Union of Concerned Scientists

FACT SHEET

Federal Support for EV Charging

Policies for Rapid, Equitable Investments

Consumer electric vehicles (EVs) are here today, but accelerating their deployment requires investments in charging infrastructure. Federal policies can break down barriers to this deployment, making EVs and EV charging more accessible to those whose mobility needs are best served by a vehicle. The policies should be designed to fill information gaps, assist drivers and hosts of charging stations in paying for the upfront costs of charging, and align the interests of drivers and the charging hosts. They should emphasize increasing access to EV charging for renters, residents of multi-unit dwellings, and drivers who cannot install charging at home.

Introduction

The future of transportation is electric, which has wide-ranging benefits (Box 1). Already, a variety of electric vehicles (EVs), from bikes and scooters to cars, buses, and heavy trucks, move both people and goods. For consumers, the modes of personal mobility that best serve people and communities vary. This fact sheet focuses on barriers to charging infrastructure deployment for consumers whose mobility needs are best served by a personal or shared motor vehicles and federal policies to address those barriers. Those policies constitute part of a broad agenda to increase access to all modes of clean personal mobility and goods movement.

Box 1. Electric Vehicles Can Benefit Everyone

EVs are an essential strategy to reduce climate and air pollution from transportation. Even on today's electricity grid, EVs across vehicle types produce fewer greenhouse gas emissions than do comparable gas and diesel vehicles, and EVs will improve as renewable energy provides a greater share of electricity (O'Dea 2018; O'Dea 2019; Reichmuth 2020). Because driving on electricity produces no tailpipe pollution, swapping gas and diesel vehicles for EVs can reduce health inequities from exposure to transportation pollution (Reichmuth 2019).

EVs can benefit all electricity customers by creating downward pressure on electricity prices and supporting the grid. Most EV charging is flexible, so drivers and fleet operators can charge their vehicles at times that are better for the grid, such as at night, when the grid typically has spare capacity, or in the afternoon, when solar resources are more plentiful. This "managed charging" uses grid resources more efficiently and spreads fixed grid costs over additional electricity sales from EV charging. This creates downward pressure on rates for all customers—even those who do not own an EV. Where the electricity needs of EVs have led to distribution upgrades, revenues from charging have vastly outweighed the grid investments made to serve those EVs (Frost, Whited, and Allison 2020). More sophisticated vehicle-grid integration can enhance the benefits EVs provide for all electricity customers. For example, drivers can export electricity to provide power and support the grid's stable operation.

EV Charging Infrastructure for Consumer Vehicles

Access to charging infrastructure must precede or coincide with EV adoption. For consumers whose mobility needs are best served by vehicles, whether shared or personally owned, the drivers need regular, reliable access to charging at home, work, or public locations, or some combination of these sites. Home charging is low cost and convenient, while public and workplace charging are critical for longer-range travel, higher-mileage drivers (such as taxi and ride-hailing drivers), and those with limited or no access to home charging. Level 1 or Level 2 alternating current (AC) power charging is generally most appropriate for home and workplace charging, while public charging requires Level 2 or direct current (DC) fast charging (Table 1) (Hardman et al. 2017). Level 1 charging uses the same power level as a regular wall outlet; level 2 charging uses the same power level as is used for many home appliances, such as a clothes dryer.

Table 1. Types of Chargers

	Level 1	Level 2	DC Fast
Voltage	120 volts AC	208-240 volts AC	50-1,000 volts DC
Maximum Power, kilowatts (kW)	1.9 kW	19.2 kW	450 kW[1]

Level 1 or Level 2 AC power charging is generally most appropriate for home and workplaces, while public charging requires Level 2 or DC fast charging.
SOURCE: CRISOSTOMO ET AL. 2021.

Charging Infrastructure Needs

Home charging, considered primary infrastructure, is a virtual necessity for consumer EVs: The EV is parked at home most of the time, and most EV charging will likely occur there (Davis and Alexander 2014; TRB and NRC 2015). Residential charging is also typically less expensive than charging at commercial locations, particularly public charging stations.[2] The essential nature of home charging underscores the need to facilitate it, particularly for renters and residents of multi-unit dwellings (MUDs) who face higher barriers to installing home charging.

