C2ES CENTER FOR CLIMATE AND ENERGY SOLUTIONS

COMMENTS OF THE CENTER FOR CLIMATE AND ENERGY SOLUTIONS

This document constitutes the comments of the Center for Climate and Energy Solutions (C2ES) on the development of guidance for electric vehicle charging infrastructure deployment by the Federal Highway Administration and the Department of Transportation (Docket No. FHWA-2021-0022-0001).

C2ES is an independent, nonprofit, nonpartisan organization dedicated to advancing strong policy and action to reduce greenhouse gas emissions, promote clean energy, and strengthen resilience to climate impacts. Through the *Climate Innovation 2050* Initiative, C2ES has worked closely with more than four dozen leading companies to examine the decarbonization challenges facing the United States and develop pathways toward decarbonization, including through developing *Getting to Zero: A U.S. Climate Agenda*, a comprehensive policy agenda to decarbonize the U.S. economy by 2050.

The views expressed here are those of C2ES alone and do not necessarily reflect the views of members of the C2ES Business Environmental Leadership Council (BELC).

Executive Summary

The funding for electric vehicle (EV) charging infrastructure at the scale of the Infrastructure Investment and Jobs Act has the power to revolutionize the American passenger auto fleet and enable accelerated EV adoption nationwide, a necessary component of decarbonizing the U.S. economy to address climate change. Both the formula funding and discretionary grant programs it creates will support the vital build out of charging infrastructure to meet both stationary and transitory charging needs across the nation's highways and communities. Yet in implementing the funding, the Department of Transportation (U.S. DOT) and Federal Highway Administration (FHWA), as well as state departments of transportation, must ensure equity in siting, deployment, and operations while maximizing benefits to communities.

The Federal Highway Administration and Department of Transportation are requesting information regarding the development of guidance for electric vehicle charging infrastructure deployment. In the following comments, C2ES has developed responses to several of the statutory considerations for the EV Charging Program and other requests regarding the implementation of the Charging and Fueling Infrastructure Program.

As most of the funding will be reserved for alternative fueling corridors, care should be taken when siting infrastructure to provide maximum benefit both to through-drivers and local communities.[1] In particular, the size and type of infrastructure should take into account both community needs and the local power sector infrastructure. Funding should also remain available to provide for local make-ready infrastructure upgrades and other associated grid maintenance costs.

Easily accessible fast-charging and alternative refueling infrastructure along highly trafficked highway routes is essential to helping drivers build confidence that switching to a battery electric or alternative fuel-powered vehicle will continue to meet the same range needs as their current gasoline-powered vehicle. At the same time, many communities can benefit from access to fast charging as well as Level 2 charging infrastructure, which can expand local residents' abilities to make the switch, even if they are unable to install home charging. In addition to siting, proper maintenance and upkeep of chargers is also necessary to build driver confidence, and projects should be awarded funding to cover continued maintenance in addition to installation.

Additionally, electrification across sectors in the coming decades is expected to significantly increase the nation's annual electricity demand, and high instantaneous power needs for EV chargers will be a major draw on existing power sector infrastructure. Including funding eligibility for Level 2 charging infrastructure may help to minimize local grid impacts while providing an option with lower installation, maintenance, and operation costs.

Currently, communities that are disproportionately underserved by charging infrastructure include rural communities with low population densities, low-income communities, and communities with high population densities and low housing ownership rates, among others. Additionally, rates of access to charging remain low in many communities that have historically experienced high levels of air pollution, especially from automobile exhaust. As access to charging is often a prerequisite for EV adoption, relatively low rates of EV uptake in these areas should not disqualify them from eligibility for funding. It may actually make the impact of funding for charging installation more impactful than it would be in areas with higher rates of adoption.

All these underserved communities should be equally prioritized for charging and refueling infrastructure funding, though again, funding implementation should include processes for community and local stakeholder engagement. This engagement can take multiple forms, such as comprehensive outreach and information sharing, participatory budgeting, and inclusive planning processes.

Finally, the following comments include examples of best practices from public and private entities that have successfully implemented charging infrastructure programs at the state and local levels.

