FUTURE ELECTRIC
Utility Regulation

THE FUTURE OF TRANSPORTATION ELECTRIFICATION: UTILITY, INDUSTRY AND CONSUMER PERSPECTIVES

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Foreword by U.S. Department of Energy

The provision of electricity in the United States is undergoing significant changes for a number of reasons. The implications are unclear.

The current level of discussion and debate surrounding these changes is similar in magnitude to the discussion and debate in the 1990s on the then-major issue of electric industry restructuring, both at the wholesale and retail level. While today's issues are different, the scale of the discussion, the potential for major changes, and the lack of clarity related to implications are similar. The U.S. Department of Energy (DOE) played a useful role by sponsoring a series of in-depth papers on a variety of issues being discussed at that time. Topics and authors were selected to showcase diverse positions on the issues to inform the ongoing discussion and debate, without driving an outcome.

Today's discussions have largely arisen from a range of challenges and opportunities created by new and improved technologies, changing customer and societal expectations and needs, and structural changes in the electric industry. Some technologies are at the wholesale (bulk power) level, some at the retail (distribution) level, and some blur the line between the two. Some technologies are ready for deployment or are already being deployed, while the future availability of others may be uncertain. Other key factors driving current discussions include continued low load growth in many regions and changing state and federal policies and regulations. Issues evolving or outstanding from electric industry changes of the 1990s also are part of the current discussion and debate.

To provide future reliable and affordable electricity, power sector regulatory approaches may require reconsideration and adaptation to change. Historically, major changes in the electricity industry often came with changes in regulation at the local, state or federal levels.

DOE is funding a series of reports, of which this is a part, reflecting different and sometimes opposing positions on issues surrounding the future of regulation of electric utilities. DOE hopes this series of reports will help better inform discussions underway and decisions by public stakeholders, including regulators and policymakers, as well as industry.

The topics for these papers were chosen with the assistance of a group of recognized subject matter experts. This advisory group, which includes state regulators, utilities, stakeholders and academia, works closely with DOE and Lawrence Berkeley National Laboratory (Berkeley Lab) to identify key issues for consideration in discussion and debate.

Introduction

By Lisa Schwartz

While the residential, commercial and industrial sectors of the U.S. economy are heavily electrified, the transportation sector today uses little electricity.[1] Pure battery-electric vehicles (EVs) and plug-in hybrid EVs each represented less than 1 percent of the nation's total vehicle sales in 2017.[2]

A recent comprehensive assessment of transportation electrification looking out to the year 2040 made the following observations:[3]

- Battery costs, and thus EV prices, will continue to decline over time, especially with substantial gains in technology learning and economies of scale, as well as robust research and development.
- A modern power system that supports vehicle-to-grid communication and time-of-use pricing will be a vital component of a future where plug-in EVs make up a large fraction of the light-duty vehicle fleet.[4]
- EV adoption seems to be greatest when multiple actions are taken in parallel, such as improving consumer awareness, providing direct subsidies and making infrastructure investments.
- Public charging is a critical component for encouraging consumer adoption of EVs.[5]

The role of utilities in providing EV charging infrastructure to support increased transportation electrification is a strongly debated issue. This report presents differing viewpoints on several key questions:

1. What are the potential benefits and risks of transportation electrification — to electric utilities, to retail electricity customers and to society?
2. What roles should utilities versus competitive providers play in accelerating deployment of EV infrastructure? What infrastructure investments are others making, and how should utilities complement those investments?

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[1] While this report focuses on passenger vehicles, this statement holds for the sector as a whole. Most transportation electricity use is for transit, commuter and intercity passenger rail. Transit rail is completely reliant on electricity, but intercity and commuter rail also rely heavily on diesel fuel, as do air and marine travel modes.
[2] U.S. Energy Information Administration, *Annual Energy Outlook 2018*, Feb. 6, 2018.
[3] Todd Levin, Steven Plotkin and Yan Zhou, Argonne National Laboratory, "Transportation Sector," in *Electricity end uses, energy efficiency, and distributed energy resources baseline*, by Lisa Schwartz, et al., Berkeley Lab and Argonne National Laboratory, January 2017.
[4] An increasing number of medium- and heavy-duty EVs also will require these services.
[5] The relative importance of public charging (open to all users) versus private charging (limited to select vehicles) depends on the characteristics of individual owners. For example, public charging infrastructure may be less of a priority for households that use an EV primarily for short trips to and from home and use another vehicle for longer range travel. But for households where EVs are their sole vehicles, or that require all vehicles to be multi-functional, the widespread availability of public charging infrastructure with short recharge times is an essential consideration. See Levin et al. 2017.

3. Who will use EVs — and how?
4. What types of utility infrastructure will be needed to serve EV users, who should pay for it, and how will utilities recover their fixed costs?
5. What incentives should EV customers face to encourage right-time charging and discharging?
6. What policy and regulatory approaches will:
   - Encourage efficient siting of charging stations — including fast-charging
   - Enable utilities to participate in infrastructure deployment
   - Foster competition by competitive EV charging providers
   - Establish enforceable standards to facilitate consumer adoption of EVs
   - Address underserved markets
   - Protect consumers

Authors representing diverse perspectives provide their responses:

- *Utilities* – Philip B. Jones, Alliance for Transportation Electrification (Chapter 1)
- *Third-party service providers* – Jonathan Levy, EVgo/Vision Ridge (Chapter 2)
- *Consumers* – Jenifer Bosco, John Howat and John W. Van Alst, National Consumer Law Center (Chapter 3)

Jones calls for policy and regulatory measures that enable utilities to play a significant role in closing the infrastructure gap for EV charging. He lays out a comprehensive path, from mandates for vehicle emissions and fuel efficiency, to stakeholder processes and studies, and to public utility commission decisions that balance incentives for utilities to accelerate capital investments in charging infrastructure with affordable retail rates, while ensuring charging services are accessible to all communities, rate classes and potential EV owners. He outlines the market transformation process that is needed for EV infrastructure to overcome market barriers and leap over the "valley of death," striking comparisons with challenges that energy efficiency technologies have faced and the strong utility roles that helped the efficiency industry gain a more secure foothold in the market. With the EV infrastructure "pie" growing quickly, Jones recommends a focus on increasing the *size* of the pie, rather than arguing who gets a particular slice (or the crumbs). Finally, he discusses actions several states are taking to prepare for an electrified transportation future and provides a regulatory toolbox for public utility commissions to consider, as well as short case studies of state activities.

Levy stresses the need for utilities to work with EV charging companies, policymakers, regulators and other stakeholders to address opportunities and challenges in the marketplace today. The critical areas for utility focus in his view are EV charging tariff structures, "make-ready" infrastructure,[6] expeditious interconnections for charging stations and consumer education. Levy urges a driver- and rider-centric approach to charging infrastructure that avoids a

[6] The electrical infrastructure up to the charger, such as wiring and conduit.

patchwork of utility programs across the country, along with policy and regulatory approaches that enable a robust and sustainable private charging industry. He sees the relationship between utilities and EV charging companies as "coopetition": While at times a utility may "undercut" other market participants, the utility also will benefit by working with experienced EV charging companies that have sited, installed and operated charging solutions for customers — and EV charging companies can benefit from utilities as customers. He suggests that utilities seek out gaps in the market and complement investments by others that rely on a broad base of infrastructure to benefit drivers broadly. Specifically, he recommends that utility investment focus in the area between private and public capital — for example, make-ready investments that advance the public good, facilitate the utility's pursuit of additional customer demand, and buy down some capital costs to attract more private capital.

The National Consumer Law Center (NCLC) examines the implications of transportation electrification for consumers, particularly low-income households, and explores policy approaches to address equity and access concerns and maintain public support for electrification. NCLC suggests that transportation electrification policy should aim to achieve the following:

- Increase transportation access and security for low-income consumers
- Equitably allocate costs and benefits for low-income consumers
- Address the disproportionate air pollution burden that low-income communities face from power generation and transportation sources

NCLC calls for pursuing EV infrastructure investments in a way that lessens the impact on ratepayers and shields low-income households from unaffordable rate increases, while providing sufficient infrastructure to support broad EV adoption. Among the strategies NCLC recommends are the following:

- Bill payment assistance programs to reduce the burden on vulnerable customers
- Rate designs that preserve affordability for low-income consumers
- Separate EV charging rates, possibly accompanied by separate meters, to spread a manageable amount of early costs among EV drivers, but at a rate that is not so high that it would serve as a disincentive to low- and moderate-income drivers as they consider whether to drive EVs
- Time-of-use and other rate design options to optimize charging times and help lower the cost of electricity for all consumers
- Incentivizing infrastructure for public transportation and school buses to spread benefits
- When charging stations are to be installed, placing them in locations that are responsive to community needs and can be used by low-income communities and low-income residents of multifamily buildings

- Incentives to increase private investment in charging stations that serve the needs of low-income communities

Applying consumer protection strategies to ratepayers more broadly, the Maryland Office of People's Counsel recently proposed principles for considering utility proposals for EV infrastructure investments, in order to balance multiple considerations, such as grid optimization, interoperability, underserved communities, public needs and the competitive market, as well as potential ratepayer benefits.[7] Cited potential gains from utility EV programs include demonstrable system benefits, managing EV loads to reduce energy costs, aggregation of EV demand for dispatch as a distributed energy resource, and fostering coordinated regional planning.

According to the People's Counsel, design and implementation of utility EV programs should:

- result in a more efficient grid through load management;
- align with and balance the state's various policy goals, including targets for reducing air pollution and energy waste;
- with respect to size, scope and costs, be based on reasonable analysis and alignment with policy objectives;
- result in optimally sited EV infrastructure; and
- use effective evaluation, measurement and verification practices to encourage transparency and inform ongoing program design and improvement.

A recent resolution by the National Association of State Utility Consumer Advocates also highlights the need for careful consideration of utility EV investments in order to minimize the impact on ratepayers.[8] The resolution in part calls for "states to continue to evaluate and analyze key electric vehicle adoption issues with an emphasis on the core responsibilities of public utilities, a specific focus on the efficient integration of electric vehicles and charging infrastructure into their systems, the avoidance of adverse impacts on the system from electric vehicle loads, the development of alternative rate designs if appropriate, the adaptation of distribution planning to minimize system risks and provide the opportunity for longer term system and cost benefits for their ratepayers, and the equitable sharing of any costs and benefits."

[7] Comments of the Maryland Office of People's Counsel, Case No. 9478, March 27, 2018, https://webapp.psc.state.md.us/newIntranet/Casenum/NewIndex3_VOpenFile.cfm?FilePath=C:\Casenum\9400-9499\9478\\37.pdf.

[8] National Association of Utility Consumer Advocates, Resolution 2018-02, *Urging the Adoption of Policies and Regulations to Protect Ratepayers as Electric Vehicle Adoption Rates Increase*, June 25, 2018.

1. A Utility Perspective on the Future of Transportation Electrification

By Philip B. Jones, Executive Director of the Alliance for Transportation Electrification

Introduction

Electrifying transportation has become a hot topic across the country. Electric utilities are taking on this challenge seriously, first to assess the status of the marketplace, and then to move on to specific plans and utility filings at state public utility commissions (PUCs).

State commissions have started to take notice, following on the heels of the "smart" electricity grid discussion of recent years. Multiple states have initiated generic dockets in which utilities and stakeholders can come together in a collaborative way to explore the issues in greater depth. Some have acted to clarify the legal definition of a public utility in light of third-party infrastructure providers who insist that they should not be regulated by commissions. All of these activities constitute good progress toward an "electrified future" with a number of broad factors at play: technology enabling lower cost batteries and great advances in electric drive technologies, state goals to reduce greenhouse gases (GHGs), and the need for electric utilities to participate in development of new loads that could have significant impacts on the distributed grid of the future.

The electric vehicle (EV), as one type of alternative fuel vehicle (AFV) to the internal combustion engine (ICE), is not a new subject. There are several types of EVs being developed and put into the commercial market today, including all-electric light-duty vehicles (called BEVs, or battery electric vehicles), plug-in hybrid EVs (or PHEVs, which have a small ICE to boost the range of the vehicle and address "range anxiety") and all-electric buses.[9]

About a century ago, EV technology was developed for deployment in some major U.S. cities, but the technology never really succeeded in lifting off. The ICE, fueled by petroleum, became the mainstay of our transportation fleet along with fueling infrastructure of over 160,000 petroleum filling stations today. The battles over the deployment of that technology at the time were fierce and continued in the 1990s surrounding the introduction of General Motors' EV1 car in California.[10] Since that time, several other AFVs tried to gain market share, such as compressed natural gas (CNG) vehicles, and the hydrogen-fuel cell vehicles that are being marketed today. Yet the EV today is widely predicted to assume the pole position in this emerging marketplace.

[9] Other types of on-road and off-road vehicles use electric propulsion, but this essay focuses largely on light-duty vehicles and buses.
[10] As depicted in the 2006 movie "Who Killed the Electric Car?"

Transformation of the Vehicle Market: Technology and Competitive Forces

What are the key factors of this transformation in the vehicle market that make it unique compared to previous unsuccessful attempts?

Technological change: Rapid changes are occurring in both the source of power for EVs and related components and electronics, especially in the cost of lithium ion batteries. Obviously, increasing scale has played a huge role in this significant lowering of the cost curve, especially with Tesla's giga factory outside of Reno, Nev. But battery manufacturers and auto original equipment manufacturers (OEMs) have made great progress in the battery control systems as well.

Reducing air emissions: Reducing air emissions from mobile sources of pollution for both light- and heavy-duty vehicles is perhaps the most important catalyst in the transformation of the vehicle market. While the utility sector and its previous heavy reliance on coal-fired generation was the largest source of stationary emissions over the past three decades, many of those plants have been retired on an accelerated basis due to both environmental regulations and increasing competition of cheap natural gas enabled by hydraulic fracturing. Accordingly, in most states and regions now the largest source of emissions is the transportation sector, which has finally gotten the attention of state policymakers and regulators. Some states have adopted voluntary goals to reduce GHGs to limit global emissions by 2050 to those necessary to achieve the goals of the Paris climate accord. Other states have adopted laws or regulations, such as SB 350 in California, that mandate the lowering of emissions in transportation through electrification.

Global investments: The automotive industry has been making huge investments in EV technologies in terms of billions of dollars devoted to research and development, product development, retooling or construction of new assembly plants for EVs, and investments in energy storage and battery technologies. To many observers, the tipping point has already been reached in the automotive industry in the transition from ICEs to EVs. It certainly has for Volvo (owned by Geely Automotive of China), which announced in 2017 a definitive timetable to phase out the production of ICE vehicles and focus solely on an all-EV fleet over the next five or seven years. China is already the largest market for EVs in the world and also the largest automotive market with annual sales in the range of 27 million vehicles per year. It has become a catalyst in accelerating the move toward EVs since most American and European automakers want to be successful in the Chinese marketplace. In North America, Nissan and General Motors have made the strongest efforts over the past decade to advance the market for a reasonably priced EV through the development and introduction of the Nissan LEAF (a BEV) and the Chevy Volt (a PHEV) and recently the all-electric Chevy Bolt EV. Yet many other manufacturers have developed both PHEVs and BEVs for light-duty vehicles and are offering them for sale in the United States, as well as in China and the European Union (EU). Although the EV market is global in nature, auto OEMs choose to introduce different types of vehicles in different markets, including U.S. regional markets, based on a number of factors such as production, supply chain, policy support, anticipated EV infrastructure and expected demand from consumers. The number and type of new EV models (today, about 130 globally) is expected to increase dramatically over the next five to 10 years.

Consumer demand: Consumers are demanding more choices for both clean vehicles (commonly referred to as ZEVs, or zero emitting vehicles) and "cool" new technologies that enable both good performance as well as connectivity to the public Internet that allows navigation and location-based systems, safety systems, and autonomous or semi-autonomous driving features in the vehicles they use. This should not be a surprise to utility executives, PUCs and stakeholders in state energy regulatory proceedings across the country. For the past decade, new technologies and startups have been introducing their products and services to the utility sector with features that allow more customer engagement and choice. In fact, many utilities have responded by dedicating staff and resources to "customer solutions" or "technology strategies." This same truth applies to EVs and the infrastructure (called EVSE, or electric vehicle supply equipment) — namely, that the consumer will be empowered to use this equipment for transportation, but also for potential uses in the future in grid integration efforts, such as demand response and distributed storage.

Information technologies: Machine learning and artificial intelligence are playing a key role in the transformation of the automotive sector. While semi-autonomous driving features and global positioning systems started to be deployed years ago, the advent of cheaper sensors, cameras and big data are challenging the fundamental way in which automobiles are developed and built. Large information technology companies based in Silicon Valley, such as Waymo of Alphabet, Uber, Lyft and many smaller companies, are forcing traditional automotive companies to change fundamentally the way in which they design and think about vehicles. Ride-sharing models, and the rapid development of transportation network companies (emphasis on network), are transforming the industry as well as accelerating the move toward EVs. Almost every conference on EVs over the past year has featured a panel on "SAEV," or shared autonomous electric vehicles, that explored the mobility issues in depth. Admittedly, there will be challenges on this road toward an autonomous, connected future, as well as accidents and fatalities in which the technologies are insufficiently tested or robust to put on our streets and public highways. Safety regulators, both at the federal and state level, will play a vital role in shaping the regulatory regime for this future of SAEV. But most observers believe that this trend is inexorable, and also that the EV, not the ICE, must be the optimal platform for these vehicles in the future.

Transformation of the Vehicle Market: Government and Corporate Policies

While the discussion above focuses on the technology and competitive forces shaping this transformation, policy and regulatory measures have obviously played a vital role. In fact, the thrust of this essay is on policy and regulatory issues that state agencies, especially the PUCs, can shape and influence. The following summarizes some of the general policy instruments for reducing air emissions from the transportation sector, before getting into more depth on the specific menu of options in the regulatory toolbox later in this essay.

National ZEV mandates: California, specifically the California Air Resources Board (CARB), has led the way in developing a regulatory approach to require a certain number of ZEVs to be a part of each auto OEM's sales in the state. The intent was to spur the development and sales of EVs and hydrogen fuel-cell cars. It is a complex mechanism that caps emissions for each automaker in the state but allows credits to accrue that can be banked for future years for use in nine other states (largely Regional Greenhouse Gas Initiative states in the Northeast) that have signed a memorandum of understanding with California. Under the Clean Air Act, Section 177 allows other states to adopt California's vehicle emission standards without prior approval from the U.S. Environmental Protection Agency (EPA). The 12 states that have done so (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont and Washington) are expected to be more proactive and aggressive in pushing for EV adoption through regulatory and other incentives in the coming years.

CAFE standards (corporate average fuel efficiency): These federal standards on average fuel efficiency across all vehicle types, administered by the National Highway Transportation Safety Administration and the EPA, provide a foundation for each auto OEM in meeting corporatewide averages on a national basis, including ZEVs such as EVs. After the recession of 2008 and the federal bailout of several auto manufacturers, the CAFE standards were increased considerably with an option for an interim review for the 2021–25 period to review their efficacy. If the EPA uses this review process to relax substantially the higher CAFE standards adopted during the previous administration, it would potentially remove one form of regulatory support for EV sales.

State tax credits: For income tax-based states, this has amounted to a credit in the range of $2,000 to $5,000 for the consumer who purchases an EV from an auto dealer in that state. For the few states without an income tax that impose some type of sales and use tax, the tax credit waives all or some of the imposed sales tax based on value subject to a cap. Several states, including Georgia and Washington, have abandoned such fiscal support for EVs.

Government procurement policies: Some state governments have adopted procurement policies for some state agencies to purchase a certain number of EVs, as a percentage of the overall fleet of vehicles, by a certain date.

Preferential access to high occupancy vehicle (HOV) lanes: In California and several other states, EVs may legally drive in the less crowded HOV lanes during rush hour times, which can be a big attraction to an EV owner. Other states or local governments may consider similar preferential policies for EV drivers in the future.

Workplace charging: More companies that have adopted strong environmental sustainability policies and larger organizations that wish to promote EV adoption are offering the infrastructure for EV charging at the workplace. The company will often undertake the upfront capital cost of these EVSE projects and dedicate a certain portion of their parking lots to these purposes. They offer the charging services to the employees at no cost or greatly reduced cost, and the company is responsible for negotiating the terms of the service interconnection agreement with the distribution utility. For those workers who live in multi-unit dwellings where it is difficult to deploy charging stations, this offers the substantial benefit of charging at work instead of having to go to a more inconvenient public charging station. Moreover, for states like Hawaii and California with solar overgeneration during daytime hours, this workplace charging can help absorb some of the excess energy. Utilities in other states, however, generally do not have solar or renewable overgeneration in daytime hours and may experience peak loads during these times. Accordingly, as penetration rates of EVs increase and more companies offer workplace charging, these charging behaviors will have to be coordinated closely with the distribution utility (especially if these charging stations are not connected to the network of the distribution utility, or an EVSE network operator).

State legislation: A variety of state laws on the books address AFVs such as CNG vehicles and EVs, providing guidance and encouraging utilities to propose certain programs or tariffs to promote accelerated EV adoption. Such laws generally provide broad guidance to the PUC, or other state agencies, to carry out the goals of the state in developing higher EV penetration rates. Yet some laws in place, such as in Colorado, obstruct the development of holistic transportation electrification plans by not allowing ratepayer funds to be used in these efforts. State level policies and regulations with regard to EVs are critical and variable.

State Laws Affecting EV Development

- The most impactful bill is undoubtedly SB 350, which passed the California Legislature in 2015. The bill increased the state's Renewable Portfolio Standard (RPS) to 50 percent and required the utilities to develop widespread transportation electrification plans and submit them to the California PUC for review. After much stakeholder engagement, the large investor-owned utilities (IOUs) in California submitted detailed plans to the Commission in two segments, which were heavily debated and litigated. The Commission approved the first round of priority review projects in January 2018.
- Washington HB 1853 passed in 2015. The bill directed the Washington Utilities and Transportation Commission (UTC) to engage with utilities and stakeholders and put forward a comprehensive policy statement on EVSE and provided a potential financial incentive for the utility to invest in this infrastructure.
- Oregon SB 1547, in addition to increasing the state's RPS, urged utilities to file EV infrastructure plans with the Oregon PUC and set forth criteria by which those plans were to be reviewed.
- Many other bills have been introduced and debated in state legislatures. Some have been direct and prescriptive to PUCs, while others have afforded more discretion to PUCs to develop regulations within an overall policy goal. Some state bills have focused on what are argued to be the negative impacts of EVs, either on the general budget of the state (such as the Georgia Legislature removing the state's $5,000 tax credit) or on transportation funding sources for a state relying on taxes on petrol at the pump.

Build the infrastructure and they will come: This is the approach that Tesla took when it rolled out the Model S sedan several years ago. The company reasoned that, due to range anxiety and other uncertainties for new EV drivers, it had to make the transition to the EV as easy as possible. That meant building out at its expense, and negotiating detailed service interconnection agreements with many utilities, public-facing direct-current (DC) fast charging stations both within urban areas and most notably in the intercity highway system. Some believe that Tesla has lost substantial money by not recovering its capital investment in such chargers from users, even if a certain portion of the cost is built into the purchase price of the vehicle. This strategy has proven to be an essential part of spurring sales of Tesla vehicles and has satisfactorily addressed the "range anxiety" issue which its internal surveys showed to be the most challenging issue for a new EV buyer.

Regulated investor-owned utilities (IOUs), of course, are generally not allowed to take such risks on the regulated side of their business since PUCs would probably not sanction an extensive build-out of infrastructure without either a strong public interest case or a cost-benefit study that demonstrates an acceptable level of benefits. Utilities could choose to build out these services through their unregulated subsidiary or build them out early with shareholder funds (as Kansas City Power & Light decided to do several years ago after being denied rate recovery on the regulated side). Yet, as I argue later, this approach may not be sufficient to get the infrastructure to scale quickly enough, especially if the trends of rapid EV introductions are correct and if universal access of charging infrastructure is to be achieved. Furthermore, if the public policy of the state is requiring by statute or urging the utilities and commissions to act in this area — whether it be environmental, economic development or technology/grid modernization — I believe the best approach is to pursue deployments on the regulated utility side, in order that the process be transparent, be fair to all rate classes, address the issues of disadvantaged communities, and be consistent with the just and reasonable precedents in ratemaking with each specific commission.

1. What are the potential benefits and risks of transportation electrification — to electric utilities, to retail electricity customers and to society?

EV technologies and EV infrastructure pose unique challenges to a heavily regulated sector such as the electric power industry due to the nature of the regulatory compact with the state commissions and requirements of the ratemaking process. The electric sector has adopted many new technologies over the past few decades, such as air conditioners, efficient water heaters (not necessarily grid-enabled), and certain energy efficiency measures such as compact fluorescent lamps (CFLs) and light-emitting diodes (LEDs). However, some technologies have not succeeded in the market transformation process for a variety of reasons. Before providing a menu of regulatory options for state commissions later in this essay, brief comments about the benefits and risks of accelerating the deployment of EVSE may be instructive.