Public and workplace charging are critical complements to home charging for increasing the adoption of EVs and enabling the switch of vehicle miles from gasoline to electricity. Estimates for away-from-home charging infrastructure needed to support vehicle electrification vary from 2 to 4 DC fast-charging plugs per 1,000 EVs and 40 to 60 away-from-home Level 2 plugs per 1,000 EVs (Nicholas, Hall, and Lutsey 2019; Wood et al. 2017). The ranges in estimates arise from the geographic scope of studies and variations in modeling assumptions, such as the level of EV deployment, the availability of home charging, the ratio of battery EVs to plug-in hybrid EVs, and driving behavior.[3] A recent draft analysis by the California Energy Commission found higher charger-to-vehicle ratios are required to support that state's goals for EV deployment (Crisostomo et al. 2021).

The need for charging infrastructure to support the transition to EVs is immediate due to the long lifetimes of motor vehicles.[4] The United States must transition the sales of consumer cars and trucks to 100 percent zero-emission vehicles by 2035 in order to achieve deep decarbonization in the transportation sector by mid-century.[5] The Union of Concerned Scientists estimates that the ramp-up to 100 percent zero-emission vehicle sales in 2035 could translate into approximately 100 million EVs on US roads by that year.[6] Based on estimated charger-to-vehicle ratios from the literature, those EVs will require 170,000 to 330,000 public dc fast-charging ports and 3,700,000 to 6,170,000 nonresidential (i.e., public and workplace) Level 2 ports by 2035 (Nicholas, Hall, and Lutsey 2019; Wood et al. 2017). Currently, 80,174 Level 2 and 16,590 DC fast-charging outlets are installed across the United States (DOE n.d.a).

Barriers to Deploying Charging Infrastructure

Two goals are critical to rapidly transitioning consumer vehicles to EVs: increasing access to home charging and deploying public and workplace charging infrastructure far more widely. Unfortunately, challenges persist to meeting both goals. These include a lack of experience and expertise, insufficient coordination and logistical challenges, and high upfront costs. Moreover, the communities that would benefit most from the ability of EVs to reduce pollution face the greatest barriers to adopting EVs; these include barriers to deploying charging infrastructure.

LACK OF EXPERIENCE AND EXPERTISE

The switch from gas to electric vehicles involves a paradigm shift not only for the technology but also for "fueling" locations and behaviors. Drivers contemplating EV adoption and property managers—the landlords, homeowner associations, employers, and other entities serving as site hosts for MUDs and public and workplace charging—may be unfamiliar with charging technologies, including such critical aspects as levels of charging, electrical needs, local permitting, utility interconnection, and charger upkeep, along with a variety of logistical issues, such as how to enroll in applicable electricity rates. Moreover, drivers may not know where or when to charge in order to minimize their charging costs while meeting their mobility needs. Easy access to experts and comprehensible materials are essential to support and accelerate EV adoption.

At the same time, electric-sector entities, such as utilities and regional grid operators, would also benefit from access to centralized expertise and information sharing. Such sources of knowledge would help them better understand the impacts and benefits that EVs may have on the electric grid.

COORDINATION AND LOGISTICAL CHALLENGES TO HOME CHARGING

Home charging is typically the easiest way to charge an EV, which is why EV drivers do 80 percent of their charging there (DOE n.d.b). If available, home charging is easy because an EV typically spends many hours parked there, particularly overnight (TRB and NRC 2015). However, some housing types present challenging barriers to infrastructure deployment.

Single-family homes with dedicated parking are the simplest case, provided the homeowners can finance the installation. These homeowners can install a charger and any needed wiring upgrades on their property at their own discretion. In contrast, drivers who rent single-family homes with dedicated parking must overcome coordination and split incentives between the driver-tenant and the landlord to have charging infrastructure installed. Renters and

homeowners in MUDs face additional challenges in terms of parking spaces and misaligned incentives between an individual driver and the building owner or homeowners' association. Drivers themselves are neither responsible for nor authorized to make capital investments at MUDs or rented houses, so property managers must support charger installation. However, property managers often get little or no return on such investments, even if the cost is low (Baldwin, Myers, and O'Boyle 2020). In this way, the incentives are split between EV drivers, who would benefit from charging, and property managers, who are responsible for investing in infrastructure.

