Clean Transportation
COLLABORATIVE

ENSURING EQUITABLE ACCESS TO ELECTRIC VEHICLE SUPPLY EQUIPMENT IN DISADVANTAGED COMMUNITIES: KEY ISSUES AND CONSIDERATIONS

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Texas A&M Transportation Institute
Georgia Tech College of Engineering
Johns Hopkins Bloomberg School of Public Health
College of Engineering The University of Texas at El Paso
UC Riverside CE-CERT

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The Center for Advancing Research in Transportation Emissions, Energy, and Health's (CARTEEH) Clean Transportation Collaborative (CTC) is developing a series of white papers that document and summarize current literature and best practices to determine the state of America's transition to clean transportation. The white papers may also identify gaps that can be addressed by research; document issues relevant to policymakers; and present potential solutions for practitioners and industry leaders to consider during this transition to clean transportation. The white papers are intended to facilitate discussion within the CTC and to allow for the development of targeted research and analysis on specific topics related to clean transportation.

1. Introduction

As the United States strives to decarbonize its transportation sector, the motivation to transition light-duty consumer vehicles from internal combustion engine vehicles (ICEVs) to lower emission vehicles continues to gain traction. In the near-term, battery electric vehicles (EVs) are the most widely available vehicles that eliminate tailpipe emissions, and there is anticipation that a significant proportion of light-duty consumer vehicles will transition from ICEVs to EVs within the next several decades. This is supported by commitments from several prominent vehicle manufacturers to transition some, if not all, of their new vehicles from ICEVs to EVs as well as federal legislation that supports the development of EV charging infrastructure. However, one significant consideration that the transportation industry must consider is how and to what extent EVs will be accessible to all segments of the U.S. population. To fully realize the benefits of an electrified transportation sector—including individual benefits such as cost savings on gas and maintenance and societal benefits such as reduced traffic-related air pollution (TRAP) and greenhouse gas emissions—it is imperative that all segments of the population that rely on automobile travel have access to EVs and EV supply equipment (EVSE). When considering the barriers that impact equitable access to EVs, the two that are most likely to disproportionately affect historically disadvantaged communities (DACs) are (a) the ability to purchase EVs and (b) access to EV charging stations or EVSE (Dixon et al., 2022). With respect to purchasing EVs, several unknown factors make it challenging to knowledgeably discuss the long-term economics of EV purchase prices. Some of these unknown factors include: the true cost to scale manufacturing of EVs to meet the demand of the U.S. automotive industry, the long-term maintenance costs of EVs, and the yet to be fully established secondary market for EVs. Due to the fact that these factors are reliant on the market forces that are outside of the scope of the public-sector transportation industry, this paper will instead focus on the primary considerations that policymakers, planners, and other stakeholders must consider regarding equitable access to EVSE, as opposed to access to EVs themselves.

The remainder of this paper will focus on providing context, background, and key considerations that inform transportation industry stakeholders regarding equitable access to EVSE. The key considerations discussed include: (1) availability and access to EVSE, (2) safety considerations for EVSE in DACs, and (3) the economic implications of siting EVSE in DACs.

2. Background

Equity in transportation refers to the systemic and fair treatment of all road users, particularly in underserved or disadvantaged communities (United States Department of Transportation [USDOT], 2022b; Brodie, 2015). There has been an increased emphasis on equity in transportation in recent years, with the Justice40 Initiative being an excellent example of the federal government providing guidance to the transportation industry regarding how to effectively incorporate equity into transportation decision making. The Justice40 Initiative was established in 2021 to address decades of underinvestment in disadvantaged communities that have been disproportionately impacted by climate change and pollution. The program's strategic focus on equity aims to promote social and economic opportunities through equitable access to affordable and reliable transportation options (USDOT, 2022b). This initiative is relevant when considering how to ensure equitable access to EVSE in DACs since the distribution of EVSE for public use will have an impact on DAC members' ability and willingness to purchase and drive EVs, which in turn has an impact on mobility options and clean air.