Benefits

One of the most obvious benefits from accelerated deployment of EV infrastructure is to reduce carbon emissions through the electrification of transportation, especially in those states that have adopted either voluntary or mandatory goals to reduce GHG emissions. The level of GHG reductions, of course, depends both on the current generation mix of fossil fuels compared to zero carbon generation, and just as important, the trend lines of such generation over the next decade as older, less efficient coal plants are retired. GHG emissions from the transportation sector have become the largest source of emissions in many states as the generation fleet has become less carbon intensive. Some states are pursuing an ambitious goal of "80 x 50," namely 80 percent reductions over 1990 levels on an economywide basis, which are ambitious and implicate strongly the transportation sector and not just the electric power sector. Although the scientific bases of such deep reductions are disputed by a minority, the majority of climate scientists and sovereign countries have adopted these goals to prevent global temperatures from rising over 2 degrees Celsius.

Decarbonization studies have been conducted by states and utility consultants that set forth the policies necessary to achieve these goals. In nearly every study, the transportation sector plays a critical role in such reductions of GHGs, not to mention a reduction in tailpipe pollutants by introducing more EVs and AVFs. Based on these environmental imperatives, as well as favorable economics for wind and solar (and lower prices for natural gas), many utilities are developing their own decarbonization studies, or more specifically, "Pathway to 2030" studies that set forth both the analysis and a series of recommendations for economywide actions that should be taken to achieve these goals in a little over a decade, a relatively short time period for utility planning and investment. Southern California Edison completed notable studies in 2017 for the entire state of California, calling for 7 million light-duty vehicles in the fleet by 2030.[11] Another recent study by National Grid entitled "Northeast 80x50 Pathway," covering power generation, transportation and the heating sector, calls for 10 million light-duty EVs by 2030 in the northeastern states and New York.[12] The Southern Company performed a similar study on the decarbonization of its fleet across its service territory in the states in which it operates as a regulated utility.[13] In my view, these are all best-of-breed studies that highlight the bold and ambitious actions that must be taken on an economywide basis at the state and regional levels to achieve these environmental goals. In each of these studies — both decarbonization studies to 2050 and Pathway studies to 2030 — transportation electrification and the deployment of EV infrastructure necessary to fuel them is one of the key recommendations, together with further decarbonization of the power sector and electrification of home energy uses.

The benefits of innovative technologies and related economic development activities (increased state economic growth, jobs, tax base and such) are difficult to quantify and not generally in the purview of state commissions (although some state commissions do have the ability to promote certain utility programs with a broader economic impact through an "economic development tariff," which could be used for DC fast charging stations). Later, however, I address some possible methods, such as the societal cost test, in which utilities and commissions can attempt to quantify some of these potential benefits as well as the costs. Certainly, from an economic development standpoint, there are benefits to maintaining a competitive industrial base for the automotive industry working together with the information technology sector. And most analysts have concluded that other countries, such as China and those in the EU, are proceeding quickly with a rapid transformation of their automotive sectors to EVs and are building out the necessary EV infrastructure — with or without U.S. industries moving in the same direction.

Another benefit to increased use of EVSE is more efficient utilization of the distribution grid, assuming the utility is successful in managing charging sessions to move to off-peak hours and that consumer behavior changes to accommodate these grid benefits. This also maximizes the higher utilization of a variety of distribution assets, with longer asset lives, that have already been placed in rate base and may have been underutilized to this point. Through dynamic pricing schemes, such as off-peak and super-off-peak rates at night and higher peak rates during the daytime, the consumer should be able to benefit from these rate differentials as well. Some

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[11] See Southern California Edison. 2017, The Clean Power and Electrification Pathway. https://www.sce.com/wps/wcm/connect/0d0cca70-d100-4004-8ed1-d180637af3ff/SCE_CleanPowerandElectrificationPathway_WHITEPAPER.pdf?MOD=AJPERES

[12] See http://news.nationalgridus.com/wp-content/uploads/2018/06/80x50-White-Paper-FINAL.pdf

[13] See Southern Company (2017).

analysts call these possibilities “filling in the valleys” during off-peak hours, or in states like California with solar overgeneration during the day, “soaking up the excess energy” during the day to avoid negative pricing in wholesale markets. In either case, both the utility and the EV owner/ratepayer should be able to realize substantial financial benefits through managed charging and dynamic pricing schemes.

As EVSE technologies mature and achieve more operational certainty in managing bidirectional flows in the distribution grid, V2G (vehicle-to-grid) will offer additional benefits and services to both the EV owner and the grid. V2G refers to vehicles capable of receiving power to their onboard battery from electric power in the distribution grid, as well as the reverse flow of power from a mobile battery to the grid. Essentially, the onboard battery in the vehicle, which is distributed in a garage at the edge of the grid, can become a resource to the utility and grid by offering services that energy storage services (frequency regulation and other ancillary services) offer to the grid today. Several pilots have tested this concept, but full-scale operation is probably several years away. In the near future, the more commercially mature options are for demand response (DR) to be utilized in the EVSE since this is already incorporated into the design of many of the charging stations and network management systems on the market today. With proper market structures and design of DR programs, the benefits of avoiding additional capacity and deferral of such investments are possible.

In terms of revenue requirements and overall rates, several studies have demonstrated that there should be downward pressure on rates over time as EV infrastructure is deployed, as managed charging facilitates better utilize the grid, time-of-use rates are implemented, and these loads result in increased marginal revenues to the utility.[14] Unfortunately, most utilities and commissions still do not have a great deal of data to verify such downward pressure on rates, and the impact on revenue requirements, and many of the utility programs approved by commissions, are in early stages of development. But we should have such data in the next several years. Commissions will have the ability and, of course, the statutory authority, to use such increased revenue for the benefit of all ratepayer classes. Also, the increased marginal revenues (over costs) should accrue to the benefit of the utility over time and help offset some portion of the lower to flat growth that has challenged the utility industry recently. Some rate mechanisms like full revenue decoupling, and the ability of commissions to return the net revenues to ratepayers in general rate cases, may mitigate these increased marginal revenues to the utilities. Yet, from an overall financial perspective using the financial metrics used by ratings agencies and Wall Street, this increased load from EVSE will certainly be viewed as a net positive to the regulated utility sector.

Consumer choice is another benefit of deploying EV infrastructure since this becomes a grid-edge asset closer to the end user in the evolving distributed grid architecture of the future. Consumers can make their own decisions on how to use the EV infrastructure, either in their

[14] See Energy and Environmental Economics, Inc. (2014).

own garage or in a neighborhood fast charging cluster, and can set the level of involvement to their preference. Although quantifying customer satisfaction can be difficult, utilities can assess progress by performing surveys by customer class and type of charging infrastructure. (Avista has already done this for its pilot programs.) Commissions should assess such surveys as well as engage directly with the utility's customers through their consumer affairs staff, recognizing that quantifiable metrics are difficult to use. Due to the rapid proliferation of new technology that consumers can use to manage their energy usage and other DERs such as distributed storage and DR, it appears that consumer engagement is a force that is growing in importance, which utilities and commissions need to address. If the utilities do not take on this challenge seriously, a large number of innovative and aggressive non-utility competitors are prepared to fill this role, either on their own or in a venture with the utility.

Finally, for the benefits directly to the consumer that have traditionally not been considered party of utility decisionmaking, the avoided costs of petroleum fuel will be substantial. I will address how to deal with both these costs and benefits in a later section on cost-benefit methodologies. Furthermore, most analysts assert the total cost of ownership of an EV will be less than for an ICE vehicle in several years. Consumers should examine not just the upfront purchase cost of an EV (which is certainly higher now, especially without federal or state tax credits), but the total cost over its 12-year average vehicle life. There is no question that the maintenance costs for an EV are substantially less than those of an ICE vehicle.

Potential Risks

The most obvious risk is to build out a significant amount of EV infrastructure early, while the market does not develop sufficiently — in other words, overbuilding the charging stations. Some skeptics harken back to earlier attempts to develop AFVs, most notably CNG-fueled vehicles, and the fueling infrastructure over the past decade or two. Some skeptics of utility investment in this area would refer to the low profitability of non-utility charging providers to date, and the private sector has not been able to respond to the deployment challenge with the necessary speed and scale. Utilities may suffer from poor EV market intelligence and make similar mistakes in investing too rapidly before the EV market truly develops, according to this line of reasoning.

For utilities, if the market does not develop according to its projections and consumers do not buy EVs in sufficient quantities, the utility may suffer the risk of stranded assets. Although the scale of capital investments in EVSE may be small in the "early adopter" phase, and is much less than investments in distribution grid assets, this could pose a dilemma both for the utility and the commissions in how to deal with such a situation.

Another related risk could be technological obsolescence of certain EVSE, and how quickly hardware or software could become obsolete in the future given the rapid pace of technological change in the industry. Requiring open standards, or interoperability, in utility requests for proposals (RFPs) for EVSE vendors would mitigate this potential risk. A few utilities and Electrify America, created as a result of the Volkswagen (VW) settlement with U.S. and California regulators (where Appendix D allows up to 15 percent of the monies to be allocated to EVSE), are requiring vendors to submit bids in an open protocol called Open Charge Point Protocol (OCPP) and certify they are compliant. But the fact remains that several of the major vendors in the EVSE community, and Tesla as well, have developed proprietary systems especially for the management of these distributed charging station assets in their network management systems. Such systems are part of their business model and value proposition they have presented to their investors when receiving early funding, so this is a complex and challenging issue which may pose risks to the overall development of an EV market that allows customer choice, roaming among networks and ease of use.

Of course, as with all other projects either under a utility program approved by the commission or undertaken by a third-party developer, there is execution risk of building out the EVSE on time and within budget. Similar to the need for proper maintenance of non-utility charging stations today operated by various host sites, EV charging providers and others, the utility will have to devote adequate resources to the proper maintenance and repairs (an O&M expense) with utility personnel, or if contracted out to EVSEs or third parties, ensuring that this occurs. This is a risk similar to other types of assets in the overall asset management program of a utility. It can be done well or not so well given the levels of investments and dedicated personnel. This will be especially important since, compared to vegetation management, substation maintenance or pole replacement programs, this will be a clear, consumer-facing function with visibility for the utility. Finally, the potential risks include the argument that the regulated monopoly — as opposed to a third-party provider — is not the best means by which this sector can innovate and prosper. In fact, the skeptics argue that utilities will try to stifle innovation in this field of EVs and EV infrastructure.

2. What roles should utilities versus competitive providers play in accelerating deployment of EV infrastructure? What infrastructure investments are others making, and how should utilities complement those investments?

How the EVSE market should best develop, and the roles of the regulated utilities and third-party providers, are among the most contentious issues within the EV ecosystem, which I define as the broad group of stakeholders in the electric power, transportation, IT, environmental nongovernmental organization (NGO) and technology sectors interested in accelerating EV adoption.

Some third-party providers assert that the incumbent utility is not prepared to best assess these EVSE technologies and will stifle innovation and competition if the commission allows the utility to own and operate the EV infrastructure. Such parties have spent significant resources and time to litigate against utility proposals to develop, own and operate certain EVSE programs in many states across the country, which has required the utility, EV advocates and stakeholders to engage in evidentiary hearings and processes that can last for months. These efforts have applied to modest pilot programs in which the utility wants to experiment in building out a certain charging infrastructure, such as DC fast charging clusters in an urban area or with a metro transit agency for all-electric buses. These extended legal and administrative processes have resulted in delays in EVSE deployments in many states, thus aggravating the infrastructure gaps.

Of course, litigation in the context of a rate case or another proceeding will ultimately be utilized as larger and more comprehensive proposals are developed, and that is proper and fair. But I believe that now a more collaborative approach is necessary, since the EVSE industry is still in such a nascent stage of development, with many stakeholders who are new to commission processes. Moreover, as with other new and emerging technologies introduced into the electric sector in the past decade, the commissioners, the staffs, consumer advocates and other traditional intervenors have to learn and understand some of these quite new concepts in transportation electrification, since they involve the transportation, IT, and other technology industries as well as coordination with other state and local government agencies.

I already have set forth the benefits and risks above at a broad level. Opponents of utility ownership or active involvement in EVSE deployments will emphasize those risks, such as stifling innovation, the risk of either overbuilding or stranded assets, and crowding out of non-utility third parties if commissions allow a strong utility role. I do not believe there is much credence in these arguments as the EV industry positions itself for much greater scale quickly, which will require much greater scale and build-out in EVSE. Furthermore, I do not believe that this market, especially in this nascent stage, needs to be categorized in a black or white fashion. There are many modes of market development that are possible here, which will depend on several key factors such as the electricity market structure in a state, the position of commissions on these issues given past precedents for similar third-party participation, and statutory or other guidance from the executive and legislative branches.

I argue the need for a strong and robust utility role, including utility ownership and operation on a regulated basis, as one of the most important ways to deploy infrastructure quickly in order to meet the infrastructure gap, thereby helping to transform the EVSE industry.

Gaps Between Supply and Demand

First, let me address the concept of "market failure," or what may be perceived to be the "gaps" or "shortcomings" between the supply/allocation (i.e., capital investments) and the demands by current and future EV owners for these services across all types of charging infrastructure. Market failures are "situations where competitive markets fail to achieve a collective optimum."[15] I do not intend for this essay to be an extensive treatise on the microeconomics of the EVSE market, and issues such as information asymmetries, externalities, and other issues in the economics literature. Economists often play an important role in regulatory proceedings on

[15] See Salanie (2000). "Microeconomics of Market Failures." MIT Press. https://mitpress.mit.edu/books/microeconomics-market-failures

issues such as cost of capital studies and determining interclass equity in rate design. This essay is meant to be a policy guide for regulators and decisionmakers in state commissions and other state agencies who have to make difficult decisions in understanding the EV technologies, how market development should proceed in an efficient and fair manner, and how to set the proper rates and rules.

But there are many studies, analyses, and submittals to commissions to indicate that several gaps in the overall market for EV infrastructure deployment exist today among the several types of charging infrastructure: Level 1 (L1) and Level 2 (L2) home charging, L2 public charging, workplace charging, and DC fast charging, either in urban clusters or intercity corridors. To date, for a variety of reasons, there has been substantial underinvestment in many of these facilities according to most observers, which has resulted in the substantial infrastructure gap in overall EV infrastructure to which I have already referred.

Charging infrastructure has many characteristics of a public good. It is available for many individuals to use, but no single entity likely has the economic incentive to supply it, resulting in a collective action problem. In that light, the market failure for DC fast charging is fairly obvious, both in the urban locations as well as in the intercity corridor locations. The capital investments in DC fast charging are quite expensive and are dependent on the siting, permitting and land acquisition costs for such sites. Finding an optimal location is especially vital since the utility or developer of the DC fast charging wants to make it as easy as possible for the EV owner to find the location. Yet even if successful in siting and building out a DC fast charging station, the use case projections for the first several years, in terms of charges per day, dwelling times and pricing for the service make this a challenging business case.

Finding the "sweet spot" in pricing the services per kilowatt-hour for public DC fast charging is an especially challenging task, and several commissions and municipal utilities have had to grapple with this issue. As the most recent demonstration of this, the New York Power Authority (NYPA) demonstrated clearly such gaps in the market for DC fast charging in New York state, especially in the intercity highway corridors and the more rural parts of upstate New York.[16] Moreover, a U.S. Department of Energy (DOE) report on EV infrastructure to meet a central scenario target by 2030 (for 15 million PEVs nationally) projects the number of required DC fast charging stations at about 8,500 (with over 27,000 plugs).[17]

Another market shortcoming is the multi-unit dwelling (MUD) challenge, largely in urban areas, where it is difficult to get the necessary permits and approvals to install charging stations in

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[16] See Docket 18-E0-0138, filed 4-13-2018, Joint Petition for Immediate and Long-Term Relief to encourage statewide deployment of DC fast charging facilities for electric vehicles, filed by NYPA, NY Dept. of Environmental Conservation, NY State Dept. of Transportation, and NY State Thruway Authority. http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterSeq=56005.

[17] See EERE. 2017. National Plug-In Electric Vehicle Infrastructure Analysis. https://www.energy.gov/eere/vehicles/downloads/national-plug-electric-vehicle-infrastructure-analysis

parking lots or structures of the buildings. Unfortunately, these market gaps affect populations that are largely low to moderate income that live in such dwellings, and are in neighborhoods that can be characterized as disadvantaged communities both economically and environmentally. As we experienced in the efforts to get energy-efficient lighting (CFLs and then LEDs) into larger MUDs over the past decade, one faces the same sort of split incentive for the landlord and the tenant. Namely, the landlord has little incentive to pay some level of upfront capital investment for a charging station, even with the contribution of the utility to provide service to the EVSE, and the tenant therefore may be locked out of the opportunity for a charging station, not to mention the barrier of upfront capital costs for the installation of an L2 charger. A variety of approaches are being developed to address the challenges of deploying charging infrastructure in MUDs, both for-profit and nonprofit models. But most of these approaches will have a strong relationship to the utility in program design and funding sources.

Besides the difficulty to serve the MUD market, there appears to be an overall gap in the market, both now and in projections to 2030, in the nonresidential, public-facing L2 charging infrastructure. Several studies and analyses in key states with higher EV penetration rates have studied this gap and, of course, in many of the DC fast charging deployments by Electrify America, non-utility providers and utilities will include several L2 chargers that can service the PHEVs not capable of DC fast charging today. According to the U.S. DOE study cited above, the number of public-facing L2 plugs that will be necessary is 601,000 plugs: 451,000 in cities, 99,000 in towns, and 51,000 in rural areas. In summary, we face substantial infrastructure gaps for many types of charging infrastructure across the country, both today and in most projections to 2030.

Role of Utility in Addressing Market Gaps

If market gaps exist, how can the utility step in to help alleviate this situation? First, the utility can be a catalyst in transforming the EV charging market. A comprehensive portfolio approach is the most efficient and equitable way to achieve both the goals of accelerating EVSE deployment and ensuring that charging infrastructure programs are designed in a way to serve all types of customers, thereby satisfying a public interest test. The commission will have the obligation to oversee the implementation of these EVSE deployments, and either through reporting requirements or consultations with the utility and vendors, monitor their progress over time.

One of the most critical challenges facing EV infrastructure today is scale, namely how to position a relatively nascent and fragmented industry and find ways to increase the infrastructure to much greater scale in a short time frame. Utilities are well suited to take on this challenge, due to their ability to access low-cost capital, both debt and equity, and the long time horizon they adopt when building out infrastructure as utility assets. Utilities can also create internal teams that span engineering, customer solutions and vendor relationships in a focused way. Although the size and scope of utilities can sometimes slow down technology deployments due to tendencies to be risk-averse, the size and scope of a utility can be turned into a powerful force if it is properly mission-focused and operating in a stable regulatory and policy environment. In addition, with the increasing scale of EVSE projects offered through an open RFP process with vendors, the utility should be able to carry out this work with multiple vendors as the entire EVSE industry scales up through more favorable terms with large quantity purchases and sustained agreements over time.

Another advantage to a robust utility role is the need for a strong planning function in which the utility can coordinate the type, location and power requirements of the EVSE throughout the entire system of the utility, to ensure least-cost highest value investments for all utility customers. Again, utilities have scale through large footprints in either urban or rural areas that traverse many types of geography, demographic classes and income levels. Most are required by statute or rule, or due to the long-lived nature of distribution grid assets, to make detailed plans for asset purchases and management over decades-long time horizons. No other organization in the EVSE space, such as third-party service providers, can perform this role as a utility can.

Utilities are moving (some would say too slowly) toward distribution resource planning that is much more granular to enable greater integration of distributed resources such as storage, DR measures and EVSE. The utilities need to plan for this increased EVSE load, and their impacts on the integrated grid, but it can be done either outside of the IRP process or within the IRP process. The commissions can set forth guidelines and metrics for such planning for increased EVSE deployments and loads, and perhaps link these efforts to distribution resource planning for increased DERs in the grid. The Oregon PUC is dealing with this issue now in a separate docket that resulted from its approval of EVSE pilot programs both for Portland General Electric and Pacific Power.

Yet, as the Washington UTC Policy Statement points out, planning for EVSE deployments involves several other state and local government agencies, such as state departments of transportation, state environmental agencies, and large city departments of transportation. This is a complex coordination issue for state planning for EVs and EVSEs, and the utilities and commission will be an important player, but certainly not the only one, in developing such plans. But the lack of attention to these planning and coordination issues could result in a poor outcome; namely, we could be facing situations in the future with higher penetrations in which the utility has detailed knowledge of location and charging requirements of EVSE under its control, but no awareness of other EVSE operated by non-utility parties.

Moreover, this leads to the need, as EV penetration rates increase across feeders and locations in a distribution grid, for some entity to have real-time situational awareness of these charging stations and be capable of taking immediate action to protect the reliability of the grid, such as in an overvoltage situation caused by a cluster of EVSEs charging at the same time. Again, only the utility can fulfill this function and has an obligation to the public for the safe, reliable operation of the grid. This role does not necessarily imply a utility ownership interest, but it does imply that third-party operators of EVSE must share data in real time with the distribution utility so that it can respond quickly and effectively to various contingencies.

The utility, if it manages its customer relationships well, has access to a significant base of end-use consumers who may be interested in purchasing an EV for a variety of reasons. One of the major challenges in deploying more EV infrastructure is that consumers lack knowledge of the benefits of EVs. Such support for education and outreach to both end users and key players in the distribution of EV products and services (e.g., automobile dealers) mirrors similar support for utility activities in market transformation, such as that for lighting equipment in the Pacific Northwest and elsewhere. Such support needs to be carefully targeted, limited and monitored with sound metrics. Yet utility activities, initially with pilot programs, will be essential in helping to act as a catalyst in this emerging market and attempting to reach out to all types and classes of ratepayers or potential buyers of EVs. While the utility may not have the expertise internally to carry out these activities, it can partner with more experienced organizations like Forth Mobility in the Pacific Northwest and Plug-in America nationally, and EV owners associations can partner with the distribution utility to carry out such targeted outreach programs.

Finally, as states start deliberating about EVs and building out the infrastructure, they should think carefully about the accountability issues for such programs and capital expenditures for public-facing charging stations and equipment. Regulated utilities have the duty and obligation to provide reliable, affordable electric service to all customers who request it — in other words, it is a monopoly service that is regulated by the state PUC. A utility therefore has the duty to assess carefully the access and affordability issues, especially for low- to moderate-income communities, when it asks the commission to approve its program. The commission also has the duty to oversee these programs in a way that provides services to all communities in a fair and efficient way when offered by the regulated utilities. Moreover, to require the utility to serve just the low- and moderate-income communities and disadvantaged areas, while allowing third parties to pick the most desirable sites for EVSE (sometimes called cherry-picking), as some advocate, is not a fair and sustainable roadmap for EV infrastructure over the long term.

Utility Engagement in Context: The EVSE Pie

A robust utility role in EVSE deployment, to be fair, has potential risks and downsides as are often pointed out in articles and in advocacy before state commissions and legislatures. First, utility investment as a regulated monopoly could potentially push out investments of private capital for third-party service providers — the so-called “crowding out” effect. Second, since they are a regulated monopoly, critics question if utilities are really going to be innovative and stay abreast of the latest trends on technological development, compared to Silicon Valley-funded startup firms. Third, some critics argue that since the utility’s interest is mainly in rate-basing capital investment, this could lead to overinvestment in certain types of charging infrastructure. Depending on how quickly demand grows for EVs in the private auto market, they argue that this could lead to higher rates due to the return on equity on deployed capital, and perhaps stranded assets down the road. Finally, they argue that utilities are not well suited, and lack sufficient experience, to procure and deploy EV infrastructure at scale in an efficient manner which could result in cost overruns, or so-called "execution risk."

While there may be some truth in each of these arguments, I believe that the EVSE market will not be developed in a black and white, or binary, manner with the third-party service providers and the utility owners operating completely apart from each other. Obviously, the distribution grid exists, will operate and be modernized far into the future, and will undoubtedly transform itself to accommodate both EVSE and other forms of distributed energy resources. The commission has authority to oversee and monitor these rules to ensure that adequate access is provided fairly by the utility to such parties, while ensuring that the utility recovers its costs in a reasonable manner. In the future, the devil will be in the details in enforcing "fair play" in these areas.

Moreover, there are a variety of ownership, or joint venture, possibilities that are currently being explored in EV infrastructure where the EVSE firm can bring technology, software and network management experience (such as vehicle to grid know-how) to the table, while the utility can bring its scale, engineering experience and detailed knowledge of the grid to the table. The utility may want to put its brand on the charging stations it rolls out, and the vendor may be fine supplying the solutions on a turnkey basis including all back-office and network management systems. Or there could be a different division of responsibilities as both parties look at hardware, software, value propositions and so on. The point is that a variety of business structures are possible in order to develop the EVSE market, and the particular solution will differ from state to state, and utility to utility.