Comments Specific to FHWA and DOT Requests

Connections to the electric grid

Electrification in the transportation, industrial, and buildings sectors will significantly increase annual electricity demand in the United States. In addition to the electrification of vehicles, which will likely have the largest impact on overall power demand, the electrification of other sectors will place additional demand on electricity generation resources. Utilities, grid operators, and government leaders must engage in proactive planning and investment in the modernization of grid infrastructure to prepare for the challenges and opportunities provided by transportation electrification.

Outlook: EVs and the grid

In 2020, annual sales of plug-in EVs made up around 2 percent of total vehicle sales, with sales in 2021 projected to rise to 4 to 5 percent of total vehicle sales.[2] Additional forecasts estimate that the number of EVs in the United States could swell from 1.5 million to 10 to 35 million by 2030.[3] If the actual number falls somewhere in the middle of that range, around 20 million EVs by 2030, that would create an additional 60-95 TWh of annual demand and potentially 10-20 GW of peak load.[4] For reference, the United States produced 4,118 TWh of electricity in 2019, excluding distributed solar generation.[5] To meet customer needs, the United States will need to make significant investments in infrastructure to support charging in residential, workplace, and public settings, including alternative fueling corridors along major highways. The Pacific Northwest National Lab found that the existing grid can likely accommodate up to 30 million EVs with unmanaged charging, but with thoughtful management, including intentional approaches to reduce the impact of EV charging during times of high demand, that number doubles.[6]

A key dimension to consider is the type of charging required. The faster the charging time, the greater the instantaneous power requirement per vehicle; in other words, a faster recharge time means a charger must be able to draw more power (i.e., Watts) at any given moment. When added up across numerous chargers on the grid, greater instantaneous power requirements for EV charging mean greater potential to increase peak load, which could require additional generation and transmission capacity to ensure reliability and minimize congestion.

In many locations, new charging infrastructure will precipitate major upgrades to local distribution networks and the high-voltage bulk transmission system. These upgrades can be minimized to some extent through intentional approaches to reduce the impact of EV charging during times of high demand, including: setting vehicle charging prices higher during typical seasonal and daily peak periods to encourage charging during non-peak times; incentivizing charging opportunities during periods of high renewable production (i.e., solar midday and wind overnight) non-coincident with peak periods; and adopting "managed" or "smart" charging technologies and programs that give electricity suppliers remote control over EV charging times and levels. On-site energy storage can also reduce instantaneous pressure on the grid when multiple fast chargers are used simultaneously. Siting of chargers should take into account local grid conditions and local availability of storage, and be inclusive of both Level 2 and DC fast charging options to provide a range of charging speed options while allowing flexibility to reflect local capacity.

Although tariffs will play a vital role in ensuring that vehicles charge off-peak, they could nevertheless result in a large volume of consumers starting to charge at the beginning of the off-peak period (e.g., 11:01 PM), resulting in a "mini-peak." For this reason, active load management/ smart charging will likely become increasingly beneficial to the electric grid as more EVs are deployed. In order to enable active load management/smart charging programs, utilities, grid operators (e.g., balancing authorities and ISOs), and other stakeholders should work together to develop incentives which provide reasonable compensation for the development and operation of these programs, including customer recruitment and retainment.

Funding distributed through the EV Charging Program should include eligibility for necessary grid upgrades and should incentivize on-site storage to bolster grid resilience and reduce the pressure of the additional load. It should also incentivize the utilization of programs to manage peaks with smart charging and demand-responsive pricing to drive customer utilization to off-peak times. Funding for grid upgrades should augment existing funding commitments by utilities to build out infrastructure.

Vehicle-grid integration

EVs could also be power system infrastructure through vehicle-grid integration programs and technologies. EVs have the potential to serve as smart, flexible load, and charging can be managed to match grid needs through smart charging programs that can leverage technologies such as automaker telematics to actively manage charging. Going a step further, by leveraging the stored energy in a multitude of car and truck batteries, vehicles could help balance intermittency issues and mitigate future peak load challenges.