MUDs may offer their residents assigned parking spaces, shared parking spaces, or no parking at all. Where MUDs do have parking, whether assigned or shared, a driver's desire to have charging installed may clash with the interests or budgets of building managers. At locations with dedicated parking, drivers may resist having to switch parking spots either to gain access to charging or to accommodate access for another driver (Baldwin, Myers, and O'Boyle 2020). For MUDs with shared, unassigned parking, property managers must arrange for sharing common chargers, potentially stretching charging investments further. However, shared chargers may not provide the certainty of charging access that drivers require to adopt a personal EV.

Drivers who rent apartments in MUDs face misaligned incentives and coordination challenges most acutely. And it may not be feasible for drivers in MUDs or single-family homes that lack dedicated parking to get access to home charging at all. These drivers must rely on charging away from home, such as at a public station or the workplace. As EV adoption becomes more widespread, these "charging nomads" will increase in number.

LOGISTICAL CHALLENGES AT PUBLIC AND WORKPLACE LOCATIONS

Public and workplace charging face their own logistical challenges. As with MUDs, incentives for investing may be split between employee-drivers and employers. Moreover, workplaces come with a variety of parking arrangements, from assigned parking to shared parking to no parking at all. Workplaces with shared parking must arrange how charging will be shared. A workplace without parking might partner with the local government or a third party to install curbside or other parking nearby. A further challenge to installing charging at workplaces can be uncertainty around whether charging provided by the employer is taxable income for the employee and, if so, how to assess the value of that benefit (TRB and NRC 2015).

UPFRONT COSTS AT HOME

Charging power is a key driver of the upfront cost across the variety of home charging situations. Residential chargers can serve single-family homes and some MUDs, while many larger MUDs may require the durability and functionality of a commercial charger (Nelder and Rogers 2019).

Considering only the charger itself, today's residential Level 2 charger models cost from just under $400 to almost $700, while commercial models cost $2,500 to $4,900 (Nelder and Rogers 2019). In addition, trenching, wiring, and panel or transformer upgrades may be required to make a site ready for a charger on the customer or utility side of the electricity meter. Paying for this "make-ready" infrastructure, along with labor, permitting, and taxes, adds up to a range of additional upfront costs. Ongoing data and networking charges (if applicable), maintenance, and electricity costs can also create a funding challenge.

Notably, low-income homeowners often live in older housing that may have deferred maintenance, which means the make-ready investments are especially high and often prohibitively expensive (US Census Bureau 2020b). Also, low-income drivers who own single-family homes may lack access to financing at reasonable terms to pay for installing charging, even if they overcome other coordination and logistical challenges, exacerbating the upfront-cost challenge for these drivers.

UPFRONT COSTS AT PUBLIC AND WORKPLACE CHARGING LOCATIONS

High upfront cost is also a barrier for the operators of workplace and public charging stations. Level 2 public and workplace charging encounter similar costs to those at MUDs that require commercial-grade, Level 2 chargers. DC fast chargers are more expensive: purchase prices range from $20,000 for a lower-end, 50 kilowatt charger up to $150,000 for a higher-end, 300 kilowatt charger (Nelder and Rogers 2019).

As with chargers for homes, make-ready infrastructure, labor, permits, and taxes add to the upfront costs for Level 2 and DC fast charging at away-from-home locations. The required make-ready infrastructure and upgrades generally increase as the kilowatt power of chargers at the station location increases. Accordingly, while EV adoption is in its early days, the operators of public DC fast charging face a particular challenge as they lack a viable business model for recouping the very high upfront charger and make-ready costs through operating revenue.