The remainder of this section provides context that frames this paper's discussion of equitable access to EVSE. The first subsection provides a brief discussion about the recent increase in the prevalence of light-duty consumer EVs in the American automotive market, followed by background on recent federal policies that are intended to support the proliferation of EVs in the United States. Finally, this section will provide framing and context on how equity is viewed through the lens of transportation and how access to EVs fit into the broader context of equity—as defined by USDOT.

2.1. How EVs Have Continued to Gain Momentum within the Automotive Industry

EV ownership has grown substantially over the past decade. In 2011, there were only approximately 22,000 EVs on U.S. roads. That number has soared to over 2 million EVs in 2021 (Colato & Ice, 2023). Unsurprisingly, this resulted in minimal business case incentives to invest in EVSE in the early days of EV ownership. During this period, EVSE was characterized by small pockets of private charging stations associated with specific vehicle makes, such as Tesla-only chargers. This often resulted in EVSE that were mostly distributed in higher income neighborhoods consisting of residents who could afford high-priced EVs (Hsu & Fingerman, 2020). However, as consumer demand for EVs has grown, several vehicle manufacturers—both legacy automobile manufacturers and new startup manufacturers—have successfully brought new EVs to market. This increase in demand has led to the purchase price of EVs aligning more closely with their ICEV counterparts. Several of the early model EVs that entered the market in the early 2010s have become less expensive to purchase while offering longer ranges (Henderson, 2020). One example is the Chevrolet Bolt EV; in 2017, the Bolt EV's inaugural year, the purchase price started at $37,495, with a range of 238 miles. In 2023, the Bolt EV's starting purchase price fell to $26,595, while its range increased to 259 miles (Blanco, 2022). With growing market share, increasingly competitive prices, longer ranges, and tax-friendly federal rebates (currently $7,500 for a new EV purchase), EV ownership appears poised to continue its upward trend in the United States. However, with increased acceptance and demand for EVs, the long-term impact to EV purchase prices—which directly impact ownership—is yet to be determined. As stated above, the true cost of scaling production of EVs is unknown, and recent reports have indicated that the rise in demand for EVs has subsequently led to a rise in their average purchase price (i.e., $54,000). This is reportedly due in large part to the increased cost of the raw materials used to construct EV batteries, including lithium, nickel, and cobalt (Colias, 2022).

While several sources indicate that the economics of producing enough EVs to meet U.S. demand are uncertain at this juncture (Baik, 2019; Shine, 2022; Wayland, 2022; Yozwiak, 2022), one aspect of the EV ecosystem that is clear is that as EV ownership expands, so too must EV charging infrastructure. Furthermore, the lack of access to EVSE is a significant barrier to EV adoption—and in some cases, may be as significant a barrier to EV adoption as purchase price (Kumar & Alok, 2020; Winjobi & Kelly, 2021). This has been recognized at the federal level, and recently passed legislation, namely the Infrastructure Investment and Jobs Act (IIJA), has provisions that provide abundant resources to state, regional, and local transportation agencies to develop expansive EVSE to support the transition from ICEVs to EVs.

2.2. How Federal Policy Is Providing Money for EVSE

With the signing of the IIJA in November 2021, the U.S. Congress authorized $7.5 billion of funding in both formula and discretionary programs for EVSE (FHWA, 2023). Prior to the IIJA, there were minimal incentives to invest in widescale EVSE, and most publicly available EVSE were installed by private companies. However, with the five-year authorization of the IIJA and its substantial funding associated with EVSE, the United States is poised to alter this paradigm. Funding for EVSE will flow through the IIJA's National Electric Vehicle Infrastructure (NEVI) Formula program (FHWA, 2022). The objective of the NEVI program is to provide state transportation agencies and public utility commissions with resources that will fund up to 80 percent of the project costs when implementing EVSE throughout the United States. To gain access to the federal formula funds in the IIJA through the NEVI program, state departments of transportation were required to submit a NEVI plan by August 2022. As of 2023, the federal government has approved plans by all 50 states, Puerto Rico, and Washington, D.C. (Joint Office of Transportation and Energy, 2023).

