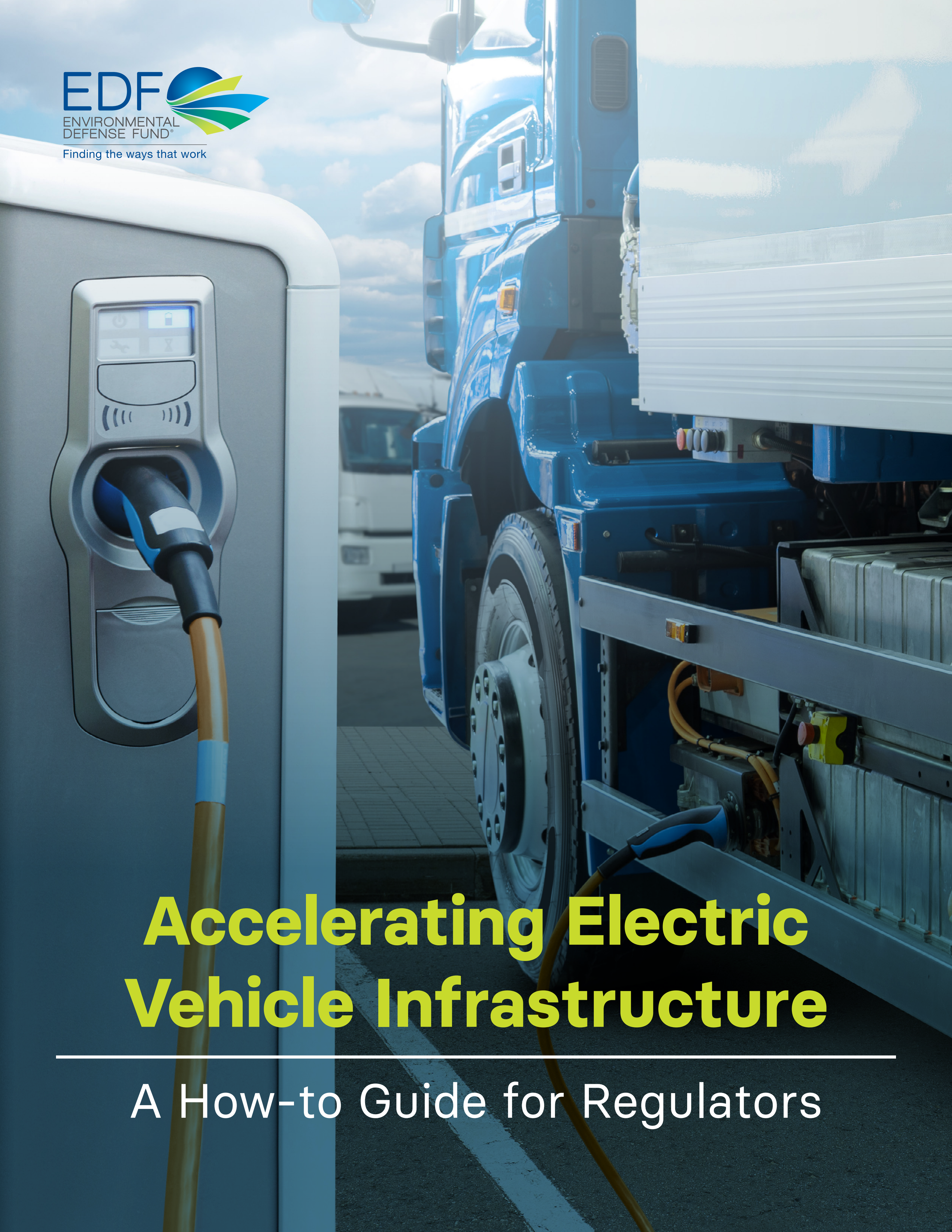
EDF
ENVIRONMENTAL DEFENSE FUND®
Finding the ways that work



Accelerating Electric Vehicle Infrastructure

A How-to Guide for Regulators

Executive Summary

In response to a groundswell of public opinion, state policymakers and utilities throughout the country are embracing electric vehicle (EV) technology as a way to mitigate climate change and reduce air pollution. The challenges of doing so are not purely financial or technological. EV technology needs to be proliferated in a way that promotes equitable deployment of resources while maximizing environmental benefits. Therefore, state policymakers and utilities must prioritize the needs of stakeholders in low-income and pollution-burdened areas. They must also pay heed to the needs of all types of vehicles. Rather than focusing on light-duty vehicles (LDVs), medium- and heavy-duty vehicles (MHDVs) must be contemplated as well.

Financially, the upfront costs of transportation electrification – while decreasing rapidly – can still be significant, despite savings of the lifetime of the vehicle. But, progress is aided by the falling price of electric vehicles, the economies of scale of per-vehicle costs of charging infrastructure[1], and lifetime cost savings across vehicle segments - all of which can be stimulated by public investment, through use of ratepayer and other investments, in the near term.

From a technological point of view, while EVs represent a significant new load on the grid, that additional load can be managed to a certain extent by, for example, pairing with on-site renewables and stationary batteries. Even better, the batteries of vehicles such as freight trucks can be harnessed to provide grid-level storage benefits at costs that are orders of magnitude lower than conventional batteries.

In order to balance all these factors, there must be an informed, holistic approach in deploying resources – including vehicles, charging stations and distributed energy systems – in order to support EV growth in the most beneficial way.

This paper offers seven approaches that state policymakers and utilities should consider as they explore how best to facilitate the new era of transportation electrification. By adopting these guidelines, states will be able to drive more rapid, widespread, and equitable deployment of infrastructure and EVs. Moreover, these strategies will help ensure that the transition occurs in a way that maximizes climate, health, and economic benefits.

It should be noted that there is a certain amount of emphasis on electrification of trucks and buses, by virtue of the experience and expertise of the authors; as such, while there are many considerations described in this paper that will apply to vehicles of all sizes, some recommendations are specifically geared towards heavier vehicles. To the extent possible, that distinction has been noted in the text that follows.

By adopting these guide-lines, states will be able to drive more rapid, widespread, and equitable deployment of infrastructure and EVs.

Differentiate policy approaches for LDVs and MHDVs.

Recharging electric MHDVs powerful enough to haul freight generally involves equipment that is more capable than for LDVs, and may require more maintenance. To capture the benefits associated with electrification across the full range of vehicle types and business models, state policymakers and utilities should create policies and programs that support electric MHDVs as well as electric LDVs. Public spending on widespread charging infrastructure, at least including equipment on the utility side of the meter, and potentially rebates and customer-side installations, will be necessary in the near-term to promote greater levels of private investment.