Vehicle-to-grid (V2G) technology allows two-way flow between vehicle batteries and the grid. However, vehicles and their chargers have to be designed and enabled for this technology. Currently, very few light-duty and medium-duty vehicles can use V2G charging, though there are pilot programs in various states exploring the V2G potential of electric school buses.[7] Conflicting technical standards regarding inverter operation will need to be resolved before V2G-equipped vehicles or charging stations are allowed to connect to the grid in any widescale fashion. The Combined Charging System—a widespread EV charging standard—is currently establishing a range of V2G standards, which could help enable much greater participation; more complete standards are expected by 2025, and products could follow soon afterward. Another key variable is uptake by consumers. Currently, there is no compensation mechanism for exporting power back to the grid under V2G for retail customers; the situation is more complex for commercial and industrial customers. Without a clear and easily accessible economic incentive for customers, V2G's use will remain limited. Funding under the EV Charging Program should give priority to programs that can support future integration of V2G technologies, anticipating future developments in this space to take advantage of the energy stored in millions of vehicles. However, funding eligibility should not be limited to these applications, particularly in near-term implementation, to reflect that this technology is not currently widespread.

Power-sector emissions reduction

With regards to renewable generation, there is no logistical reason to require generation to be sited on or near new charging stations, as these locations may not be conducive to high-capacity generation, and the instantaneous power needs of a single EV charger are significantly greater than the generation capacity of a similarly sized solar array.[8] Rather than building in requirements or incentives for expensive onsite generation to the EV Charging Program, efforts to reduce emissions associated with charging should take a system-wide perspective and focus instead on supporting the addition of new cost-effective, large-scale renewable generation sources to the overall energy mix. In particular, new renewable and clean generation should be prioritized over new fossil-fuel-powered generation if the additional demand from EV charging requires new generation sources to come online.

The need for publicly available EV charging infrastructure in rural corridors and underserved or disadvantaged communities

Maximizing VMT impact

Currently, rural uptake of EVs is considerably lower than metropolitan areas due to limited charging infrastructure and EV availability, as well as cost barriers and cultural factors. Yet, paradoxically, rural drivers often have much higher annual vehicle miles traveled (VMT) than their urban counterparts and thus higher fuel costs. Battery range and availability of public charging infrastructure greatly impact a driver's willingness to purchase an EV, and battery ranges in existing EV models are often perceived to be less than the distance between public chargers in rural areas, especially where most charging takes place at home and public chargers are not highly visible.[9] Larger, less-efficient models like SUVs and pickups are often more practical and culturally preferable in rural areas, meaning even by mile traveled, rural drivers use significantly more gasoline. A recent study found that the top 10 percent of drivers by gasoline consumption accounted for 32 percent of all U.S. consumption, more than the bottom 60 percent combined.[10] Cost savings among rural drivers for switching from gasoline to electricity are therefore amplified.[11] Moreover, given that rural drivers have higher VMT, emissions reductions per EV adopted would be higher in these communities. Additionally, strategic deployment of public charging in rural areas could be more beneficial to high-VMT drivers who may need to "fuel up" more frequently due to higher daily miles traveled than lower-VMT drivers who may be able to meet most of their charging needs at home.

Enabling accelerated rural EV uptake

As automakers continue to expand models to include those that would appeal to rural communities, such as Ford's electric F-150 Lightning (the gasoline Ford F-150 is the most popular vehicle in many rural states, and in more than 30 states nationwide), accessible public charging infrastructure will be critical to support the purchase and utilization of these vehicles.[12] Siting of chargers along alternative fuel corridors should maximize accessibility to residents across rural communities, providing options for both visiting drivers passing through and local residents on regular routes, further encouraging higher utilization rates. As charging infrastructure often predicates EV uptake, the selection of charging sites should not be discounted in areas with low rates of EV ownership.

