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WHITE PAPER

Transportation Electrification: States Rev Up

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TRANSPORTATION ELECTRIFICATION: STATES REV UP

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Executive Summary

Governors and states more broadly are pivotal in the ongoing transformation of the transportation sector to one that is increasingly electrified. The transition necessitates decisions regarding a wide range of issues including education and outreach efforts, vehicle and charging infrastructure incentives, the location and specifications of public charging infrastructure, electrification corridor designations and signage and, in some states, allowable vehicle emissions levels.

Motivations for action vary. One of the most common objectives is lowering transportation-related emissions, either of smog-forming pollutants, greenhouse gases or both. Additional reasons for action include economic development, fuel diversity, and responding to electric utility interest in maintaining or growing load growth.

States have revved up their actions dramatically in the past few years. They have expanded their toolkit beyond tax incentives and education programs that characterized earlier years. New actions include governors issuing executive orders to electrify state fleets, adopting zero-emissions programs, developing strategies for investments under the VW emissions test cheating settlement, clarifying rules for third party providers of charging infrastructure, approving proposals by electric utilities for using ratepayer funding to support infrastructure investments, and establishing regional programs to advance infrastructure and vehicle programs.

Despite the strong interest in transportation electrification and robust action taken to date, all states are confronting one or more challenges to overcome low adoption rates. These challenges include lack of consumer awareness and education, limited charging infrastructure that contributes to range anxiety, high upfront costs that prevent equitable access to EVs, and uncertainty in dealing with the impacts to transportation revenue.

To assist governors in achieving their various transportation electrification goals, NGA hosted a series of four regional workshops, from November 2018 to April 2019, that engaged 40 states from across the country. The workshops included officials from a variety of governors' offices, state agencies and departments alongside experts from the private sector, academia, federal agencies and nonprofit research and policy organizations. This paper summarizes the insights and lessons learned gathered from those four workshops and identifies areas of common challenges. For each workshop's agenda and slides, please visit NGA's website.

The paper is organized around eight themes that were discussed at each workshop:

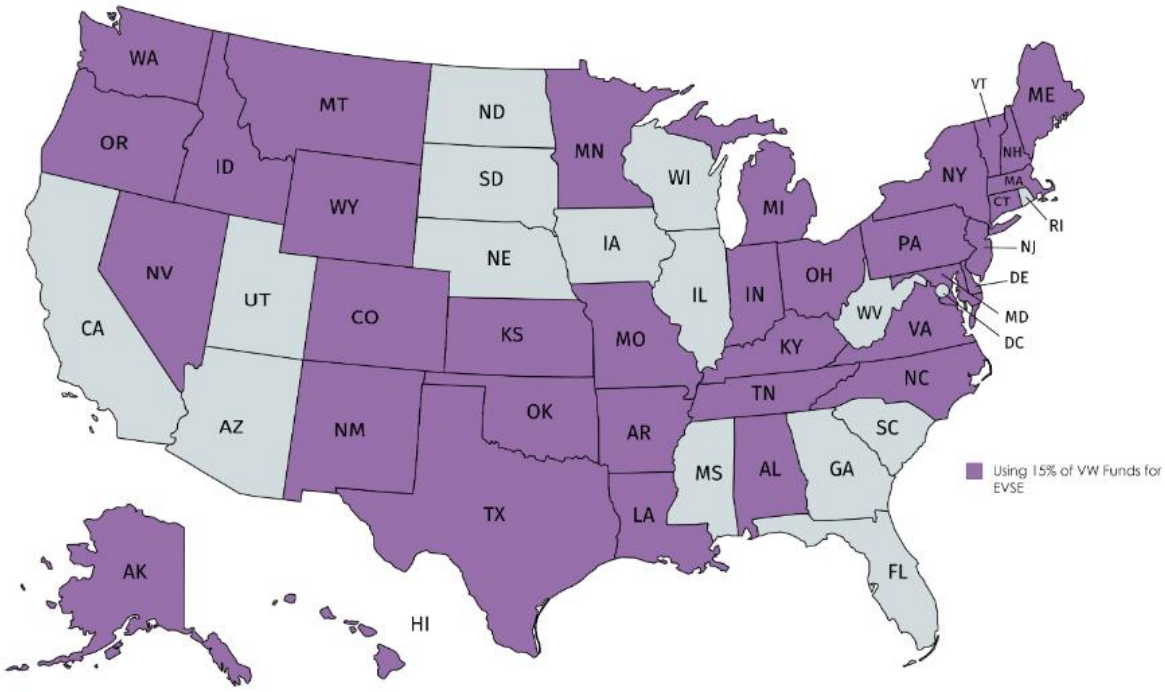
- Crafting Incentives, Policies and Consumer Awareness
- Enhancing State Fleet Electrification to Lead by Example
- Determining How Much Charging Infrastructure is Needed, What Type and Where
- Improving Regional Coordination Around Infrastructure Corridors
- Deciding Who Owns, Operates and Pays for the Infrastructure
- Managing the Grid for Benefits and Impacts
- Achieving Electrification for All
- Addressing Impacts to State Revenues

Key observations from the workshops include:

- There is a high degree of interest in the topic of transportation electrification in states across the country, as evidenced by the high level of state participation in the NGA workshops (40 states in total).

- The funds awarded to states under the VW emissions cheating settlement have enhanced interest in electrification broadly, with 35 states opting to use the full 15 percent share allowed for electric vehicle charging infrastructure investments and many leveraging the remaining 85 percent share of funding for electric vehicle incentives and purchases.[1] See Figure 1 for a map of states using the full 15 percent share allowed for EV charging infrastructure.