Prioritize electrification in pollution-burdened communities.

Deployment of charging stations, particularly those needed to support electric MHDVs, should be prioritized to support vehicles operating in low-income, pollution-burdened communities, as well as for small businesses, independent owner-operators and those populations historically underrepresented. Given the disproportionate burden MHDVs place on public health[2], the benefits of electrification in terms of air quality and environment will be notably larger in communities impacted by emissions from trucks and buses - and the relatively higher financial burden of small businesses must be considered. Effort at both the state and utility level needs to be concentrated around proactively and meaningfully engaging stakeholders to identify and overcome barriers to EV deployment.

Collaboratively build marketing, education and outreach (ME&O) plans.

Utilities, in collaboration with various local organizations and businesses, should develop targeted ME&O materials to help disseminate information to potential EV purchasers, including private truck fleets. They must recognize that different communities and market segments will need nuanced approaches to how information is provided and presented.

Monitor load data.

State policymakers should require utilities to collect and monitor data to show the extent to which EVs are being effectively integrated into the grid, ensure prudent expenditure of ratepayer funds, and demonstrate progress against predetermined metrics and goals.

Design rates that maximize the benefits of EVs.

Utilities should structure rates to incentivize charging behavior that actively promotes low-cost renewable energy. They should provide a suite of options that accommodate the varied needs and capabilities of electric LDVs and MHDVs, ensuring fuel-cost savings where feasible, and minimizing grid infrastructure build-out.

Harness the potential for vehicle-grid integration (VGI) capabilities of EVs and on-site distributed energy resources.

State policymakers and utilities should develop policies and programs that effectively facilitate VGI as a way to increase grid asset use, avoid costly grid build-out, integrate renewable energy resources, and increase grid resiliency.

Ensure the use of standards that will future proof equipment and ensure a better customer experience.

To more effectively harness the benefits of EVs and provide a better customer experience, state policymakers and utilities must develop across-the-board standards for infrastructure, communication and safety.

In summary, the age of transportation electrification is upon us, and the deployment of vehicles, infrastructure and associated resources must take issues of social equity into account. Further, all programs need to be designed so that EVs are integrated into the grid in the most cost-effective and environmentally beneficial way, while also ensuring that all types of vehicles are electrified, including medium- and heavy-duty freight trucks and buses. Education and awareness are key. With the right approach, state policymakers and utilities will be able to rise to the challenge of ushering in this new era of electric vehicles – one that is cleaner, more socially equitable and results in a more resilient electric grid system, too. This white paper aims to help them step forward with confidence.

Introduction

Scaling deployment of infrastructure necessary to support all manner of EVs, including MHDVs, is necessary to achieve critical climate, air pollution, and clean energy targets.

Transportation pollution is one of the most pernicious and impactful problems facing the United States today, given its significant contribution to emissions that worsen climate change and air quality. As a result, climate change is creating increasing weather and flooding hazards, and people are suffering health effects such as respiratory and cardiovascular illnesses and premature death[3]. Worse, transportation pollution disproportionately impacts communities typified by low income and/or people of color. Ports, distribution centers and major transportation arteries are often situated near these communities given the structural racism that plagues our society; as such, air pollution is worst in these areas, and these communities are often more vulnerable to severe weather events. Policies must prioritize reducing emissions in these communities.

It is also critical to recognize and incorporate the different impacts of MHDVs and the potential benefits of electrifying these vehicles. MHDVs contribute 24 percent of U.S. transportation-related greenhouse gas emissions, making them the second-largest contributor after LDVs[4]. Eliminating pollution from all new freight trucks and buses no later than 2040, and from freight trucks and buses used in urban and community areas no later than 203,5 would prevent 57,000 premature deaths and eliminate more than 4.7 billion metric tons of climate pollution by 2050[5].

There are core differences compared to LDV charging infrastructure that need to be considered. For example, charging electric MHDVs often requires more sophisticated, more powerful hardware - and on a much larger scale - that can be more expensive than that for light-duty vehicles, including DC fast-charging equipment. In addition, placement of charging stations are likely to be different; while many customers operating LDVs will need access to public charging because their living situation makes access to charging difficult, the majority of commercial fleets will utilize private charging, including private depots, truck stops and distribution centers. Plans to deploy charging station deployment must also account for the diverse array of business and ownership models presented by the commercial sector.

Already, policymakers, utilizing state-wide policies and multi-state initiatives, are recognizing the importance of decarbonizing the full range of road traffic – not just LDVs, such as cars and trucks, but MHDVs, such as diesel-powered delivery vans, school and transit buses, and short- and long-haul freight trucks[6].

The increasing viability and availability of zero-emission trucks and buses means this transition is feasible. However, important barriers must be considered. Aside from the upfront cost of these vehicles, which remains a near-term challenge, the charging infrastructure cost is also a similarly important consideration. Scaling deployment of infrastructure necessary to support all manner of EVs, including MHDVs, is necessary to achieve critical climate, air pollution, and clean energy targets[7].

This document is designed as a primer for policymakers, and utilities that draws on EDF's MHDV expertise, and offers a practical, common-sense roadmap of how to expand zero-emission vehicles and infrastructure.

Sound infrastructure policies and programs are crucial for a rapid, equitable and environmentally responsible transition to EVs. State policymakers and utilities need to carefully, yet swiftly, plan for and deploy infrastructure while providing space for substantial input from a variety

of stakeholders, including environmental justice and community advocates, small businesses and businesses owned by women and people of color. This whitepaper is designed to act as a starting point for those stakeholders. While it lays out important principles at a big-picture level, utilities and policymakers will need to go into more depth in order to establish a successful infrastructure program that balances all the factors in play.

A successful infrastructure program will include the following key approaches:

1. Building transportation electrification plans that recognize and account for the differences between MHDVs and LDVs;
2. Ensuring equity is prioritized in the transition to an EV future;
3. Developing ME&O approaches that assist all ratepayers in adopting EVs;
4. Setting forth transparent metrics and goals that measure the impact of transportation electrification on the grid and ratepayers;
5. Ensuring VGI maximizes the benefit of transportation electrification on the grid and to EV drivers;
6. Designing rates that minimize the impact of transportation electrification on the grid and preserve cost savings relative to diesel; and
7. Developing standards for infrastructure, communication and safety, to help harmonize transportation electrification efforts.