As stated, the opportunity presented by the IIJA to expand EVSE throughout the United States could be the tipping point between the "chicken and the egg" argument that characterizes the interdependence between EV ownership and access to charging. To meet this need, EVSE deployment will need to consider various use cases, such as access to charging for people who don't have home chargers and EV users who make longer trips or travel between cities. Furthermore, for sites associated with IIJA/NEVI funding, there needs to be considerations for how funding for EVSE will be sustained after this five-year funding period. Business models within the EV space are evolving, and the economic factors that influence these models will continue to advance in the coming years.

2.3. Viewing EV Infrastructure through the Lens of Equity

USDOT has identified three overarching goals to combat inequity associated with transportation: (1) reduce disproportionate burdens, (2) prioritize equitable receipt of benefits, and (3) engage DACs in participatory planning (USDOT, 2022a; Brodie, 2015). The following summary table (Table 1) provides an overview of how EV adoption might address, fall short of, or help achieve these goals.

Table 1. USDOT Equity Goals and Associated EV Adoption Considerations

USDOT Equity Goals	Considerations Regarding EV Adoption and Access to EVSE for DACs
Reduce disproportionate burdens	The widescale adoption of EVs may reduce TRAP, which may improve public health. However, at this juncture, it is unknown if the health benefits of EV adoption will be equally distributed throughout all communities within the United States. More research is needed to determine the relationship between the benefits of EVs and equity.[1]
Prioritize equitable receipt of benefits	Ensuring that all communities have equal opportunities to purchase EVs as well as ensuring that all communities have equitable access to charging infrastructure are the two key considerations that will impact the equitable receipt of benefits as they relate to EV adoption. The purchase prices of EVs are largely influenced by private sector factors and more research is needed to determine whether the cost of EVs will present a barrier to the equitable receipt of benefits of EV adoption. Conversely, access to EVSE can be largely influenced by public sector factors and is the primary scope of this paper, which will discuss how access to charging stations will prioritize the equitable receipt of benefits of EV adoption.
Engage disadvantaged communities in participatory planning	Participatory planning will likely not impact whether DACs have equal opportunities to purchase EVs; however, it is a critical component to ensuring equitable access to EV charging in all communities in the United States.[2]

[1] Please note that this paper does not focus on the health equity component of EV adoption.

[2] Please note that this paper does not focus on the need to engage DACs in participatory planning.

In the case of equity, engaging DACs in participatory planning is a critically important component of the equitable decarbonization of the U.S. transportation sector. Stakeholder identification, stakeholder engagement, widescale community engagement, and participatory planning within DACs is critically important to ensure widescale access to the health and economic benefits that will result from the United States' transition from ICEVs to low-emissions vehicles. However, this paper will not focus directly on this goal, but the ability to achieve equitable access to EVSE will rely heavily on it.

3. Key Issues Impacting Equitable Access of EVSE

Access to EVSE, access to safe EVSE, and equally distributed benefits of economic development at EVSE locations among all segments of society are three key issues that require careful consideration to ensure that the implementation of EVSE results in the equitable receipt of the benefits of all segments of society. The following subsections will provide an overview of each key issue, including availability and access to EVSE, safety considerations for EVSE in DACs, and the economic implications of siting EVSE in DACs.

Prior to discussing these issues in-depth, it is helpful to consider the demographic characteristics associated with current EV ownership since it provides useful context regarding not only who owns and has access to EVs but also what segments of the population are currently left out of the individual and societal benefits that EVs may provide. The current demographics of EV buyers include individuals who are male, have high-income, are highly educated, are homeowners, live in multiple vehicle households, and have access to charging at home (Hardman et al., 2021). These demographic data help clarify the challenges that the automotive industry faces regarding the implementation of EVSE since following current ownership trends to determine where to implement EVSE will prohibit significant segments of the population—notably members of historically DACs—from receiving the benefits of EVs. The following sub-sections provide in-depth discussion regarding three key issues that must be considered during the finite time frame that public funding is being utilized to implement EVSE.