In many cases, local governments — both cities and counties — are interested in advancing the EV agenda and will offer to be involved in development of the EV infrastructure by partnering with a company or utility to advance a project. Also, auto OEMs and all-electric bus manufacturers have a role to play and can bring different assets to a program with a third-party service provider, utility or local government. Most auto OEMs in North America have made it clear that their core competencies are designing and building EVs, not building out electric infrastructure. They argue that the EVSE deployments are much closer to the core competencies of regulated utilities, namely building out and operating an efficient, reliable distribution grid that can accommodate emerging technologies like this. In my view, this is probably a fair division of responsibilities going forward in developing this nascent marketplace. Other countries, such as China and those in the EU, may choose to develop different models for EV infrastructure and its sustained operations. But at least in North America, this rough "division of labor" recognizes the billions of dollars that automakers already have spent on EVs, not to mention the capital spent on battery development, and that the OEMs still have much to do to contain and reduce costs to make EVs more affordable at point of purchase. Moreover, it recognizes the political reality in most states across the country, both with the executive and legislative branches, that there is little to no appetite for raising taxes or fees on existing users of ICE vehicles to fund these deployments, or trying to fund these activities out of general funds or appropriations.

Accordingly, I believe that the EVSE "pie" is growing quickly, and rather than arguing or discussing who gets this slice (or the crumbs), we should all focus on increasing the size of the pie. Most analysts have predicted rapid growth for EVs in the future, and the EVSE infrastructure must be built out rapidly to accommodate that growth. A collaborative approach addressing the needs of all stakeholders in a fair manner is the best way to show tangible signs of success at this stage of market development.

3. Who will use EVs — and how?

4a. What types of utility infrastructure will be needed to serve EV users?

The following addresses various aspects of questions 3 and 4 together.

Current Demand and Projections

Many studies have been published on future market demand for EVs by a variety of automotive and energy analysts, including Bloomberg New Energy Finance (BNEF), the International Energy Agency (IEA), UBS, Goldman Sachs and McKinsey, as well as Edison Electric Institute and the U.S. Energy Information Administration. Since this is a global market for sales of EVs with a highly integrated global supply chain, such studies usually study the global market demand for EVs — both light-duty and all-electric buses and others. Most studies conclude that China is and will continue to be the largest market for EVs over the next two decades, with the EU and North America following but growing briskly with at least 25 percent to 30 percent growth rates in the near future.

For example, BNEF just published its 2018 Outlook in the spring, and its projections have increased compared to the 2017 Outlook.[18] BNEF projects sales of all EVs to reach 30 million globally, growing from 1.1 million in 2017 to 11 million in 2025, to 30 million in 2030. It projects that by 2040, 55 percent of all new sales of automobiles will be EVs, and 33 percent of the installed global fleet will be electric. Some of the most important assumptions in the modeling include: the pace at which battery costs decline (BNEF, IEA and several others believe these costs will continue to decline rapidly over time and make EVs cost-competitive with traditional ICEs without any incentive by 2024 or so), other cost containment measures by auto OEMs, regulatory and policy mandates or incentives, and GHG regulations or a potential carbon price. Availability of EV charging stations, especially the public-facing Level 2 and DC fast charging stations, is another critical assumption.

[18] See Bloomberg. Electric Vehicle Outlook 2018. https://about.bnef.com/electric-vehicle-outlook/#toc-download

While they vary a good deal from the low end of market penetration to the high end, the trend lines for number of EVs to be introduced, as well as the number of charging stations to be built, is certainly increasing. The question is not if, but when, the tipping point occurs and how fast growth rates turn out to be. Growth of EV registrations was about 28 percent in 2017, and the total number of registered EVs in the United States at the end of that year was about 790,000.

In North America, the largest producers of EVs have been Nissan, Tesla and General Motors (GM), in that order. It is difficult to get accurate figures broken out by country, and as stated before, this is truly a global industry, with China being the largest market and the EU in second place. By the end of the third quarter of 2017, Tesla had sold about 257,000 vehicles globally, with about 145,000 in the United States. Nissan sold over 300,000 vehicles in the same period, although in 2017 its sales flattened out somewhat due to the introduction of an improved LEAF version for 2018. For GM, sales of the all-electric Chevy Bolt have been overtaking sales of the Volt in many states, with both vehicles offered in all 50 states.

Not many detailed demographic studies exist publicly on the demographics of EV buyers. A quick analysis of the market transformation process is useful here.

As defined by the American Council for an Energy-Efficient Economy and cited in the Washington Utilities and Transportation Commission (UTC) Policy Statement,[19] the process of market transformation occurs when a strategic process is developed by utilities, vendors and stakeholders, with the support of government agencies, to intervene in a market to both remove a number of barriers and exploit opportunities to accelerate the development of the market and consumer behavior to an equilibrium, or standard practice among the market participants. This type of market transformation process was utilized successfully in the transition of lighting equipment from less energy-efficient incandescent bulbs to more efficient bulbs — first the CFL and then the LED. Such interventions and market processes do not always succeed, of course, and this iterative process must align with both the public policy interests of the state, as well with the planning and technology deployments of both vendors and utilities.

This process outlines various stages of development in a technology, and the need to get beyond the "valley of death" for an industry in the early days of innovation where technology enthusiasts purchase products. But the industry is not at scale yet, and the early adoption among the enthusiastic buyers is insufficient to move the needle. It describes several stages of participants in this market development process: first the innovators and technology enthusiasts, then the early adopters, the early majority pragmatists, and the late majority conservatives, and finally the laggards and skeptics.

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[19] See Docket UE-160799, Policy and Interpretive Statement Concerning Commission Regulation of Electric Vehicle Charging Services, June 14, 2017, https://www.utc.wa.gov/_layouts/15/CasesPublicWebsite/GetDocument.ashx?docID=147&year=2016&docketNumber=160799

Along this continuum, the EV buyer is likely somewhere between the early adopter phase and the early majority pragmatist phase. The early buyers of EVs were probably the technology enthusiasts and visionaries, who were likely motivated both by the desire to mitigate climate change (environmental) as well as the “coolness” factor in buying the electric drive technologies (innovation). Such buyers probably bought the early versions of the Nissan LEAF and the Chevy Volt in particular. Especially for the limited range of the earlier battery packs of the early LEAFs, these were primarily urban dwellers who used the vehicle either for commuting to work or running errands. The Chevy Volt, a PHEV with a gasoline engine and extended range, probably appealed to a broader class of potential customers since it allowed driving over longer distances. These buyers tended to be middle- to upper-income households at the start, although used Nissan LEAFs can be purchased for a very affordable price today. About 15 models of EVs were sold in the market in late 2017.

Meanwhile, Tesla buyers were overwhelmingly upper income, likely motivated by the technological innovation and “coolness” of the Model S and Model X. As technology enthusiasts and visionaries, and probably with an environmental ethic as well, these buyers were undoubtedly motivated by the story and brand created by Tesla founder Elon Musk, and his ability to disrupt and change what they perceived to be a conservative automobile industry. However, with the announcement a couple of years ago of the Model 3 sedan (with an initial price in the high $30,000 range) and the large number of people who signed up to purchase the car with a deposit, this demographic is certainly changing and moving more broadly into the middle-income category. More important, just as Tesla has been able to use economies of scale at its gigafactory for batteries together with Panasonic outside of Reno, this new Model 3 could move the market to greater scale.

In summary, getting the EV market to greater scale, in both the production and assembly of the car, and to more of the “mass market,” is critical today. Tesla’s Model 3, if it can resolve quickly its mishaps in supply chain, assembly and overall production efficiencies at its California factory, will certainly help move this market from the early adopter phase to the scaled-up early majority pragmatist phase. Yet Nissan and GM, as the current top producers of EVs, will also play a critical role in providing the basis by which the overall industry can “leap over the valley of death” and get to a more stable phase in the market. Both companies have deep knowledge and significant engineering experience in managing global supply chains, working with parts suppliers, and managing assembly lines efficiently and with quality controls. Many other auto OEMs, including Audi, VW, Honda, Kia, Mitsubishi and many others, have announced broader product offerings for EVs over the next several years. BNEF expects that by 2020, there will be 39 models of PHEVs and 44 models of pure battery electric vehicles (BEVs) available for sale in North America. Accordingly, the next two to three years will mark a critical phase in the market development of this industry, to see if it can get to greater scale and attract the more “pragmatic” EV buyer who can help transform this market further.

The Infrastructure Gap

Based on the more conservative market projections discussed above, it is apparent that we collectively face a big challenge in getting the necessary EV infrastructure sited and built in time to meet this expected demand. Although it is unclear at this point how those EVs will be allocated among the various states, cities and regions, it is reasonable to assume that the auto OEMs will be assessing the state of publicly available infrastructure in each state as they produce and allocate these new EVs to auto dealers.

Let's just briefly consider the supply and demand issues for EVs and EV infrastructure in the state of California. Today, the state has about 340,000 registered EVs in the hands of consumers and driving on its highways and roads. There are about 16,500 public, nonresidential ports available for charging outside of the home, which is clearly inadequate for the current needs and huge aspirations in California. Now let's just take the EVSE projects already submitted by the three California IOUs to the California PUC, both priority review and standard contracts, and assume they are approved and will be built. Add to that base the $800 million investment in California that Electrify America will make over the next several years. And add in the plans of Sacramento Municipal Utility District, Los Angeles Department of Water and Power and other public utilities that have plans to deploy EV infrastructure.

According to the California Energy Commission (CEC), this level of infrastructure will meet only between 4 percent and 8 percent of the total demand for public EV infrastructure, which was based on the 1.5 million vehicle goal by 2025. Governor Brown raised that goal in his January 2018 executive order to 5 million vehicles, and he proposed an additional 250,000 EV charging ports to be built by 2030.[20] One should be skeptical of the feasibility of such ambitious goals since some of the key elements of building out the EVSE are not in place yet. Yet one should also applaud the California parties for taking on these huge challenges in transforming the vehicle market from fossil fuels to electric-fueled transportation in a short period of time. The point is clear — even California faces a substantial gap in building out the necessary infrastructure.

Other states that wish to advance accelerated EV sales face a similar gap in infrastructure, especially the states and cities that have put forward ambitious clean energy goals, including transportation electrification, as part of their climate change agenda. One can certainly put the other West Coast states, Oregon and Washington, and the Regional Greenhouse Gas Initiative states in this general category. The governors of each state have proposed through executive orders to raise the goals of registered EVs to 50,000 vehicles by 2020. Furthermore, each state has put forward sound policies to encourage greater access and affordability for low-income

[20] CA.gov. 2018. Governor Brown Takes Action to Increase Zero-Emission Vehicles, Fund New Climate Investments. https://www.gov.ca.gov/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/

groups and encouraged transit agencies and school districts to address and set up interagency coordinating groups.

The Oregon PUC recently approved, after extensive delays caused by litigation of a multi-party settlement, modest pilot programs for both Portland General Electric and Pacific Power, the two major electric IOUs in the state. In addition, the Washington UTC recently approved the extension and expansion of a previous pilot program for Avista Utilities, which owns and operates EVSE across all types of charging infrastructure, and recently both Pacific Power and Puget Sound Energy (PSE) filed fairly modest pilot programs with the Joint Stakeholder group for review. But the stark reality is that the EV infrastructure in the ground and approved for deployment will be inadequate to meet the aspirational goals of each state.

State-specific studies conducted by consulting firms[21] have outlined several scenarios for greater EV sales in those states, based on national-level studies and scenarios, and set forth their own analysis of the benefits and costs of policies to spur greater EV adoption. Depending on the scenario, each of these studies reinforces the conclusion that a substantial infrastructure gap exists in each state. In addition, the National Renewable Energy Laboratory is studying the issues in greater depth for several states, including the potential size of the infrastructure gap, the types of charging infrastructure to be deployed, and an estimate (or confirmation of the utility's estimates) of the costs of various proposed scenarios.

In summary, most studies that have been done for a specific state or region have concluded that there is a significant infrastructure gap, and today's infrastructure is clearly inadequate to accommodate greater penetration of EVs. Accordingly, if states are truly serious about enabling a transition to electrification of transportation, much more needs to be done quickly by the commissions, or other state or local government agencies, to set the policy and regulatory framework to meet the unique needs of this transformation.

4b. Who should pay for EV infrastructure, and how will utilities recover their fixed costs?

5. What incentives should EV customers face to encourage right-time charging and discharging?

6. What policy and regulatory approaches will:

- **Encourage efficient siting of charging stations — including fast-charging**
- **Enable utilities to participate in infrastructure deployment**
- **Foster competition by competitive EV charging providers**
- **Establish enforceable standards to facilitate consumer adoption of EVs**

[21] For example, see Electric Vehicle Cost-Benefit Analyses (No date). https://www.mjbradley.com/sites/default/files/NE%20PEV%208%20state%20Summary%2009nov17.pdf

- **Address underserved markets**
- **Protect consumers**

The following addresses various aspects of questions 4b, 5 and 6 together.

Interoperability and Open Standards

A key challenge for the EVSE sector at this time is to build out a system that is built on interoperability and reflects the principles of open standards. Among other industries, the software industry has faced a similar challenge in the past with different systems not being able to operate with each other seamlessly. To date, a number of proprietary systems have been developed and are being deployed for EVSE, of which Tesla is the most notable and successful example of a network management system that does not communicate easily with others. Several other EVSE companies have also developed proprietary systems, from the charging stations to the central office systems that function well within their "silo" but do not communicate easily with other network management systems (so-called "roaming" among different systems) and are difficult to adapt to a truly open system.

There are several aspects to these interoperability issues. At the front end of the system are issues that face the consumer and the EV owner: the basic differences among the different plugs or ports — namely, the differences between the SAE Combo, ChaDeMo and J1772 plugs. Of course, adapters can be provided by the auto OEM to accommodate these differences, but these are not easy for the first-time EV buyer to understand and accept. In addition, many EVSE providers require the EV buyer to subscribe to their membership club, and essentially become a member of that particular "tribe" for an EVSE provider. A first-time user of a charging station can obtain charging services from the vendor by calling customer service and providing a credit card number, but that sort of system appears to be anachronistic and inefficient in this era of automated, encrypted payment systems over the Internet with RFID cards. These issues, which directly face the consumer, must be addressed quickly and effectively.

California probably has the most experience in facing up to these challenges since it has the deepest penetration of EVs in distribution systems and, as a result, has been encountering these consumer issues early. California's Vehicle-Grid Integration Communication Protocol Working Group was established by the California PUC and CARB to address many of these issues and recently published a draft report after many months of hard work. While this working group does not pretend to resolve the fundamental issues of proprietary systems tied to business models, both among the EVSE companies and the auto OEMs, it has made progress in defining some of the core consumer issues that need to be addressed soon and a consolidated value framework.

A central interoperability issue is the central office of the EVSE system, or what is generally called the *network management system.* This is largely a complex mix of software, or a platform on which these systems reside, that remotely controls the charging stations deployed in the field and collects large amounts of data from both the EV user and the vehicle, such as time, location and dwelling time. These large amounts of data, or Big Data, are quite valuable and can be used for a number of purposes by the EVSE provider, the utility or third-party providers that may wish to offer new services or products. Moreover, in the broader area of intellectual property and Internet protocol (IP) for such network management systems, certain EVSE providers have become aggressive in asserting their control over certain patents related to network management systems controlling distributed resources like EVSE (and demand response and distributed storage) over communications protocols such as WiFi and the public Internet. While we have witnessed litigation and struggles in other software industries, such disputes over IP in the courts are bound to slow EVSE deployment if they are continued.

Another critical area of interoperability is to offer a uniform, transparent solution for the method of charging between the charging station and the network management system for whoever is offering the services to EV owners. In the future, this should be the goal of any state or region. The objective is to connect any network management system seamlessly with any charging station, or EVSE, regardless of which vendor developed the system and deployed the EVSE in the field. While this may not be easy to achieve in the near term, policymakers and commissions should keep this in the forefront of their thinking as they oversee EVSE deployments.

Electrify America is building out the first for-profit national charging system in the country and has made interoperability a key criterion of its grant-making for EVSE deployments for workplace charging and multi-unit dwellings in 15 metropolitan areas. Specifically, Electrify America requires vendors to use the most commonly accepted protocol that utilities and vendors are gravitating toward in this space — namely, Open Charge Point Protocol (OCPP), developed under the auspices of the Open Charge Alliance (OCA). Although based in the Netherlands, the OCA is a global consortium of public and private EV infrastructure companies that have joined forces to promote open standards and interoperability. It has both a process by which members can offer new functions to the OCPP, and a self-certification process by which EVSE vendors can determine whether or not they comply with this commonly accepted open standard.

As utilities become more involved in building out EVSE in their service territories, I believe that both policy and regulatory officials, as well as those responsible for managing RFPs, should become familiar with OCPP, both the previous version 1.6 and the recently adopted version 2.0. Other efforts to develop protocols or standards for EVSE are ongoing, especially in the link between the charging station and the network management system, but none are as far along in development as OCPP. Moreover, based on what commissions and stakeholders have observed in other standards-setting bodies such as the Smart Grid Interoperability Panel and the new IEEE Standard 1547 for smart inverters, such processes take far too long to reach consensus and may not develop the proper solution for the EVSE provider or utility which needs to deploy infrastructure urgently to meet the infrastructure gap. Therefore, as utilities and commissions are often required to do, one should not necessarily strive for perfection in a "standard" accepted by all, but instead move forward with the "protocol," such as OCPP, that appears to have the greatest support and momentum from the global EVSE community today.

The Regulatory and Policy Response — High Level

State commissions, and other state agencies responsible for energy and environmental policies, have started to address these issues in earnest. Some states are in a more advanced stage of progress than others, which is dependent on the overall regulatory and policy culture in that state as well as specific statutes that direct the commission or other state agencies to do certain things. California is clearly in the lead in many of these proceedings and its legislature has directed CPUC, CARB, CEC and others to address many aspects of these challenges. Other West Coast states, as well as mid-Atlantic and northeastern states, have been some of the first to rule on utility petitions and organize workshops and proceedings around EVSE.

Yet this is clearly not a bicoastal state issue ignored by our industrial heartland. EVSE policy has become an important regulatory and policy issue to states all across the country in the last couple of years. And since the automotive and transportation sector has such a large economic impact and is important in many states in the Midwest, the South, Texas and elsewhere, these regions have recently started to become more proactive in EV adoption and EV infrastructure discussions. Besides being a challenging set of issues from a regulatory and policy standpoint, the economic development aspects of the emerging EV ecosystem also have caught the attention of policymakers and regulators all over the country.

The key policies affecting EV adoption and EV infrastructure will largely be made at the state and local government level. State governments will likely be looked to for more leadership for several reasons. For example, because EV planning issues span across local governments and, in fact, interstate boundaries, state-level laws and regulation (except in states dominated by public power entities governed by city or local boards) can provide a consistent framework throughout the state. And in order to get as much scale as possible, it is preferable to have a state rather than a local approach to electric utilities, automotive OEMs, and technology and IT firms. This is not to say that locally driven solutions and initiatives, like smart cities programs in Columbus, Seattle, Orlando, Atlanta and Denver do not carry weight. They do carry a good deal of significance, and often can help spur more coordinated action at the local government and state level and bring key stakeholders together for important purposes. But such programs face inherent challenges as the industry, by necessity, seeks to scale up and achieve greater reach, lower costs and more efficiencies across a number of jurisdictions.

Even with state-level approaches, however, the industry will have to address difficult issues if state commissions and other agencies decide to regulate and oversee the EV industry, as well as EVSE deployments, by different regulatory and policy methods. We live in a federalist system of government in the United States in which the states exercise substantial authority, both policy and regulatory, where the federal government is not explicitly given such authorities, or where the U.S. Congress has not pre-empted the states. Certainly, state air quality and environmental agencies, along with state energy offices and transportation agencies, will be key players in this transition of the transportation sector, which makes the case for intrastate collaboration even more important. Also, as we have seen with the Clean Air Act and the Sec. 177 states, as mentioned earlier, certain states may decide to adopt the EV-related standards of California or another leading state (assuming California's broad waiver under the Act stands). While this may not necessarily lead to the phenomenon of states being the laboratories of democracy enunciated by Justice Brandeis, it can lead to different approaches in some key regulatory and policy areas that can introduce unnecessary complexity and add costs to the rapidly growing but small EV industry.

For these reasons, I believe that a more consistent approach is desirable, necessary and better for EV owners. We should encourage collaboration across a large number of diverse stakeholders in developing the policies and tariffs in the regulatory toolbox which allow commissioners and policymakers to adopt consistent regulations and policies that have a good fit in that particular state. Obviously, there will be differences in approach that reflect the differences in statutes and rules, the nature of the electric power market (either vertically integrated or restructured), and the laws and rules regarding vehicle purchase and registration and activities of automobile dealers. Yet one of the most important issues affecting the EV and EVSE ecosystem today is creating the proper regulatory environment and rules so that the utilities and third-party providers can scale up this industry in a rapid and cost-efficient manner. We have seen the vital importance of economies of scale in other emerging energy technologies such as energy storage. The same principles apply to the EV industry writ large — for education and outreach with potential EV owners, as well as EVSE deployment efforts.

Before I outline my views on practices developed by state commissions, I offer several higher-level comments, in brief, that are more oriented toward process, capability building, and what I call political and regulatory cultural issues. It is vital for both the state as a whole (including the PUC) and the regulated utility to develop an overall strategy and a specific roadmap to guide their activities.

- *Education and outreach:* This is an important component of the regulatory toolbox and for utilities to develop certain innovative pilot programs to assist in educating consumers, stakeholders and organizations. Most early EV programs and tariffs, such as those in California, Oregon and Washington, include pilot programs to increase consumer awareness, work with automobile dealers, and offer technical assistance to both commercial and residential customers. These are generally categorized as an operating expense, and subject to certain limitations. But the education effort is far more important and pervasive than a tariffed part of a program. As we move from the "early adopter" phase to the "early majority" phase, and then to the "mass majority" phase, education of what an EV is and how it operates, and how EV infrastructure works, is critical in each phase of this journey. This should be a shared responsibility, in my view, among government agencies, utilities, third-party providers and others because the benefits of education accrue to all in the ecosystem. Ride and drive programs to get consumers to drive an EV for the first time and understand the different charging types, like the retail showcase operated by Forth in Portland, Ore., or the EV Discovery Centre in Toronto, Ontario, are good examples of such outreach. Such retail showcases are usually funded from a variety of resources including the auto OEMs, utilities, vendors, EVSE firms and others, which is the proper approach.

- *Take a long-term view:* Some people call this a "revolution" although I prefer the term "transformation." But the fact is that the current system of developing and selling ICE vehicles, fueled by petroleum, has developed over at least a century. Especially regarding the current fueling infrastructure, car owners have become accustomed to having a certain type of station — numerous, pervasive, easy to use, and coupled with convenience stores that often earn greater margin on products sold in the store inside than at the pump outside. Current owners like it cheap and convenient. These habits will not change overnight, and the amount of infrastructure and capital that are necessary to devote to this is significant. Accordingly, the return on these capital investments (ROI) cannot be considered, in my view, in the time frame that typical venture capital funds, or short-term investors, expect from their capital outlays. Instead, they should be viewed over a decades-long perspective, which complements nicely the long-term view of utilities and other investors involved in electric power generation, transmission and delivery.

- *Market transformation:* This is related to the fueling infrastructure transformation discussed above, but focuses on the development of the EV and EVSE industries. Innovative energy efficiency technologies over the last couple of decades, such as CFLs and LEDs for lighting, and more recently advanced heat pumps for heating and cooling, faced similar challenges: high upfront capital costs, consumer education, and a challenging payback or ROI. But we faced those challenges and overcame them with a variety of approaches, including a strong utility role, that helped the nascent industry through the "valley of death" to a more secure foothold in the market. Commissions and other state agencies should keep these lessons in mind as we deal with the challenges of EVSE.

- *Encourage a broad stakeholder process:* Strong leadership at the top, with a comprehensive vision, is certainly a vital component of a state plan. Yet to put this state vision into practice, the key implementing organizations — utilities and third-party service providers — and the state commissions need to have as much consensus as possible on implementing the components of this strategy in a pragmatic and locally driven way. Perfect consensus, at each step of the way, is of course impossible to achieve, but the decisionmakers should develop an efficient and broad stakeholder process, with timelines and deliverables, that include key parties and enable real actions to be taken. Several state commissions, or the utilities preparing to file cases with those commissions, have developed superior stakeholder processes, such as in Ohio, Michigan, Minnesota, Hawaii, Maryland and Washington state. Usually, the commission staff play a key role in both developing the scope of the stakeholder process and making sure it is inclusive and robust, such as the PC 44 proceeding at the Maryland PSC. Key stakeholders include utilities, EVSE vendors (network operators), EV vendors (equipment and software), environmental NGOs, large industrial and consumer users, consumer advocates and state-based drive electric associations.