Figure 1: States Maximizing VW Settlement Funds for Charging Infrastructure[2]



- Electric utilities are another force sparking state engagement and interest in transportation electrification. Utilities are interested in supporting EVs through creative approaches that help spur development. Many states are deciding whether utilities or third-party vendors should be allowed to own and operate chargers.[3]

- States are in different stages of transportation electrification, both within and across regions, with most experiencing low EV adoption rates, although some are moving more quickly and vigorously than others to increase those rates. The top three states for EV adoption, based on market share in 2018, are:

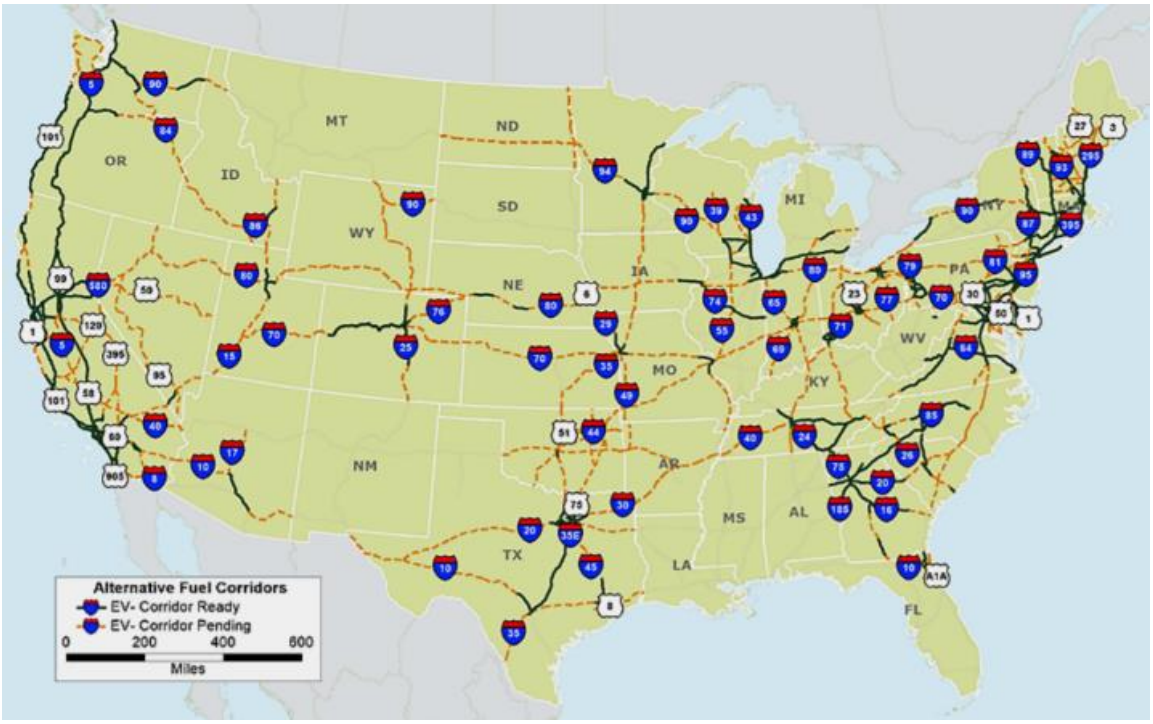
- **California** – 7.84 percent
- **Washington** - 4.28 percent
- **Oregon** – 3.41 percent[4]

- Electrifying state fleets is a largely untapped opportunity, that can include light, medium and heavy-duty vehicles, and calls for procurement and budgeting reforms. These efforts can help states lower costs, increase visibility of vehicles, and encourage manufacturers to provide a greater inventory of EVs in a state.

- States are seeking ideas and examples for how to address equity concerns. Many states are in very early stages, but eager to ensure that electrification benefits are shared across various demographics (income levels, racial identity, urban and rural locations). This was a common comment among states.

- Federal corridor designations are made at a steady pace. As seen in Figure 2, the Federal Highway Administration has designations in 46 states through its Alternative Fuel Corridors Program.[5] Corridor designations are encouraging regional cooperation to build out a national network.

Figure 2: Alternative Fuels Corridors[6]