Electrification of Medium- and Heavy-Duty Vehicles Will Need More Resources

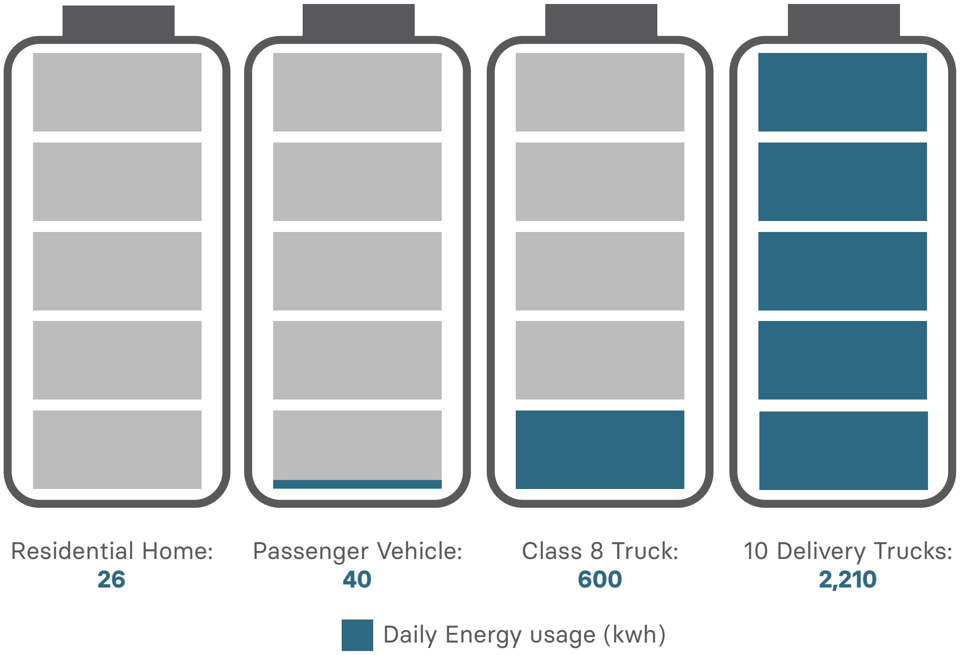
Conventional MHDVs contribute disproportionately to toxic air pollution and climate change, relative to the number of these vehicles on the road. As such, transportation electrification plans and policies must make sure there is appropriate emphasis placed on MHDV electrification. Because the technology and adoption of electric MHDVs currently lags that of lighter vehicles, additional resources and assistance will be needed, at least initially, to make sure that adoption scales in line with policy targets.

Consider a Variety of Charging Requirements

Electric MHDVs have larger batteries, diverse charging requirements and more expensive charging infrastructure, compared with electric LDVs. A level 2 charging station delivering AC power is suitable for quickly charging most LDVs, such as the Nissan Leaf – which has a 40-kWh battery. But that same charging station is insufficient for most MHDVs, which have much larger batteries, such as the Freightliner e-Cascadia's 550 kWh

Why electric trucks need differentiated energy planning

Specialty energy programs for electric trucks can maximize benefits



It is clear the cost of the necessary infrastructure is a barrier to increased adoption.

battery[8]. To successfully electrify fleets of all sizes, state policymakers and utilities must not assume LDV infrastructure will be suitable for MHDVs, and instead ensure fleets are provided with direct-current (DC) fast chargers at depots, and, as necessary, at en-route public locations.

Additionally, the power levels needed for charging MHDVs – particularly as their numbers scale – have the potential to have a much bigger impact on the power grid than LDV charging if not carefully managed. For context, level 1 charging supplies a power output of 1.3 kW to 2.4 kW, while DC fast charging supplies a power output of up to 350 kW[9]. Scale all this up to even a fraction of the nearly 4 million Class 8 freight trucks currently on the road, and there will be a massive draw on power grids that requires careful forward planning and measures to mitigate negative impacts.

The good news is that increased adoption of solar panels on houses and commercial structures will drive more clean power into the grid at low cost. Careful planning to mitigate significant buildout of distribution grid infrastructure and associated work, such as trenching and line extensions, will be needed. If the costs of doing so are put solely on the customer, this could be detrimental to the economic viability of MDHV electrification, because it has the potential to overshadow the other lifetime cost savings inherent in the transition.

To that end, decision-makers at the state level as well as at utilities should consider new rules that require rate-basing some of these costs, at minimum on the utility side of the meter. An example to look to is California Assembly Bill 841, which catalyzed a recent decision at the California Public Utilities Commission requiring utilities to provide on-site grid upgrades on the utility side of the meter at no cost to the individual customer[10].

Further, to bolster MHDV electrification, state policymakers and utilities should develop robust relationships with fleet owners to ensure they are preparing the grid for increased MHDV electrification without unnecessary delays and that technologies, such as on-site solar and storage, are put in place as a way to help mitigate expensive, avoidable grid build-out. This utility outreach should also be conducted with an eye to understanding the unique barriers that a particular fleet has, and determine the extent to which utility intervention can alleviate those barriers.

Account for Operational and Cost Disparities

The charging behavior of typical MHDV fleets versus LDVs is vastly different. While LDVs are typically parked 95 percent of the time[11], commercial fleets tend to have significantly higher rates of utilization. LDVs often have flexibility as to when and where they charge, but MHDV fleets, whose drivers often have to operate on tight schedules and may drive many more miles, must ensure that available charging is sufficiently convenient and fast to accommodate those needs. These are likely DC fast chargers and Level 2 chargers at private depots, with en-route charging needed for long-haul applications. MHDV infrastructure programs should prioritize private-depot charging, with a secondary focus on public DC fast charging along common truck corridors where needed.

State and utility policymakers should also keep in mind that within fleets, there are a variety of different operational and business models. Truck fleet operators may look for charging stations at warehouses and shipping distribution centers, thereby avoiding ownership of charging infrastructure. Infrastructure programs should be flexible to cater to multiple ownership schemes, understanding, for example, that many fleets are not owners of the sites where they will park and charge their vehicles.

Consider a Variety of Financing Options

It is clear that the cost of the necessary infrastructure for EVs, particularly MHDVs, is a significant barrier to increased adoption.