Improving accessibility in high-density residential areas

While rural areas often face low densities of charging infrastructure, residents of densely populated or multifamily residences also face disadvantages in access to charging because many of them cannot install home charging systems. As many of these areas also have low rates of EV ownership, because of both the lack of charging access and lower average incomes that make many current EV models unattainable, equitable installation of public chargers must prioritize expanding access for these residents. Public funding support is crucial for expanding access to disadvantaged communities because, while affordable housing authorities have a strong interest in EV sharing programs, their budgets are often limited.[13]

Public fast charging is essential to making EV drivers—especially new ones—more confident in their vehicle's ability to meet their needs. Yet at the same time, public Level 2 charging can help fill gaps in charging access while keeping installation costs comparatively low and moderating grid impact. Formula funding to states should incentivize high volumes of public Level 2 chargers in centralized, accessible, safe locations where many residents of multiunit housing can access them.

Many low-income communities are also disproportionately affected by air pollution, which can cause a host of health problems, especially in children. Eliminating tailpipe emissions from vehicles in these communities should therefore be prioritized, and formula funding for charging infrastructure should incentivize the installation of infrastructure where the local air pollution reductions will be most beneficial.

Fostering enhanced, coordinated, public-private or private investment in EV charging infrastructure

Assessing EV charging infrastructure needs

In order for productive public-private partnerships or private investment to advance the buildout of EV infrastructure, all stakeholders must be well informed on the status of a jurisdiction's EV infrastructure buildout. Regularly conducted state- or locally led efforts to assess EV charging infrastructure needs will help states determine where existing EV chargers are and anticipated areas of need.

For example, the California Energy Commission (CEC) is required to biennially assess progress to meet the state's EV goals.[14] CEC has partnered with the National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, and the University of California, Davis to assess anticipated charging infrastructure needs for a wide range of EV use cases and numerous vehicle classes, accounting for local conditions.[15]

As part of this needs assessment, states will need to determine priority communities and jurisdictions where charging infrastructure should be located. States must be particularly clear on how they plan to deploy EV chargers in disadvantaged and low-income communities. This will likely require states to determine how they classify disadvantaged communities, which may require the use of screening tools such as the EPA's EJScreen or a state-specific tool. When deciding where to locate EV infrastructure, it is critical that policymakers consider a wide range of factors beyond just income: the infrastructure law's inclusion of rural areas as well as communities with a low ratio of private parking spaces to households is a good example of more inclusive criteria. An additional criterium that can be considered in conjunction with these is air pollution burden.

Especially along highway corridors, many minority communities face outsized pollution burdens (as mentioned previously).

Community-oriented development

Inclusive stakeholder processes along the project development cycle are critical and must occur bi- and multilaterally between the private sector, government, nonprofits, and local communities. In order to ensure that proposed projects align with community needs and priorities, communities must be involved in decisions made regarding the development of EV infrastructure; thus, any private company looking to invest or deploy EV charging infrastructure should consult the communities residing in or located near where it plans to develop projects. Pacific Gas & Electric (PG&E) has an EV Charge Network Program Advisory Council, which provides feedback and guidance for the Program, which allowed businesses to partner with PG&E to receive incentives for installing 10 or more EV chargers in workplace parking lots and garages.[16] The PG&E Program Advisory Council will continue providing feedback and guidance on other PG&E EV programs after the conclusion of the EV Charge program in 2021. Additionally, the CEC solicits comments from external organizations for any analysis it conducts, creating an inclusive stakeholder process wherein external feedback enables more informed rule and decision making.

For states without clear guidance on plans to deploy EV charging infrastructure, sound policy can provide a platform on which to build comprehensive and inclusive programs. In Arizona, California, Colorado, New Mexico, New York, and Oregon, to varying degrees, utilities are required to account for disadvantaged, low-income, or other qualifying communities in their buildout of EV charging infrastructure.[17] The more specific these policies are, the more guidance utilities will have to guide their planning processes.

Other factors to consider in developing the EV Charging Program guidance

Commercial, medium- and heavy-duty applications

EV charging applications for commercial fleets have significant greenhouse gas reductions benefits, and fleet chargers can have significantly higher utilization rates than public passenger vehicle chargers, increasing their public benefit.