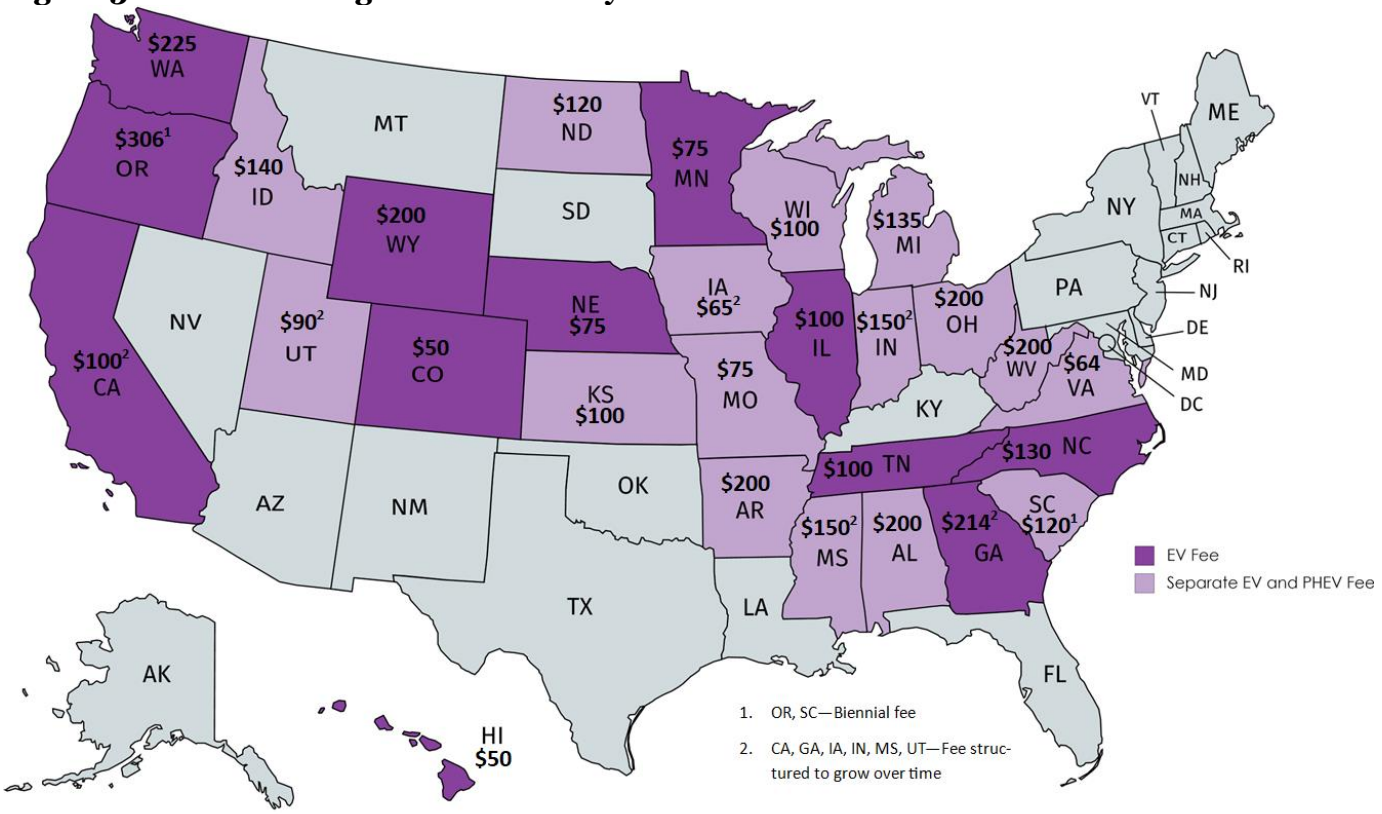


- Interest in hydrogen-fueled electric drivetrain vehicles is largely contained to **California**, due to high costs and limited infrastructure, but applications for heavy-duty vehicles, including transit buses, could grow in the coming years as costs decline.

- A growing number of states are adopting additional registration fees for electric vehicles, bringing the total to 28 states as of September 2019, as seen in Figure 3.[7] There is disagreement around whether the levels being adopted are representative of the impact of EVs on transportation infrastructure costs. There is also concern that such fees create a disincentive to EV purchases.

As governors continue to advance EV adoption, states will be exploring additional actions within these topics as well as others.

Figure 3: Annual EV Registration Fees by State[8]



Background

From November 2018 to May 2019, the National Governors Association (NGA) Center for Best Practices held four regional transportation electrification workshops. We adopted a regional approach to capitalize on similarities such as geography, electricity market structure, current electrification adoption levels and electric power resource mix, to facilitate discussions among neighboring states and because many states already have approached developing electric vehicle charging corridors regionally. Through meetings in **Connecticut** (for the Northeast region), **Tennessee** (for the Southeast region), **Washington** (for the Western region), and **Missouri** (for the North/Central region), NGA engaged 40 states for a total of 230 participants from states, nonprofits, associations, federal agencies, academia and the private sector.

The workshops deliberately involved state officials representing a variety of perspectives, including: governors' offices; transportation, natural resources and environment departments; public utility commissions; energy and economic development offices; and utility consumer advocates. Participants also included representatives from the American Association of State Highway and Transportation Officials (AASHTO), National Association of Regulatory Utility Commissioners (NARUC), National Association of State Energy Officials (NASEO) and National Association of State Utility Consumer Advocates (NASUCA), to help inform the workshops and share insights with their respective members.

While transportation electrification has a strong connection to energy and environmental policy, the four regional workshops were developed as part of NGA's Transportation Learning Network (TLN) in order to enhance the engagement among all three areas of policy making and involve transportation officials who are typically not as engaged in state electrification efforts. NGA's TLN helps governors and their staffs explore new approaches and share lessons learned in the rapidly evolving world of transportation policy. The activities of the TLN include an annual Transportation Policy Institute for governors' policy advisors, quarterly webinars, policy guidance and in-depth technical assistance through workshops, retreats and other NGA meetings. NGA will continue to provide policy support around transportation electrification through a broad energy, transportation and environmental lens.

The four workshops focused on eight themes that were identified through NGA's past work with states, including a series of webinars in late 2018 and early 2019, discussions at past NGA energy- and transportation-related workshops and the development of two policy roadmaps on Transportation and Energy Innovation as part of then-**Nevada** Governor Brian Sandoval's 2018-2019 Chair's Initiative, *Ahead of the Curve: Innovation Governors*. The eight themes were:

- Crafting Incentives, Policies and Consumer Awareness
- Enhancing State Fleet Electrification to Lead by Example
- Determining How Much Charging Infrastructure is Needed, What Type and Where
- Improving Regional Coordination Around Infrastructure Corridors
- Deciding Who Owns, Operates and Pays for the Infrastructure
- Managing the Grid for Benefits and Impacts
- Achieving Electrification for All
- Addressing Impacts to State Revenues

For each theme, this paper describes the challenges, questions, observations, data, research and solutions discussed at the workshops. The paper ends with a note about outstanding issues not covered in the workshops and worthy of future discussions.

Crafting Incentives, Policies and Consumer Awareness

States need to overcome large gaps in consumer awareness about EV availability and incentives, develop best practices to engage original equipment manufacturers (OEMs), incentivize dealers to better promote EVs, and dedicate stable monetary incentives for EV producers and consumers. Most significantly, states must determine where to allocate limited resources to spur the greatest action. In particular, workshop participants were struggling with the chicken-and-egg question: What is the most effective way to apportion incentives to incentivize electric vehicles and charging?