- *Collaboration, not litigation:* As a commissioner of the Washington UTC for 12 years, I truly place great value on judicial process, with full evidentiary rights for recognized intervenors, coupled with *ex parte* rules for certain complex and high stakes proceedings such as general rate cases and mergers involving transfer of utility property. However, facilitating the coordination of state policies and developing the rules for a nascent market are not suitable for a full-blown judicial process, in my view. In fact, to date, there has been far too much litigation at state commissions on utility filings to proceed with EVSE tariffs and plans, and there has been insufficient collaboration among parties at the front end. This has had the perverse effect of delaying and slowing down overall investment in EV infrastructure in many states across the nation, which serves no benefit at all for the entire EV ecosystem.

- *Don't be afraid to experiment:* In other words, don't let perfection be the enemy of the good. This is a difficult area to get it right from the very start, whether it be a utility tariff, the location of Level 2 or DC fast chargers, or an innovative approach to increase access to low- and moderate-income households in multi-unit dwellings. While it is important to establish an overall strategy over five or 10 years, or develop a multi-year pilot program to develop targeted data and assess consumer behavior, one must not be afraid to act in the beginning and put some programs in place. Such programs should have a certain amount of flexibility and dynamism built into them, with appropriate benchmarks overseen by the commission and stakeholders, and the commission should develop guidance that allows utilities and stakeholders to innovate in these areas. Moreover, commissions should not penalize utilities for making mistakes, on perhaps some stranded assets or a program that didn't perform as expected, if those issues were discussed, vetted and well understood earlier in the process, and as much "future-proofing" as possible was built into the hardware and network management systems (for remotely controlled charging) as possible.

Regulatory Toolbox — Specific Commission Actions and Practices

With the above high-level statements as a prelude to action, what process and specific actions could a state commission take to both show leadership in this emerging area, and to respond to the petitions or filings of regulated utilities or interested stakeholders in EVSE?

Utilities have filed petitions for EVSE deployments and rate designs with commissions across the country, with varying results. Some state commissions and other state agencies have developed policy guidance or issued specific orders within or outside of a general rate case, while other states have not acted at all. Some commissions have decided to first deal with the legal issues associated with the development of the EVSE market — for example, what are the fundamental aspects of a "public utility," does the battery charging and discharging in an EV constitute a "sale for resale," and should the commission or the state attorney general be authorized to regulate aspects of a third-party provider of EVSE? Moreover, certain state legislatures (California with SB 350 and Oregon with SB 1547 as examples) have provided statutory direction for the commissions and other state agencies to take certain actions, with varying results, while other jurisdictions have either required or "encouraged" regulated utilities to file EVSE petitions with the state commissions by a date certain.

We have learned a good deal from the pilot programs and the limited number of tariff programs that have been put in place to date in states like Georgia, New York, California, Oregon, Washington, New York and Hawaii. But we must keep in mind that EVs still constitute less than 1 percent of the overall light-duty fleet, as a national average, and that outside of certain neighborhoods in certain states, we do not have sufficient data and experience to make definitive judgments about what really works. That is why experimentation is still so important in this evolutionary regulatory process, and why we need to iterate and build flexibility into programs.

Having stated those caveats, let me proceed to several lessons learned to date, and what could constitute a "menu of preferred options" or best practices that have been learned by utilities and third-party providers. Moreover, we should keep in mind constantly the point about scale — that these best practices must be able to scale up quickly, efficiently and hopefully across jurisdictional boundaries.

- **Recognize the PUC as both a facilitator and a decisionmaker.** In certain states, the PUC has played a useful role as a facilitator of workshops and state proceedings where multiple state agencies, a variety of utility types (IOUs, municipal utilities, public utility districts and rural cooperatives) can discuss openly the opportunities and challenges of EVSE deployment. Certainly, a push or nod from the governor or legislature helps initiate such a process and can help differentiate the specific lines of responsibility of each state agency. This does not have to be the PUC; it could be the state energy office, the state transportation agency, the state air quality agency, or a state department of motor vehicles or licensing agency. The key point is to achieve good coordination and information sharing, consistent with the statutes and rules in that state, in a transparent way. Finally, the PUC must be mindful of its quasi-judicial role in ruling on a regulated utility petition on EVSE and ultimately cost recovery, so there are some inherent limitations in its role here.

- **Develop a state-specific strategy with goals and a roadmap.** Many good national-level studies and projections of the EV market have been published in the last few years, as described above. Several state- or region-specific studies have been performed by Rocky Mountain Institute (RMI), M.J. Bradley, Regulatory Assistance Project (RAP), and others for states like Illinois, Maryland and Rhode Island.

  While these studies are helpful, more detailed work needs to be done at two levels. First, as some states have done with deep decarbonization pathway studies, a coordinated state agency approach (such as the decarbonization pathways study by Evolved Energy Research, for Washington Governor Inslee and the state Office of Financial Management[22]) is a necessary and sensible approach for EVs and EVSE. Some states earlier developed EV plans usually through their transportation department, sometimes supplemented with a voluntary goal set by the governor for EV adoption by 2025 or 2030. However, such studies need to be integrated with both transportation planning (more on that below) and electric power planning for the EVSE loads in some sort of clean energy or EV pathway study. In addition, the regulated utilities should develop a clean energy or EV pathway study on their own to guide internal actions, capital investments and ultimately utility filings with the commission. Earlier, I referred to pathway to 2030 studies by utilities to develop a statewide or regional approach (namely, SCE, National Grid and Southern Company). A more recent example of such a study on a two-state basis is "Economic and Grid Impacts of Plug-in EV Adoption in Washington and Oregon," by E3, March 2018.[23]

- **Integrate EVSE in the utility planning process.** Apart from overall transportation policies at the state and local government level, utilities will need to make greater efforts to plan for EVSE loads in future planning processes. Namely, for those states that are vertically integrated, utilities will need to start finding ways to incorporate these projected EVSE loads into their existing load forecasting models for integrated resource planning, or start a parallel planning process recognizing the unique features of the EVSE to be a flexible load integrated with the grid and capable for V2G services such as

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[22] Evolved Energy Research. 2018. Decarbonizing Washington State. https://www.evolved.energy/single-post/2017/05/20/Decarbonizing-Washington-State

[23] Study by Energy and Environmental Economics for the Pacific Northwest Utility Transportation Electrification Collaborative, 2018. See "Study: Deploying Electric Vehicles Would Bring Big Benefits to NW," *Clearing Up*, June 22, 2018.

demand response and distributed storage in certain cases.[24] The Washington UTC Policy Statement notes, ". . . we anticipate requiring utilities to more explicitly include scenarios for transportation load forecasting."[25] Yet at the same time, the Washington UTC recognized the complexity of overall statewide and local government transportation planning, and which agency or agencies should take the lead in developing the modeling and forecasts. In addition, the Oregon PUC has recognized the importance of this issue. As a follow up to SB 1547, the PUC established a proceeding to address whether or not, and how, to plan within or outside of the integrated resource planning process (IRP) with other agencies for the expected increase in electric loads generated by various types of EV charging infrastructure. Accordingly, Oregon will be a bellwether state to watch in the future.[26]

The EVSE load forecasting issue could become conflated with requirements for distribution system planning by the utility, and how far and how quickly the commission should go in requiring such planning by the utility given the potential cost, computational needs and complexity. Accordingly, for the time being, I believe the issues should be treated separately and proceed along parallel tracks, depending on the state. Yet this is a choice that each commission will have to make, depending on its existing IRP and distribution system planning rules (where they exist) and in coordination with other state and local government agencies.

The Washington UTC Policy Statement concludes that the state transportation agency will continue to lead state planning for and prioritizing state investments in intercity corridor EVSE investments, and that the UTC and the utilities that provide electric power to DC fast charging stations along those corridors should share data and be involved in such planning. Approaches will vary among the states, of course, depending on the type and organization of statewide transportation infrastructure and planning. But as Electrify America builds out its national network of intercity charging stations and EVSE, it appears necessary and sensible to find an efficient way to coordinate such planning among the various transportation agencies, utilities, third-party providers and EVSE firms, and Electrify America.

- **Set timetables and make some early progress in EVSE deployments.** Establishing a robust stakeholder process among multiple parties is key to an effective strategy. Yet within that context, it is important to set specific goals, benchmarks and timetables for certain action, and require the many parties to adhere to those schedules. This requires that staff with knowledge and capabilities in the EV sector coordinate this process with

[24] In restructured states, planning for such loads must still be done, but probably in a different way than a traditional planning process.
[25] See Washington UTC (2017), 22.
[26] See Order No. 16-447 in Docket No. AR 599: https://apps.puc.state.or.us/orders/2016ords/16-447.pdf.

both firmness and fairness (more on that below). If not done well, the stakeholder process could evolve into a never-ending cycle of notice and comments, meetings that produce no real outcomes, and ultimately a sense of "stakeholder fatigue" without tangible progress. With that in mind, the commission should think of designing the process in a way that could produce "early wins" in some aspects of EVSE deployment, outreach and education, access and affordability, or another component of a program that could both garner greater consensus among stakeholders and lead to action quickly through an efficient RFP and deployment process.

- **Think about scale.** While it is fine to experiment and conduct some pilot programs in the early phases, the commission, utility and stakeholders need to be thinking about how to scale up such programs in a timely and cost-efficient manner. Given the size of the infrastructure gap and need for accelerated EVSE deployments, stakeholders should not be thinking just about doing a pilot program for a few years and writing a report about lessons learned. Instead, the programs should be designed with scaling up built into key phases and components of the program.

- **Identify a lead commissioner and lead staff.** While this could be an informal designation, I believe it is a good idea to identify a lead commissioner who has a passion or active interest in EVs to take the lead for other commissioners in establishing the process, scope of work, and coordination with other agencies. It is more efficient to organize the work, and to deal with the multiple stakeholders who will inevitably be involved in the workshops and proceedings, at the outset. Usually, this occurs informally through a process of self-selection in most commissions, but it is important to have some sort of "blessing" of this process if the designee is not the chair of the commission. Likewise, it is vital to have a lead staff person, assisted by several people on the staff who are interested in this topic and familiar with the issues, to assist the commission in organizing the workshops, notices and comments, and managing the process toward the goals and deadlines that are established. Unfortunately, commissions in general do not have adequate resources to devote specifically to emerging areas like EV adoption and EVSE deployment, and they are stretched thinly in several important areas like general rate cases, rulemakings and responding to legislative requests. The larger EVSE community needs to step forward here to assist with education and outreach and provide materials and speakers at the request of staff, and generally be available as an external resource.

Process, Rate Design and Cost Recovery

- **Establish a generic docket or workshop.** Since many of these issues are complex technically, and nascent, I believe it is sensible to establish a generic docket or workshop-like proceeding to gather stakeholders and national experts and discuss both a framework and substantive issues. As stated above, the commission is probably a good choice as both a venue and a facilitator of such a process, but a broad number of state agencies, national laboratories, utilities, environmental nongovernmental organizations, and consumer advocates need to have a seat at the table. Besides establishing an agenda, the commission needs to establish goals, timelines and benchmarks for such a process. Although the Administrative Procedures Act (APA) in each state generally allows for such workshops, states will differ in their specific approach and type of proceeding to be established.

In addition, where the APA and commission rules allow joint workshops with commissions of neighboring states, the commission should consider organizing such a proceeding at some point with sister agencies in other states since EV owners will travel across borders, and certain interstate corridor planning has been occurring already. The West Coast Electric Highway of DC fast charging on the Interstate 5 corridor (California, Washington, Oregon and British Columbia) is one example of such interstate coordination. More recently, the governors of seven states in the Rocky Mountain region have launched a joint initiative called “Rev West Plan” to develop DC fast charging stations along major interstate highways connecting those states and encourage collaboration with other state-based efforts already underway (like in Utah, led by Rocky Mountain Power). While the governors and state energy offices have usually taken the lead in such ambitious efforts, the commissions will play an important role in reviewing and approving utility-sponsored activities in interstate efforts, and it would be sensible to consider joint workshops or proceedings.

- **Encourage and allow utility filings concurrently.** While a generic proceeding is useful in reviewing general and higher level policy issues, it is important for the commission to allow and in fact encourage utilities (at the appropriate time) to make specific filings for EVSE in a parallel track. As stated earlier, I believe that it is urgent for commissions and state agencies to address the infrastructure gap issues now, and work with stakeholders to accelerate EVSE deployments. This can occur either in a separate petition, which could be considered on the normal open or business meeting agenda of the commission after a stakeholder review process, or in the context of a general rate case, which has been more typical. Such filings, whether they be for pilot programs or for more permanent tariff changes or programs, include the necessary detailed information on capital and operating costs, type of charging infrastructure, education and outreach activities, and other issues. Such filings generally seek the authority to start new programs or initiate a change in rate design, such as demand charges or a time-of-use rate. Decisions on ultimate cost recovery and application of a prudency review are generally deferred to the subsequent rate case.
- **Encourage the use of a portfolio approach for utility programs.** As stated earlier, the portfolio approach has been effectively utilized in the past by regulated utilities, with

commission approvals, to help accelerate the market for certain energy efficiency technologies. The same principles, in my view, apply to the nascent and emerging technologies in EV charging types, which include the following types: L1 residential, L2 residential, L2 workplace charging, multi-unit dwelling charging, either L2 or newer technologies, and finally public-facing DC fast sharing (traditionally in the 50 kilowatt (kW) range but now developing to 150, 250 and perhaps even 450 kW charging). Some of these charging technologies are in the early phases of market development and cannot stand alone on a separate business case. Accordingly, it makes sense to incorporate all of these charging types into a portfolio approach, subject to a rigorous review and a cost-benefit test applied by the commission, and by the utility in its programs and tariffs submitted to the commission. More importantly, the commission and stakeholders, including the consumer advocate, should assess the EVSE on a portfolio basis over which to spread costs and benefits among various charging types and rate classes in a manner that satisfies a "just and reasonable" test.

The Washington UTC's Policy Statement, which adopts a portfolio approach, summarized these concepts as follows:[27]

> *We agree it is appropriate to allow utilities to offer a range of EV charging services on a regulated basis, eligible for a standard authorized rate of return, provided that the infrastructure investments meet our traditional rate-making requirements as discussed earlier (e.g., used and useful, prudence, and just and reasonable rates). . .*
>
> *Accordingly, we adopt a policy supporting a "portfolio approach" to electric vehicle charging services, similar to the approach used in utility conservation programs. Rather than a single "measure" or program offering, utilities should provide customers with multiple options for EV charging services, designed to serve a range of customer types, target multiple market segments, and evolve as technology changes. A program portfolio of EV charging service offerings will promote customer choice by allowing customers to choose among a portfolio of services meeting the criteria as outlined in this policy statement.*

- **Cost-benefit tests:** This will be a critical issue for the commissions to decide as the utilities file petitions to initiate EVSE programs and ultimately seek to recover costs either in rates (above the line) or from shareholders (below the line). This is a complex and challenging topic. The text box covers a few of the key cost-benefit tests and their strengths and infirmities for use with utility EVSE programs.

[27] See Washington UTC (2017), 33.

Cost-Benefit Tests for Utility EVSE Programs

- *Ratepayer impact measure (RIM):* Several utilities, especially in the early phases, have used this test since it focuses primarily on the benefits and costs to end-users or consumers of the utility, and the benefits and costs associated with the tariff. Such a test is probably suitable for more conservative, modest EVSE programs that resemble a line extension tariff, such as the building out of make-ready infrastructure (trenching, conduit, wiring, and any upgrades on the utility side of the meter). However, for more complex EVSE programs that involve make-ready on both the customer side and utility side of the meter, utility ownership of the charging station, or some type of joint venture or facilitation with a third-party service provider, the RIM test does not incorporate both the costs and ultimate benefits.
- *Utility cost test (UCT):* In general, the UCT is the converse of the RIM test, in that it focuses on the costs and benefits for the utility system associated with the specific EVSE program. The strengths of this test are that it attempts to assess those measures that achieve a UCT of greater than 1.0 with the assumption that such programs should provide benefits to consumers in the entire rate class. However, this test does not apply well in certain programs with a strong public policy ("social welfare") purpose such as energy conservation for low-income households, or for an emerging technology such as EV charging equipment in which the market development is still in the early stages.
- *Total resource cost (TRC):* This cost test is often used in assessing the benefits and costs for energy efficiency measures and is assessed across the entire territory of the utility. It includes both the costs and benefits for the utility, but also for all program participants. If the benefits exceed the costs, it is deemed to be beneficial to ratepayers across the whole service territory of the utility. One of the key issues is the determination of the discount rate to be used to determine the net present value of the measure of the asset's life.
- *Societal cost test (SCT).* This is a variant of the TRC, but instead of focusing just on the utility's service territory, it focuses instead on the costs and benefits either imposed on the entire society or benefits to society that would accrue from a specific measure. Hence, it attempts to include environmental effects (such as the cost of carbon dioxide or some type of carbon adder, and other air pollutants), the impacts on water and other natural resources, and so on. The SCT attempts to develop a discount rate based on broad social factors, while the TRC uses an average cost-of-capital approach.

Several commissions have been in the forefront in grappling with these cost-benefit issues, such as California, Hawaii, and other jurisdictions that tend to favor the approach of including a "carbon adder" or other explicit recognition of the environmental effects of energy production and delivery. Recently, the California PUC published a working paper on the SCT as part of its integrated resource planning proceeding.[28] Other jurisdictions, however, have not been as comfortable in proceeding down the path of trying to use the SCT for either energy efficiency or any other emerging technology, due to the lack of an explicit state policy on either carbon or environmental effects, or the difficulties inherent in trying to quantify such environmental effects. Such proceedings and discussions are often contentious and polarizing. An excellent foundational document (although not entirely applicable to EVSE and other distributed

[28] CPUC (2017). http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M175/K295/175295886.PDF

resource-type grid assets) is the National Standard Practice Manual, which sets forth the key issues for assessing costs and benefits broadly in the energy efficiency sector.[29]

Yet the EVSE deployment issues, and utility filings with the commissions, will inevitably bring similar issues to the fore and introduce new costs and benefits not in the realm of utility costs and delivery of service. One such key factor, of course, is the avoided cost of petroleum that is now purchased and delivered by oil refinery and distribution companies to gasoline stations in the utility's service territory. So, which resource cost test, if any, can be used to quantify those savings to EV owners, or should they be done outside of either the RIM test or SCT? Certainly, the avoided carbon and other tailpipe emissions from an ICE vehicle fueled by petroleum can be quantified, but these calculations have been done by state environmental agencies, and not by the utility or reviewed by the commission staff. Moreover, just as with other distributed energy resources, the EVSE will increasingly be engaged in the future in utility grid integration efforts, and especially provide benefits to the utility through V2G features in avoided capacity and energy costs at certain times of the day. The RIM test may be suitable for very modest programs in the early stages of market development, but as the EVSE scales up quickly, such a test cannot be used effectively given the scope of this market transformation. Hence, the utilities, commissions and stakeholders will need to address these issues with the help of outside experts familiar with these cost-benefit tests in order to develop a proper framework for reviewing utility proposals.

DC fast chargers and demand charges: Among rate design issues, one of the most challenging to address is demand charges (relative to volumetric charges) associated with the higher voltage charging of DC fast charging, or DCFC. In nearly every EV conference that I have attended in the last couple of years, there is at least one panel in which the EVSE firms and other EV advocates are sharply critical of the utility representatives on the panel concerning high demand charges imposed on, for example, a 50 kW DC fast charger. They argue that unless there is no demand charge, or there is some sort of demand charge "holiday" or reduced demand charge, it will be very difficult to deploy these assets on the grid and deal with the overarching concern of potential EV owners — namely, range anxiety for longer distance driving. While on the defensive, the utility representative is not shy about pushing back about the need for a timely recovery of its costs through cost-of-service ratemaking and comparing EVSE loads to other higher-voltage loads such as irrigation or commercial and industrial customers, which by the nature of physics impose relatively higher costs on the feeders and transformers close to such load in the distribution grid. I have witnessed such discussions multiple times, with the two sides seeming to talk past each other.

As a commissioner, I addressed this issue when Avista Utilities had to develop a certain rate for DC fast charging in its application to the Washington UTC. We eventually approved a pilot program for a comprehensive package (essentially the portfolio approach) of charging

[29] NESP (2017). *National Standard Practice Manual.* https://nationalefficiencyscreening.org/

infrastructure which it owns and operates, from L1 residential charging to public-facing DC fast charging. Since there were little data and no historical experience on which to base a "cost-based rate," the utility looked at what other EVSE firms were charging in the marketplace, and what other states had authorized in their pilot programs. The only "fact" that we knew was that in the early days of market development and in the several locations it was considering, the DC fast charging stations could not survive on a stand-alone business case. We were essentially being asked to experiment and select a rate that would strike a balance between the EV owner's willingness to charge at that public location and the capital cost recovery. It turned out that Avista set the rate too high for the first phase of the pilot program and had to adjust it during the second phase. Learning from this, I think it is fine to experiment in a pilot program and perhaps get it wrong the first time, but more important to make a mid-course correction and change it for the benefit of customers. Utilities across the country are trying different approaches on siting, communications protocols, relationships with host sites, and rates charged, and I believe that soon a variety of practices will emerge.

In addition, certain utilities, with commission approval, are already trying creative proposals to deal with the unique challenges of putting DCFC into the utility-operated distribution grid that can help stimulate the growth of this component of the charging infrastructure, or at least allow it to survive. Southern California Edison has implemented an "economic development tariff" for these types of DCFC loads in which they waive the demand charge for the first five or six years of the tariff and increase the volumetric charges simultaneously, subject to other terms and conditions. This appears to be having some success in its service territory. Meanwhile, both Portland General Electric and Pacific Power in Oregon have introduced new rate schedules, approved by the commission, that attempt to address the higher voltage, unique needs of such loads as DCFC by mitigating demand charges and increasing volumetric charges. We are still in the early days of such programs and need more data and experience to assess their success or lack thereof.

Time-of-use (TOU) rates, or dynamic pricing: Several utilities have adopted some type of TOU rate to encourage EV owners to charge during off-peak hours, generally 11 p.m. to 6 a.m. or overnight. Some utilities have developed "super off-peak rates" in addition to a more gradual approach to off-peak pricing, which provide further incentives for the consumer. For the tariffed programs that are EV only, a second meter is usually required to be installed in order to develop billing-grade metering information for the utility. Some utilities have also developed a whole-home TOU rate that does not require installation of a second meter, in which not just the EVSE, but the entire electric usage of the household, is on a TOU rate. To date, the record is uneven in terms of which program is either the most popular or successful in shifting EV charging to off-peak hours, although recent data appear to show more uptake for the EV-only tariff compared to the whole-home tariff.

In addition, some utilities such as Consolidated Edison in New York have developed programs with the auto OEMs in which the (billing grade) metering data are produced in the telematics package of the vehicle itself and provided to the utility for billing purposes, which obviates the need for a second meter and associated costs. As large quantities of locational data are generated through such technology, however, care must be taken to protect both the security of such data (cybersecurity measures) and the personal identifiable information contained in such metering data.

Depending on whether the market is vertically integrated or restructured with an ISO as the grid operator, the utilities will pursue different options for TOU rates associated with EV charging. While utilities (and state commissions) can learn from each other and a certain menu of "dynamic rate options" can be developed, the ultimate rate design will have to be customized for the unique service territory and cost-of-service embedded into the utility's existing rates. However, the overall principle of finding an efficient rate design to move the EVSE load to off-peak hours must remain paramount in the minds of the utilities and the commissions. If this is not achieved in practice, one of the main benefits of EVSE deployment — so-called "smart charging" — will not be realized, and utilities may face increases in their critical peaks during certain hours. This would indeed be a perverse and unfortunate outcome to increased EV adoption and usage in a utility's service territory.

Cost recovery issues: I believe that most commissions will continue to apply traditional regulatory principles for the recovery of capital investments in EVSE assets by the regulated utilities — namely, just and reasonable rates, used and useful, prudence, and equity and rough parity among the rate classes. These issues will be decided case-by-case by each state commission, depending on the persuasiveness of the evidence in the utility's proposal and the arguments of staff, the consumer advocate and other intervenors in that case. While these will be the foundational principles for cost recovery, other factors will certainly be considered, especially if the legislature has provided certain statutory direction for EVs and EVSE, or if the commission has earlier issued policy guidance.

The issues of EV adoption and accelerated EVSE deployments may involve several public policy issues including not just the normal capital investments by electric utilities to carry out "affordable and reliable service," but also the environmental aspects of EVs as well as certain economic development aspects of the convergence of the automotive/transportation and IT and software industries with the electric power industry. These factors have some degree of impact on the public policy of the state, and each state's regulatory and policy culture differs in important respects. Where the legislature has spoken clearly on the public policy, one hopes that the commission will strike the appropriate balance between providing the incentives, including the authorized equity return, for the utility to accelerate capital investments in EVSE, while ensuring that rates continue to be affordable and that these new EVSE services are accessible to all communities, rate classes and potential EV owners. Yet at the end of the day, the commission must make its decisions based on the evidence submitted in the proceeding, and on the broad regulatory principles stated above, which provide flexibility and discretion for decisionmaking.

