesla Model Y had no less than 40% of respondents rate it as "exceptional" in every category, and the Tesla Model 3 saw at least 39% of respondents rating it such. The Mustang Mach-E received the highest ratings of any EV for "styling and appearance," with 89% of its owners rating it as "exceptional". The Audi e-tron led in "comfort", with 86% calling it "exceptional." Table 2 shows what EV drivers liked most about each vehicle, considering which characteristics were most often rated "exceptional" for that model.

Vehicle	Most Exceptional
Tesla Model 3	Performance
Chevy Bolt	Performance
Nissan LEAF	Reliability
Tesla Model Y	Performance
Tesla Model S	Performance
Chevy Volt	Reliability
BMW i3	Performance
Kia Niro	Safety Features
Toyota Prius Prime	Reliability
Tesla Model X	Safety Features
VW ID.4	Comfort
Ford Mustang Mach-E	Styling and Appearance
Honda Clarity	Ease of Charging
Audi e-tron	Comfort

Table 2: Most "Exceptional" features of each EV with more than 100 responses, as rated by drivers

"Range" and "navigation system" had the most frequent ratings of "unsatisfactory," with the survey-wide frequency of that rating at 12% and 14% for the two categories. Some models had as few as 0.5% calling their range "unsatisfactory," while other models had as high as 29% assigning that rating. We specifically asked about navigation systems due to the key role these can play in helping EV drivers find compatible and available charging stations. Drivers of gasoline vehicles may find gas stations by visible signs towering over highways or marking exit ramps; on the other hand, EV drivers often rely on apps, whether on their phones or built into the vehicles. A well-designed navigation system can make an EV much more user-friendly.

Charging speed is sometimes portrayed as a barrier to EV adoption; however, only 9% of respondents felt that charging speed was "unsatisfactory" for their vehicle, while 20% found it "exceptional." In general, newer models were more likely to be rated "exceptional" and less likely to be rated "unsatisfactory," although "satisfactory" was the most common rating for all models.

Ride-Sharing and Delivery

While only a small fraction of respondents reported using their EVs for ride-sharing or delivery services, this fraction still constituted 384 respondents. Those respondents were generally satisfied with the viability of the vehicle and of

charging networks for such applications, as seen in Figure 16 and Figure 17. However, there is room for improvement.