Commercial medium- and heavy-duty vehicles, including class 8 trucks, large pickups and vans, delivery trucks, and buses, make up 24 percent of U.S. transportation emissions.[18] Electric and alternative-fuel options are becoming increasingly available and cost-effective in this sector, increasing the need for nationwide charging and fueling infrastructure that can meet the unique requirements of these vehicles.

Especially along designated alternative fueling corridors, publicly accessible charging and fueling infrastructure is necessary to support the operations of medium-duty and freight vehicles traveling long distances. In addition to supporting passenger vehicle infrastructure, a portion of the EV Charging Program funds should support building out this commercial vehicle infrastructure. States should work with other states, local governments, and private companies to identify high-traffic freight routes to maximize the effectiveness and utilization of medium- and heavy-duty charging and fueling infrastructure, and to produce the most significant greenhouse gas reduction benefits.

According to the guidance set forth in the Infrastructure Investment and Jobs Act, EV Charging Program funds are limited to "projects directly related to vehicle charging and only for EV charging infrastructure that is open to the general public *or to authorized commercial motor vehicle operators from more than one company*." FHWA and DOT should provide more guidance on how eligibility is determined, including type of vehicle, level of charging, and other company eligibility.

Examples of best practices relating to project development of EV charging infrastructure and hydrogen, propane, and natural gas fueling infrastructure at the State, Tribal, and local levels

There are best practices along the spectrum of project development for EV charging and hydrogen fueling, from educating communities on the proposed technologies to project implementation and infrastructure roll out.

EV Experience Fleet Program

Regarding project development of EV charging infrastructure, in the early stages, communities must be engaged and educated on EVs more broadly prior to construction and infrastructure roll out. It is possible that communities along alternative fuel corridors, especially in rural areas, are unfamiliar with the proposed infrastructure and may be hesitant to support its development. Rural electric cooperatives are a critical partner in expanding rural awareness of and receptivity to EVs. For example, the Tri-State Generation and Transmission Association launched the EV Experience Fleet program to allow members to borrow different EVs both to hold Ride & Drive events and for general staff use.[19] These cooperatives can provide critical knowledge and information regarding community-specific circumstances and attitudes, and can tailor educational efforts to align with community priorities and concerns. Partnerships between trusted information sources (like rural electric cooperatives) and researchers can ensure that consumers receive accurate and up-to-date information on the benefits of EVs. There is ample data on the benefit that EVs bring to their owners, such as the finding from the National Renewable Energy Laboratory that "public charging provided several thousand dollars' worth of tangible value to PEV-driving households."[20]

Project Beehive

Public-private partnerships have been a critical tool to roll out alternative fueling infrastructure in Utah, especially for hydrogen. The Utah Inland Port Authority (UIPA), a state agency overseeing Utah's logistics system, launched Project Beehive in 2021 in partnership with BayoTech, Dominion Energy, and Lancer Energy.[21] The group is working to establish a distributed hydrogen production hub and fueling stations across the state, namely in UIPA's Salt Lake valley port area and key freight corridors. Project Beehive's model is unique in that it facilitates supply chain coordination to grow both demand for, and supply of, hydrogen and other alternative fuels. The initiative brings together companies with expertise in multiple stages of the hydrogen supply chain, from hydrogen feedstocks, to hydrogen generation equipment, to fuel station construction. The UIPA and partners have also been actively soliciting zero-emission vehicle manufacturers and regional fleet operators to access the hydrogen supplied through the initiative, thus helping to cultivate a user base for the infrastructure. This type of supply chain coordination, coupling production with fueling and outreach to users, can minimize the chicken-and-egg challenge that fueling infrastructure often faces, in which infrastructure doesn't get built until a user base is present, and potential users do not adopt technology until infrastructure is in place. Project Beehive's logistics focus also broadens the impact of its hydrogen fueling infrastructure and maximizes decarbonization by allowing access not only for vehicles, but for other fuel cell-powered equipment, including trains, yard tractors, drayage trucks, and railway locomotives. Hydrogen fueling provided by the stations can be an advantageous decarbonization tool for these medium- and heavy-duty users (for whom electrification may not be feasible), but for non-hydrogen users, EV charging and CNG/LNG refueling is also available at the stations for mutual benefit.