Consumer protection issues: An array of consumer protection issues should be addressed by the commission at some point, either in a policy statement or rulemaking at the front end, or as part of a general rate case. As stated above in the section on interoperability and open standards, the commission has an opportunity to shape these discussions in several ways, while recognizing that it is fundamentally an economic regulator and not a standards-setting body. For example, a commission could require a utility to include an open standard or protocol, such as OCPP, as part of the utility's RFP process with vendors, or impose other requirements to encourage more consumer-friendly "openness" on the front end of the EV systems.

As part of the "regulatory compact" in which the regulated utility has a natural monopoly subject to full and fair regulation by the commission, the laws in all states exempt the regulated utilities from normal fair competition laws for the protection of consumers (sometimes called *Section 7* or *Federal Trade Commission regulation,* typically carried out by the consumer protection division of the state Office of the Attorney General, AG). For utilities, consumer protection responsibilities fall squarely on the shoulders of the commission staff, which is tasked to develop rules and procedures to protect consumers from issues like inaccurate billing, service disconnections, managing payment plans for hard-pressed customers with the utilities, and so on. Commission staff usually has the authority to receive and adjudicate complaints that cannot be resolved between the utility and the consumer. As a corollary, the third-party service providers of EVSE should be subject to the oversight of the state AG, which should handle any consumer complaints.[30]

[30] There is little evidence that this has occurred in any state to date.

Consumer Protection Issues With EV Charging Services

In a new and emerging sector of EV charging services, one can imagine several issues which may arise due to the new and emerging nature of this technology:

- Is the utility-owned charging station, perhaps managed by a third party or solutions provider, really charging the appropriate rate as in the stated tariff?
- How does one deal with consumer confusion (and perhaps complaints) if there is a big disparity in charging rates (and perhaps terms and conditions) between a utility-operated EVSE and that of a third-party service provider in the same neighborhood?
- If the utility has contracted with a third party to operate the EVSE, should that party be subject to the consumer protection rules of the commission, or should the utility be the party subject to the rule and any enforcement action as the ultimate owner?
- In terms of standards and features for EVSE, should the commission (or other state agency) require some sort of national standards (such as those promulgated by the National Institute of Standards and Technology) for such equipment, or should the state develop its own uniform standards and procedures for such EVSE?

Many other questions and concerns are certain to arise.

California, with its ambitious goals for EV adoption, passed a law (SB 454) signed by the governor in September 2013, which addressed many of these consumer-facing issues. It gives responsibility for enforcing "consumer protection standards" to CARB, not the commission staff, and addresses issues such as encouraging interoperability among proprietary EVSE systems, requiring membership clubs of EVSE to "open up" to some degree, and so on. The CARB is scheduling public hearings and stakeholder comments on these issues and intends to develop prescriptive rules in the fall of 2018. Those discussions may have repercussions beyond its borders.

In a relatively short section of its policy statement (showing that it is just starting the process of assessing potential consumer issues), the Washington UTC stated the obvious — that the practices of regulated utilities are not subject to the state's Consumer Protection Act (the equivalent of the federal FTC equivalent, Section 7). It then states, "Notably, Commission rules focus on protecting customers from public service companies exercising monopoly power, not from the practices of such companies operating in a competitive market. It is therefore essential that the terms and conditions of EV charging services be just and reasonable."[31] The policy statement indicates a preference for the utility to offer options to customers for utility-owned charging equipment at customer sites at the end of the equipment's useful life and cites one utility's concerns about any potential commission rule on billing requirements with respect to

[31] See Washington UTC (2017), 36.

how it may affect the way utilities display pricing at utility-owned charging stations. In short, even for a relatively advanced state with respect to EVSE like Washington, the commission, other state agencies, the utilities and third-party service providers have just begun to scratch the surface in terms of the consumer protection issues which will inevitably arise as EV adoption rates increase.

Case Studies to Date

The following is a summary of key regulatory proceedings in several large or forward-leaning states, starting with California, which today accounts for about 45 percent of the registered EVs in the country.

California

California is a pace-setter in encouraging laws and policies that stimulate EV ownership and requiring IOUs to file ambitious EVSE programs with the PUC. As mentioned above, Governor Brown issued an executive order in January 2018 which set forth revised (higher) voluntary goals of 5 million EVs on California roads by 2030 and 250,000 charging ports. I also referenced earlier the consumer protection bill, SB 454 (2013), that CARB is administering.

Yet the major legislation driving EV adoption and EVSE efforts in California today is undoubtedly SB 350 (2015). The section on transportation electrification requires the PUC to order each of the six IOUs in the state, and especially the three large utilities (Pacific Gas and Electric, Southern California Edison and San Diego Gas & Electric — PG&E, SCE and SDG&E), to file applications for programs that accelerate widespread transportation electrification.[32] The three large IOUs submitted these plans to the commission in January 2017, in total amounting to nearly $1 billion in capital investments in all types of EVSE for light-duty EVs and significant programs for SCE and PG&E for medium- and heavy-duty EVs. The California PUC held more than a dozen hearings and workshops to discuss these proposals and issued an order in May 2018 through a unanimous decision by all five commissioners, approving about $738 million in investments by the utilities and a conditional approval of a residential charging program for SDG&E.[33]

What are some of the lessons learned from the California experience to date? First, both the commission and other key state agencies, notably CARB and CEC, have shown an “all hands on deck” response to the implementation of the directives included in SB 350 regarding transportation electrification. The responses have been substantial and comprehensive, and the dedication of utility staff, stakeholders and agency officials to these processes has truly been impressive.

Second, as Californians readily admit, they will make some mistakes and there will be valuable lessons learned in either the many pilot programs or the more permanent tariffed programs

[32] See CPUC (2018). Transportation Electrification Activities Pursuant to Senate Bill 350. www.cpuc.ca.gov/sb350te/
[33] Applications 17-01-020, 17-01-021, 17-01-022, Agenda ID #16408 (Rev.2).

under the standard review projects of the IOUs. Since the programs are being implemented at greater scale than in other states, these can be quite useful benchmarks as utilities elsewhere start to scale up their programs. Finally, and most important, the outcomes of these proceedings, and the utility implementation of these multiple projects, will have a significant and beneficial impact on the EVSE ecosystem throughout the country and internationally. However, CEC studies indicate that after the implementation of these SB 350 transportation electrification programs, and the $800 million investment by Electrify America in EVSE assets in California, there will still be a substantial amount of infrastructure work to be done to satisfy the needs of the governor's goal of 5 million EVs on the road by 2030. The goal of the Pathway Study to 2030 by SCE mentioned above is even higher, at 7 million EVs, leading to a larger infrastructure gap.

Oregon

As in California, the Oregon Legislature passed a seminal clean energy statute (SB 1547, 2016) that had significant bearing on transportation electrification, among other issues. The bill provided clear direction to both the regulated IOUs in the state and the commission regarding what factors and criteria should be followed in developing EV-related proposals. Both Portland General Electric (PGE) and Pacific Power (PAC) subsequently developed a series of forward-looking pilot projects in filings to the commission in 2017, after which multiple stakeholders engaged in settlement talks that resulted for PGE in a relatively modest series of investments for pilot programs with TriMet for all-electric buses, education and outreach, and an expansion of DCFC in Electric Avenue charging stations in downtown Portland.

Despite the multi-party settlement, ChargePoint contested the settlement and requested a full evidentiary hearing on both the settlement and the legal interpretation issues surrounding the key transportation electrification provisions in SB 1547. This delayed the overall implementation of the pilot programs by nearly nine months. The commission, after several rounds of briefing and comments, rejected nearly every substantive argument of ChargePoint and approved all of the pilot programs in both the PGE and PAC filings. The programs are being implemented today.

What are the lessons learned from the Oregon experience to date? First, as in California, the regulatory process ultimately produced a good and balanced decision for the utility and most stakeholders, despite litigation. Although the programs approved to date are modest, they set the foundation for more substantial programs in the future, and the utilities, vendors and stakeholders should learn some valuable lessons from these pilot programs. Second, unlike the California PUC, the Oregon PUC is authorizing the utilities to take more of an ownership role, or certainly a strong facilitation role, in these emerging programs, so they will offer lessons on this sort of market development in Oregon. Finally, the commission's orders reflect its desire to maintain a large amount of discretion in implementing through traditional ratemaking principles the fairly broad factors and principles included in SB 1547.

Washington

Legislation passed in Washington state (HB 1853) in 2015 was less prescriptive than the bills passed in California and Oregon. Washington was fortunate in having a bipartisan EV caucus in the legislature that worked cooperatively to pass a bill that afforded the commission a good deal of discretion in its implementation. The bill recognized the essential role of regulated public utilities in building out the EVSE necessary to achieve that state's goals in transportation electrification and provided the opportunity for an additional incentive through a bonus equity return (with limitations on total revenue requirements).

I have referred to the policy statement developed by the Washington UTC (Docket UE-160799) several times in this essay, which I regard as a best practice for any state commission starting to address this subject. The legislature encouraged the commission to carry out such a broad approach and report back to it by the end of December 2017. The statement is comprehensive and addresses the need to think about these challenges in the context of market transformation. In particular, the policy statement cites other literature, stressing the utility role in catalyzing certain actions to assist the industry in getting beyond "the valley of death" to a more mature market structure. It recommends that utilities should take a portfolio approach when proposing programs for EVSE to the commission and indicates that the commission will give substantial weight to such factors when ruling on cost recovery for EVSE investments in a future rate case.

While the policy statement was being developed through workshops, Avista Utilities proposed a modest pilot proposal for a utility-owned and operated program (with a request for proposals to be used to select third-party vendors) covering all infrastructure types. This proposal was not suspended for litigation but instead considered during the normal biweekly open meeting procedure. I was a commissioner at the time, and along with others, witnessed the many questions and concerns that were raised by staff and other parties. It took three open meetings until the commissioners approved it unanimously. In May and late June 2018, both Pacific Power and Puget Sound Energy (PSE) filed modest but comprehensive proposals to the Joint Stakeholder Group, under the auspices of both UTC staff and the utilities, where such proposals are vetted in detail by stakeholders prior to formal filings with the commission.

What are the lessons learned from Washington state? First, the process demonstrates the importance, where possible, of bipartisan consensus in the legislature in passing a bill that is both sensible and short and affords the authority to the commission to work out the details. Second, even though the bill offered the incentive of a bonus rate of return, the regulated utilities (even Avista in its pilot program) did not immediately develop a proposal to take advantage of this incentive. This demonstrates, in my view, that potential EVSE investments in the distribution grid will only make a relatively small incremental addition to the rate base, and that the utilities are deliberate in approaching the commission, and staff and stakeholders, in order to get broad approval for programs that raise challenging issues. Finally, the commission and its staff have established a constructive joint stakeholder process where the regulated utilities are required to submit proposals informally for detailed vetting for 60 days, prior to more formal action with the commissioners present.

Michigan

Michigan has shown great leadership in this area over the past year or two, but has not had the benefit of specific statutory direction. Instead, the commission has tried through a series of technical workshops, and notice and comment periods, to engage with the broad stakeholder community in Michigan, and specifically the auto OEMs, to develop policy guidance and direction for the utilities and stakeholders. This process was started due to the commission's deferral of a proposal that CMS Energy made for utility-owned EVSE (largely intercity corridor charging with DCFC) that it did not find was well vetted and mature.

The results of this process have been impressive. The first technical workshop in August 2017 attracted panels with EVSE experts from around the country, as well as a full hearing room of stakeholders. A short notice and comment period followed in which the commission asked for specific comments on all aspects of EVSE deployments, including possible pilot programs and "creative partnership" ideas. In response, led by the nongovernmental advocacy organization Michigan Energy Innovation Business Council (MiEBC), a broad group of stakeholders coalesced around a number of high-level principles for EVSE deployment in joint comments. The MiEBC continued its work with a broad group of stakeholders with additional meetings and workshops of its own, to which it invited commission staff. The commission followed that with an order in December 2017 which called for another workshop in February 2018, which was facilitated by the Center for Automotive Research (CAR). At the workshop, the commission asked for more detailed pilot proposals from the two utilities, CMS Energy and DTE Energy, and encouraged further informal talks among the stakeholders to reach more consensus.

Finally, both utilities have come forth with substantive and comprehensive proposals for EVSE deployments in Michigan in the context of larger general rate cases. CMS Energy's May 2018 filing, while modest in proposed capital investments, includes some innovative concepts in rebate-based programs by asking for regulatory asset treatment as well as partnerships with local governments and auto OEMs. The DTE Energy proposal on EVSE is likewise included in a general rate case, addresses many of the same issues in the CMS proposal, and covers various types of charging infrastructure in a phased approach responding to many stakeholder concerns.

What has been learned from Michigan? First, even in the absence of statutory direction, the commission has much discretion to pursue a policy framework on EV adoption and infrastructure issues. Second, education and outreach on both the fundamentals and technical details of EV infrastructure continue to be important for commissioners, commission staff, and certain stakeholders who have focused on other issues to date. The multiple technical issues involved in various types of EV infrastructure present many learning challenges, especially given the rapid changes in battery technology and automotive technologies, including shared autonomous vehicles (the new "transportation mobility" paradigm), as well as learning from the utilities' experience to date across the country with various rate designs in pilot programs. Third, a collaborative process is more useful than a litigated process as a means to share this large body of rapidly changing information and data on EV adoption and EV infrastructure. Of course, each party retains its due process rights to litigate these issues in the general rate case context, but the collaborative approach prior to the filings has demonstrated a significant advancement in the body of knowledge and much greater consensus than would have been otherwise possible.

Other Key States

While there is not enough space in this essay to cover every state doing proactive work on EV policy and regulatory issues, the number of states showing interest and taking tangible steps to address these issues, through technical workshops and other means, is impressive. Moreover, it is occurring in every region of the country. The Midwestern states, in particular, have shown considerable interest over the past year, and the Southeastern states are starting to show strong interest as well. I briefly summarize below a few other state commissions that have shown leadership on these issues and where the regulated utilities and stakeholders have stepped up to move the process forward.

Maryland: The Maryland Commission, through commissioner engagement and strong staff facilitation, has shown exemplary leadership in a collaborative process, initiated in January 2017, that brought together a large number of utilities, EVSE firms, environmental NGOs and other stakeholders together. The EV working group is part of a larger grid modernization effort.[34] After several months of deliberation, workshops and opportunities for comments, the working group submitted its comprehensive proposal to the commission in January 2018. The utility proposals in this proceeding amount to about $105 million in investments for Maryland EV infrastructure. In response, and after various attempts to pursue full evidentiary hearings with litigation, the commission decided on a legislative style hearing process to examine these proposals. This proceeding is still in process with hearings scheduled for September 2018.

Ohio: The Ohio Commission has undertaken an ambitious grid modernization proceeding called Power Forward, in which it is attempting to set forth the key issues of technology, grid evolution and the proper regulatory response.[35] It has not been required by statute to carry out such a broad and comprehensive proceeding, but instead has been proactive in attempting to chart the future of the distribution grid in the state. In March 2018, the commission organized a full day of hearings on the issues of EV adoption, rate design and EV infrastructure for the regulated utilities in Ohio and invited national experts, associations, EVSE firms and others to testify and

[34] State of Maryland Public Service Commission. (2016).
[35] Ohio PUC. PowerForward. https://www.puco.ohio.gov/industry-information/industry-topics/powerforward/

answer questions from the commissioners. The commission anticipates issuing a report on Power Forward that includes a substantive discussion of EV issues based on the March hearings.

Hawaii: Hawaii has long been considered a leader in clean energy development, currently aspiring to a goal of 100 percent renewable energy generation by 2045 as well as transportation electrification. Previous efforts to develop policies on electrifying transportation by Hawaiian Electric (HECO) were not judged to be sufficient. Accordingly, HECO engaged in a broad stakeholder process in 2017 to develop foundational support for a more comprehensive strategy for the electrification of transportation (EoT). A comprehensive EoT report was submitted to the commission in March 2018, including several near-term action items as well as a longer term strategy. In June 2018, the commission established a proceeding[36] and invited public comments.

Minnesota: The Minnesota PUC established a generic docket for EV adoption and EV infrastructure issues.[37] Minnesota utilities and stakeholders in-state and around the country were invited to present at a workshop in March 2018, including auto OEMs, NGOs, EVSE firms and vendors. The workshop attracted diverse and broad attendance, including a number of state agencies and local governments and transit agencies. The commission subsequently asked for public comments. The process has been collaborative and transparent. Meanwhile, Xcel Energy has conducted a series of stakeholder workshops, led by neutral facilitators, in which it is exploring discrete EVSE issues in more depth (such as DC fast charging, education and outreach, and medium- and heavy-duty vehicle electrification). These activities are increasing the knowledge base of transportation electrification in Minnesota. It is expected that utilities will make specific filings in the fall of 2018.

Conclusion

The opportunities and challenges of transportation electrification are before us now. As EVs take an increasing share of both the auto and bus markets over the next two decades, these changes will require the urgent attention of state commissions and policymakers across the country. This fundamental transformation of markets affects not just the regulated electric power sector, but also the auto OEMs, bus and truck manufacturing, auto supply chain, and IT sector involved in software relating to shared autonomous EVs. These sectors have rarely worked together in a coordinated and effective way to promote common goals and collective benefits. Accordingly, although there are great opportunities for growth and substantial benefits to consumers who will own and drive EVs, there also are several challenges to address.

This essay argued for several key propositions. First, in this nascent development of the market, it is critical that the various industry players try to collaborate before state commissions, and policymakers, rather than litigate and pursue short-term interests. Second, addressing the

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[36] State of Hawaii PUC (2018).

[37] Minnesota PUC. Docket No. E999/CI-17-879, https://mn.gov/puc/.

infrastructure gap in each state is an urgent issue since all states today have woefully inadequate infrastructure in place, which increases the potential EV owner's concern about range anxiety and retards industry progress overall. Third, the utility has a vital role to play in the development of the overall EVSE market and ensuring that it can develop smoothly for the benefit of all consumers, disadvantaged communities and workplaces.

A variety of market models are possible, from utility ownership and operation of the charging stations and service interconnections to a less intrusive role that provides make-ready infrastructure to the charging location and offers a rebate to the host site. Yet as EV penetration grows, along with the need for longer term planning of the distribution grid for EVs and other types of DERs, the utility role in maintaining an efficient, reliable and secure grid will only grow in importance. This essay highlighted the regulatory tools that already exist for planning, utility filings and ultimately cost recovery, and the public interest is well served by these approaches. Some new tariffs and programs will be developed, for sure, and rate design and incentives for smart, managed charging during off-peak hours will be critical.

Finally, this essay argued strongly for requiring some type of protocols for interoperability and open standards, especially at this early stage of market development of EV infrastructure. The private industry market today is developing in a way that potentially could lead to several incompatible proprietary systems, both hardware and software, that do not allow systems to communicate and share information with each other easily. This is true both on the front end of the charging system (plug compatibility and roaming among different EV service providers), as well as the back end on the network management systems. The regulated utilities, and the state commissions overseeing them, can play key roles in ensuring that a more open ecosystem is developed that enables consumer benefits, lowers costs (by avoiding locking in a certain vendor), helps avoid stranded costs as technology improves, and provides a more open data sharing system.

It is timely and important for all stakeholders to engage constructively and collaboratively on these issues now to promote the common goals of building robust EV infrastructure that can offer substantial benefits to all consumers. Such a process also can help ensure that policies and regulations allow U.S. industries to stay competitive in this critical suite of industries, promote a clean environment by substantially reducing carbon and tailpipe emissions, and, with rate design for smart and managed charging, allow more efficient utilization of the distribution grid.

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State of Maryland Public Service Commission (2016) Docket Public Conference (PC) 44, IN THE MATTER OF TRANSFORMING MARYLAND'S ELECTRIC DISTRIBUTION SYSTEMS TO ENSURE THAT ELECTRIC SERVICE IS CUSTOMER-CENTERED, AFFORDABLE, RELIABLE AND ENVIRONMENTALLY SUSTAINABLE IN MARYLAND, https://webapp.psc.state.md.us/newIntranet/AdminDocket/CaseAction_new.cfm?CaseNumber=PC44.

Washington UTC (2017) Docket UE-160799, Policy and Interpretive Statement Concerning Commission Regulation of Electric Vehicle Charging Services, June 14, 2017. Page 22. https://www.utc.wa.gov/_layouts/15/CasesPublicWebsite/GetDocument.ashx?docID=147&year=2016&docketNumber=160799https://www.utc.wa.gov/_layouts/15/CasesPublicWebsite/GetDocument.ashx?docID=147&year=2016&docketNumber=160799

2. An Industry Perspective on the Future of Transportation Electrification

By Jonathan Levy, EVgo/Vision Ridge[38]

Introduction

The future of transportation is electric. And the future is here a lot sooner than many thought would be the case. Globally, automakers are seeing increased demand for electric vehicles (EVs) as a better way to drive, in addition to global regulatory trends further spurring the move away from internal combustion engine (ICE) vehicles altogether.[39] The Zero Emission Vehicle program created by California[40] and joined by nine other states[41] has created a market floor that consumer demand is surging beyond in California today, with other states expected to follow closely behind. Accordingly, statewide targets continue to combine with private sector innovation to spur this market from early days to maturity.

Nissan, BMW, Tesla, and GM are leading the path to transportation electrification today with even bigger plans to come, and the rest of the automotive world is also reading the writing on the wall. Major commitments from automakers include Volvo's planned end to its ICE vehicles starting in 2019,[42] VW group moving toward offering 80 EV options by 2025,[43] Ford doubling planned EV investments from a previously announced $4.5 billion between 2017 and 2020 to $11 billion between 2018 and 2022,[44] Toyota aiming for at least 10 EVs in the early 2020s,[45] and so on from every major automaker. And that's before even taking into consideration new market entrants that are virtually exclusively EV plays.

These automakers have an imperative to sell cars, and they recognize that in order to sell electric cars, consumers must have confidence in the availability of charging infrastructure. While the average American drives less than 40 miles per day,[46] availability of charging

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[38] Vision Ridge Partners is a Boulder, Colo., based investment firm focused on investing in sustainable real assets that can deliver competitive financial returns and positive environmental impacts. Vision Ridge is the controlling investor in EVgo, the nation's largest public network of fast chargers for EVs.

[39] NBC. 2018. Consumer Reports names its top 10 cars for 2018 — and there are surprises. www.nbcnews.com/business/autos/consumer-reports-names-its-top-10-cars-2018-there-are-n850271

[40] Multi-State ZEV Task Force. https://www.zevstates.us/

[41] Automotive News (2016). ZEV mandates get harder to ignore. www.autonews.com/article/20160627/OEM11/306279987/zev-mandates-get-harder-to-ignore

[42] Volvo Car Group (2017). Volvo Cars to go all electric. https://www.media.volvocars.com/global/en-gb/media/pressreleases/210058/volvo-cars-to-go-all-electric

[43] The Verge (2017). VW to electrify entire 300-car lineup by 2030. www.theverge.com/2017/9/11/16289292/vw-electrify-entire-300-car-lineup-2030

[44] Wired (2018). Ford Finally Makes Its Move Into Electric Cars. www.wired.com/story/ford-electric-cars-plan-mach-1-suv/

[45] CNBC (2017). Toyota to make over 10 battery EV models in early 2020s. https://www.cnbc.com/2017/12/18/toyota-to-make-over-10-battery-ev-models-in-early-2020s.html

[46] U.S. DOT Bureau of Transportation Statistics. https://www.bts.gov/statistical-products/surveys/national-household-travel-survey-daily-travel-quick-facts

infrastructure remains a major concern for potential EV buyers,[47] even as battery ranges increase as costs come down. While home charging will remain important for large populations of consumers, the rapidly growing multi-unit dwelling and often analogous ride-share markets likely will not have access to their own home chargers. Accordingly, public charging—already perceived to be critically important by potential EV buyers[48] — will take on more and more importance in order to enable broader electrification of the transportation sector.

With more than 1,050 fast charging stations across more than 66 U.S. markets, EVgo is the nation's leader in public fast charging[49] for EVs. No one has built more public fast charging stations than EVgo, and the company will continue to expand and accelerate additional deployment of fast charging stations in the United States. EVgo is in the business of making EVs accessible, affordable, and reliable for Americans across geographies and demographics.

In 2017, the National Renewable Energy Lab (NREL) issued an analysis on EV charging infrastructure, concluding that "about 8,000 DCFC stations would be required to provide a minimum level of coverage nationwide in cities and towns" across the United States.[50] Currently there are about 16,000 charging stations *total* in the U.S., and approximately 80 percent of those are Level 2;[51] accordingly, that minimum investment case requires nearly tripling the current DC fast charging (DCFC) infrastructure. The NREL report further concludes that "Modeled results for a 15-million PEV market estimate a DCFC plug requirement of 25,000 in U.S. communities."[52]

EVs have already moved beyond leading edge early adopter drivers to mainstream vehicle buyers with the LEAF, i3, Model III, Bolt, and more. For transportation electrification to proliferate even more, charging companies, automakers, utilities, policymakers, and other stakeholders have to work together to maintain and build on the momentum that brought us from approximately 3,000 public charging stations in 2011 to 16,000 today.