The cost of infrastructure for MHDV charging is significantly higher, given the greater power levels needed, not only due to the cost of the charging stations themselves, but also the behind-the-meter buildout potentially needed to accommodate this new load. For example, a study showed that costs of infrastructure for a fleet of 50 class 8 trucks can be anywhere between $10 million and $40 million[12]. Without support for these costs, fleets – in particular small businesses – may not be able to successfully transition to EVs.

Utility programs that are designed to strategically deploy infrastructure necessary to support increasing numbers of medium- and heavy-duty vehicles are a good start, but states should avoid putting all their eggs in that basket. Using utility programs as the sole source of public investment will either be insufficient to move the needle sufficiently or will put an untenable burden on ratepayers.

A variety of mechanisms need to be considered in tandem. This includes tactics like rebates from states and utilities, and low carbon fuel standards, in which an entity obtains credits for the use of electricity that they can then sell, further enhancing the attractiveness of a transition to zero-emission vehicles, as well as technical assistance and on-bill financing[13]. Of course, any of these mechanisms must be designed in conjunction with and in a way that benefits communities most impacted by transportation pollution. An interagency working group that considers a holistic suite of policies and how they can be structured and coordinated to be most efficient is critical in ensuring effective progress on vehicle and infrastructure deployment.

Ensuring Environmental and Social Equity

The transportation sector has long been a disproportionate contributor to environmental and economic injustices in the United States. While diesel-powered delivery trucks and tractor trailers make up only 10 percent of vehicles on U.S. roads, they generate more than 45 percent of nitrous oxide emissions and around 28 percent of greenhouse gas emissions from on-road vehicles, as well as nearly 57 percent of fine particulate matter[14].

MHDVs tend to drive through and park in areas of low-income communities and communities of color. Electrification of these polluting vehicles must be prioritized in these already pollution-burdened communities. State and utility policymakers should also work with communities who are understandably opposed to increased traffic to increase funding for expanded, more affordable public transit solutions and undertake a careful analysis of the impact of facilities and truck traffic of any kind in these communities[15]. To be equitable, any transportation electrification approach should also target small businesses that may not have the same access to capital and information, or technological know-how. To better ensure equitable infrastructure deployment, state policymakers and utilities must proactively engage with stakeholders in these communities to identify and overcome barriers to deployment. Strategies can include setting out criteria for charging station placement, establishing a variety of rates that will benefit residents and businesses in these communities, and financing solutions that meet the needs of would-be participants who may not have access to the levels of capital available elsewhere.

Engage Impacted Communities to Understand and Overcome Barriers

State policymakers and utilities need to meaningfully engage with stakeholders based in pollution-burdened communities, including environmental justice experts and advocates and small and women- and minority-owned businesses, to ensure that their priorities, viewpoints and expertise are included in transportation electrification programs. For example, as the Greenlining Institute writes, transportation electrification plans and policies must "include processes that deeply engage community members to learn about their priorities, needs and challenges to adapting to climate impacts, otherwise known as a Community Needs Assessment."[16]

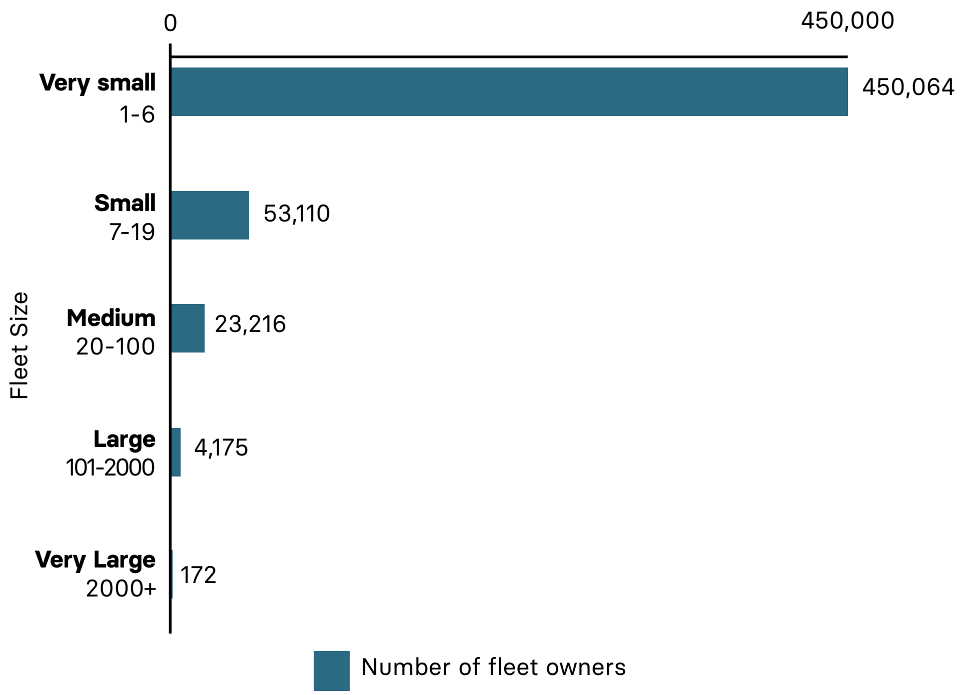
Allocate Funding Equitably

Investment in and deployment of EV infrastructure to accommodate vehicles of all sizes in low-income, pollution-burdened communities is already lagging behind wealthier communities. To target investment that benefits residents and small businesses in these communities, utilities and state policymakers should use tools such as mapping the proximity of these communities to sources of pollution like warehouses and freight corridors, and establishing where communities are most impacted by pollution and income disparities. They should also gather health statistics that can demonstrate where the greatest disparities lie and determine where communities are underserved in terms of infrastructure and vehicle deployment. For instance, given its importance in ensuring an equitable outcome, state policymakers and utilities could invest in the expansion of public charging opportunities near multi-unit dwellings, which are often in low-income and pollution-burdened areas, and which generally lack charging on-site. Investment should also be targeted to facilitating the purchase and use of charging stations and distributed energy resources for small fleet owners who may lack sufficient capital and information to take advantage of these solutions without assistance. To date, utilities have often worked on fleet electrification with large fleets because large fleets have capital; however, as shown in Figure 1, businesses with smaller fleets tend to be far more prevalent.