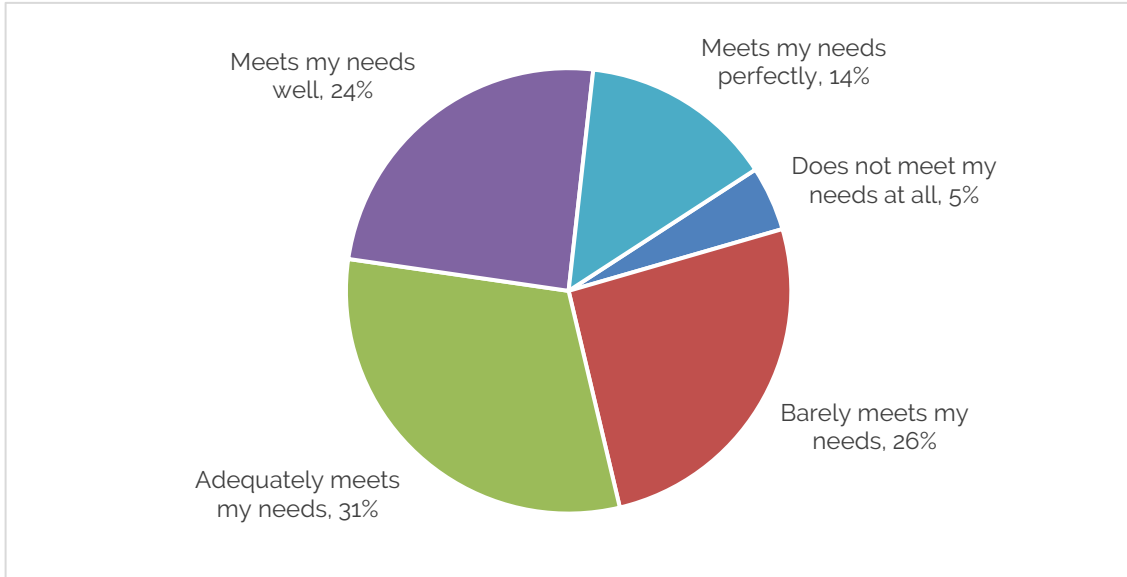


Figure 16: Responses to "How well does an EV meet your needs for ride-sharing and/or delivery services?"

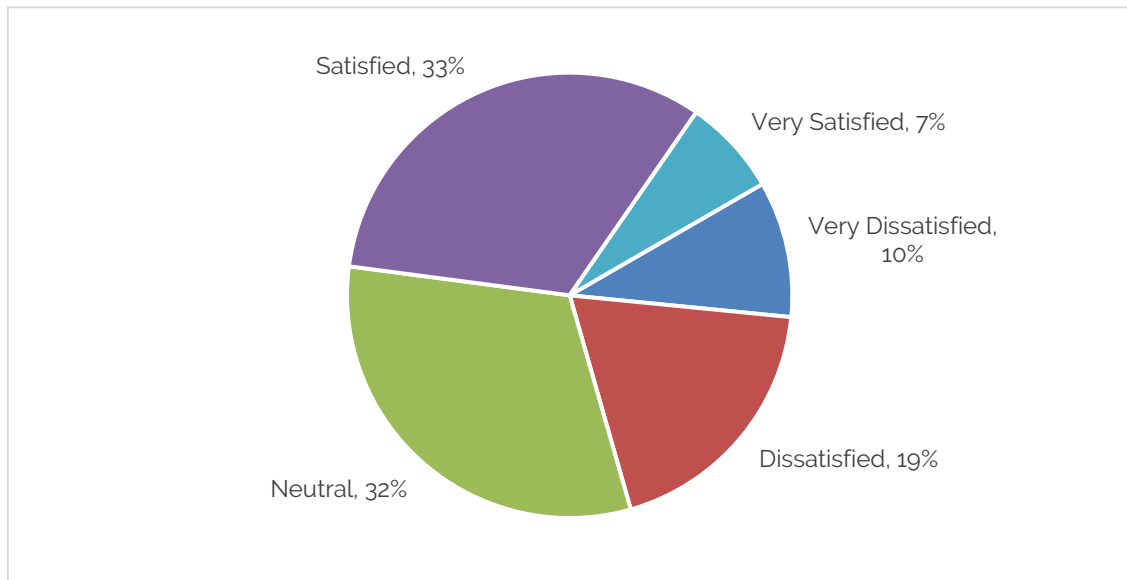


Figure 17: Responses to "How satisfied are you with public charging for ride-sharing or delivery services?"

EV "INTENDERS" - THE NEXT WAVE OF OWNERSHIP

CONVERGENCE AND DIVERGENCE

Those who do not currently own an EV but are considering purchasing one within the next 12 months share some similarities with current owners. Like current EV owners, these "intenders" are motivated by environmental and clean air impacts but are more interested in cost savings. The early adopters who are current EV owners have, in many cases, paid a premium that subsidized this developing technology and did not necessarily realize significant cost savings. Figure 18 compares the proportion of intenders who indicated that a factor was "most important" to them when considering the purchase of an EV to that of owners.