Sustainable commercial approaches to EV charging infrastructure are key to electrification of the transportation sector. Utilities, policymakers, and automakers all have incentives to facilitate a robust and competitive ecosystem for charging.

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[47] McKinsey & Company (2017).
[48] *Ibid.*
[49] "Fast charging" meaning direct current fast charging (DCFC) of 50 kW+.
[50] U.S. DOE, EERE (2017). National Plug-In Electric Vehicle Infrastructure Analysis. www.nrel.gov/docs/fy17osti/69031.pdf
[51] electrek (2017). U.S. has now ~16,000 public electric vehicle charging stations with ~43,000 connectors. https://electrek.co/2017/06/19/us-electric-vehicle-charging-stations/
[52] U.S. DOE, EERE (2017). National Plug-In Electric Vehicle Infrastructure Analysis. www.nrel.gov/docs/fy17osti/69031.pdf

1. What are the potential benefits and risks of transportation electrification — to electric utilities, to retail electricity customers and to society?

Benefits

As the Rocky Mountain Institute (RMI) boldly averred in last year's *From Gas to* Grid report, "the world doesn't need any more cost-benefit analyses; they've already been done, and they show that vehicle electrification has numerous benefits for drivers, utilities, communities, and society as a whole."[53] The benefits RMI identified include fuel savings, utility customer benefits through positive ratepayer impacts, generation savings, peak capacity savings, vehicle-to-grid benefits, greenhouse gas benefits, and more.[54] The Electric Power Research Institute also has examined transportation electrification through the lens of a "ratepayer impact measure" (RIM) and found significantly positive net RIM values across multiple case study scenarios.[55] While there remain some concerns regarding distributional impacts across segments of utility ratepayers, these broadly accepted benefits include a number particularized to EV drivers and riders as well as general advantages of transportation electrification.

First and foremost, EVs are a better way to drive. They accelerate more quickly,[56] they require less maintenance,[57] they reduce or eliminate noise[58] and air pollution, and they are at the cutting edge of technology. For the cost-conscious consumer, EVs also have a lower total cost of ownership (TCO) than ICE vehicles.[59] As McKinsey points out, "acceleration and driving performance are now among the top benefits that many potential buyers now cite when considering EVs. The benefit of instant torque from e-motors was not a part of the consumer conversation for early EV models."[60]

The McKinsey report highlights that "avoiding the gas station" and "fun to drive" are major considerations for EV buyers and guiding principles for the EV charging industry. No one likes going to the gas station, and public fast charging companies like EVgo provide drivers with an opportunity to take 30 seconds to plug in their car and then leave it to charge while they go grocery shopping, grab lunch, or get a haircut. With EVgo's 50 kW fast chargers, those

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[53] Rocky Mountain Institute (2017), p.9. *From Gas to Grid.* www.rmi.org/wp-content/uploads/2017/10/RMI-From-Gas-To-Grid.pdf
[54] *Ibid.*
[55] EPRI (2016). The Value of Transportation Electrification. http://www.chargevc.org/wp-content/uploads/2017/12/6-EPRI-The-Value-of-Transportation-Electrification.pdf
[56] Plugless (2018). Four of Top 10 Quickest Cars in the World Are EVs. www.pluglesspower.com/learn/four-of-top-10-quickest-cars-in-the-world-are-evs/
[57] Inside EVs (2013). EV vs ICE Maintenance – The First 100,000 mile. https://insideevs.com/ev-vs-ice-maintenance-the-first-100000-miles/
[58] While there are safety/accessibility concerns regarding the lack of noise from EVs, particularly for pedestrians, it is the writer's opinion that the advantages are significant, e.g. https://electrek.co/2018/05/15/electric-vehicles-reduce-stress-for-drivers-brain-monitoring-study/
[59] Palmera et al. (2018).
[60] McKinsey & Company (2017), 15.

customers can come back after 30-45 minutes and be at 80 percent charge or more. With the move to even higher speed charging (150 kilowatts [kW] and higher), the rate of charge can be matched to the use case for drivers — and retailers and other charger hosts — to maximize optionality for the customer.

From an environmental perspective, transportation-sector emissions have surpassed electricity generation as the leading source of carbon dioxide (CO_2) emissions in the United States.[61] One solution, as pithily espoused by journalist David Roberts and others, is to electrify everything and clean up the grid.[62] Electrification is particularly appropriate for decarbonization of transportation. While there remain potential applications for hydrogen, drop-in liquid fuels, and other solutions, the convenience of electricity and the investments made by international automakers in EVs make it likely that electrification can tackle the lion's share of the carbon reductions needed in this sector. Lifecycle emissions from battery EVs[63] are more than 50 percent less than traditional ICE vehicles, and the numbers continue to improve as lower carbon electricity sources take on a higher percentage of the U.S. generation mix.[64] The inextricable link between pollution and human health further underscores the societal benefits from a transition to electrified mobility with a cleaner grid. As has been well documented elsewhere,[65] poor air quality disproportionately impacts low-income communities, and environmental justice organizations recognize the equity impacts of reducing transportation emissions, particularly in urban environments.

Additionally, with automakers rapidly moving toward an autonomous vehicle reality sooner than originally anticipated,[66] there is an even greater urgency to electrify this segment of the economy. It is not a foregone conclusion that autonomous vehicles will be fully electric[67] despite the synergies of engineering, economics, and the environment. With ride-share operators like Uber and Lyft representing a growing portion of vehicle miles traveled, the worst case scenario from a climate perspective is a world of ICE autonomous vehicles leading to greater sprawl through exurban growth.

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[61] U.S. Energy Information Administration (2017). Power sector carbon dioxide emissions fall below transportation sector emissions. www.eia.gov/todayinenergy/detail.php?id=29612

[62] Vox (2017). The key to tackling climate change: electrify everything. www.vox.com/2016/9/19/12938086/electrify-everything

[63] Vehicles that do not contain an internal combustion engine, with all power provided by a battery that must be charged by an external source.

[64] U.S. DOE, EERE. Emissions from Hybrid and Plug-In Electric Vehicles. www.afdc.energy.gov/vehicles/electric_emissions.php

[65] National Institute of Environmental Health Services. www.niehs.nih.gov/research/programs/geh/geh_newsletter/2016/4/spotlight/poor_communities_exposed_to_elevated_air_pollution_levels.cfm; Mikati et al. (2018).

[66] Reuters (2017). GM plans large-scale launch of self-driving cars in U.S. cities in 2019. www.reuters.com/article/us-gm-autonomous/gm-plans-large-scale-launch-of-self-driving-cars-in-u-s-cities-in-2019-idUSKBN1DU2H0

[67] Automotive News (2017). Hybrids are better for autonomy, Ford says. www.autonews.com/article/20171211/OEM06/171219941/ford-hybrid-autonomous-technology

Utilities wisely see both opportunities and challenges with vehicle electrification. In a world of flat-to-declining electricity demand, those with green eyeshades are highly motivated to serve the load that comes with a spate of EV chargers across each and every utility jurisdiction. Tremendous benefits also may accrue to utilities from the value of EVs as mobile storage assets on the grid and for load balancing as EVs draw excess power during times of peak wind and solar generation. Additionally, the EV charging load can avoid system waste through curtailment, as explored in more depth below in response to question 5 regarding anatidae-evocative charts.

Benefits resonate throughout the electricity system to retail electricity customers as well. EVs can provide direct services such as frequency regulation and shift/shave demand in a way that can enable utilities to avoid or delay investments for which ratepayers would otherwise foot the bill.[68] Especially paired with distributed solar and/or storage, charging infrastructure empowers individuals looking to maximize their economic and environmental efficiency in a world of two-way flows on the grid. Additionally, fuel savings themselves and a lower TCO accrue as direct economic benefits for end users. Finally, there is the broadening of the customer base that can benefit the existing universe of ratepayers. Depending on the rate design, as more kilowatt-hours are sold, utilities may have a larger market over which to spread fixed costs, potentially benefitting all utility customers whether or not they personally drive EVs.

Risks

In terms of risks, planning is integrally important. Driver- and rider-centric perspectives are necessary to make sure that the EV charging industry is built for what is needed for the cars, not necessarily what the utilities would ideally design. A large installation of Level 2 (L2) chargers[69] that stay connected to long-dwell time vehicles[70] may be best for a utility looking to draw energy from some of those parked cars during peak demand and dispense excess generation into them at other times. But drivers on the interstate and even on the go in cities are far more interested in fast charging on demand. Siting two or even four 50 kW chargers together is manageable for utilities today. But six 150 kW chargers at a highway rest stop previously only drawing enough electricity to keep the lights on at a gas station and a fast food restaurant is a very different planning challenge that may require decisions about new generation, as well as for distribution system planning.

Beyond siting and planning issues, another risk pertains to stranded assets, a cost burden that utilities would almost certainly seek to shift to ratepayers. Building public charging infrastructure based on utility priorities without understanding broader market conditions and

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[68] For example, see Glavic and Alvarado (2016).

[69] Level 2 provides charging through a 240 volt alternating current plug requiring additional infrastructure beyond existing outlets. Level 2 adds about 10 to 60 miles of range to a vehicle per hour of charging time, making it best suited for long-dwell time charging. U.S. DOE, EERE (No date). Charging at Home. https://www.energy.gov/eere/electricvehicles/charging-home.

[70] As noted elsewhere, L2 charging is considerably faster than "trickle" charging from non-upgraded sources, e.g., wall outlets, but would still require cars to be parked for hours to add significant range.

trends may result in siting and construction of infrastructure that is not optimally located for current or future customer usage. By working in concert with the EV charging industry, incentives can be aligned toward increased utilization of both charging stations and existing utility assets. Transportation planners and private sector charging companies should be involved in collaborative approaches to siting and sharing risk across the capital stack — public sector, utilities, and private sector — which may yield longer-duration assets as partners take advantage of ongoing market lessons learned. Utilities would also benefit from sharing technology risks in a rapidly changing market that may shift from 50 kW to 150 kW to 350 kW charging stations sooner than expected.

For end users, the most important stakeholders, the biggest risk today may be an insufficient quantity of public charging options to have confidence in their driving experience. Despite the reality of the average American driver's relatively infrequent charging needs, perception is what drives range anxiety. More public charging infrastructure — especially fast charging — breaks down barriers to adoption and actual usage of EVs.

Active and financially sustainable participation from the EV charging infrastructure industry is needed to fulfill the promise of transportation electrification. The industry has grown rapidly over the last decade but faces challenges that require strong stakeholder coordination, supportive regulatory regimes, and high penetration of EV sales across the country in order to achieve the market conditions to grow profitably across the country.

2. What roles should utilities versus competitive providers play in accelerating deployment of EV infrastructure? What infrastructure investments are others making, and how should utilities complement those investments?

4. What types of utility infrastructure will be needed to serve EV users, who should pay for it, and how will utilities recover their fixed costs?

The following addresses various aspects of questions 2 and 4,[71] including the interplay between roles of various players as they relate to ownership of infrastructure.

Infrastructure Needs

With rapid adoption of EVs, utilities and charging companies alike need to plan for an ever-growing number of chargers in garages, at office parks, in retail settings, and along highways, in addition to the continued installation of home chargers. There will almost certainly be a role to play for all levels of charging — trickle, L2, DCFC, and even higher speed charging.

As noted above, the infrastructure needs to electrify transportation across the United States far exceed current investment plans — despite anticipated investments being significant and

[71] A response to question 3 follows this section.

greater than often understood. Morgan Stanley projects a need of nearly $400 billion in U.S. investments in charging infrastructure by 2040.[72] A broad base of players will be deploying resources to meet U.S. infrastructure needs.

For example, EVgo's capital allocations for new fast chargers continue to increase, and we plan to work with our investors, automakers, retail site hosts, and other stakeholders to expand the EVgo fast charging network in and beyond the current 66 markets covered today. EVgo is not alone in that endeavor. With new EV models coming to market — many with longer ranges, lower price points than earlier models, or both — public and private funds to build out new L2 and DCFC chargers are accelerating.

As a result of Volkswagen's diesel settlement, $2 billion for transportation infrastructure will be spent by Electrify America under Appendix C and up to $435 million distributed by states and tribes through a national environmental mitigation trust established under Appendix D.[73] Utilities across the country are proposing investment plans for charging infrastructure programs, but not all public utility commissions (PUCs) are willing to allow rate-basing and/or utility ownership of EV charging stations.[74] The sheer number of service territories can create a patchwork for implementation that would benefit greatly from partnership with experienced national charging infrastructure providers.

As for where charging infrastructure should be deployed, the answer is virtually everywhere. Different categories of charging will not just have different use cases but also different geographic imperatives. Given that the average American drives less than 40 miles per day, trickle charging at home for between 2 and 5 miles of range per hour of charging can be a "top off" for consumers relying mainly on public and workplace charging. L2 charging for between 10 and 25 miles of charge per hour can align well with drivers charging during an eight-hour workday or overnight at home or a hotel. For a 30-minute grocery store trip or hour-long dinner, DC fast charging will be imperative, especially as batteries get larger and larger. Along highways, 150 kW and higher speeds will be necessary to get drivers moving in shorter and shorter amounts of time. All of these use cases imply distinct geographies, and the push for faster charging times in new locations will increase pressure on utilities, charging companies, and transportation planners to work together to site facilities to accommodate larger demands on the grid in a way that aligns with the distribution system's abilities and the economics of charging networks. In order to achieve public charging station coverage beyond the markets

[72] Bloomberg (2017). The World Must Spend $2.7 Trillion on Charging Stations for Tesla to Fly. www.bloomberg.com/news/articles/2017-10-11/tesla-ev-network-shows-a-2-7-trillion-gap-morgan-stanley-says

[73] Appendix D allows up to 15 percent of $2.9 billion to be spent on charging infrastructure. NASEO & NACAA VW Settlement Clearinghouse. https://vwclearinghouse.org/about-the-settlement/

[74] See, e.g., the Kansas Corporation Commission's decision in Kansas City Power & Light Company (2016): http://estar.kcc.ks.gov/estar/ViewFile.aspx/20160913110134.pdf?Id=4b0556f3-425d-4469-8eb1-a105109511ec

that are attractive in the near-term, support from utilities and other policymakers may be needed so that, say, Pueblo, Colorado, does not have to lag behind Denver for too long.

Roles for Utilities vs. Competitive Providers

One important consideration when it comes to proposed utility ownership is the need for a consistent charging experience for drivers. While the ideal of 100 percent seamlessness is not likely achievable, a reliable and easy to understand user interface and customer service approach through collaboration with experienced charging providers can be a win-win for utilities and providers alike. A patchwork of utility programs in a vacuum potentially adds complexity to an already rapidly expanding set of stakeholders at the same time that automakers and policymakers are clamoring for more integrated charging experiences for the public, and for two key reasons from the automakers' perspective.

First, the majority of marketing tools are national or large-regional in scope, and communications related to charging must be consistent for that geographic scope — consider television, print, and online marketing among others. Second, dealership management and marketing has made streamlined communications critical to success. Consider that a dealership representative in Bethesda, Maryland, might have to ask a prospective buyer which among three different utilities their home and workplace are served by before being able to describe how to charge their car and how much it will cost. Dealership representatives are already struggling with understanding and explaining today's EV ecosystem[75] with a finite number of players in the charging space that would proliferate as individual utilities launch their own programs — unless there is careful coordination and work with private sector partners.

There remains disagreement inside the industry and among policymakers on the appropriate role of utilities in terms of financing, owning, and operating EV charging infrastructure.[76] Given the desire of utilities to increase customer demand for electricity and their expertise in installing infrastructure, it makes sense for utilities to be more than a mere stakeholder in the process. First and foremost, there is the tariff structure itself, which utilities propose for regulatory approval and which needs to better reflect the economic reality of demand charges inhibiting economic viability of public charging infrastructure, particularly in lower utilization markets. EV-specific tariffs and elimination of demand charges, such as New York Power Authority has proposed,[77] would go a long way to enabling shared goals for EV fast charging deployment. Additionally, there is largely industry and stakeholder consensus — even among those who oppose utility ownership of EV chargers — around the importance of utilities installing "make-

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[75] WardsAuto (2017). Car Dealerships Fail EV-Selling Test, Mystery-Shopping Study Indicates. http://wardsauto.com/dealer/car-dealerships-fail-ev-selling-test-mystery-shopping-study-indicates

[76] PEW (2017). Should Utilities Build Charging Stations for Electric Cars? www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2017/09/11/should-utilities-build-charging-stations-for-electric-cars

[77] Utility Drive (2018). New York agencies propose shifting EV fast chargers to non-demand charges. www.utilitydive.com/news/new-york-agencies-propose-shifting-ev-fast-chargers-to-non-demand-charges/521465/

ready" infrastructure[78] before the charger interface, completing interconnections expeditiously, and educating consumers.[79] Rate-basing make-ready infrastructure can provide the utility and its customers with benefits while also buying down the costs of installing the rest of the charging equipment for private sector partners. However, whether regulated utilities, with their low cost of capital, should compete directly with EV charging companies remains a point of contention. There are both commercial and policy reasons for disparate views on the appropriate role of utilities, but the fact is that a growing number of utilities are seeking to increase their involvement with and investment in EV charging.

Private investment is interested and motivated to deploy capital in charging infrastructure for actual and projected high utilization cases. In a market with high EV adoption and registration, EV charging companies are more likely to move quickly to build robust infrastructure in markets with favorable electricity tariffs and other policies than in locations with high demand charges and other attributes that can constrain profitability.

The relationship between utilities and EV charging companies is likely to be one of "coopetition." At times, a utility may undercut other market participants, and that threatens the viability of individual businesses with thin margins. But utilities are also potential customers that can and will benefit tremendously from working with experienced EV charging companies that have sited, installed, and operated charging solutions for customers. Options for coopetition could include coordination on specific geographies that industry sees as unprofitable, economic incentives for third-party siting near utility infrastructure with spare capacity, and true public-private partnerships where utilities and charging companies share risk and upside within a given market.

In some cases, including where tariff structures or likely EV adoption curves put return on investment in charging infrastructure outside of a reasonable payback period, utilities may be best positioned to make the capital investments necessary to unlock those markets. However, utility business cycles and the bespoke nature of siting charging stations mean that utilities should work in partnership with experienced EV charging partners to deliver the infrastructure EV consumers need in a driver-centric manner. Utilities should seek out gaps in the market where they can fill in the white spaces that bear more risk than other market participants may be able to bear at this time and complement others' investments that rely on a broad base of infrastructure to benefit drivers in all service territories.

Private capital and public capital have different risk appetites and goals, and there is an opportunity for them to complement one another. Where the market is ripe or reasonably foreseeable, EV charging companies can, should, and will deploy risk capital to pursue a return. Where public policy priorities are not aligned with market incentives, public capital is

[78] "Make ready" is the electrical infrastructure up to the charger — e.g., wiring and conduit.
[79] Nigro and Walsh (2016).

appropriate to spur and leverage private capital, as has traditionally been the case with government grants. Utility investment can sit in between those two traditional tiers of capital — for example, with make-ready investments that advance the public good, facilitate the utility's pursuit of additional customer demand, and buy down some capital costs to attract more private capital. The system benefits outlined above, paired with broader societal benefits from ubiquitous installments, may mean that ratepayer-supported capital is appropriate to bridge the gap between what is readily economic and where the market still needs to develop. Utilities are accustomed to using ratepayer capital for time-tested, mature technologies such as transformers, electrical panels, conduit, wires, and concrete — all of which are part of the make-ready infrastructure. By contrast, both charging stations as new technologies and the dynamic business models of charging station operators carry risks. The private sector can and should lead in both of these areas, in concert with these other key stakeholders.

3. Who will use EVs — and how?

EV adoption is no longer solely for the city dweller with two cars. We have moved beyond the "bleeding edge" and are now seeing EV sales increase across the country and demographics, thanks in part to cheaper pre-owned EV options and lower-cost, longer-range vehicles like the Chevy Bolt, Tesla Model 3, and extended range Nissan LEAF. A 2017 CarMax survey found that EV owners are a diverse bunch, spanning all geographies, ages, income, and educational levels.[80]

Given that lack of awareness remains the primary reason car buyers do not consider an EV,[81] those numbers should continue to grow as EVs penetrate the public consciousness and proliferate. Early adopters paying a premium for EVs and willing to endure usage hiccups are giving way to drivers who are buying EVs for a panoply of reasons and will use and power their EVs in a variety of ways that complement their daily lives: trickle charging to top off overnight; L2s at the workplace, at some homes, and at some long dwell time destinations; and fast charging for intercity travel and on the go in cities and towns.

While the vast majority of EV miles traveled (eVMT) will likely take place in urban settings — in part due to the fact that only 19 percent of the American population lives in rural areas — EVs are and will be an option for drivers across geographies. Longer-range EVs unlock possibilities for those Americans in "the country" that drive approximately 2,500 miles more annually than the average American driver.[82] Once that barrier is knocked down, solving the charging infrastructure needed to power rural EV drivers becomes far more manageable.

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[80] CarMax (2017). 2017 Hybrid & Electric Cars Survey Results www.carmax.com/articles/hybrid-electric-2017-survey-results

[81] electrek (2017). Lack of awareness is surprisingly still the biggest problem for electric vehicle adoption. https://electrek.co/2017/01/03/electric-vehicle-adoption-awareness/

[82] http://publicaffairsresources.aaa.biz/wp-content/uploads/2016/09/AmericanDrivingSurvey2015_FactSheet.pdf

One priority for the EV charging ecosystem is to ensure access to charging for drivers of all walks of life. The lack of a garage or a dedicated parking space should not foreclose the ability of an individual to drive an electric car. Public charging is a way to enable EV ownership for residents of multi-unit dwellings and individuals without the means or desire to spend the upfront capital to install a home L2 charger. Experience from the early days of deploying L2 chargers has shown that drivers are not willing to pay very much for public slow charging.[83] In California, a majority of EV drivers indicated they have access to "free" charging at home or at work, yet they are willing to pay for charging and especially for fast charging.[84] For the massive population of potential EV drivers without access to charging at home or work, public fast charging breaks down a barrier to make sure multi-unit tenants do not get left behind on the pathway to vehicle electrification.

Perhaps the most significant shift in how Americans drive — or ride — is the continued expansion of transportation network companies (TNCs) like Uber and Lyft. Increased VMTs by TNCs are reducing mass transit participation and personal vehicle ownership,[85] particularly amongst younger Americans.[86]

Figure 2-1 illustrates the growth of Uber and Lyft from 2014 to 2017. Additional market entrants are likely to proliferate as the market segment continues to grow. The nature of their business requires maximum uptime as utilization of the vehicle drives profitability. As TNCs electrify their fleets, trickle charging or even L2 charging is economically undesirable as hours spent charging are hours lost to make money off of the vehicle.[87] This reality becomes even starker in an autonomous vehicle future. It is not unreasonable to picture a world where TNCs are benefitting from the lower TCO and downtime EVs provide while keeping their autonomous fleets charged and operational through frequent fast-charging.

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[83] AAA Foundation for Traffic Safety. American Driving Survey: 2014–2015. https://cleanvehiclerebate.org/sites/default/files/docs/nav/transportation/cvrp/survey-results/California_PEV_Owner_Survey_Report.pdf

[84] Ibid.

[85] ITS (2017).

[86] USA Today (2016). Millennials spurn driver's licenses, study finds. www.usatoday.com/story/money/cars/2016/01/19/drivers-licenses-uber-lyft/78994526/

[87] Additionally, questions arise from the use of residential electricity rates for what is essentially a mobile commercial load.

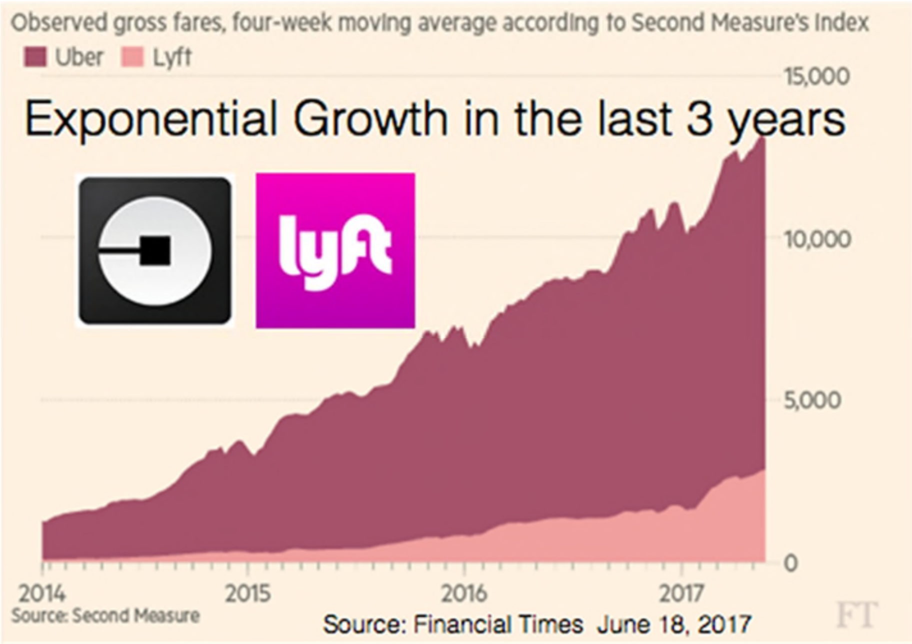

Figure 2-1. Growth of Uber and Lyft, 2014 to 2017.
Source: Financial Times, June 18, 2017.