Figure 2

Small fleets make up a significant portion of conventional freight trucks

Source: FMCSA Motor Carrier Management Information Systems



Train Workers to Understand a Zero-Emissions World

To meet state metrics and goals, enough unionized workers need to be hired and trained to install EV infrastructure and necessary grid upgrades. As stated by the BlueGreen Alliance, labor standards are key to ensuring a successful transition to EVs, given the higher wages and benefits that come with being part of a union[17]. These employees should understand and be able to convey information about available rates and how best to take advantage of price signals that can significantly lower bills, installation and use of charging stations, and operations and maintenance costs relative to conventional vehicles at minimum. State policymakers and utilities must also prioritize job growth in order to build wealth in low-income, pollution-burdened communities through such measures as training programs and ensuring equitable pay and benefits. Resources like the Greenlining Institute's Electric Vehicles for All: An Equity Toolkit provide commonsense and actionable solutions to ensuring that wealth is built in communities that are underserved or disproportionately burdened by socioeconomic, pollution, and health factors[18].

State policymakers and utilities need to involve members of low-income, pollution-burdened communities and advocates for those communities from the outset to develop approaches for transportation electrification programs.

Building an Effective Marketing, Education, and Outreach Strategy

Education and awareness are key. Utilities need to embark on ME&O initiatives that involve staff facilitating initial and ongoing conversations with potential buyers, dealerships and other stakeholders to provide information about EV infrastructure and ownership.

State policymakers should direct utilities to develop robust ME&O programs that are tailored to communities that have been historically neglected by efforts to deploy infrastructure necessary to support EVs. Additionally, small businesses should get extra attention, since they often have less capital with which to make the transition to zero-emission vehicles, and may lack the requisite expertise to undertake the transition without intervention.

Utilities can act as a "one-stop shop" for potential and current transportation electrification program participants to obtain information in various languages and a variety of formats, including in-person help for those that may not have internet access. They are perfectly positioned to broaden accessibility, and to support equitable, widespread electrification. Utilities throughout each state should collaborate with each other and relevant stakeholders in order to align ME&O efforts, as deemed appropriate by regulators.

Develop ME&O in Consultation with Impacted Communities

State policymakers and utilities need to involve members of low-income, pollution-burdened communities and advocates for those communities from the outset to develop approaches for transportation electrification programs – which must include ME&O plans.

Utilities should partner with entities such as community-based organizations, dealerships, original equipment manufacturers, city officials and electric vehicle service providers – depending on the situation – to create and execute ME&O programs that communicate the environmental and financial benefits of EV adoption to harder-to-reach communities, including individuals and businesses in low-income, pollution-burdened communities.

Recognizing the benefits of collaboration, state policymakers and utilities should consider allocating some portion of ME&O funding to community-based organizations better equipped to conduct local outreach.

Tailor ME&O to Facilitate All Manner of LDV and MHDV Electrification

Given their vested interest in ensuring minimal impact on the grid, utilities should play an equal role creating and executing ME&O programs on topics such as rates and managed charging.

Utilities should tailor ME&O for a diversity of use cases and fleet sizes in the MHDV sectors, and should work closely with a wide range of stakeholders to better understand the barriers they are facing before developing outreach programs.

In particular, utilities should be proactive about addressing the needs of small fleets, as these smaller companies are often ignored in utility infrastructure programs. Further, ME&O programs should provide information about the impacts of different rate structures on the total cost of ownership, the ability of managed charging to enhance cost savings compared to diesel fuel, available rebates and incentives to mitigate upfront cost of infrastructure and vehicles, and programs that support vehicle and infrastructure deployment administered by state and federal agencies. Utilities should provide additional assistance as necessary to ensure charging station solutions fit the size and needs of a particular fleet type. By tailoring the programs for specific market segments, with individual needs, utilities and state policymakers will be better equipped to electrify in a way that maximizes cost benefits and aids in the achievement of broader zero-emission-vehicle and clean energy targets.

Establishing Targets and Metrics to Enhance Results

State policy-makers should develop metrics and goals that ensure sensible and practicable infrastructure deployment.

To adequately monitor progress, state policies and utility programs need to be measured against clearly defined metrics and targets that help ensure the best outcomes, corroborated through consistent collection of data. State policymakers must require utilities to collect information such as the rate of deployment of EV infrastructure associated with their programs, the extent to which charging load is being optimized to coincide with low-cost times and high renewable energy availability, the use and effectiveness of incentives to facilitate VGI capabilities, and the potential and realized cost savings associated with these programs.

Conduct Grid Capacity and Market Potential Analyses

State policymakers should develop metrics and goals that ensure sensible and practicable infrastructure deployment. They will need to calculate how much additional grid infrastructure and generation capacity is reasonably needed to accommodate increased load. They can exploit market potential analysis to determine when and how much anticipated demand growth will be coming onto the grid. They will also need to learn how to minimize expensive grid build-out through efforts such as managed charging, incentivization of advanced vehicle capabilities, and increased use of non-wires solutions such as on-site solar and storage. Policymakers should also stay aware of market signals that reflect transmission operator forecasts of energy availability. If these steps are not taken, utilities will inevitably pass the costs of otherwise unnecessary grid upgrades on to ratepayers. Further, grid stability, caused by poorly managed load, may suffer.

Publish Regular Reports

By consistently and publicly reporting the metrics described above, and inviting comment, state policymakers and utilities can benefit from the expertise of stakeholders and enable more effective, faster deployment of charging infrastructure, including in currently underserved areas. Intelligently harnessing the knowledge of a wide community will promote economies of scale, and result in steadily decreasing costs.

These reports should include, but not be limited to:

- Cost of installation for EV infrastructure broken down by vehicle class;
- Estimated timelines for interconnection and build-out of any necessary grid infrastructure;
- Costs avoided through VGI, and the resulting reduced grid congestion, pollution and greenhouse gas emissions;
- Percentage of infrastructure deployment occurring in low-income, pollution-burdened communities;
- Deployment data broken down by site type, vehicle type and market sector;
- Detailed load analyses to determine achievement of optimal load shape, and to evaluate how rates are effectively impacting beneficial charging behavior; and
- Information on how feedback from stakeholders has been addressed, particularly those from low-income, pollution-burdened communities, as well as the list of stakeholders that were consulted.

These reports should be followed by an independent, publicly available, assessment of where programs are not meeting expectations and how those disconnects can be overcome. Regular reporting will ensure programs and policies are effective, identify areas of improvement, and ensure that ratepayer money is being spent in alignment with state goals.