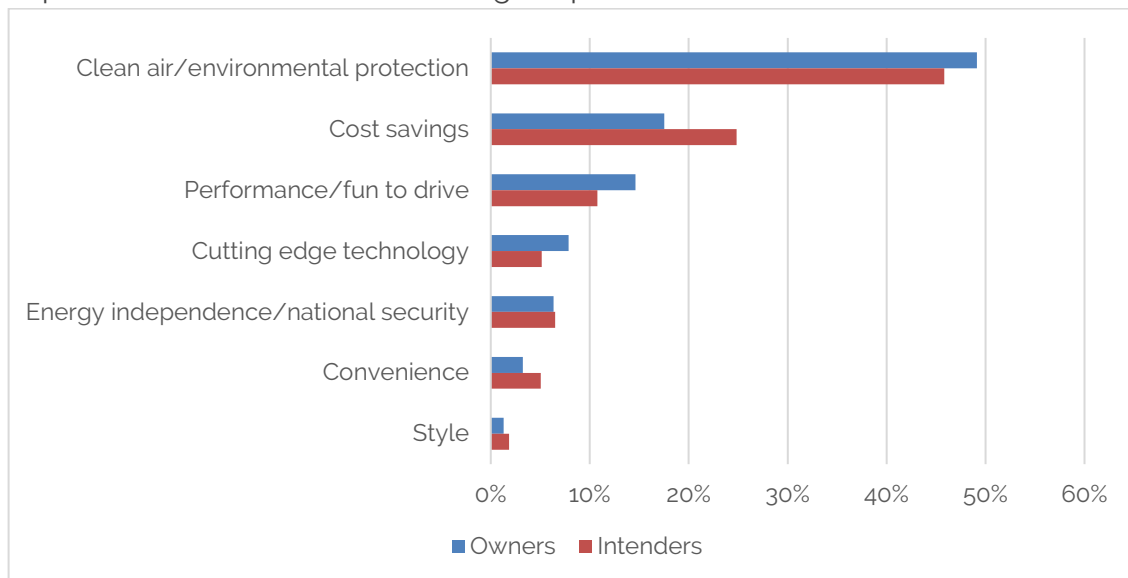


Figure 18: Percentage of respondents indicating a factor is the single most important purchase consideration

We considered that perhaps our membership (including those who do not yet have EVs) might skew more towards the environmental goals, so we compared our membership responses to those from social media advertising. Differences were minor, as seen in Figure 19. Across all categories, "clean air/environmental protection" was most frequently named the single most important motivating factor by a wide margin, followed by cost savings (which were more frequently cited by intenders than owners).