3.1. Availability and Access to EVSE

The lack of available EVSE in DACs is a significant barrier to EV adoption (Kumar & Alok, 2020; Winjobi & Kelly, 2021). This issue is currently exacerbated within DACs because the current socio-economic trends in EV ownership have led to many public EV chargers being installed in predominantly high-income locations since that is where those that currently own EVs live, work, and play (Hsu & Fingerman, 2020). Notably, a 2019 analysis of existing EV charging infrastructure found that in the 20 zip codes in the United States that have the highest number of EVSE, the median home price was $782,000, which is 2.5 times more expensive than the rest of the country (Richardson, 2019). Unsurprisingly, studies have also found that areas with the least access to public EVSE tend to have higher rates of non-white populations, higher rates of individuals living below the federal poverty level, higher population densities, lower levels of educational attainment, and higher proportions of multi-family residential units (Hsu & Fingerman, 2020; Roy & Law, 2022). Further compounding access to EVSE for members of DACs is the fact that these communities have a higher proportion of renters than homeowners (Greif, 2015)—which results in a reliance on public charging infrastructure.

There is currently little guidance regarding how to ensure EVSE funded through public funding (e.g., IIJA) will be located within DACs (Huether, 2021). The U.S. Department of Energy (USDOE), through the NEVI formula program, has indicated the EVSE must be non-proprietary, allow for open-access payment methods, be publicly available, and be located on corridors that are designated as Alternative Fuel Corridors by the Federal Highway Administration (USDOE, 2022). While being non-proprietary, publicly available (i.e., not available only to subsets of drivers), and requiring open-access payment methods are all components that have impacts on ensuring equitable access among DACs, there is no requirement regarding how to ensure that EVSE is sited at locations *within* DACs. FHWA has, however, provided high-level guidance for siting EVSE in DACs, including conducting meaningful community engagement and performing community needs assessments (FHWA, 2022; USDOT, 2022b).

The lack of specific guidance and requirements from the federal government associated with IIJA/NEVI funding is further exacerbated by the lack of research on the topic of distributional equity for EVSE. A recently published systematic review found that less than one-third of the studies on the topic of EVSE have discussed the disparities in EV charging for DACs (Carlton & Sultana, 2022). Based on these findings, additional research is needed on best practices for siting EVSE in DACs.

3.2. Safety Considerations for EVSE in DACs

In addition to considerations for siting EVSE within DACs, it is also imperative that EVSE is developed in a manner that is safe for the user. Historically, there has been a trend of underinvestment in transportation infrastructure within DACs, which has led to an overrepresentation in serious injuries and deaths associated with traffic violence among members of lower socioeconomic status communities (Yu et al., 2018). To that end, it is imperative that this EVSE is equitably designed across all segments of society, including DACs. The following subsections will discuss the established safety design guidelines that are relevant for the types of locations that EVSE are typically located in as well as the connection between safe pedestrian facilities and EVSE.

3.2.1. Safety Design Guidelines for EVSE

In addition to ensuring chargers are accessible to users within DACs, it is also imperative to consider the safety of these users (Transportation and Climate Initiative, 2012). Locations that are ideal for the installation of EVSE include tourist destinations (e.g., national parks, historical sites), businesses (e.g., retail stores, restaurants, hotels), institutions (e.g., universities, municipal buildings), and transportation facilities (e.g., rest stops, gas stations, park-and-rides, parking garages) (USDOT, 2022c). Several of these locations have been cited by the Federal Bureau of Investigation (FBI) as sites where crimes frequently occur. In 2021, parking garages, parking lots, convenience stores, and gas stations were identified as being among the top 10 locations where violent crimes occurred (FBI, 2022). When considering crime statistics with respect to EVSE location and design, it is imperative that crime data are considered with great care and attention to bias. Finally, results from a national survey showed that females are more concerned about their safety while charging at a public station (Consumer Reports, 2022). When considering design elements that will ensure the safety of users within DACs, there are standard guidelines associated with parking that specifically address safety. Some of the relevant design guidelines include:

Lighting: Whether in a parking lot, on-street parking, or in a parking garage, one of the most cited design guidelines to enhance user safety is ample and sufficient lighting. Increased visibility is a critical component to ensure both the safety of the user as well as minimize vandalism. Design considerations for lighting include uniformity (i.e., minimal or no gaps in lighting), vertical and horizontal illuminance, minimal opportunities for glare, sufficient brightness, and reliability. In some cases, the installation of EVSE may present opportunities to upgrade existing lighting to modern lighting technology, which are more sustainable, reliable, and potentially brighter (FHWA, 2021; Smith, 1996; USDOT, 2015).

Natural surveillance and proximity to amenities: Natural surveillance refers to designs that maximize the ability for an individual (in this case the EVSE user as well as other individuals in the area) to openly observe their surroundings. Placing EVSE in parking locations that have minimal visual barriers (e.g., concrete walls, foliage, large utilities, etc.) increases the ability for individuals to see others and be seen. Natural surveillance can also be enhanced by placing EVSE near pedestrian facilities. (The safety of pedestrian facilities is discussed in more detail in the next section.) In addition to these physical design guidelines that enhance natural surveillance, siting EVSE near amenities enhances natural surveillance since additional individuals will be present to visit these locations, regardless of whether they are using EVSE (Smith, 1996; USDOT, 2015).

Active surveillance: Active surveillance refers to security features that are visible and actively surveilling a location. Features such as security cameras, security personnel, and panic buttons are examples of active surveillance and are effective countermeasures to implement near EVSE in high-risk locations (Smith, 1996; USDOT, 2015).

3.2.2. Safety Considerations for Pedestrian Infrastructure and EVSE in DACs

As discussed, it is often cited that EVSE should be located near a variety of amenities due to the length of charging times and to enhance the safety of users. Moreover, studies have found that individuals feel safer in locations with well-designed pedestrian facilities (e.g., wide and visible sidewalks, well-marked crosswalks, pedestrian crossing signals, etc.) that have a mix of land uses (Hong & Chen, 2014; Loukaitou-Sideris, 2006). When an EV user exits their vehicle, they become a pedestrian, and providing safe pedestrian infrastructure to connect EV users to nearby amenities is a critical component to the safety of EV users. Unfortunately, DACs have suffered from a lack of adequate public investment in safe pedestrian facilities. This results in pedestrians within DACs being disproportionately impacted by traffic violence (Rajaee et al., 2021; Thornton et al., 2016; Yu et al., 2022). When considering the implementation of EVSE within DACs, ensuring investment in safe, state-of-the-practice pedestrian infrastructure is a critical component to ensuring the safety of EV users within these communities.

3.3. Economic Implications of Siting EVSE in DACs.

The charging time for EV batteries can take anywhere between 30 minutes to several hours depending on the vehicle and the type of charging equipment (USDOT, 2022d). This will result in EV adopters transitioning from spending approximately five minutes filling their ICEV full of gasoline to charging an EV for at least 30 minutes—even longer in some cases. One of the outcomes of the additional time spent charging is an expectation that EVSE will need to be sited at or near a variety of amenities—many of which are mentioned previously in this paper. In some cases, it is expected that the installation of EVSE will stimulate the development of new amenities (Burmahl, 2022). In addition, it is expected that EVSE implementation will result in thousands of new job opportunities associated with building and maintaining charging stations (Carr et al., 2021). Ensuring that members of DACs benefit from EVSE siting is also aligned with the Justice40 Initiative, which aims to ensure that at least 40 percent of the benefits from certain federal investments—including from the implementation of EVSE—reach underserved communities (USDOT, 2022e).