If EVs are to make up a significant market share of vehicles sold, growing significantly beyond current levels of 2 percent of light-duty vehicles in 2018, consumer awareness will need to increase substantially.[9] Recent research from Morning Consult shows that only 33 percent of potential car buyers would consider buying an EV, citing concerns over charging infrastructure and high upfront costs.[10] On top of this, 84 percent of car buyers are uncertain whether their state offers any EV purchase incentives.[11] Finally, awareness of available makes and models remains lacking. For example, in 2017, **California** residents identified fewer EV models than they identified in 2014, despite a near doubling of available models.[12]

States are grappling with how to best engage car dealers, as well as OEMS, with both groups being essential to EV availability and promotion. Research from ITS America and the University of California at Davis found that many dealers are "less than enthusiastic" when selling EVs as opposed to gas vehicles.[13] Furthermore, customers reported less satisfactory experiences with dealers when purchasing EVs.[14] One proposal for increased engagement includes tying incentives for car dealers to EV sales. For instance, an incentive for each EV a dealership sells, such as the $300 one offered by **Connecticut**, could provide a low-cost way to leverage the sales expertise at dealerships.[15]

From the 2011 models to the projections for 2019 models, the range for EVs will have increased an average of 15 percent every year, due to better battery technology, increased public investment, vehicle efficiency and other improvements.[16] Currently, 13 fully electric models are available with an average range of 194 miles, with further enhancements on the horizon. Automakers are seeking to grow this market with improved range and more models, including pickup trucks, sport utility vehicles, vans and other popular models. Collectively, they have committed $255 billion of funding through 2023.[17] For instance, Ford Motor Company has pledged to increase spending toward EVs, putting $11 billion toward vehicle production and research.[18] While there are increased private-sector commitments to EV spending, federal support may be drying up. Automakers including Tesla and General Motors recently surpassed the 200,000 EV sales threshold, meaning car buyers will no longer receive the $7,500 tax credit unless federal law changes.[19] Tesla and General Motors are asserting that the tax credit should remain until EVs are cost-competitive with traditional gasoline vehicles.[20]

State Solutions

There are a number of state EV incentives and policies that show promise in addressing the barriers to EV adoption. Rebates and tax credits have proven to be effective policy tools; of the top nine states in EV market share in 2018, eight had purchase rebates or tax credits of $1,500 or more.[21] **California**'s multiple incentives sparked its 7.8 percent EV market share in 2018, the highest rate in the country.[22]

Governors are embracing public education through regional collaboration. The nine governors of **California**, **Connecticut**, **Maryland**, **Massachusetts**, **New Jersey**, **New York**, **Oregon**, **Rhode Island** and **Vermont** signed the Zero-Emission Vehicle (ZEV) Task Force MOU to commit to 3.3 million EVs on the road by 2025. Each state will lead-by-example through public fleet electrification goals as well by creating standards to promote EV awareness.[23]

Beyond governors, organizations and companies are driving EV awareness. Forth holds an annual conference to highlight transportation electrification across the country. This last year more than 1,000 participants attended the event to learn about the latest EV trends such as heavy-duty vehicle electrification and charging times.[24] Electrify America and GM are each working to spread EV awareness. Electrify America is spending $45 million on a national education campaign as part of its VW Settlement to build out an electric charging corridor.[25]

Many of the leading states, including **California**, **Washington** and **Oregon**, are incentivizing EVs contingent on either consumer incomes or vehicle purchasing price to limit using scarce resources to support "anyway" buyers and to broaden access. **California** offers several incentives, such as a $2,500 EV purchase rebate or "cash on the hood," for car buyers to help meet the state's aggressive ZEV mandate.[26] This rebate increases up to $2,000 as income levels decline. **Oregon**'s Clean Vehicle rebate program offers EV buyers, who qualify as low- or moderate-income, as much as a $2,500 purchase rebate.[27] **Washington** reinstated a sales tax credit for both new and used EV purchases to help address first-cost barriers across economic strata. Car buyers in the state will receive up to $2,500 off new vehicles under $45,000 and up to $1,600 off used vehicles under $30,000.[28] Additionally, **Connecticut** caps incentives on fully electric or plug-in hybrid vehicles above $50,000, while allowing rebates for fuel-cell vehicles costing up to $60,000.[29] **Delaware**, **Maryland**, **New York**, and **Pennsylvania** all offer similar tiered rebates, dependent on vehicle price.

Outside of purchase rebates, states are removing barriers to EV adoption through various strategies. **Connecticut** offers dealers a $300 incentive for any EV sold or leased.[30] **Vermont** has stated that it will not implement an EV registration fee until sales surpass an "early-adopter stage" to avoid dissuading purchasers.[31] Many states, including **California** and **Maryland**, offer EV charging infrastructure rebates, however these funds typically are exhausted quickly.[32]

Finally, states are starting to develop incentives using funding provided by the Volkswagen Mitigation Settlement ("VW Settlement"). In 2016, Volkswagen agreed to a $14.7 billion settlement for cheating on emissions testing. Of this, $2.7 billion was allocated to the Environmental Mitigation Trust to be divided among the states, territories, District of Columbia and tribes commensurate with Volkswagen diesel vehicles sold in each jurisdiction. The funds can be used for diesel emissions-reduction actions, including up to 15 percent for EV charging infrastructure. A total of 35 states plan to use the full 15 percent allotment; others will use at least

some portion; many other states are allocating the remaining funding to EV fleets and transit purchases.[33]

Enhancing State Fleet Electrification to Lead by Example

States operate large fleets of various vehicle types, including, depending upon the state, light-, medium- and heavy-duty vehicles, public transit and maritime vessels. While only a portion of the national fleet, incorporating electric vehicles into state-owned fleets has two advantages: the vehicles are under the direct control of the state government, and they can be centrally recharged, lowering the infrastructure burden. Electrifying state fleets offers an opportunity for states to lead-by-example, promote efficient transportation, support a nascent market, reduce state fuel and maintenance costs by switching to a less expensive and more stable fuel source, and lower related transportation emissions.