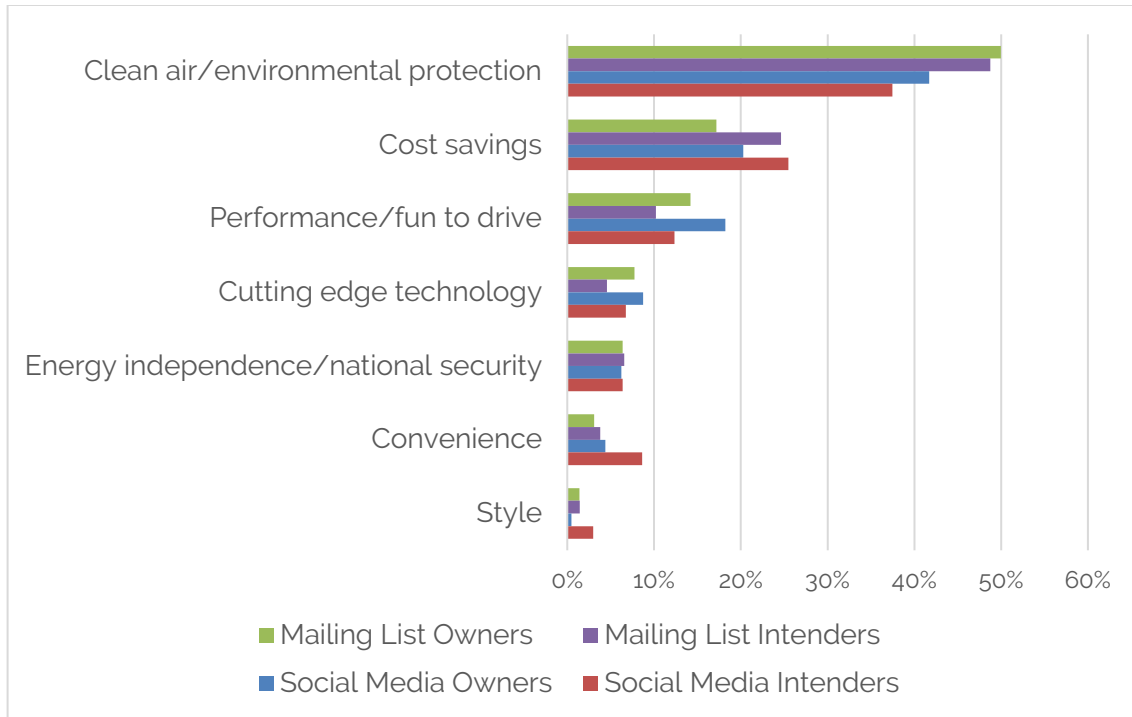


Figure 19: Most important motivating factor by source of response

Intenders also find EV-specific websites to be the most valuable source of information on EVs but have derived less value from information resources as a whole than current owners. This disparity is greater for more specialized resources such as EV-specific websites or forums and is not as great for more generalized resources. Figure 20 compares the proportion of owners and intenders who indicated that an information source was "very valuable" or "essential."

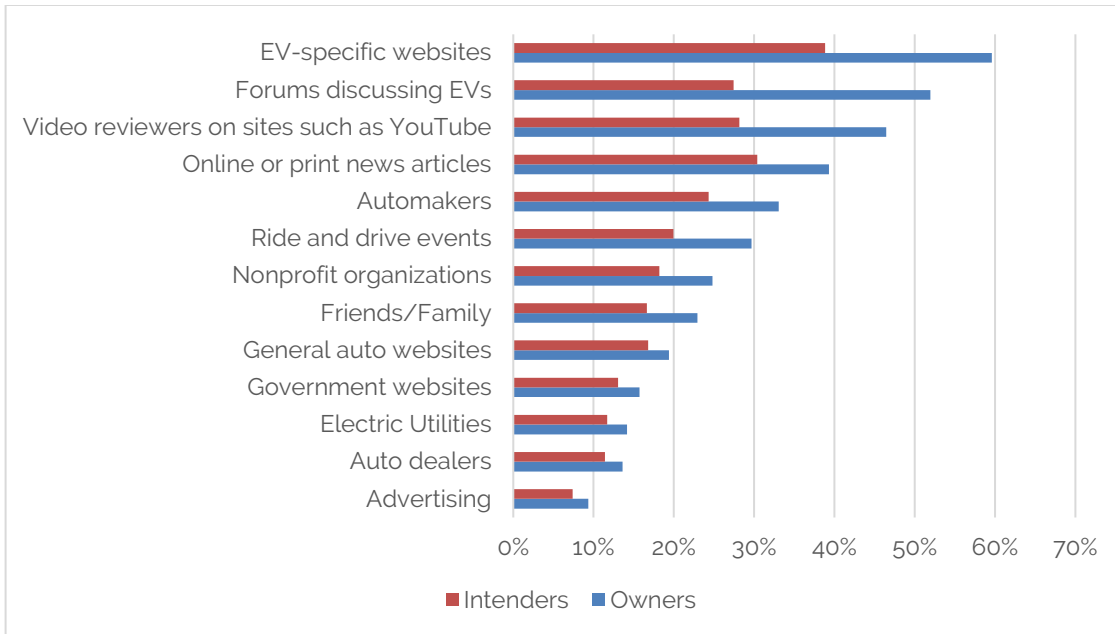


Figure 20: Percentage of respondents indicating an information source is "very valuable" or "essential"

The demographics of population groups also offer cases of similarity and divergence. Intenders are older; they were younger in our 2020 survey. They are less likely to earn over \$75,000 per year. Figure 21 and Figure 22 display the demographic makeups of the two response groups.