The question of who will benefit from the economic opportunities associated with the implementation of development of amenities near EVSE, the revenue generated from user fees collected for charging vehicles, and new job opportunities are key issues to consider with respect to USDOT's goal of prioritizing the equitable receipt of benefits and the siting EVSE in DACs (USDOT, 2022f).

3.3.1. Economic Benefits of Amenity Development and User Charging Fees at EVSE Sites within DACs

USDOT's Equity Action Plan identifies uneven resource distribution as one of the root drivers of economic inequities, especially among small, disadvantaged businesses who often have less growth capital and expertise (USDOT, 2022f). While there is limited research to date that provides a definitive estimation of the economic impact of siting EVSE at existing businesses within DACs, research shows that investments in new transportation infrastructure (e.g., new roads, freeway spurs, etc.) can stimulate economic development due to increased access and connectivity to existing and new jobs and resources. Conversely, underinvestment in transportation infrastructure—as historically experienced among DACs—can inhibit economic growth by limiting accessibility (OECD, 2020). This model is relevant in the case of implementing EVSE within DACs because these investments have the potential to boost economic growth—both with respect to existing amenities and the development of new amenities near charging stations. Existing businesses within DACs might experience economic benefits from the installation of EVSE by the generation of new trips to locally owned businesses or through the collection of user charging fees (TxDOT, 2022).

Of note, the Justice40 Initiative identifies three important metrics to measure the economic benefits associated with EVSE implementation (Zhou et al., 2022):

- Dollars spent on EVSE owned by or providing revenue to organizations located in DACs.
- Number of and percentage of EVSE owned by organizations located in DACs.
- Number of and percentage of EVSE owned that provide revenue to organizations located in DACs.

3.3.2. Economic Benefits of Job Creation Associated with EVSE Siting in DACs

In addition to spurring economic development through amenity access and development, it is expected that the IIJA and NEVI program will result in the creation of thousands of new job opportunities. The jobs commonly cited as being associated with EVSE implementation include engineers and technicians who will be responsible for installing and maintaining charging facilities. Even assuming a low EV adoption scenario, experts indicate that implementing EVSE could generate nearly 40,000 jobs over the next 10 years. That number jumps to over 60,000 jobs over the same period if EV adoption is high (Carr et al., 2021).

In addition to the estimations above, the USDOE's Argonne National Laboratory developed an online tool—JOBS EVSE—that estimates the economic benefits associated with EVSE development, construction, and operation. The tool provides estimations ranging from job creation to local economic benefits (Ke et al., 2022). However, this tool does not specifically predict the economic implications for DACs.

As public money is utilized to implement EVSE, considerations for providing members of DACs with access to job opportunities is a critical component of ensuring the equitable receipt of benefits associated with the United States' transition to clean energy. Similar to metrics associated with the economic benefits of fostering business opportunities listed in the section above, the Justice40 Initiative has also identified metrics to measure the benefits of access to jobs associated with clean energy within DACs. These metrics include (Zhou et al., 2022):

- Dollars spent on job training programs for participants from DACs.
- Number of participants from DACs in job training, apprenticeship, and STEM education programs.
- Number of hires or jobs created resulting from DACs' installation or related job growth opportunities.
- Number of contracts and/or dollar value awarded to small businesses that are principally owned by women, minorities, disabled veterans, and/or LGBT persons, such as charging station service providers.

4. Conclusion

This paper provides an overview of the issues related to the equitable access of EVSE. As discussed in the previous sections, siting decisions, safety factors, and economic implications of EVSE are all key issues to address when considering how to ensure all segments of society have access to EVs. In order to achieve USDOT's goal of prioritizing the equitable receipt of benefits for everyone, it is imperative to consider the needs of DACs. This will be achieved through robust stakeholder engagement and participatory planning. Addressing the current inequities with respect to access to EVSE is one of the first and most critical steps to fully realize the goal of decarbonizing the transportation sector.

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