Suggested topics to address in guidance on project development

To ensure that projects are developed and deployed efficiently and equitably, any guidance on project development must, at a minimum, address: a process to comprehensively identify all relevant stakeholders, plans for the engagement and education of all stakeholders, and identification of local circumstances and priorities through a multi-stakeholder process.

Stakeholder identification

Comprehensive stakeholder identification ensures that all relevant actors are present when projects are developed. These actors include but are not limited to: representatives from state and local government, underrepresented and disadvantaged communities, electric utilities, energy regulators, local community groups, and the private sector. Within the stakeholder identification process, the responsibilities of each actor must be clearly specified, and this process will likely look different between states and localities; for example, in California, utilities have not been permitted to own public DCFC chargers, whereas utilities in other jurisdictions are permitted to do so. Within relevant laws, jurisdictions must identify which agencies, sectors, and actors will be responsible for each part of infrastructure roll out, and each step of the project development process must involve community stakeholders.

Community engagement

Given that communities are uniquely positioned to understand and advocate for hyperlocal circumstances and concerns, community engagement can "greatly improve utility EVSE programming."[22] This engagement can take multiple forms, such as comprehensive outreach and information sharing, participatory budgeting, and inclusive planning processes.[23]

Those looking to engage communities can look to examples in the electricity sector: in Oregon, Portland General Electric established a process to continually involve all interested stakeholders in order to gather feedback for its Distribution System Plan, including partnering with local NGOs to conduct workshops and holding specific stakeholder meetings.[24] Similar processes can and must be employed by subnational and Tribal governments as well as private sector stakeholders to ensure that projects are developed in tandem with those who will be impacted by their presence.

Regarding community outreach in particular, it is likely that many communities affected by the deployment of the proposed infrastructure may be unfamiliar with both the proposed technologies and the impetus for their construction. Equally as important as providing opportunities to engage is the process of informing communities on the technology-specific process, proposed timelines, and justification for project development. Ideally, the project development process is designed such that communities are included from the very beginning stages, co-creating solutions that align both with policy and business goals while considering local circumstances. It is important for those looking to develop projects to acknowledge that if communities are wholly involved in the process, it is likely that any project vision will undergo changes to account for community-specific circumstances and needs.

By undertaking engagement and outreach processes throughout the project development timeline, developers can ensure that any project is inclusive, predictable, and supported by the community it is affecting.

Endnotes

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[1] Alternative fuel corridors designated by FHWA should provide flexibility for charging and alternative fueling infrastructure to serve local communities by expanding eligibility to within 5 miles of a designated highway.

[2] U.S. Environmental Protection Agency, *The 2021 EPA Automotive Trends Report*, EPA-420-R-21-023 (Washington, DC: U.S. Environmental Protection Agency, 2021), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013L1O.pdf.

[3] Michael Hagerty, Sanem Sergici, and Long Lam, "Getting to 20 Million EVs by 2030 Opportunities for the Electricity Industry in Preparing for an EV Future," The Brattle Group, presented in June 2020, https://www.brattle.com/wp-content/uploads/2021/05/19421_brattle_-_opportunities_for_the_electricity_industry_in_ev_transition_-_final.pdf.

[4] Ibid.

[5] "Total Energy: Monthly Energy Review: Table 7.2a," U.S. Energy Information Administration, accessed September 15, 2020, https://www.eia.gov/totalenergy/data/monthly/#electricity.

[6] Lynn Roeder, "Influx of Electric Vehicles Accelerates Need for Grid Planning," Pacific Northwest National Laboratory, last modified July 29, 2020, https://www.pnnl.gov/news-media/influx-electric-vehicles-accelerates-need-grid-planning.