A major challenge for state fleet electrification is the high upfront costs for many electric vehicles, particularly transit vehicles such as buses, where battery costs remain steep. State workshop participants also highlighted the barriers of limited range and slow installations for heavy-duty charging stations. Other challenges include: navigating budget processes that do not account for operational and maintenance savings; installing charging infrastructure on state property; and overcoming complex procurement systems. Furthermore, fewer states directly own public transit vehicles and have less leverage in decision-making. Despite a lack of fleet ownership, states may be looked to for fleet purchase incentives. As EV technology advances and battery costs decrease, larger fleet electrification will become more viable for states to support.

State Solutions

Several states are utilizing their VW Settlement funds to address the upfront cost barrier to state fleet electrification. **Hawaii** is using more than half of its VW Settlement to electrify school buses, shuttles and public transit.[34] **Rhode Island** committed its entire VW Settlement to fleet electrification and is replacing up to 20 diesel buses with battery electric transit buses.[35] **Washington** is allocating a portion of its VW Settlement to fleet electrification, including funding for electric ferries. In addition, Washington state offers incentives for electric trucks, buses and vessels and has the most aggressive EV fleet requirement in the country: 50 percent of all new state passenger vehicles must be electric by the end of 2020.[36]

Apart from VW Settlement funding, **Maryland** and **New York** offer vouchers to help with fleet vehicle deployment. **Maryland**'s program offers up to $20,000 for fleet vehicle purchases, while **New York** offers vouchers of up to $60,000 for eligible trucks.[37,38] **Vermont**'s zero-emission vehicle action plan requires 25 percent of its fleet be zero emissions by 2025. These states are taking the lead in fleet electrification and identifying strategies to spur EV adoption despite limited funding and ownership of fleet vehicles.

Determining How Much Charging Infrastructure is Needed, What Type and Where

The fear of being unable to complete a trip in an EV due to a depleted battery and lack of chargers, known as "range anxiety," is a key barrier to EV adoption. To overcome this hurdle, more charging

infrastructure in appropriate locations, as well as faster charging options such as Direct Current (DC) fast chargers, may be needed. Electrify America is developing its own nationwide charging network, growing out of the $2 billion VW Settlement allocation. States also are making decisions around use of utility ratepayer funds, standardizing charging infrastructure and managing billing systems.

Electrify America is a key driver for charging infrastructure construction and participated in the workshops. The private company is a subsidiary of Volkswagen and tasked with building out a network of electric vehicle charging stations as a result of the VW Emissions Test Settlement. Electrify America plans to site 2,000 chargers in nearly 500 locations across 42 states by the end of 2019. The company will spend its $2 billion funding allotment by 2026 over several cycles and aims to install chargers 70 miles apart on all major roadways.[39] States at the NGA workshops demonstrated an eagerness to partner in upcoming cycles with Electrify America to improve coordination for siting charging infrastructure.

Installing charging infrastructure is a significant undertaking. McKinsey and Co. estimates that the United States will need to spend up to $11 billion by 2030 to ensure that charging stations in both public and private settings are as accessible as gas stations.[40] Currently, 80 percent of all charging occurs at home, typically with level two chargers (see Figure 4), but many individuals lack the ability to charge at home, creating a significant barrier to EV ownership.[41]

Figure 4: Types of Charging Infrastructure

	Charger	Location	Miles of Range Added per hour Charged[42]	Average Cost[43]
Level 1	120V AC	Home	15 miles	N/A
Level 2	240V AC	Home	30-90 miles	$1,000
Level 2	240V AC	Parking Garage	30-90 miles	$3,500-$7,500
Level 2	240V AC	Curbside	30-90 miles	$5,000-$13,000
DC Fast Charge	480V DC	Public Stations	90-200 miles in 30 minutes	$30,000-$70,000

State Solutions

To address charging needs, most states are utilizing their VW Settlement funds for eligible charging infrastructure projects. There are 35 states utilizing the full 15 percent allocation for EV charging installations.[44] **Tennessee** plans to use its VW Settlement to install chargers at government- and non-government-owned facilities, workplaces and multi-unit residences to prepare for increased EV adoption.[45] **Virginia** used its VW Settlement funding to contract with EVGo to set up a charging corridor on frequently traveled roads. The corridor will feature DC fast chargers and multiple plug-ins per site, ensuring that 95 percent of state residents live within 30 miles of a charger.[46]

Finally, states are using tools developed by researchers at MJ Bradley and the National Renewable Energy Laboratory (NREL) to tackle "range anxiety" by making a more precise identification of charging needs and locations. MJ Bradley offers an EV charging tool where states can input charging infrastructure priorities and subsequently generates optimal locations for chargers.

NREL similarly developed a planning tool to identify EV charging needs per state. The tools are being used by states to identify charging needs based on various policy objectives such as EV targets.

Improving Regional Coordination Around Infrastructure Corridors

Range anxiety is often cited as a core barrier to greater EV adoption. Several programs at the federal and state levels are working to build range confidence by coordinating infrastructure deployment around heavily traveled corridors across multiple states. Such efforts call for a variety of federal, state, local and private partners. Having a large number of partners can mean efforts can take a while to get under way but ultimately will have larger impacts than any one player working independently. Additionally, state participants discussed how coordination among various stakeholders can be challenging.

A key challenge for states is the federal prohibition on commercial activity at interstate rest areas. Particularly, this creates barriers to EV charging in rural regions where a rest area could be a convenient plug-in opportunity. This law was instituted in 1960 to incentivize cars to stop at local businesses in towns instead of commercial enterprises on interstates.[47] The prohibition contributes to "range anxiety" for drivers along highway routes with limited charging options.