Mitigate Impacts on the Grid

VGI encompasses the various ways EVs and charging infrastructure can provide grid services. The aim is to increase the use of grid assets, avoid unnecessary grid build-out, integrate renewable energy resources, reduce the cost of electricity supply and increase grid resiliency[19]. VGI strategies include enabling vehicles to put energy back into the grid ("vehicle-to-grid" (V2G)), enabling vehicles to power buildings ("vehicle-to-building" (V2B)), and managing vehicle charging based on grid conditions ("managed charging" (V1G)).

Effective VGI can be facilitated by strategic placement of charging infrastructure and distributed energy resources (DERs) like on-site solar and storage, which can reduce total cost of ownership[20]. These options also provide important services to the grid, such as off-peak charging, and utilities should also be proactively exploring them with fleets. To incentivize and unlock the multifaceted benefits of VGI, state policymakers should evaluate the solutions offered by V2G, V2B, and V1G, on a level playing field with traditional grid service solutions.

Mitigate Fleet Charging Infrastructure Costs

The costs of building out charging infrastructure remain a significant barrier to widespread transportation electrification. VGI offers fleet owners wishing to electrify their vehicles a means of doing so in a more cost-effective manner, and the creation of fair incentives for V2G, V2B, and V1G make sound economic sense in the long run. Costs can also be mitigated through strategic use of DERs such as solar and storage. For example, UPS introduced non-mobile battery storage and active network management technology that balances load with supply at its London depot. In doing so, it was able to increase the number of 7.5 tonne electric trucks from a baseline of 65 to 170, without having to invest in more chargers or perform an expensive upgrade of the power supply connection[21].

Minimize Impact on the Grid While Maximizing Environmental Benefit

One of the most impactful benefits of EVs is that they can act as batteries on wheels, both minimizing the need for grid buildout and supporting renewable energy targets. More specifically, programs that harness EV batteries can minimize the need for additional fossil-fuel powered generation and expensive fixed storage. It has been shown that EV battery storage can cost as little as a tenth of traditional storage[22].

Effective VGI can be used to both provide grid capacity and avoid curtailment of renewable energy. Curtailment becomes necessary as more renewables come onto the system, causing oversupply during the middle of the day, when the sun is brightest, or the middle of the night, when the wind is strongest. It is becoming a common – and expensive – practice. In addition to managed charging, installation of onsite DERs such as solar can minimize the overall impact on the grid[23].

By implementing VGI strategies and incentivizing investment in stand-alone batteries where large numbers of EVs exist, state policymakers and utilities can increase the environmental benefits of EVs and reduce the need for expensive grid build-out.

Leverage EVs to Increase Resilience of Power Supply

EVs are a valuable resource for grid operations. The large storage capacity of electric MHDV fleets, like school buses,

are particularly well-positioned to supply energy to the grid and buildings during power outages that may occur as a result of natural disasters. State policymakers should therefore require utilities to implement and begin piloting VGI solutions as part of their resilience plans to leverage the potential of EVs to provide power to the grid and buildings during power outages, as well as play a key role in grid operations such as balancing electricity supply and demand.

Develop Metering that Facilitates VGI and Grid Services

Utilities must coordinate a common, transparent metering data format to achieve smooth integration of VGI and other EV grid services. Through this common format, utilities can help ensure ratepayers are responsive to and benefit from market signals – the way in which the cost of a resource will convey a message to consumers about how to alter their use of electricity based on available supply.

State policymakers should require utilities to prioritize submetering for all EVs. Because submetering devices measure energy usage after it reaches the primary utility meter, to account for the actual energy usage by individual vehicles, they provide utilities and charging station operators with valuable load data. This allows EV owners to easily participate in VGI without being burdened by the extra cost of installing additional utility grade meters.

Designing Beneficial Electricity Rates for Electric Vehicles

Utilities should develop rates with the diverse needs of commercial and residential customers in mind.

Rates must be structured to incentivize charging behavior in a way that accommodates the varied needs of LDVs and MHDVs, ensures fuel cost savings, helps integrate available renewable energy, and mitigates build-out of expensive grid infrastructure.

Utilities can help ensure that EVs benefit all customers by encouraging EV customers to enroll in time-variant rates, which reflect the time-varying costs of electricity over the course of the day and can result in a more efficient use of the grid. Utilities should develop rates with the diverse needs of commercial and residential customers in mind. State policymakers must give utilities agency to build a suite of rates that reflect this diversity without being overly prescriptive – provided that overarching metrics and goals are achieved. These options can include time-of-use pricing (e.g., peak period, off-peak period, interim period), whereby prices vary, but remain consistent from day to day; or critical peak pricing, when the price may increase dramatically on different days to reflect system conditions.

Consider the Differing Needs of Small and Large Businesses

Standardizing electricity rates for all businesses is a flawed approach. Different businesses have differing energy needs, depending on size of business, as well as the size and uses of its fleet, and will have varying ability to respond to certain price signals. While it is inherently more difficult for operators that run a fleet of trucks for 24 hours a day as a business necessity (around a busy port or warehouse, for example) to manage their usage, other businesses could be effectively incentivized to adopt technological interventions and adapt their charging behavior to better suit the practicalities of delivering renewable energy. Rates should reflect those differences, appropriately passing through system costs while avoiding undue penalization. To that end, a suite of rate options is necessary. For example, Southern California Edison has adjusted its pricing schedules to apply different rates to different customer classes in buildings, often lowering overall costs of electricity; the same should be done for charging electric vehicles[24].

Prioritize Cost Containment Across the System

Utilities can incentivize charging at off-peak times to take advantage of low-cost renewable energy that may otherwise have been discarded through expensive curtailment. This will also reduce demand during peak times when fossil fuels are the dominant source of energy[25]. Expanding the number of hours covered by off-peak rates will smooth out demand among EV customers, reducing the strain on grid infrastructure and maximizing the use of renewable energy[26]. By the same token, breaking up the periods over which peak demand is identified for the purposes of determining rates – avoiding what is termed non-coincident peak demand – will reduce price spikes and make EV charging more economically feasible, especially for MHDV fleets with larger energy needs.

While these are not minor tweaks, they are critical, as they represent an opportunity to move into an electric vehicle reality sooner rather than later. Recent research conducted by Lawrence Berkeley National Laboratory, Pacific Gas and Electric and the Natural Resources Defense Council demonstrates that shifting EV charging of LDVs to off-peak times could enable the grid to accommodate EVs at all homes without upgrading most parts of the distribution system[27].