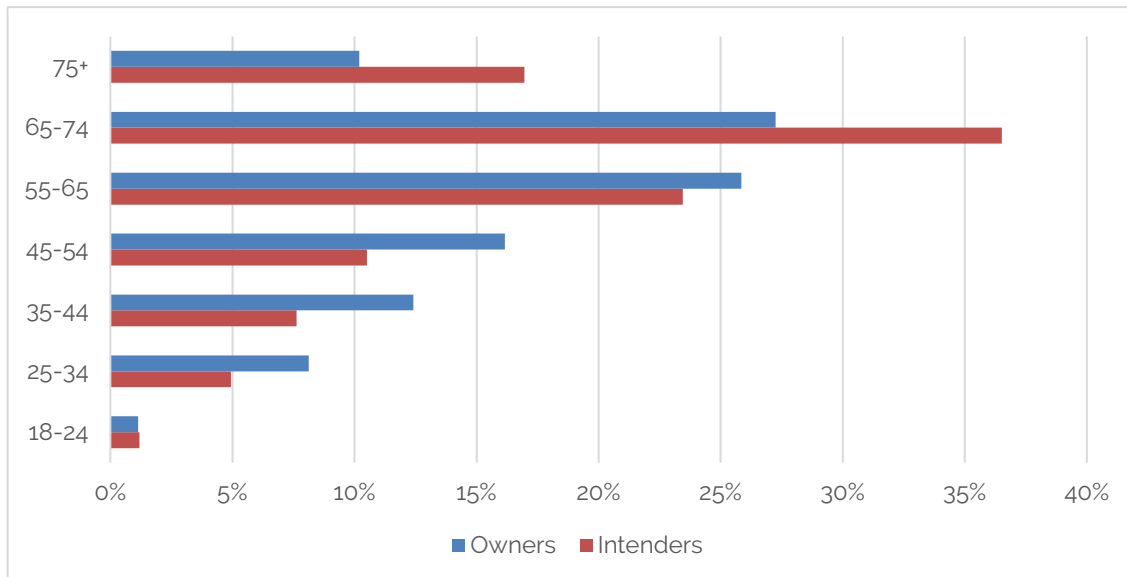


Figure 21: Age distribution of respondents

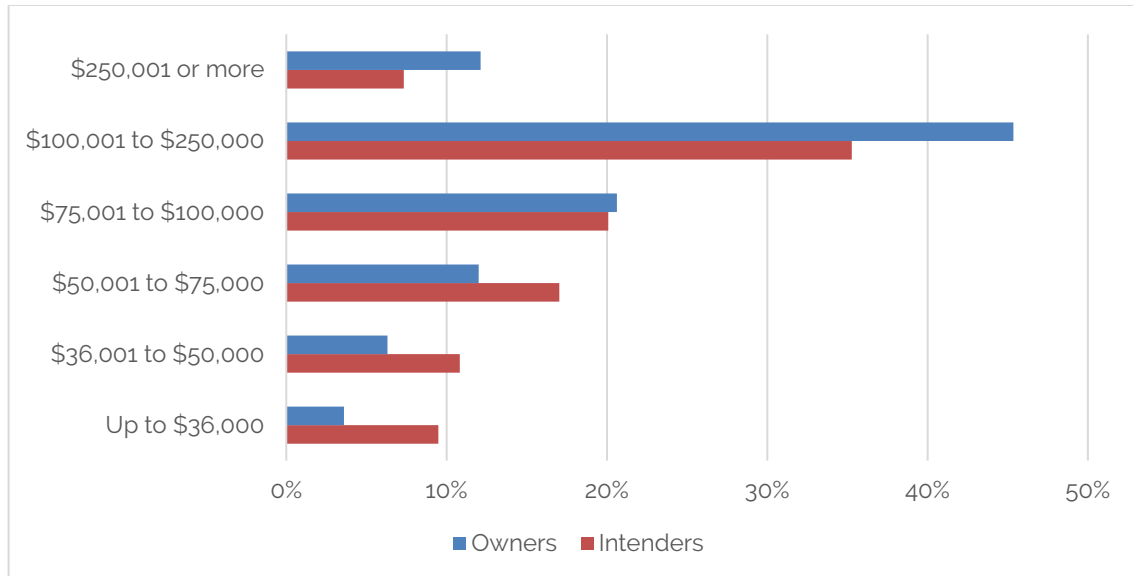


Figure 22: Income distribution of respondents

There are relatively few used EVs on the market, and EVs are still an emerging technology, so the profile of EV buyers does skew higher-income. About 20% of respondents reported buying their EV used, not an insignificant amount—however, in the U.S., about *two-thirds* of vehicle sales are used cars and trucks. This segment became very expensive in 2021 due to supply chain issues. The used EV proportion will increase as more used EVs come onto the market. As that occurs, buyers of used EVs should be supported with credible and reliable information on vehicle performance and battery condition.¹²

Single-family homes with garages offer a lower-cost charging solution than most multi-unit dwellings, and single-family home residents represented 85% of EV owners and 84% of EV intenders. Access to low-cost home charging was one of the most significant economic factors in EV adoption, so it is not surprising that single-family home residents dominate our demographics. Apartments and condominiums may have a garage or parking lot with dedicated parking spaces, or a parking lot with non-dedicated spaces, or may not have parking at all (requiring residents to rely on street parking). Installing charging infrastructure for such buildings does carry a higher capital cost, especially if done as a retrofit where trenching through concrete or asphalt is required. The cost of EV charging is much less if addressed during building construction. Building codes to require new construction to have a significant fraction of "EV-ready" parking spots will enable greater adoption of EVs by residents of multi-unit dwellings.

¹² Plug In America has developed a Used Electric Vehicle Buyer's Guide, available online at <https://pluginamerica.org/why-go-plug-in/used-electric-vehicles/>

CONCLUSIONS & FURTHER RESEARCH