State Solutions

At the federal level, the Federal Highway Administration (FHWA) is helping states tackle this challenge by designating Alternative Fuel Corridors and increasing transportation awareness for EV owners. During the NGA workshops, the FHWA provided guidance to state participants in how to apply for corridor-ready or corridor-pending designations. As of 2018, the program has nominated 79 corridors covering more than 135,000 highway miles. Corridor signage is another component of the program and is undergoing installation in **Louisiana**, **Minnesota**, **Rhode Island** and **South Carolina**.[48]

Meanwhile, states from various regions have established their own collaborative efforts to offer EV drivers range confidence:

- The West Coast Electric Highway is a collaboration between **California**, **Oregon**, **Washington** and British Columbia to establish a network of EV fast-charging stations infrastructure along major interstates and roadways.

- REV West is a regional collaborative initiated by a Memorandum of Understanding signed by the governors of the eight intermountain states of **Arizona**, **Colorado**, **Idaho**, **Montana**, **Nevada**, **New Mexico**, **Utah** and **Wyoming**. The program identifies best practices for creating an EV corridor across major roadways in the region.

- The Transportation and Climate Initiative is a collaboration of the 12 East Coast states of **Connecticut**, **Delaware**, **Maine**, **Maryland**, **Massachusetts**, **New Hampshire**, **New Jersey**, **New York**, **Pennsylvania**, **Rhode Island**, **Vermont** and **Virginia**, that includes the Northeast Electric Vehicle Network to support the development of EV

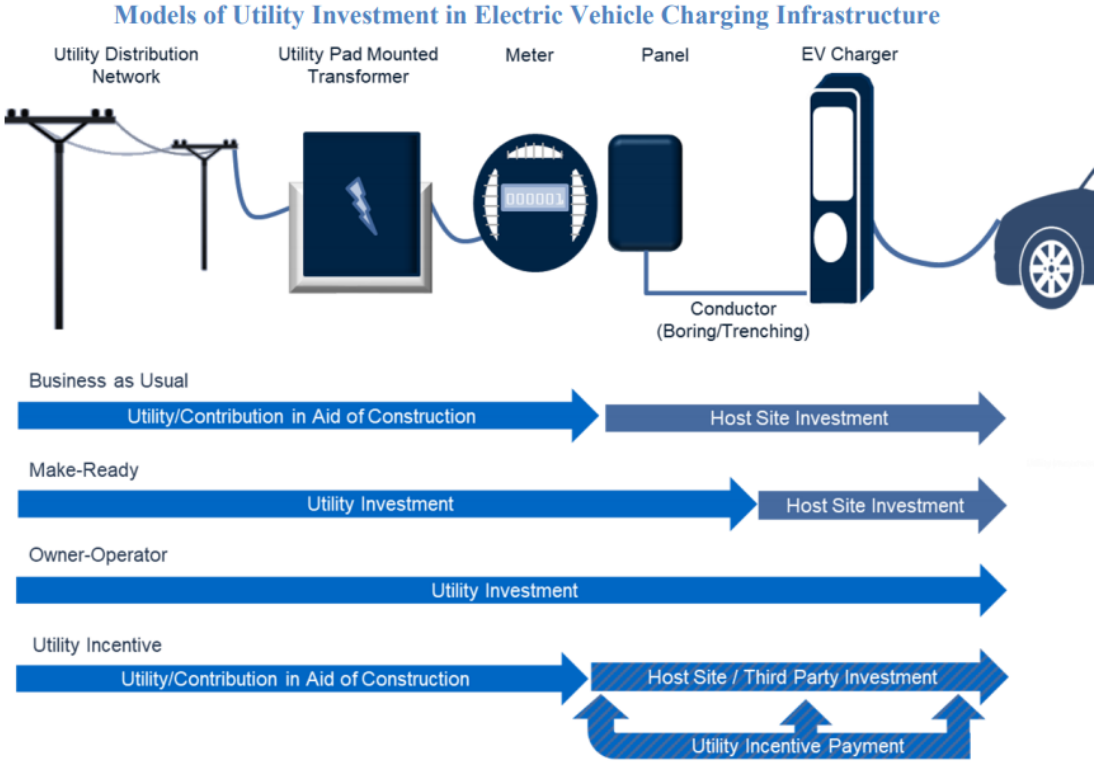
fast-charging corridors. These efforts build on the region's cap-and-trade program for electric utilities, the Regional Greenhouse Gas Initiative, to help reduce carbon emissions from the transportation sector.[49]

Deciding Who Owns, Operates and Pays for the Infrastructure

Electric vehicle charging infrastructure installations require engagement from states, municipalities, regulators, utilities and private companies. Ownership models can be complex, upfront costs are challenging, and permitting delays create barriers. Utilities and regulators have significant roles to play due to their ability to drive investment and structure rates effectively. As seen in Figure 5, state regulators can approve utility actions to assist in EV adoption by (1) deploying "make-ready" installations that enables infrastructure up to the point of installing a charger, (2) owning and operating installations, or (3) providing financial incentives to host sites. Public power entities also can pursue similar efforts.

States are finding that charging fees are an unsustainable funding source, due to a lack of overall EVs and public charging usage.[50] Identifying companies ready to take on these costs is challenging, as it is a risky investment. Utility involvement is yet to be clearly defined, but utilities' participation is helpful because they have the funding scale and scope to take on charging projects. Utility roles will vary based on project needs and regulatory environment. As EV adoption grows, economies of scale will make charging operation and ownership more sustainable.

Figure 5: Charging Infrastructure Utility Models[51]



Source: M.J. Bradley & Associates

State Solutions

One policy solution to these challenges that is becoming more widespread is for utilities to provide "make-ready" installations. These installations are the electrical infrastructure, such as trenching and conduits, that enables charging readiness at host sites. This solution addresses upfront cost barriers and makes charging infrastructure cost-competitive. Make-ready installations can also put downward pressure on electric rates because increased utility sales displaces fixed charges and lowers overall prices. **Massachusetts** pursued make-ready efforts by working with the utilities National Grid and Eversource on charging infrastructure programs. The utilities will cover costs of "behind the meter" charging, while taking on any upgrade costs to the chargers.[52] The two utilities were approved for spending $70 million on charging infrastructure and make-ready models, highlighting the need to incorporate the public and private sectors into EV charging.