Even better, data from Southern California Edison and Pacific Gas and Electric – the two utility service territories with the most EVs in the U.S. – clearly show that electric LDVs are already generating more revenues than costs, especially if time-variant rates are used, keeping rates down for both EV drivers and non-EV drivers[28].

If this downward pressure on rates also results from the deployment of heavier vehicles, accelerating the EV market for all vehicles will mean utilities can offer savings to all customers, not just the ones committed to electric vehicles. This is a critical message for policymakers to broadcast – vehicle electrification, intelligently managed, offers long-term benefits to everyone.

Keep Bills Manageable for Customers

Charges based on surges in demand can quickly become the biggest portion of a ratepayer's bill if charging times are not managed correctly. Utilities and state policymakers must recognize the at-times unwelcome novelty of demand management for electric MHDV fleets. They can mitigate the impact with solutions like depot-based distributed energy, automated charging technologies, demand-charge holidays and subscription rates[29]. Successful utility billing systems and bill protection programs can also help customers adapt to new rates and feel more comfortable in embracing the whole idea of EVs.

These solutions will be particularly important in the short-term, as cost savings will be critical for would-be early adopters who can lead the way forward for more reluctant others. To that end, a phased introduction may be a good solution in the near-term. Southern California Edison offers its commercial and industrial customers with EVs a demand-charge holiday, which abolishes what is for many fleets the biggest piece of their bill for 5 years before slowly phasing it in, in order to give fleets time to adjust to the implications of adopting the new fuel source. Over the long-term, these solutions may no longer be needed as vehicle numbers reach scale.

Developing Successful Infrastructure Plans

As utilities consider exactly where to place infrastructure, they must keep an eye on improving air quality in pollution-burdened communities and the need to account for the differing charging needs of electric LDVs and MHDVs, all while mitigating grid upgrade costs. State policymakers and utilities should establish uniform, transparent infrastructure standards and priorities in their transportation electrification plans so that these decisions make sense and can be executed in a timely fashion.

Establish Uniform Communication Standards

Standards are important, so that facilities and technologies are fungible. If a third-party metering company goes out of business or does not provide the requisite maintenance to ensure a charging station remains used and useful, policymakers and communities face the risk of stranded assets and short supply. If the charging station cannot be taken over by another provider because of proprietary or defunct technology, the result is an unusable piece of technology.

To avoid this, state policymakers should require that all charging equipment deploys standardized, open charge point protocol (OCPP) that allows any EV charger to work with any charger management software, thus allowing other companies to take over stranded charging stations. Use of standards like OCPP and open charge point interface (OCPI), which more easily allow access to charging station data such as location, accessibility and pricing, will help ensure that EVs can use multiple service provider networks. It will also help establish roaming standards; a critical element as the adoption of electric vehicles spreads to those crossing state lines.

Communication standards should also include OpenADR, which provides a foundation for the automated, same-language exchange of information between utilities or other entities and customer end-use control systems, in order to facilitate demand response.

Finally, to unlock the potential for EVs to be an asset to the grid, not just a drain, drivers must be able to receive price or incentive signals regardless of who owns the charging station or who made the vehicle. Therefore, to ensure consumer choice and robust, integrated grid services, it is vital that a standard enabling effective communication is established between the Electric Vehicle Supply Equipment (EVSE) and the EV. By allowing customers to seamlessly switch charging service providers, the response to grid conditions can be centralized and automated, and charging equipment will be effectively future-proofed.

Facilitate Public and Private Investment

Infrastructure programs should allow for a variety of ownership models. Ownership of charging infrastructure by utilities and third-party service providers can co-exist side-by-side, providing utility ownership of stations does not chill a competitive market. Keeping a watchful eye on market domination will provide much-needed assurance to fleets thinking about making the transition to zero-emission vehicles. This will be particularly important for small businesses and fleets operating in disadvantaged communities that are critical targets but may have less technological know-how. Scaled deployment will also unlock private investment, which will accelerate the development of needed infrastructure.

Ensure Safety and Adequate Access to Charging

State policymakers should require that all utilities adhere to predetermined safety and performance standards informed by National Institute of Standards and Technology and ENERGY STAR[30]. Utilities must also adopt cybersecurity standards, including encryption algorithms on controller boards that meet National Security Agency standards, protection against remote threats to data storage services by using FedRAMP certification and HTTPS communication, and installation of Transport Layer Security for communication between EVs and charging infrastructure. Utilities and policymakers must also explore non-grid alternatives in order to ensure charging is available during power outages – recent events in California and Texas have proven the need for preparedness in emergency situations. Hazard mitigation programs will be especially important for critical facilities like hospitals and community shelters.

Conclusion

Significant roadblocks to widespread EV infrastructure rollout still exist, but, like so many of the other technological revolutions that have occurred over the last few decades, these barriers can be overcome with well-crafted policies and programs. Policies that effectively consider equity are crucial to realizing widespread EV adoption and a future where environmental, economic and racial justice are valued above profit. To this end, state policymakers and utilities must diligently coordinate charging infrastructure policies and programs with stakeholders from low-income, pollution-burdened communities in order to maximize the benefits of transportation electrification and bring this sector to scale more quickly.

State policymakers can and should move beyond today's emphasis on electrification of LDVs, and consciously also consider how to increase deployment of electric MHDVs that transport goods and people.

This will require developing transportation electrification plans that incorporate utility programs with tailored ME&O initiatives, innovative rate structures, granular and transparent data collection, seamless vehicle-grid integration, and harmonized, common-sense infrastructure standards. By adopting the policy and program recommendations set forth in this how-to guide, state policymakers and utilities will be empowered to usher in an electric transportation future that will benefit everyone. Moving swiftly and with informed purpose towards transportation electrification, state policymakers and utilities can make a real difference, reducing pollution and the environmental and economic injustice it causes, while tackling climate change and spurring growth in green jobs.

References

[1] Michael Nicholas, Estimating Electric Vehicle Charging Infrastructure Costs Across Major U.S. Metropolitan Areas, The International Council on Clean Transportation (Aug. 12, 2019), theicct.org/publications/charging-cost-US.

[2] Hilary Sinnamon, Accelerating to 100% Clean: Zero Emitting Vehicles Save Lives, Advance Justice, Create Jobs, Environmental Defense Fund (Aug. 2020), edf.org/sites/default/files/documents/TransportationWhitePaper.pdf.