[7] It is unlikely that existing EVs could cost-effectively be retrofitted for V2G technology; James Billington, " The future of vehicle-to-grid EV charging," Electric & Hybrid Vehicle Technology International, September 4, 2020, https://www.electrichybridvehicletechnology.com/news/charging-technology/the-future-of-vehicle-to-grid-ev-charging.html; See also Electrification Coalition, *How to Amp Up Transportation Transformation: A Guidebook for Funding and Financing Electrification* (Washington, DC: Electrification Coalition, 2021), https://www.electrificationcoalition.org/wp-content/uploads/2021/01/EV-Fin-Guide-FINAL.pdf.

[8] The maximum power output of a solar panel is around 270-400 Watts, with roughly 3 panels per kW, while Level 2 EV charging typically draws 6-7 kW and DC fast charging draws at least 50 kW. Even under peak conditions, a single charger would require a solar array ranging from 315 square feet for Level 2 to 2,630 square feet for DCFC, an unrealistic and inefficient size discrepancy, especially when taking into account the likelihood of installing enough equipment to supply multiple vehicles simultaneously. EnergySage, "How much energy does a solar panel produce? Solar panel output explained," accessed January 4, 2022, https://news.energysage.com/what-is-the-power-output-of-a-solar-panel; See also Doug Vine, *Power Infrastructure Needs for Economywide Decarbonization* (Arlington, VA: Center for Climate and Energy Solutions, 2021), https://www.c2es.org/wp-content/uploads/2021/04/power-infrastructure-needs-for-economywide-decarbonization.pdf.

[9] Teri Viswanath, *Co-op EVolution – Bridging the Rural-Urban Divide on EV Adoption* (Denver, CO: CoBank, 2021), https://www.cobank.com/documents/7714906/7715341/KED-Report-Electric-Vehicles-June2021.pdf/f36a0724-62da-97f4-1615-002b893e68b0?t=1623252540572.

[10] Matthew Metz, Janelle London, and Paul Rösler, *Gasoline Superusers: their Critical Role in Meeting Climate Goals; Their Demographics; How Policy Changes Can Shift them to EVs* (Seattle, WA: Coltura, 2021), https://static1.squarespace.com/static/5888d6bad2b857a30238e864/t/60ff036e15db6a1139195020/1627325296710/Coltura+Gasoline+Superusers+Report+July+2021.pdf.

[11] Teri Viswanath, Co-op EVolution – Bridging the Rural-Urban Divide on EV Adoption.

[12] "Most popular cars in America," Edmunds, accessed December 16, 2021, https://www.edmunds.com/most-popular-cars.

[13] Puget Sound Clean Air Agency, *Facilitating Low Income Utilization of Electric Vehicles: A Feasibility Study* (Olympia, WA: Washington State Department of Transportation, 2019), https://wsdot.wa.gov/publications/fulltext/LegReports//17-19/FacilitatingLowIncomeUtilizationOfElectricVehicles.pdf.

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[15] Noel Crisostomo et al., *Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment: Analyzing Charging Needs to Support ZEVs in 2030*, CEC-600-2021-001 (Sacramento, CA: California Energy Commission, 2021), https://www.energy.ca.gov/publications/2020/assembly-bill-2127-electric-vehicle-charging-infrastructure-assessment-analyzing, 29.

[16] "Engaging Stakeholders," PG&E, accessed December 17, 2021, https://www.pgecorp.com/corp_responsibility/reports/2019/su03_engaging_stakeholders.html; See also "EV Charge Network Fact Sheet," PG&E, accessed January 2, 2022, https://www.pge.com/pge_global/common/pdfs/solar-and-vehicles/your-options/clean-vehicles/charging-stations/program-participants/EV-Charge-Network-FactSheet.pdf.

[17] Peter Huether, *Siting Electric Vehicle Supply Equipment (EVSE) with Equity in Mind* (Washington, DC: American Council for an Energy-Efficient Economy, 2021), https://www.aceee.org/sites/default/files/pdfs/siting_evse_with_equity_final_3-30-21.pdf, 10.

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[22] Peter Huether, Siting Electric Vehicle Supply Equipment (EVSE) with Equity in Mind.

[23] Noel Crisostomo et al., Assembly Bill 2127 Electric Vehicle Charging Infrastructure Assessment: Analyzing Charging Needs to Support ZEVs in 2030.

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