Additionally, utilities may own and operate charging infrastructure or provide incentives to third parties to own the infrastructure. Under allowed ownership utilities have access to capital as well as installation expertise that enables expedited infrastructure buildouts. In **Nevada**, the Public Utilities Commission allowed the utility NV Energy to own and operate charging stations and set aside $15 million for charging infrastructure.[53] However, this approach may limit alternate charging providers and involve a potential cost shift to ratepayers.

Many states, including **California**, **Michigan** and **New York**, have limited utility ownership of charging infrastructure and instead allow public and private partners to install and own chargers. This approach supports competition in the market and reduces upfront costs for charging developers. In **Michigan**, the Public Service Commission approved a $10 million pilot to Consumers Energy to provide rebates and incentives for third-party companies. The program PowerMiDrive will offer rebates of up to $5,000 for Level 2 chargers and up to $70,000 for DC fast chargers.[54]

EV charging infrastructure regulation also plays a part in deployment trends. **Kentucky** became the latest state to decide that EV chargers should not be regulated as a public utility. Nearly half of all U.S. states have issued similar rulings through their public utility commissions, which allows private investment from companies like ChargePoint and Electrify America.[55] Opponents of these rulings assert that low-income individuals will be harmed due to private companies' ability to charge higher rates. Incorporating equity considerations will continue to be important to such regulatory decisions.

Managing the Grid for Benefits and Impacts

Transportation electrification brings new challenges and opportunities to the electricity system. Utilities, grid operators and public commissioners must prepare for new, dispersed load growth and expanded peak demand that could strain the electric grid. EVs also offer potential benefits as flexible loads: EVs can charge during lower demand periods and store energy during peak demand periods while playing a role in resiliency strategies. These efforts are still under development but highlight potential for an improved electric grid system.

As the deployment of EVs increases, there is growing concern that they will, at high levels of adoption, add significantly to peak demand and create costly power system ramping needs while

threatening grid reliability. States are looking for how to design utility rates to support charging behaviors that enhance not threaten grid reliability and costs, namely inducing homeowners to not charge during peak demand periods, such as immediately after work.

State Solutions

Time-of-use (TOU) rates are emerging as a solution to concerns over changes to the electric grid. Such rates, especially when paired with "smart charger" technology, can help drivers charge during off-peak hours and enable cheaper "fill ups" that also benefit the grid by smoothing demand fluctuations. Various charging rates include (1) whole house TOU rates, (2) EV-Only TOU rates, or (3) incentivize reward programs. Whole house TOU rates involve one meter for the entire household but may need to shift other energy loads to maximize cost savings.[56]

EV-Only TOU rates avoid this issue by isolating a meter for EV charging activity which subsequently is effective at reducing electricity bills for customers.[57] Utilities in **Maryland** and **New Jersey** are implementing these rates as pilot programs. Other utilities are offering rebates or incentives for consumers to engage in TOU programs. In **New York**, Con Edison launched a program to reduce EV owners' charging costs, improve grid efficiency, and increase resiliency benefits.[58]

More than half of all investor-owned utilities have allowed time-of-use rates. Additionally, **California** requires its investor-owned utilities to provide TOU rates. A challenge with new utility rates is customer understanding of their energy bills. Utilities like Xcel Energy are seeking to address this issue by providing consumer education through TOU pilots. Xcel's program seeks to install 17,500 smart meters and expose the public to electric rate fluctuations.[59]

EVs provide valuable grid services like other distributed energy resources (DERs). Traditionally, DERs are viewed as renewable energy sources that are locally connected to distribution systems. EVs with a 30-kWh battery (which is a typical minimum for most light duty EVs) can store as much energy as an average household consumes daily.[60]

A potential EV grid service is peak demand reductions and smoothing. In particular, EVs can help address the "duck curve" concerns raised by the use of intermittent renewable resources, especially solar power.[61] With solar resources, energy is provided to the grid while the sun is shining. This energy source is lost at night, which coincides with most people returning home, turning on lights and running appliances that increase electricity demand. The resulting spike in energy usage requires a ramp-up of higher cost energy sources. EVs can avoid exacerbating peak demand by storing energy with owner encouragement to avoid peak-time charging.

Greater benefits could be realized with vehicle-to-grid (V2G) technology, where EVs feed electricity back into the grid. An intelligent fleet of EVs designed around demand response programs can help smooth grid demands, if they are enabled with smart chargers and V2G technology, as well as the necessary regulatory incentives. Such a system is not yet viable, as V2G technology and regulatory programs still are under development and automakers are struggling with concerns over warranty issues.[62] Finally, TOU rates need further refinement as utilities are observing EV charging spikes immediately as off-peak hours begin.[63]

Achieving Electrification for All

All citizens can share in some of the benefits of EVs, regardless of whether they drive an EV, including lower grid costs and lower greenhouse gas emissions.[64] However, many residents of lower-income and rural communities are not able to share in the full range of benefits, including local air quality improvements, lower overall costs of ownership, improved performance and the convenience of at-home refueling options. This can be due to a variety of barriers, including high upfront costs, incentives that do not align with income levels, a charging infrastructure that is focused on urban locations and single-family homes, and limited EV model offerings that do not include many that function in rugged terrain.

Ownership data indicates that there is an income barrier to EV purchases as some 70 percent of EV owners make more than $75,000 per year.[65] Moreover, many low-income individuals are unable to take advantage of incentives such as the $7,500 federal tax credit, or may live in multi-family dwellings without access to charging locations. They may not be able to afford a new vehicle if they can afford a vehicle at all. Rural residents may rely upon medium-duty vehicles that have high upfront costs and live far from a public recharging infrastructure.