Federal Policy to Accelerate Charging Deployment for Consumer EVs

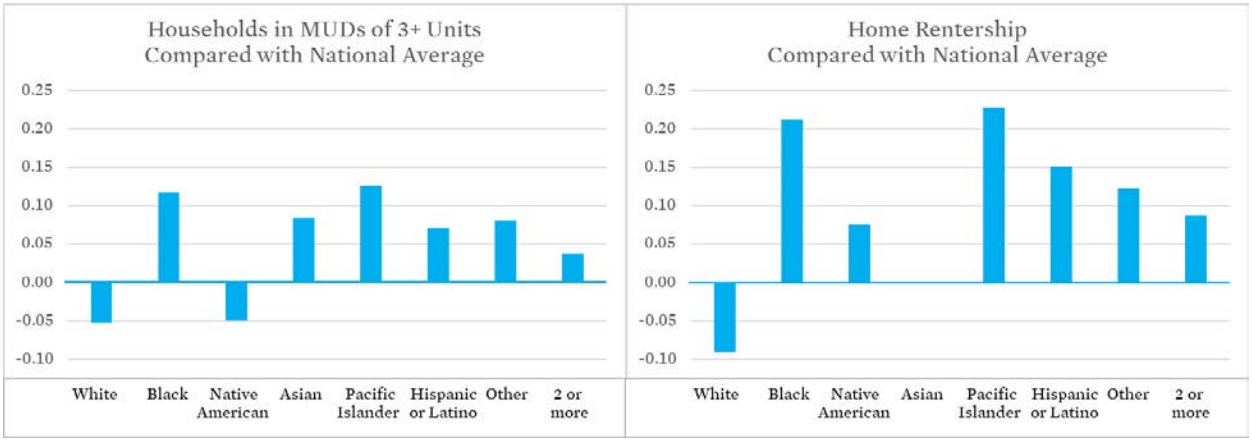
Overcoming barriers to charging access for renters and MUD residents is particularly important in order to address racial and economic inequities. On average, the household income of renters is over $6,000 less than the national average income; for residents of MUDs of three or more units, the figure is over $19,000 less than the national average (US Census Bureau 2020b). Black households rent 21 percentage points more than the national average, and they reside in MUDs of three or more units 12 percentage points more. White households rent 9 percent less and live in MUDs 5 percent less than the national average (Figure 1) (US Census Bureau 2020b). These differences derive largely from a long history of redlining, racial housing covenants, banking practices, and disinvestment in communities of color (Creger, Espino, and Sanchez 2018).

EV infrastructure policies to address inequities must distinguish between charging that is deployed in low-income or pollution-burden areas and charging that is accessible to people in those communities. Simply having a charging station in an equity-designated area does not ensure that the investment serves that community. A typical example of deployment versus access is a DC fast charging station situated in a low-income neighborhood adjacent to a highway. Proximity to the highway and the relatively higher cost of fast charging means that the station is more likely to predominantly serve drivers passing the neighborhood than residents of the neighborhood.

Policies that advance research and provide incentives and financing mechanisms can get the United States on track to installing infrastructure at a scale consistent with achieving climate goals. Notably, policies to support EV charging serve purchasers of both new and used vehicles. Increasing access to charging for all drivers can improve equitable outcomes and accelerate EV and EV infrastructure access for those who need it. To ensure equitable access,

EV infrastructure-specific policies must be part of a larger strategy that addresses such issues as land use, wages, workforce development, and access to housing and jobs.

Figure 1. Housing Type and Renter Status by Race and Ethnicity in the United States



Overcoming barriers to improving access to charging for renters and MUD residents is particularly important to address racial and economic inequities.
Note: The following US Census Bureau–defined racial groups were used in the analysis: White; Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian or Other Pacific Islander; Hispanic; Latino; and Some Other Race. In the chart above, Other includes census respondents who select Some Other Race as their only race.
SOURCE: UCS ANALYSIS OF US CENSUS BUREAU 2020a.

RESEARCH TO ADVANCE CHARGING TECHNOLOGY AND EFFICIENT INFRASTRUCTURE DEPLOYMENT

Filling information gaps is essential to facilitating the deployment of charging infrastructure. Research, development, demonstration, and knowledge-sharing programs through executive agencies and national research bodies, like the Department of Energy (DOE) and the national laboratories, can help the nation develop and refine charging technologies, optimize EV-grid integration, and reduce the cost of infrastructure. The potential to reduce costs includes soft costs like customer acquisition, financing, contracting, permitting, inspection, interconnection, installation, operations, and maintenance (Nelder and Rogers 2019). Research into and disaggregated data on local demographics where charging has been installed can expose gaps as well as land-use, climate, and pollution impacts that should inform priorities for future investments addressing both poverty and pollution (Aguayo 2020).