From a charging company perspective, TNC customers are not only desirable from an adoption lens but also from a geographic predictability lens. The typical TNC driver charges five to 10 times as often as a regular EV driver. Given the tendency to service dedicated areas, TNC drivers give charging companies more confidence about utilization of a new investment in charging infrastructure.

TNCs also provide economic mobility opportunities for some Americans. One company that rented EVs to Lyft, Uber, Postmates, and other TNC drivers on an hourly or daily basis found that 90 percent of their customers were low-income or had sub-prime credit. The ability to obtain any vehicle, let alone an EV, had been out of reach for them until a platform emerged for them to share in the sharing economy.

5. What incentives should EV customers face to encourage right-time charging and discharging?

Generally speaking, the current tariff regime with high demand charges for public EV charging is suboptimal for drivers, charging solution providers, and the electricity system itself. EV drivers want low costs for charging, and some want the ability to be compensated for grid services as utilities seek to use EVs as mobile distributed energy resources (DERs). The electricity system needs to be able to shift demand across an increasingly dynamic generation mix. And charging companies need to be able to make a return on their investments and spread their fixed costs over a larger and growing denominator of charging sessions.

The infamous California "duck curve" (Figure 2-2)[88] is growing, and EVs are an excellent candidate for helping to flatten it out. However, current retail rate structures for electricity often mean that it makes more economic sense for charging companies to install storage onsite and draw down from onsite storage during times of high solar (or wind) production to avoid utility demand charges rather than to take advantage of multiple EVs fast charging at once to use that inexpensive generation.[89] At some EVgo fast charging stations, fixed demand charges represent upwards of 80 percent of total electricity costs. Demand charges — especially those that do not differentiate between coincident and noncoincident peak[90] — may not be the most appropriate mechanisms for nonresidential customers, especially for electrified loads that can provide broader system benefits. Without a more reasonable tariff structure, EV charging stations that should be grid-level assets may be incented to pose a greater strain on the system.

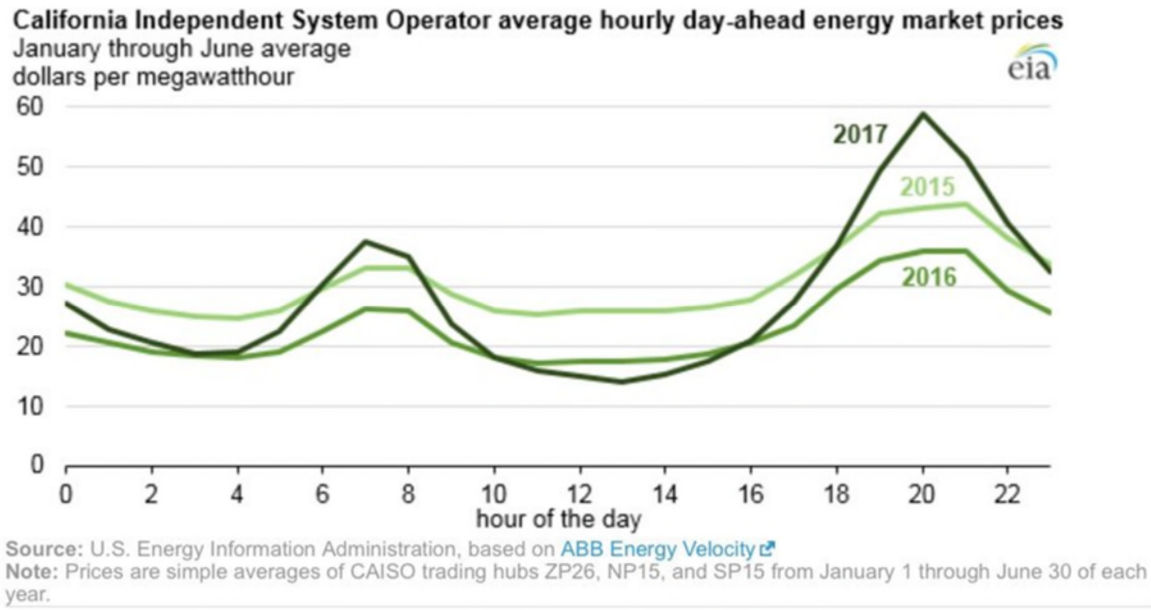

Figure 2-2. California "duck curve."

Source: U.S. Energy Information Administration, based on ABB Energy Velocity.

Beyond that macro level need, EV customers do respond to price signals, including time-of-use rates.[91] Accordingly, these customers should be compensated for being willing to have their EVs drawn down during times of peak demand on the utility system. EV charging companies should also be compensated for reducing their draw from the grid in similar circumstances. Similarly, EV drivers and charging companies should benefit from lower rates during times of peak generation

[88] The duck curve shows the difference between electricity demand and available solar energy throughout the day. DOE (2017). Also see Greentech Media (2017) and Vox (2016).
[89] CPUC (2017) and RAP (2017).
[90] RAP (2018).
[91] Utility Dive (2018). Time-of-use rates can manage EV charging, new report says. www.utilitydive.com/news/time-of-use-rates-can-manage-ev-charging-new-report-says/515284/

from resources with low marginal costs. Simple economics can help drive more efficient outcomes for all players.

6. What policy and regulatory approaches will:

- **Encourage efficient siting of charging stations — including fast-charging**
- **Enable utilities to participate in infrastructure deployment**
- **Foster competition by competitive EV charging providers**
- **Establish enforceable standards to facilitate consumer adoption of EVs**
- **Address underserved markets**
- **Protect consumers**

Where there is higher adoption of EVs, there is higher utilization of EV charging stations. That means EV sales and eVMT are the most important factors in the profitability of EV charging companies. Federal tax credits for EVs remain an important factor in buying down the incremental costs of EVs. State incentives — tax credits, grant programs, fleet purchases, etc. — and other policy support from state legislatures are also critical for EV market development. With additional global capacity rapidly coming online, economies of scale are driving battery costs down to the point where eventually the unit economics of EVs will beat those of ICE vehicles. From a consumer perspective, TCO for EVs is already better, a trend that will continue to improve as that broader trend continues unabated.

It should come as no surprise that California has led the way in U.S. EV sales year over year. The state's policies, ranging from the Clean Vehicle Rebate[92] to high-occupancy vehicle lane access for EVs, have had a meaningful impact on customer interest in EVs. But one of the biggest factors has been that automakers offer more electric models in California than anywhere else in the United States, in large part because of the Zero Emission Vehicle (ZEV) mandate.[93] As with renewable portfolio standards (RPS) for the generation side, utilities respond to statewide goals and mandates as they pursue long-term planning.

California and other states participating under section 177 of the Clean Air Act[94] provide greater market confidence for utilities to plan for EV charging and for charging infrastructure providers to bet on near-term utilization trends. Any additional states implementing ZEV mandates would likely also see increased interest from charging companies in deploying private capital. Similarly, statewide targets for EVs, like in the case of New York's Reforming the Energy Vision initiative, have been the catalyst for state agencies to think more about action plans for enabling electrification that can be underwritable for utilities looking to rate base investments as well as others seeking to deploy capital. State legislatures and governors looking to lead on

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[92] California Clean Vehicle Rebate Project. Drive clean and save. https://cleanvehiclerebate.org/eng
[93] Clean Technica (2017). US Electric Car Sales By State — Who's #1, Ohio Or California? https://cleantechnica.com/2017/05/04/us-electric-car-sales-state-whos-1-ohio-california/
[94] U.S. EPA. Vehicle Emissions California Waivers and Authorizations. https://www.epa.gov/state-and-local-transportation/vehicle-emissions-california-waivers-and-authorizations

transportation electrification should start with ZEV and statewide goals to attract model availability and private investment to help spur markets.

A number of other policy and regulatory considerations can facilitate the proliferation of the EV charging infrastructure needed to electrify transportation. EV charging is a commercially viable endeavor, but there are occasions where policy intervention is crucial or needed to obtain a public benefit that would otherwise not be achieved based on economics alone. For example, some markets that will be robust with greater EV penetration in the near future are economically challenging for the private sector today. These include lightly populated communities and low-income or other communities with low levels of personal vehicle ownership. Policymakers seeking to promote EV infrastructure investment in these communities may wish to pursue grants to incent charging infrastructure ahead of likely EV adoption, which will then spur further private investment in incremental charging infrastructure.[95]

In other cases, current market dynamics are potentially distorting, and policy and regulatory interventions would help reduce barriers to market competition. As mentioned above, tariff reform is one such area. In areas with low EV penetration, charging providers are paying fixed costs for what they may dispense once or twice a day without a base of utilization across which to amortize those costs. For example, fixed demand charges for some individual EVgo charging stations range from a low of zero to a high of 93 percent of the total monthly electricity bill. Demand charges can be the difference between an attractive location for a fast charging station and a nonstarter, and the variability of demand charges across utility service territories creates uneven incentives even within a given city.

A report by EVgo and RMI in 2017 evaluated California-specific impacts of demand charges on EV charging profitability,[96] finding that demand charges carry disproportionate impacts on the economics of EV charging stations, especially in the early days of market penetration. The point holds across the country. As Figure 2-3 from a Colorado-specific study[97] shows, a driver doesn't have to go far to encounter vastly different tariff structures that — especially in the early days of lower utilization — can be the difference between a profitable and unprofitable location for a fast charging station.

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[95] Forth (2017). Let Us Bury the Chicken and Egg. https://forthmobility.org/news/HotDog&Bun
[96] Rocky Mountain Institute. https://www.rmi.org/wp-content/uploads/2017/04/eLab_EVgo_Fleet_and_Tariff_Analysis_2017.pdf
[97] Svitak, Salisbury, and Toor (No date).

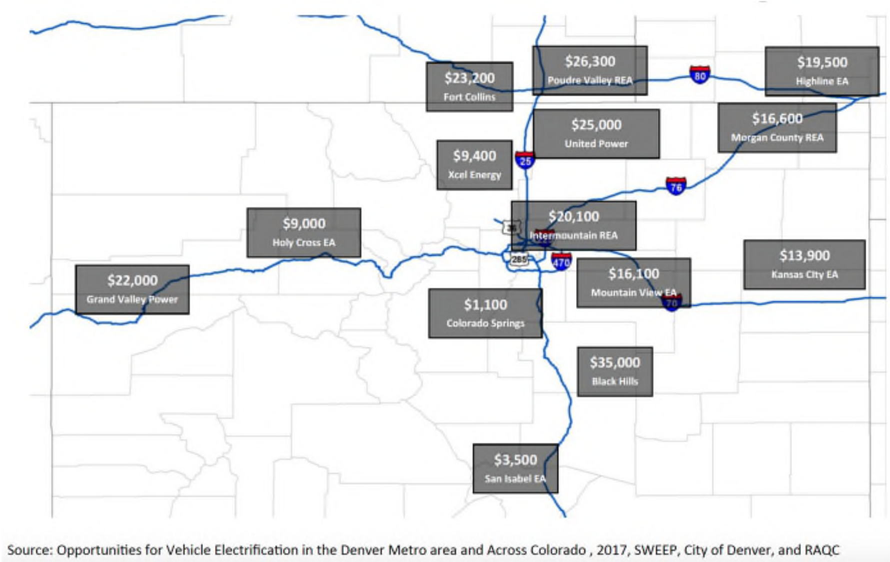

Figure 2-3.Variance in annual utility demand charges in Colorado.

Source: Svitak, Salisbury, and Toor, 2017.[98]

Recognizing that electricity demand and use cases for EV charging stations are different from typical industrial consumers on commercial rates, regulators and policymakers may wish to consider a number of tariff options, including EV-specific tariffs,[99] demand charge holidays, pairing reduced demand charges with slightly higher volumetric rates and adjusting over time, or combinations of these. Rational tariffs for EV charging, especially fast charging, can mean the difference between a private charging company investing, or not investing, in a given utility service territory.

Currently, most state and local grant programs support portions of capital expenditures (CapEx) but not operating expenditures (OpEx). To break through in those geographies with high utility demand charges and low initial utilization of charging stations, grantmakers should consider expanding support to cover OpEx, particularly in early years and then tapering over time. In fact, the peanut butter approach to financial support for charging infrastructure may need to be turned on its head entirely. In certain markets, even subsidized charging stations carry an OpEx tail that is unlikely to be recovered until higher utilization. Put another way, and looking at the map of Colorado (Figure 2-3), it may be more economically efficient and effective to provide $20,000 of OpEx support in, for example, Fort Collins for a year or two than $40,000 in upfront CapEx cost share for the chargers themselves. Conversely, deployments in Colorado Springs may be more sensitive to CapEx support with an easier path to cost recovery given the lower utility demand charges.

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[98] Svitak, Salisbury, and Toor (No date).

[99] Clean Technica (2015). Utility-Provided Special EV Tariff Rates Becoming More Common In US. https://cleantechnica.com/2015/07/06/utility-provided-special-ev-tariff-rates-becoming-common-us/

In markets like San Francisco and Manhattan, the biggest challenge is typically not capital cost but rather real estate cost, availability, or both. In some of these markets, direct support from municipal property owners would be an efficient way to increase charging station availability. For public charging ubiquity, though, commercial property owners are key. A large part of EVgo's business approach is to put fast charging where drivers shop, eat, and have fun. It takes less than a minute to plug in, and when the customers return from running errands or enjoying activities, their cars are 80 percent charged or more. Fortunately, some major retailers see the value of attracting these customers to patronize their stores.

However, other retailers merely see EV charging stations as revenue lost from parking spaces they can't rent, or incentives are misaligned when the owner of the parking lot is different than the main retailer interested in installing charging. In the past, tax credits have incented charging station ownership,[100] but that is insufficient when at times the public interest would be best served by incenting a commercial property owner to host someone else's charging equipment. One policy option is a property tax credit for site hosts to reduce friction for installing more charging stations, and additional tax incentives for vehicle purchasers and infrastructure owners or hosts would accelerate the growth of the industry.

As discussed above, TNCs will likely continue to represent a growing portion of VMT. Incenting those VMT to be eVMT through mandates, incentives, or both through a "clean miles standard" or "RPS for Rideshare" (e.g., recently introduced legislation in California[101] and a pilot in Sonoma[102]) would have major benefits for consumers and the environment while also providing increased market certainty for private charging companies to plan investments around high utilization drivers. Program design can vary from mandating TNCs to increase EV penetrations in their fleets as a logistical matter to making funds available to the TNCs, drivers, or riders — or a combination — to cover additional costs and incent change. No matter the approach, increased penetration of EVs into the TNC market has the added benefit of exposing more riders to EVs, improving awareness and visibility, and further opening the aperture for broader EV adoption.

Public charging is inherently more expensive than charging at home, just as it is cheaper to brew and drink coffee at home than at Starbucks. There are siting, construction, operations and maintenance, networking, and other costs that need to be recovered by the private companies financing the charging infrastructure. Yet as mentioned earlier, often the very occupants of multi-unit dwellings who will rely almost entirely on public charging infrastructure are low-

[100] IRS. About Form 8911, Alternative Fuel Vehicle Refueling Property Credit. www.irs.gov/credits-deductions/individuals/alternative-fuel-vehicle-refueling-property-credit
[101] Senator Nancy Skinner (2018). Senator Skinner Introduces "E-CAr" (SB 1014) to Shift Ride-Hailing to Zero-Emission Vehicles. http://sd09.senate.ca.gov/news/20180206-senator-skinner-introduces-%E2%80%9Ce-car%E2%80%9D-sb-1014-shift-ride-hailing-zero-emission-vehicles
[102] Sonoma Clean Power (2017). Sonoma Clean Power Launches EV Incentive Program. https://sonomacleanpower.org/sonoma-clean-power-launches-ev-incentive-program/

income consumers. To ensure access and promote equity, policymakers and stakeholders — including utilities — should consider financial assistance programs to promote utilization of public charging for American drivers of all income levels. These programs are currently inadequate to meet the needs for some of the most vulnerable populations, so legislators should consider growing the pie rather than dividing it further.

Additional policy considerations include local zoning and permitting timelines (which are a parallel priority to the solar industry's focus on reducing so-called "soft costs"[103]), signage (parking and highway) and enforcement of EV charging-only spaces, transportation planning, building codes/charging infrastructure requirements for parking lots, autonomous vehicle liability regimes, and more.

This is a dynamic market that has made a tremendous amount of progress over the past few years. The policy needs of today are far different than those of yesterday and will certainly be different in the near future. The key is to stay as nimble as possible and tackle challenges that make EV charging accessible, reliable, and affordable while promoting a vibrant and sustainable competitive market in the EV charging industry.

Conclusion

In 2017, U.S. EV sales cleared nearly 200,000 units,[104] with momentum picking up to far exceed that number in 2018 on the way to mass adoption. In order to deliver on the charging infrastructure needed for EVs to proliferate across the country, utilities, charging companies, policymakers, regulators, and others are going to need to work together to address opportunities and challenges in the marketplace today.

A diversity of approaches to utility investments in charging infrastructure likely will develop, in part due to the diversity of regulatory regimes and varying levels of interest. Success will come only if a driver- and rider-centric approach to charging is fostered with affordable rates and accessible infrastructure for EV charging, driven by a robust and sustainable private charging industry working hand-in-hand with utilities and other stakeholders to eliminate barriers to EV adoption for a variety of use cases.

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103 U.S. DOE, EERE. (2016). Soft Costs 101: The Key to Achieving Cheaper Solar Energy. www.energy.gov/eere/articles/soft-costs-101-key-achieving-cheaper-solar-energy

104 Inside EVs (2018). Monthly Plug-In Sales Scorecard. https://insideevs.com/monthly-plug-in-sales-scorecard/

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3. A Consumer Advocate's Perspective on the Future of Transportation Electrification

By Jenifer Bosco, John Howat and John W. Van Alst,[105] National Consumer Law Center[106]

Introduction

This chapter of the report examines the implications of transportation electrification for consumers, particularly for low-income households,[107] and explores policy approaches to addressing equity and access concerns.

There are potential opportunities for low-income consumers to benefit from transportation electrification, including lower fuel and maintenance costs, improved environmental quality, health benefits associated with improved air quality, and expanded transportation options.[108] At the same time, many consumers and low-income households already struggle to pay for basic necessities, including utility and transportation expenses.[109] In 2015, almost one in three households reported facing challenges in paying energy bills or adequately heating or cooling their homes,[110] and low-income families spent almost 15 percent of their income on transportation in 2014.[111]

Transportation electrification must proceed in an equitable way. The broader adoption of electric vehicles (EVs) will require new resources and investments to pay for infrastructure and to implement new programs and new rate design. Currently, most decisions about infrastructure investments are being made in state utility commission proceedings and state legislatures. At the state level, stakeholders are still in the process of deciding which investments are needed to advance other state transportation and environmental policies, and how these investments will be funded. In utility commission proceedings, several states have allowed for some portion of transportation electrification investment costs to be passed along to consumers through electricity rates. The extent to which low-income ratepayers and families

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105 Olivia Wein, NCLC Staff Attorney, and Ana Girón-Vives, NCLC Research Assistant, contributed to this report.
106 Since 1969, the nonprofit National Consumer Law Center® (NCLC®) has used its expertise in consumer law and energy policy to work for consumer justice and economic security for low-income and other disadvantaged people in the United States through policy analysis and advocacy, publications, litigation, and training. www.nclc.org
107 While this essay addresses some general ratepayer concerns, it focuses primarily on low-income households and families.
108 Union of Concerned Scientists (2017). *Going from Pump to Plug: Adding Up the Savings from Electric Vehicles.*
109 For example, see American Council for an Energy-Efficient Economy (April 2016), *Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities*; The Pew Charitable Trusts (July 2012). *Payday Lending in America: Who Borrows, Where They Borrow, and Why*, (finding that utility bills and other recurring expenses are the predominant reason that low-income consumers resort to using high interest payday loans).
110 U.S. Energy Information Institute Residential Energy Consumer Survey (Oct. 31, 2017). *One in three U.S. households faced challenges in paying energy bills in 2015*.
111 Pew Charitable Trusts (March 2016). Household Expenditures and Income, Balancing family finances in today's economy.

realize benefits and are not exposed to financial risks of transportation electrification are dependent on a broad range of regulatory, legislative, private sector, consumer investment, policy and program design decisions. With transportation electrification technologies in their infancy, it is critical that public policy decisionmaking appropriately capture equity and risk mitigation considerations at the outset, rather than scrambling later to rectify problems created by early actions.

The transition to increased transportation electrification should proceed in a manner that recognizes these realities and is consistent with equity,[112] consumer protection, sound electric utility rate design, and fair infrastructure investment cost allocation. As the pace of change in transportation accelerates, we should promote positive outcomes for low-income consumers through new programs, rate designs, and cost allocations that support equity and a smooth transition to cleaner and less expensive energy and transportation systems. While this essay specifically discusses low-income consumers and their needs, much of the discussion and recommendations would be broadly applicable and could benefit all consumers.

Our analysis of the potential benefits and costs of transportation electrification for low-income consumers, and possible policy solutions, flows from the following principles. In order to ensure that the transition to transportation electrification is carried out in a way that is equitable and allows benefits and costs to be allocated fairly, transportation electrification policy should aim to achieve the following:

- **Increase transportation access and security for low-income consumers.** Already, disproportionately fewer low-income consumers own vehicles than do higher-income consumers. Over the coming decades, as higher-income consumers begin to purchase EVs, low-income consumers will still be more likely to lack access to any type of car. Low-income consumers also will be less likely to find car ownership affordable, even as EV prices match the price of internal combustion vehicles. However, solutions other than individual car ownership may best address the transportation needs of some low-income communities. For instance, the most immediate direct benefits to low-income families who do not own or lease cars may

[112] Equity defies easy definition, but for the purposes of this essay, we use a concept of equity similar to the following description by the World Health Organization: "Equity is the absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically." World Health Organization. *Health Systems, Equity*, http://www.who.int/healthsystems/topics/equity/en/. Equity aims for fairness through leveling the playing field. As described by the Annie E. Casey Foundation in its Race Equity and Inclusion Action Guide, "Equity involves trying to understand and give people what they need to enjoy full, healthy lives. Equality, in contrast, aims to ensure that everyone gets the same things in order to enjoy full, healthy lives. Like equity, equality aims to promote fairness and justice, but it can only work if everyone starts from the same place and needs the same things." The Annie E. Casey Foundation (2015).

come from policies that increase the use of EVs[113] in public transportation and support affordable ride-hailing and car-sharing services. Greater access to transportation can help low-income families to achieve their employment and education goals.[114]

- **Equitably allocate costs and benefits for low-income consumers.** EVs and related technology should be accessible to low-income consumers in ways that address the mobility needs of diverse low-income individuals and households. Energy and transportation cost savings should be shared equitably as well. Costs must be allocated fairly through careful rate design and program design decisions. Policymakers should shield low-income consumers from unaffordable rate increases, design incentive programs in ways that spread the benefits to low-income consumers, and implement fair methods of funding deployment of charging infrastructure as well as transportation infrastructure such as roads, bike paths and bridges. To the extent possible, investments should be funded through sources other than electric rates.

- **Reduce air pollution.** Low-income communities are disproportionately burdened with pollution from power generation and transportation sources.[115] Transportation electrification should be implemented in a way that is consistent with other state, regional and federal emissions reduction goals, addresses the environmental justice concerns of vulnerable communities and provides public health benefits. Carbon emissions are similarly harmful to low-income households and communities, since climate change is anticipated to disproportionately impact low-income consumers.[116] Low-income communities and consumers will have fewer resources at their disposal to mitigate the effects of increasingly volatile weather brought on by climate change. Addressing climate change is therefore a consumer justice issue.

Here, we follow these principles as we discuss the questions that this report addresses, with a focus on addressing the need for consumer protections and to provide equity and access for low-income consumers with respect to electrified transport.

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[113] For the purposes of this essay, we refer to both battery EVs (vehicles that do not contain an internal combustion engine, with all power provided by a battery that must be charged by an external source) and plug-in hybrid vehicles as EVs.
[114] See Pendall et al. (2014).
[115] Bell and Ebisu (2012) (documenting racial and income disparities in exposures to specific particulate pollutants linked to cardiovascular disease, asthma, and cancer); Pratt et al. (2015).
[116] Dept. of Economic and Social Affairs of the United Nations Secretariat (2016).

1. What are the potential benefits and risks of transportation electrification — to electric utilities, to retail electricity customers and to society?