State Solutions

Many state participants in the NGA workshops expressed interest in policy ideas that could help support a more equitable system that would enhance access for all residents. While this issue continues to emerge, there are a growing number of examples of how states can help achieve vehicle electrification for all.

As noted previously, in the discussion of incentives, states including **Maryland** and **Delaware** limit rebates for vehicles exceeding certain price thresholds. **Oregon** and **California** tier rebates based on income eligibility.[66] **Washington** state refined its sales tax incentive program to ensure that consumers who cannot afford a new EV are supported if they wish to purchase a used EV. Washington also makes charging at home and at work more practical by requiring that all new buildings that provide on-site parking equip 10 percent of their parking spaces with EV charging, and allocate enough power to eventually handle 20 percent of parking charging capacity.[67]

Companies like EVHybridNoire have led "Just Like Me" campaigns on the campuses of historically black colleges to dispel the notion that EVs are not for everyone. States can consider similar efforts to help distribute benefits more uniformly, including for low-income communities. **California** is utilizing 35 percent of its VW Settlement to prioritize EV charging and incentives in low-income communities, as required by the state legislature. The state plan is required to consider air quality benefits for low-income communities that typically face disproportionate effects from vehicle emissions.[68]

Rural communities face different barriers to electrification, including limited charging availability and higher electricity rates. Holy Cross Energy in **Colorado** is a rural co-op with proactive incentives to enable EV services in its community. Holy Cross offers its members access to free Level 2 chargers and devices to take advantage of time-of-use charging rates.[69] These actions are enabling access to EVs for more drivers.

Addressing Impacts to State Revenue

States have historically relied on motor fuel tax revenue to support transportation infrastructure projects and operations, as roads and bridges continue to require significant maintenance and upgrades. Fully electric vehicles are not subject to motor fuel taxes, which may put a strain on state revenues as adoption rates increase, alongside other strains due to increasing vehicle efficiency and rising infrastructure costs that are, in many states, not matched by motor fuel tax indexing. Many states are pursuing funding alternatives such as EV registration fees and exploring road-use charges or other mileage-based user fees. States are looking ahead to the need to develop a long-term stable funding stream in light of increasing transportation electrification.

As of September 2019, 28 states had implemented an additional EV registration fee on top of standard vehicle registration fees.[70] These additional fees are designed to capture the "lost" gas tax revenue for transportation operations, but the total revenue is minimal due to EVs accounting for only 2 percent of new vehicle purchases on average.[71] There also are conflicting views on what level of additional fee accurately represents the actual burden placed on the transportation system by each EV.[72] Moreover, there are concerns that such fees are not aligned with state goals to encourage EV adoption.

One well-cited example of the impact of a state registration fee can be found in **Georgia**. Prior to 2015, **Georgia** offered a $5,000 tax rebate for EV buyers. However, in 2015 the rebate was eliminated and replaced with a $200 registration fee. The combined effect was that EV sales plummeted in the state, falling 90 percent in the year following the policy changes.[73]

State Solutions

States are approaching vehicle fees in various ways. **Maryland** and **Vermont** are waiting to implement additional registration fees until EVs reach a more significant adoption rate. Other states are mitigating potential disincentives by utilizing vehicle fees to support charging infrastructure. **Alabama**, **Colorado**, **Oregon,** and **Washington** are using a portion of the collected fees to support EV infrastructure investments. These approaches highlight innovative approaches that other states may look to as EVs eventually have a greater impact on transportation revenue.

Other policy alternatives such as mileage-based user fees show promise but also raise challenges of their own. For instance, tracking vehicle miles traveled may lead to privacy concerns, but existing pilots have shown that the technology exists to alleviate the risk of misusing travel data. Furthermore, cross-state travel may pose a challenge to mileage-based user fees if neighboring states do not participate. Additional problems that state participants discussed included unsustainable future revenues if vehicle use patterns change, and the inequitable treatment of rural drivers.

Despite certain challenges, mileage-based user fees offer benefits by more precisely charging vehicles for their miles driven. **Oregon** is seeking to capture these benefits and is the first state to enact a fully operational road user charge with its OreGO program. The program enables users to receive credits on gas tax paid and instead pay for vehicle miles traveled. OreGO utilizes a tracker to identify miles driven and fuel consumed. Due to privacy questions, program managers

have assured citizens that it does not track locations. To address cross-state travel, the program uses gas taxes as a proxy in the absence of a more generalized model.

In a separate program, the I-95 Corridor Coalition is working on a pilot mileage-based user fee program for participants in East Coast states. Starting in July 2019, the second phase of the pilot program offered 1,000 participants the option of hypothetically opting out of gas taxes and paying a road user fee instead. (Participants would receive monthly statements, but no actual money was exchanged; the statements were for illustrative purposes only.) A key question that the program is seeking to answer is how to cover cross-state travel mileage, and other interoperability concerns.[74]

Remaining Issues

The workshops covered other issues including the rise of e-mobility and scooters, corporate fleet electrification, and how to sustainably source and recycle the rare-earth elements used in most EV batteries, to address environmental or political concerns. Transportation electrification is a complex policy issue and incorporates various stakeholders. NGA recognizes that these additional issues will require more work to support governors' interests in EV adoption.

Conclusion

NGA workshop speakers and participants provided many valuable insights into transportation electrification policy. While many solutions and best practices were discussed, there were many challenges that remained. States need to continue educating the public on available EV models, incentives and charging stations. Additionally, states will have to determine which incentives are most impactful as well as equitable to consumers. States should continue utilizing the VW Settlement funding and take advantage of the electrification potential. Finally, states should respond to demand impacts caused by EVs with effective rate designs. These challenges signal that significant work remains but may be overcome by innovative policies and additional state efforts.

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