[3] Hilary Sinnamon, Accelerating to 100% Clean: Zero Emitting Vehicles Save Lives, Advance Justice, Create Jobs, Environmental Defense Fund (Aug. 2020), edf.org/sites/default/files/documents/TransportationWhitePaper.pdf; US Environmental Protection Agency, Sources of Greenhouse Gas Emissions (2018), epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

[4] US Environmental Protection Agency, Fast Facts of Transportation Greenhouse Gas Emissions, epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions.

[5] Environmental Defense Fund, Clean Trucks, Clean Air, American Jobs (Mar. 2021), edf.org/sites/default/files/2021-03/HD_ZEV_White_Paper.pdf.

[6] For example, California recently set a target for all LDVs sold to be zero-emission by 2035 and 100 percent of MHDVs to be zero-emission by 2045 insofar as feasible. Additionally, an Oregon law requires that at least 90 percent of all new vehicles sold and 50 percent of all registered vehicles must be zero-emission by 2035.Fifteen states and the District of Columbia are signatories to the "Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding," which establishes a plan for having all MHDVs sales be zero-emission by no later than 2050; these states are formulating plans to achieve this overarching target.

[7] Gladstein, Neandross, and Associates, California Heavy Duty Electrification (Mar. 2021) blogs.edf.org/energyexchange/files/2021/03/EDF-GNA-Final-March-2021.pdf; Jonathan Coignard, , et al., Will electric vehicles drive distribution grid upgrades?: The case of California, IEEE Electrification Magazine 7(2) at 46-56 (Jun. 5, 2019).

[8] Nissan, 2021 Nissan LEAF Range, Charging & Battery, nissanusa.com/vehicles/electric-cars/leaf/features/range-charging-battery.html; Daimler, Electrified on the highway Freightliner eCascadia and eM2, daimler.com/sustainability/climate/ecascadia.html.

[9] FreeWire Technologies, What's the Difference Between EV Charging Levels? (July 1, 2020), freewiretech.com/difference-between-ev-charging-levels/

[10] California Public Utilities Commission Energy Division, Resolution E-5167, docs.cpuc.ca.gov/PublishedDocs/Published/G000/M413/K061/413061495.PDF,

[11] David Z. Morris, Today's Cars are Parked 95% of the Time, Fortune (Mar. 13, 2016), fortune.com/2016/03/13/cars-parked-95-percent-of-time/#:~:text=Put%20simply%2C%20we%20just%20don,parked%2095%25%20of%20the%20time.

[12] Gladstein, Neandross, and Associates, California Heavy Duty Electrification (Mar. 2021) blogs.edf.org/energyexchange/files/2021/03/EDF-GNA-Final-March-2021.pdf.

[13] Victor Rojas et al., Financing the Transition: Unlocking Capital to Electrify Truck and Bus Fleets (Nov 2020), edf.org/sites/default/files/documents/EDF_Financing_The_Transition.pdf

[14] Jimmy O'Dea, Ready for Work - Now Is the Time for Heavy-Duty Electric Vehicles, Union of Concerned Scientists (Dec. 11, 2019), ucsusa.org/resources/ready-work.

[15] Id.

[16] Opening Comments of The Greenlining Institute on Section 6 of the Energy Division Staff Proposal for a Draft Transportation Electrification Framework. Order Instituting Rulemaking to Continue the Development of Rates and Infrastructure for Vehicle Electrification, R. 18-12-006 at 12 (Dec. 13, 2018).

[17] EV-Labor Senate Sign-on Letter (Dec. 15, 2021), bluegreenalliance.org/wp-content/uploads/2021/12/121521-36D-EV-Tax-Credit-Letter.pdf.

[18] The Greenlining Institute, Electric Vehicles for All: An Equity Toolkit, greenlining.org/resources/electric-vehicles-for-all/#tab7-section2.

[19] VGI Working Group, Final Report of the California Joint Agencies Vehicle-Grid Integration Working Group (June 30, 2020), gridworks.org/wp-content/uploads/2020/07/VGI-Working-Group-Final-Report-6.30.20.pdf

[20] Gladstein, Neandross, and Associates, California Heavy Duty Electrification (Mar. 2021), blogs.edf.org/energyexchange/files/2021/03/EDF-GNA-Final-March-2021.pdf.

[21] The Energyst, How Battery Storage and Smart Energy Management Tripled EV Capacity at UPS (May 9, 2020), theenergyst.com/battery-storage-energy-management-evs-ups/

[22] Jonathan Coignard, et al., Clean vehicles as an enabler for a clean electricity grid, Environmental Research Letters 13 (5) (May 16, 2018), iopscience.iop.org/article/10.1088/1748-9326/aabe97/meta.

[23] Jonathan Coignard, et al.,Will electric vehicles drive distribution grid upgrades?: The case of California, IEEE Electrification Magazine 7(2) at 46-56 (Jun. 5, 2019), ieeexplore.ieee.org/document/8732007.

[24] Southern California Edison, Rates & Pricing Choices, sce.com/regulatory/tariff-books/rates-pricing-choices

[25] Elizabeth Stein, Beia Spiller, and Larissa Koehler, Smart Pricing Principles for Charging Electric Trucks and Buses (Oct. 2020), blogs.edf.org/energyexchange/files/2020/10/ChargingFactSheet.pdf.

[26] Jason Frost, Melissa Whited, and Avi Allison, Electric Vehicles Are Driving Electric Rates Down (June 2020), synapse-energy.com/sites/default/files/EV_Impacts_June_2020_18-122.pdf

[27] Jonathan Coignard, et al., Will electric vehicles drive distribution grid upgrades?: The case of California, IEEE Electrification Magazine 7(2), 46 (Jun. 5, 2019), ieeexplore.ieee.org/document/8732007.

[28] Jason Frost, Melissa Whited, and Avi Allison, Electric Vehicles Are Driving Electric Rates Down (Jun. 2020), synapse-energy.com/sites/default/files/EV_Impacts_June_2020_18-122.pdf.

[29] Elizabeth Stein, Beia Spiller, and Larissa Koehler, Smart Pricing Principles for Charging Electric Trucks and Buses (Oct. 2020), blogs.edf.org/energyexchange/files/2020/10/ChargingFactSheet.pdf.

[30] NIST, Security and Privacy Controls for Federal Information Systems and Organization, nvd.nist.gov/800-53/Rev4/control/SI-7; ENERGY STAR, ENERGY STAR Certified Electric Vehicle Chargers, energystar.gov/productfinder/product/certified-evse/results.