EV owners are very positive about their experience, with 90% intending to purchase an EV as their next vehicle. EV owners recognize that the vehicles provide a public benefit in improving air quality and reducing greenhouse gas emissions, and this is an important motivating factor in EV adoption.

EV drivers were generally quite happy with the vehicles themselves, although there were some concerns about vehicle range and navigation systems. Navigation systems are crucial for helping EV drivers find compatible and available charging stations and represent a potential area of improvement. Range represents another potential area for improvement, although this concern is in part tied to the lack of charging stations. Not only are manufacturers generally shifting to longer-range vehicles as battery costs fall, but charging networks are installing additional stations.

Still, at present, lack of sufficient charging stations is the second-most prevalent concern about public fast-charging networks, with 34% of respondents noting that it was at least a moderate concern. It was essentially tied with broken or nonfunctional chargers as a problem, although broken chargers were more frequently cited as being a "major concern" or a "deal-breaker." Insufficient charging stations may deter an EV driver from taking a trip; broken charging stations may leave an EV driver stranded. Robust requirements for grant programs, including any developed under the new infrastructure bill, can ensure reliability (redundancy, uptime, and maintenance requirements). Additionally, chargers being blocked by non-charging vehicles remains a concern; implementing and enforcing laws to prohibit this behavior will be increasingly important as the EV market develops.

Most EV drivers charge at home, but workplace charging is also commonly used by those who have access to it. Plug In America supports workplace charging as a convenient solution for many EV drivers, including those without access to home charging. It is relatively low-cost for the workplace and allows the employer to advance sustainability significantly.