The DOE can play a lead role in disseminating EV infrastructure research and facilitating best practices established by early movers in the infrastructure investment and vehicle-grid integration space, as it has done on topics such as resilience with respect to climate change. The Federal Energy Regulatory Commission can undertake a complementary effort, issuing a notice of inquiry regarding the needs and opportunities for EVs in the bulk electric transmission system as EV deployment grows.

It is critical to emphasize planning charging installations to ensure that low-income communities and communities of color are not ignored in charging infrastructure deployment.

As noted above, having a charger just off the highway in a community does not necessarily mean the charger serves that community. Federal agencies can support infrastructure planning and assessments of charging distribution.

An assessment of community mobility needs is often skipped in transportation planning, leaving an information gap about which mobility solutions will work for a particular community (Creger, Espino, and Sanchez 2018). However, needs assessment is a critical step, identifying mobility barriers and the solutions best suited to meet the needs of a particular community (TransForm 2020). Federal guidance can inform minimum standards and key activities for conducting community needs assessments. Further, federal funding can support state, tribal, and local engagement in conducting those assessments, and, when appropriate, federal programs should make infrastructure grants contingent on their completion. Assessments can reveal residents' needs and preferences for owning or sharing cars, using public transit, and using personal or shared micro-mobility options like bikes and scooters. Community preferences should dictate where charging infrastructure installation would maximize community access.

Intercommunity charging along travel corridors would also benefit from assessment and planning.[7] Federal legislation should fund these kinds of research and analysis to promote the efficient, installation of charging technologies.

FINANCIAL ASSISTANCE FOR CHARGING INFRASTRUCTURE

Financial assistance to overcome upfront cost barriers can come in two forms: incentives and financing. It can also reduce the competing incentives between drivers and property managers by reducing or eliminating the cost part of the equation on the side of the managers.

Incentives can take many forms, including vouchers, grants, rebates, and tax credits. The federal Alternative Fuel Vehicle Refueling Property Credit should be extended in a way that provides long-term certainty for those who install the infrastructure.[8] This credit provides a business or personal tax incentive for installing charging infrastructure. It can be improved by clarifying that each charging unit is eligible for the credit. Further, making the infrastructure tax credit refundable would enable those taking the credit to take full advantage of it, regardless of their tax liability.

To make the installation of infrastructure feasible for drivers facing the most barriers, federal programs must go beyond the infrastructure tax credit to target installation at certain locations. Incentives for installing charging infrastructure at workplaces and MUDs, as has been proposed legislatively, can help increase access.[9] Beyond broadly available programs, upfront grants or vouchers for infrastructure that explicitly names and prioritizes low-income communities, communities of color, and pollution-burdened or climate-stressed communities are necessary to increase equitable access to charging.[10]

Legislation can also establish grant programs for installing charging infrastructure along highways.[11] Such programs would encourage more drivers to adopt EVs by making long-distance travel more feasible. Also, a national green bank should be established to finance clean energy and transportation projects, including EV charging infrastructure.[12] For rural areas, legislation can expand and fund US Department of Agriculture programs for rural electric cooperatives that promote the deployment of charging infrastructure.

The federal government also can use existing programs to support public charging infrastructure. These include the Department of Transportation's Congestion Mitigation and Air Quality Program, Surface Transportation Block Grants, and other programs. In addition, leveraging the DOE's lending authority can support the buildout of charging infrastructure.[13]

Federal legislation can also open favorable pathways to leveraging public-private partnerships for installing public charging. One such pathway would designate public charging as a qualified exempt facility for tax-exempt private activity bonds, as has been proposed in legislation.[14] Additional bonding pathways may provide further opportunities to finance charging infrastructure.

BUILDING CODES

One strategy for aligning incentives between property managers and drivers is to require the installation of charging infrastructure under residential and commercial building codes. If the infrastructure installation is required, then both the driver and property manager benefit from the investment: in the form of access to charging for the former and meeting code for the latter. Such EV-ready building codes require equipping a certain percentage of parking spaces at a location with charging stations, while a percentage of other parking spaces must be equipped only with electrical-panel capacity, wiring, and raceways to make those spaces ready for the future installation of chargers. The DOE should promote EV-ready building codes in their engagement with code-setting organizations. In addition, the department should encourage and support the efforts of state, tribal, and local governments to adopt EV-ready building codes.