Drivers noted that dealership knowledge is lacking; Plug In America's PlugStar program can resolve this. In addition, customer-facing websites (also a component of PlugStar) were cited as the most valuable information sources. Drivers most commonly reported difficulty finding information about cold-weather EV performance, and we encourage automakers to make such information available.

The demographics of our respondents implicitly indicate a gap in multi-unit dwelling charging availability; building codes, grant programs, and focused work with multi-unit dwelling properties can help overcome this obstacle.

Future surveys will include questions about the length of EV ownership to see if there are differences in perceptions or behavior between the earlier adopters and the more recent ones.

Plug In America looks forward to helping resolve the remaining barriers to EV adoption and looks forward to learning more about EV drivers with future surveys. In particular, we will look for signs of progress on the dealership experience, the public charging experience, and the availability of charging for multi-unit dwellings. We also look forward to seeing new EV models in our 2022 survey and an increase in used EV sales as the used market develops. We stand ready to provide consumer education through PlugStar and our ride-and-drive events and look forward to working with utilities and other partners in these efforts.

AUTHORS AND ACKNOWLEDGMENTS

ABOUT PLUG IN AMERICA

Plug In America is a non-profit, supporter-driven advocacy group. Our mission is to drive change to accelerate the shift to plug-in vehicles powered by clean, affordable, domestic electricity to reduce our nation's dependence on petroleum, improve air quality and reduce greenhouse gas emissions. Plug In America helps consumers, policymakers, auto manufacturers, and others to understand the powerful benefits of driving electric by providing practical, objective EV information.

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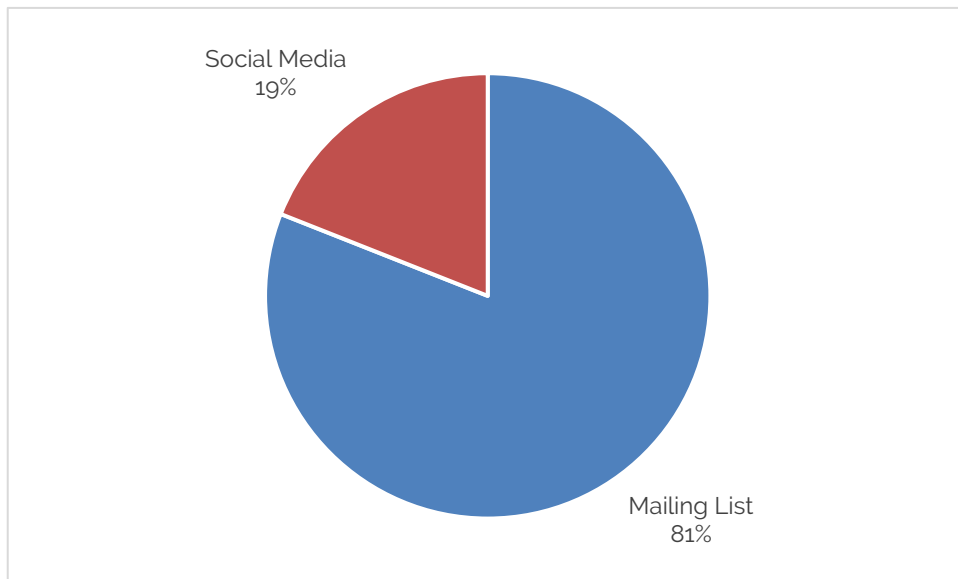
ACKNOWLEDGMENTS

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SURVEY METHODOLOGY AND RESPONSE SUMMARY

Plug-In America surveyed over 8,000 EV owners and those considering purchasing EVs in December 2021. The survey was promoted in the Plug In America e-mail subscriber list three times between December 7 and December 30, 2021 and advertised on social media between December 7 and December 28, 2021. In both cases, respondents were offered an opportunity to win a \$250 gift card. Below is a summary of data by source, including sample sizes.

Responses By Data Source



Responses By State