Finally, federal legislation should mandate a level of EV-readiness at parking facilities owned by the federal government or managed by the General Services Administration and at public lands, such as National Parks. Legislation should consider EV-readiness at affordable housing locations in consultation with the Department of Housing and Urban Development, and it should pair funding with any requirements for existing or future affordable housing locations.

Conclusion

Swift and substantial charging infrastructure deployment is essential as the United States transitions to electric transportation, and federal policy has a crucial role to play in breaking down barriers to deploying infrastructure to serve all drivers. A portfolio of policies that advance research, incentives, financing mechanisms, and building codes can get the United States on track to installing infrastructure at a scale consistent with meeting the nation's need to reduce pollution and decarbonize the economy. These policies can increase access to charging for all drivers and improve equitable outcomes in an electric transportation future. The need is great and immediate.

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Organizational affiliations are listed for identification purposes only. The opinions expressed herein do not necessarily reflect those of the individuals who reviewed it. The Union of Concerned Scientists bears sole responsibility for the report's contents.

ENDNOTES

1. DC fast charging for heavy-duty vehicles may exceed 450 kW.

2. Commercial rate structures that include demand charges and public charging business models that aim to recoup demand charges and upfront costs from customers contribute to higher charging costs at commercial locations. Customers who cannot install charging at home and must rely on public charging are at a disadvantage in adopting an EV due to higher charging costs.

3. Examples of assumptions that affect the number of vehicles a charger can support include the availability of home charging and the ratio of plug-in hybrid EVs to battery EVs on the road (Wood et al. 2017). A lower availability of home charging will tend to increase the need for both Level 2 and DC fast charging; a lower fraction of plug-in hybrid EVs relative to battery EVs could greatly decrease the need for public and workplace Level 2 ports. In addition, the ratio of public and workplace chargers to vehicles may also change as EV deployment increases. Empirical data from a number of US cities with different levels of EV deployment indicate that each charger can support more EVs over time, representing a shift from minimum sufficient coverage network to fundamental charging needs (Nicholas, Hall, and Lutsey 2019).

4. The expected lifetime for passenger vehicles exceeds 15 years (Bento, Roth, and Zuo 2018).

5. 100 percent zero-emission vehicle sales was called for by the Select Committee on the Climate Crisis (House Select Committee on the Climate Crisis 2020).

6. In this scenario, zero emission vehicle sales increase to 14 percent in 2025 and 41 percent in 2030 before reaching 100 percent in 2035, and nearly all of the zero emission vehicles sold are EVs.

7. For example, see 116th Congress H.R. 5770 Electric Vehicle Freedom Act of 2020. www.congress.gov/bill/116th-congress/house-bill/5770/text

8. See the Alternative Fuel Vehicle Refueling Property Credit, 26 US Code § 30C.

9. For example, see 117th Congress H.R. 1512 Climate Leadership and Environmental Action for our Nation's Future Act, Section 432. https://www.congress.gov/bill/117th-

congress/house-bill/1512/text?q=%7B%22search%22%3A%5B%22clean+future%22%5D%7D&r=1&s=4.

10. For example, see 117th Congress H.R. 1221 Electric Vehicles for Underserved Communities Act of 2021. https://www.congress.gov/bill/117th-congress/house-bill/1221/text?r=3&s=10

11. For example, see 116th Congress S. 674 Clean Corridors Act of 2019. www.congress.gov/bill/116th-congress/senate-bill/674/text?q=%7B%22search%22%3A%5B%22clean+corridors%22%5D%7D&r=1&s=4

12. For example, see 116th Congress H.R. 2 Moving Forward Act, Section 33192. www.congress.gov/bill/116th-congress/house-bill/2. The Clean Energy and Sustainability Accelerator, a national green bank, includes a minimum percentage investment in climate-impacted communities.

13. For a list of DOE's current financing offerings, see www.energy.gov/energy-economy/funding-financing

14. For example, see 116th Congress H.R. 2 Moving Forward Act, Section 90107. www.congress.gov/bill/116th-congress/house-bill/2

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