Utility Company Benefits

Potential benefits of transportation electrification have been identified by a wide range of observers.[117] Utilities are expected by some to realize increased revenues as they sell more electricity. In some scenarios, capacity factor[118] may be improved if most drivers charge their EVs during off-peak hours, which could increase revenues without creating a need for new generation.[119] Increased usage is projected by some industry analysts to occur as EV use becomes more widespread, at least in the longer term after the required infrastructure investments have been made.[120] Current EV drivers appear to charge their vehicles in the ways that had been anticipated and encouraged through pilot programs, primarily charging vehicles at home during off-peak hours.[121] The timing of and extent to which utility sales increase, and whether new generation capacity is required to accommodate new load, are dependent on a number of uncertain factors, including rates of adoption and charging behaviors. The timing and extent of rate reduction benefits are similarly speculative and also are based on numerous factors, including charging rates and cost recovery provisions approved by regulators.

Over the past three decades, many environmental quality and consumer advocates have focused attention on programs and policies intended to reduce electricity usage and demand.[122] These advocacy efforts were based on the assumption that reduced usage would lessen the need for new investment in environmentally harmful and expensive electric generation and transmission. Recently, with rapid improvements in renewable energy and electricity storage technologies and economics, both clean energy advocates and electric utilities have developed and promoted the concept of *beneficial electrification*, predicated on the assumption that on balance, emissions of carbon and other air pollutants will be reduced by replacing direct-fueled combustion equipment and appliances currently powered by fossil fuels with ones that run on electricity that is increasingly powered by wind and solar resources.[123]

Electrification of transportation is at the epicenter of the beneficial electrification movement, with decarbonization complementing energy efficiency and conservation efforts, and utilities eying a return to more robust sales and revenues after a period of slow or negative growth.[124]

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117 Fitzgerald and Nelder (2017).
118 The ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period. EIA: https://www.eia.gov/tools/glossary/index.php?id=C.
119 Smart Electric Power Alliance (April 2017). *Utilities and Electric Vehicles — The Case for Managed Charging*.
120 Cooper and Schefter (June 2017).
121 For instance, in 2013, the Department of Energy's EV Project determined that Nissan LEAF owners charged their vehicles at home about 74 percent of the time, and Chevrolet Volt owners used home charging about 80 percent of the time. Idaho National Laboratory (Feb. 2015a). As part of the Maryland EV Pilot Program, over 90 percent of the participating customers charged their EVs at off-peak times. Note that the pilot had only 101 participants. Pepco (2016), citing data from EPRI (2016).
122 See, e.g., National Resources Defense Council (2014) and National Housing Trust (2013).
123 See, e.g., Colburn (2017).
124 Wood et al. (2016).

Beneficial electrification objectives are highly laudable. Further, as one potential benefit, it is arguably in the interest of low-income electricity consumers to forestall the so-called "utility death spiral," brought on by the cycle of higher-income consumers taking advantage of heightened end-use efficiencies and access to non-utility generating and storage resources, reduced utility revenues, increasing retail electric rates, and flight of those customers with capacity to dramatically decrease reliance on the utility grid. For low-income consumers, the death spiral concern is that, as the last to gain access to state-of-the-art electricity efficiency, management and generation technologies, they will remain grid-reliant and be saddled with an ever-increasing share of operation and maintenance costs.

Utility Company Risks

Rapid proliferation of EVs will create new, sizable loads on the electric grid. As EVs become more commonly used, the increased demand for electricity, unmanaged charging, and the increased use of DC fast chargers could increase utility costs of operating and maintaining the grid.[125] Preparing for and managing these loads will require careful planning and, in many instances, investment in new generation, transmission and distribution capacity. For example, transmission upgrades may be required in some regions to bring new sources of renewable energy into a region to power transportation electrification. Upgrades to transformers and equipment required to operate individual distribution circuits will be necessary to accommodate new charging loads. Digital communication and sensors will be needed to accommodate vehicle-to-grid integration and, where it does not currently exist, advanced metering infrastructure is required to implement time-sensitive charging rates.[126]

Utility system planners are faced with additional risks and uncertainties. Assumptions and estimates regarding EV adoption rates and owner/operator charging behaviors will be required for making investment decisions. Deficiencies in the interoperability of new distribution equipment, and potential for obsolescence before investments are recovered, pose additional risks.

Tools for managing EV charging include time-of-use (TOU) rates.[127] TOU rates can incentivize EV charging during overnight hours or other times when there is excess power generation on the grid. However, some consumers may not be familiar with TOU rates or may not be interested. For instance, the average monthly savings of $7.43 per month in the Maryland EV Pilot Program was satisfactory for most pilot participants, but may not be enough of an attractive incentive for some consumers.[128] Although it will likely benefit utilities and some consumers to shift load through TOU rates, proactive consumer uptake of TOU rate offerings (opt-in) may remain weak.[129] Even among EV owners in California, not all have taken advantage of the opt-in TOU

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125 Smart Electric Power Alliance (2017) and M.J. Bradley & Assoc. and Georgetown Climate Center (2017).
126 See, e.g., Hopkins et al. (July 2017), 58–60.
127 Using EVs as storage resources through vehicle-to-grid technology, or V2G, is currently in an early stage of development but may eventually provide utilities with another resource for balancing the grid. See Smart Electric Power Alliance (2018).
128 Pepco (2016), citing data from EPRI (2016).
129 See, e.g., Cappers et al. (2016a), xix - xxii. In a 2012–2013 consumer behavior study of the Sacramento Municipal Utility District, researchers found that even with substantial market research and recruitment, only 19.5 percent of a sample of 10,865 residential customers volunteered to take an optional TOU rate.

rates offered by utilities.[130] If these early adopters of EV technology are the tech-savvy target market for TOU rates, the lack of full uptake among this group may indicate a lack of consumer interest generally.

TOU rates may be confusing to many consumers, and there are a limited amount of data[131] to show whether low-income consumers have benefited from TOU rates to date or are able to change their consumption in a significant way (see question 5). For residential charging, offering the option of an EV-only TOU rate (along with a separate meter) may provide a more targeted way to manage EV charging without requiring the customer to sign up for a whole-house TOU rate. Workplace charging during times of high renewable energy production also may provide opportunities for special rates or creative measures for managing EV charging loads.

Another potential risk to utilities is the possibility of a mismatch between distributed energy generation and the charging needs of EV operators. Much EV rate design discussion has focused on shifting consumers to TOU rates to encourage overnight charging. However, in areas of high solar PV adoption such as California and Hawaii, there may be a need to increase electricity usage during times of peak solar generation.[132] Rate design may help to address this issue. For instance, Hawaiian Electric Companies introduced a TOU rate at DC fast chargers operated by the utility, which is designed to encourage customers to use these charging stations during sunny hours of the day when excess generation from solar is available on the grid.[133]

Residential Electricity Customer Benefits

Increased sales have the potential to benefit residential utility customers by spreading utility costs over more kilowatt-hours, eventually lowering electric rates charged for all consumers. For EV owners, the savings could be greater. For instance, in its analysis of utility service areas in California, Georgia, Maryland, Massachusetts, New York, Ohio and Pennsylvania, M.J. Bradley & Associates projects that for EV owners, the benefits of reduced electricity rates plus reduced costs of operating and maintaining an EV will provide savings in the range of $300 to $800 annually by 2035.[134] Further, according to some projections, the financial benefits of EVs are forecast to exceed the costs of infrastructure investment after 2030.[135]

In the coming years, consumers who own or lease EVs may be able to take advantage of emerging uses of distributed energy resource, such as charging EVs with renewable energy generated through a local microgrid[136] or selling excess energy through vehicle-to-grid technology.[137]

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[130] For instance, although California EV drivers have access to TOU rates, not all drivers take advantage of them. See Union of Concerned Scientists (2017).
[131] Exceptions are discussed in response to question 5, including Cappers et al. (2016b).
[132] Gavrilovic (2016).
[133] Hawaiian Electric Companies (2017).
[134] Ceres and M.J. Bradley & Assoc. (2017). An analysis by Energy + Environmental Economics also predicts a financial benefit for ratepayers in the AEP Ohio service area. Energy + Environmental Economics (2017).
[135] M.J. Bradley & Assoc. (2017) and Ceres and M.J. Bradley & Assoc. (2017).
[136] Such projects can be designed to benefit low-income or moderate-income customers, such as the Marcus Garvey Village Microgrid in Brooklyn, NY, which aims to provide affordable energy for low-income tenants. Demand Energy, "Marcus Garvey Village Microgrid" Fact Sheet (2017).
[137] Khan and Vaidyanathan (2018).

However, EV savings projections are highly speculative at this point in time, particularly in light of the infancy of transportation electrification technologies. Electricity ratepayer benefits through increased transportation sales are undeniably speculative and pushed off into the future. Shielding ratepayers — particularly those already faced with tremendous cash flow challenges — from utility investment risk requires regulators to be cautious with unconditional cost recovery pre-approvals and to demonstrate willingness to defer portions of such cost recovery contingent on realization of projected benefits.

Residential Electricity Customer Risks

The carbon-reduction benefits of increased electrification of transportation and appliances such as natural gas water heaters will not accrue without careful resource planning and attention to rate design. Figure 3-1 illustrates that in much of the United States, the electricity generation mix continues to be dominated by power plants that burn fossil fuels, particularly at the margin and at times of peak demand.

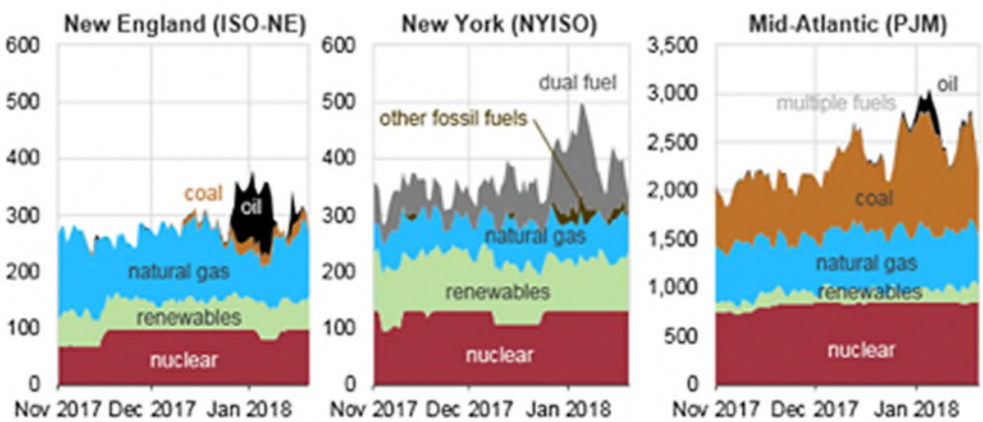

Figure 3-1. Daily generation mix in New England, New York and Mid-Atlantic, Nov. 1, 2017 to Jan. 20, 2018.

Source: U.S. Energy Information Administration (EIA) (2018)

These graphs illustrate that during the high-demand period of an extreme cold snap in the Eastern United States in January 2018, the New England, New York and Mid-Atlantic electricity system operators dramatically increased the dispatch of oil- and coal-fired generation resources. Absent the continued transition to a cleaner generating mix and rate design that promotes vehicle charging during periods when fossil-fired generation — particularly from coal and oil — are minimally required or not required, carbon reduction benefits of transportation electrification will be compromised.

A primary concern for consumer advocates is the need to spread the benefits of transportation electrification to all consumers, including low-income consumers, communities of color, elders and vulnerable populations. With any new technology, there is potential for inequity and lack of access, where benefits go primarily to well-off first adopters or to higher income consumers. Disparities can linger even as the use of a new technology becomes entrenched. For instance, many low-income and rural households still lack access to broadband internet service, and this digital divide limits education and employment opportunities in these communities.[138]

As noted earlier, transportation electrification may reduce electric rates over time. But in the short term, utilities are investing in charging station infrastructure, and have in some instances already received approval to pass some of these initial costs along to ratepayers in the form of increased electric rates. Currently, such impacts appear to be small, and at some point in the coming years, the downward pressure on rates could be significant enough to balance out the costs of infrastructure buildout.[139] However, low-income households already struggle to pay for utilities and other basic needs, and the average price of electricity has been creeping higher over the past decade.[140] Consumer advocates have stressed the need to carefully consider the costs of investments and to minimize the impact on ratepayers.[141] With thoughtful planning, rate design and program design policies can be put in place to shield low-income consumers from unaffordable short-term rate increases and to spread transportation electrification benefits to all ratepayers (see question 4). Further, as noted above, unconditional pre-approvals of significant infrastructure investments can be limited, and recovery can be made contingent upon realization of projected benefits. In light of potential benefits of transportation electrification, state and federal legislative action may be required to address issues of allocation of investment risk.

For low-income EV drivers who charge their vehicles at home, strong protections will be needed to preserve their access to electricity. Low-income consumers struggle to afford utility service and live with the risk of energy insecurity, as depicted in Figures 3-2 and 3-3. The termination of electricity service is a serious problem for low-income communities.[142] This burden disproportionately falls on people of color, and data show that utility disconnections are more frequent among low-income African American ratepayers than among similarly situated low-income white ratepayers.[143]

[138] Politico, The Digital Divide — A Special Report (Feb. 2018).
[139] Ceres and M.J. Bradley & Assoc. (2017).
[140] U.S. Dept. of Labor, Bureau of Labor Statistics (2018).
[141] See, e.g., National Association of Utility Consumer Advocates (2018) and Comments of the Maryland Office of People's Counsel on the Petition for Implementation of a Statewide Electric Vehicle Portfolio, Maryland PSC Case No. 9478 (March 27, 2018).
[142] NAACP Environmental and Climate Justice Program (2017).
[143] Howat (2015).

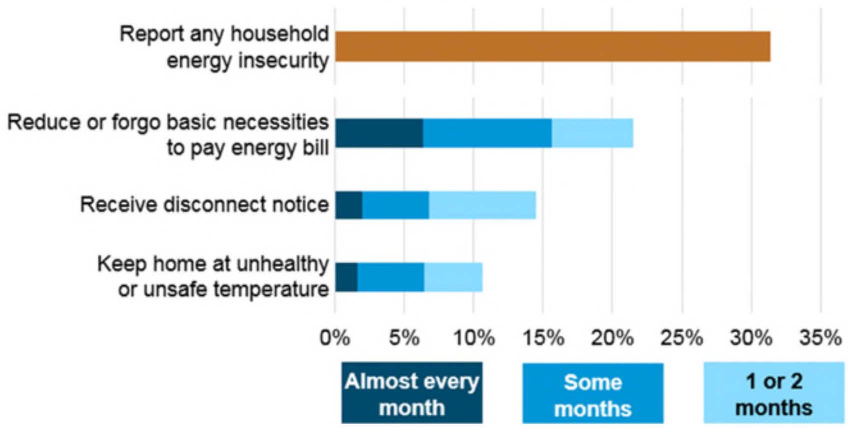

Figure 3-2. Households experiencing household energy insecure situations, 2015, percent of households.

Source: U.S. EIA, Residential Energy Consumption Survey 2015.

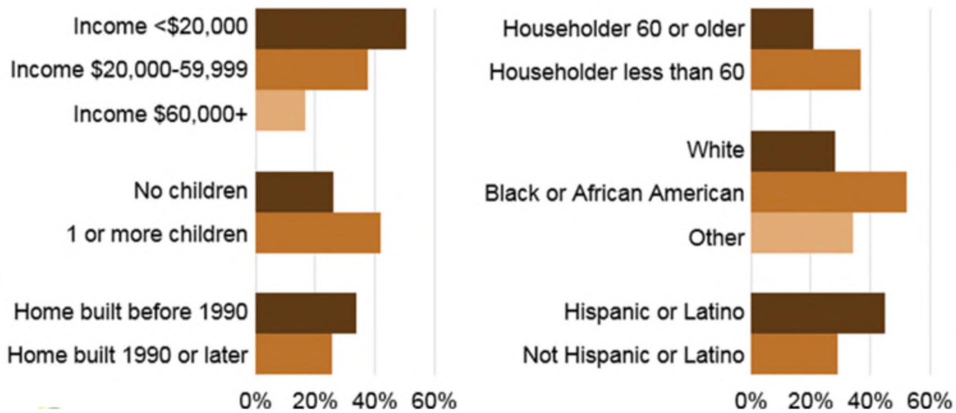

Figure 3-3. Household energy insecurity by household characteristics, 2015, percent of households.

Source: U.S. EIA, Residential Energy Consumption Survey 2015

Societal Benefits

As noted above, transportation electrification has the potential to lower electricity rates. For low-income consumers, a reduction in their disproportionately high energy burden[144] could free up resources to pay for other essential needs. The overall reduction of energy costs, even for those who do not own or drive EVs, is a significant benefit for these consumers and communities.

A potential societal benefit is the possibility that EV charging can help balance electric load and therefore provide a benefit to the electric grid. Transportation electrification could improve load

[144] American Council for an Energy-Efficient Economy (2016).

factor[145] by shifting charging to times when generation output exceeds demand for electricity, and managed charging of EVs may help align charging with periods of high solar, wind or other renewable energy generation.[146]

Further, transportation electrification could spark the creation and adoption of improved rate design. EV charging could also encourage the use of tools to shift load to off-peak times, such as TOU rates, as discussed later in this chapter.

The public health and environmental benefits of transportation electrification have been documented elsewhere, but we note that these benefits are particularly welcome and needed for low-income communities. Low-income communities and communities of color are disproportionately harmed by pollution and have suffered the negative health consequences of living close to power plants, waste facilities, highways and other sources of pollution.[147] The transportation sector is currently the largest producer of carbon emissions nationally,[148] and disadvantaged communities are potentially more vulnerable to the adverse effects of climate change. Low-income individuals are less likely to have the resources available to afford climate mitigation measures, which could include home improvements, air conditioning, replacement of damaged property after severe weather events, or relocating to a new home.[149] Transportation electrification, coupled with increased renewable energy generation, could help to reduce air pollution and advance public health and environmental justice objectives in these communities.[150]

Electrification may also reduce private and public transportation costs for consumers. This could be the result of lower fuel costs,[151] lower maintenance costs, and perhaps eventually increased vehicle longevity. These lower costs, when and if they occur, could free up money in the family budget for other needs. Lower costs could allow some families currently without access to transportation to either buy a used EV or use ride-hailing or ride-sharing services, and lower costs could also allow for greater vehicle miles traveled by existing users. While all these benefits are possible, the potential benefits are speculative at this point in time.

Societal Risks

If transportation electrification is implemented in an inequitable way, there is the risk of perpetuating a two-tiered system where benefits are mainly enjoyed by higher-income

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145 The ratio of the average load to peak load during a specified time interval. EIA: https://www.eia.gov/tools/glossary/index.php?id=L.

146 Smart Electric Power Alliance (2017). See also, CPUC (2017) (only minimal negative impacts on load found so far in California).

147 Pastor et al. (2001).

148 The transportation sector now produces 1.9 billion tons of carbon emissions per year, and the electric power sector produces 1.8 billion tons of carbon emission per year. U.S. EIA, Total Energy Data Browser, https://www.eia.gov/totalenergy/data/browser/.

149 Dept. of Economic and Social Affairs of the United Nations Secretariat (2016).

150 Addressing environmental justice concerns and preventing disproportionate harm in environmental justice communities has previously been identified as a priority within federal transportation policy. U.S. Dept. of Transportation, Updated Environmental Justice Order 5610.2(a) (May 2, 2012).

151 Sivak and Schoettle (2018).

communities, and low-income consumers are the last remaining group to drive dirtier and more expensive gasoline and diesel-fueled vehicles. Addressing equity and access concerns early in this transition can help to ensure that the transition proceeds fairly. Inequitable results for low-income consumers will harm these consumers and will also undermine public support.

While transportation electrification should lead to emissions reductions over time, regional differences may exist where coal plants remain in operation and cleaner electricity production lags. For instance, due to continued reliance on coal in the PJM territory, plug-in EVs were found to cause overall emissions damage that significantly exceeded the emissions from gasoline-powered hybrid vehicles. However, EV-related emissions were predicted to decrease dramatically by 2018, as coal-fired power plants continue to close.[152]

Although highly variable by location, it is possible that increased electricity use in transportation would lead to increased power plant emissions, and the resulting air pollution would have harmful health impacts on nearby low-income and environmental justice communities. Policymakers could avert this harm by ensuring that any increased power generation is conducted in a way that would not adversely affect the health of residents in overburdened communities.[153]

The electrification of transportation will not take place in a vacuum. Other major transformations, from ride-hailing and ride sharing to the growth of autonomous vehicles (AVs), are occurring in conjunction with electrification. While these changes could increase mobility options, they also could potentially reduce mobility options for some consumers. Lower-income households are less likely to own a car, and that will likely remain true even as EVs become more affordable. Car ownership incentives, such as rebates and tax incentives, may help some low-income families to purchase EVs,[154] but the scale of such programs is dwarfed by the number of low-income families without a car or with an older, less efficient internal combustion engine (ICE) vehicle. Absent large-scale subsidies for low-income buyers, to the extent that low-income families do get access to EVs, it will likely occur decades after early adopters avail themselves of the benefits.

Many low-income families will use public transportation, ride-hailing, car-sharing and other modes of transportation or continue to suffer from a lack of transportation as they do currently. These families who lack access to a car may benefit if electrification results in lower transportation costs and greater access to transportation. However, there is a real risk that these changing trends in transportation may speed the decline in public transportation ridership and eventually a decrease in the availability of public transport.[155] While some of the decreases in public transportation may be due to ride-hailing and other developments, fuel prices can certainly affect ridership on public transit.[156] To the extent EV adoption lowers fuel costs below

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[152] Weis et al. (2016).
[153] Welch (2017).
[154] See, e.g., the California Clean Vehicle Rebate Project offers increased rebate amounts for consumers with income of up to 300 percent of the federal poverty level, who purchase or lease a battery electric vehicle or plug-in hybrid. https://cleanvehiclerebate.org/eng/income-eligibility
[155] See, e.g., Gehrke, Felix, and Reardon (2018) and Bliss (2017).
[156] American Public Transportation Association (2011).

ICE vehicles, these lower costs may reduce ridership on public transportation. This may force lower income families to rely on more expensive car ownership or ride-hailing or ride sharing modes of transport.

One of the most important benefits to low-income consumers of EVs is the possibility of reduced transportation costs. If EVs lower costs, through greater reliability, lower maintenance costs, and lower fuel costs, they will benefit low-income consumers by reducing their transportation costs and increasing their ability to get and use a car. However, these same factors may pose risks to society. Lower costs would likely also increase the number of vehicles, vehicle miles traveled (VMT),[157] and the size of vehicles.[158] Such changes could decrease the expected benefits of EVs. They could also exacerbate the creation of non-exhaust traffic-related particulate matter from items such as tire, brake pad, and road surface wear from heavier vehicles and more VMT, especially in high traffic areas.[159] The negative impacts from these increases may be disproportionately borne by low-income communities that live nearer to roads.[160]

If there is an increase in VMT or the size of vehicles, it could cause an increase in the maintenance cost of roads and bridges. Even if lower fuel costs for EVs do not result in higher VMT or vehicle weights, increasing adoption of EVs will certainly affect the funding for maintenance and building of transportation infrastructure. Currently almost half of road infrastructure costs are paid for by federal and state gas taxes.[161] A shift to EVs will necessitate evolution of the funding mechanism for roads. Adding to the urgency is that even with the current large percentage of ICEs on the road and the addition of almost as much general funding as funding collected from road users, there is still currently a massive backlog in needed road and bridge repairs.[162] While there are several options to funding transportation infrastructure with growing EV participation from taxing VMT to funding transportation infrastructure from general revenue, there is a possibility that reliance on the gas tax may leave low-income car owners, likely to be late adopters of EVs, paying a disproportionate share of infrastructure costs.

2. a. What roles should utilities versus competitive providers play in accelerating deployment of EV infrastructure?

EV infrastructure investments must be pursued in a way that will lessen the impact on ratepayers and shield struggling low-income ratepayers from unaffordable rate increases, while providing sufficient infrastructure to support broad adoption of EVs.

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[157] See U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, Fact #906: Jan. 4, 2016 VMT and the Price of Gasoline Typically Move in Opposition. https://www.energy.gov/eere/vehicles/fact-906-january-4-2016-vmt-and-price-gasoline-typically-move-opposition

[158] Wheatley (2010), but also see Leard and Linn (2016) (finding that vehicle sales respond more to rising prices than falling prices).

[159] See, Grigoratos and Martini (2014a, 2014b).

[160] Rowangould (2013), 59–67.

[161] Dutzik et al. (2015).

[162] American Society of Civil Engineer's 2017 *Infrastructure Report Card.*

Utility infrastructure investment models may be described as falling into three categories: make-ready installation, utility ownership of charging stations, and hybrid models such as rebates for the installation of private and public charging equipment.[163] A make-ready investment model allows the utility company to install the wiring that would be needed for a charging station, but would leave the charging station installation and operations to another company or other entity.[164] Utility ownership of charging stations raises issues for regulators around the role of the utility, infrastructure needs, and how costs are to be allocated to ratepayers.[165]

Whether utility investment in infrastructure is needed to ensure that low-income communities and residents of multi-family dwellings[166] are served, or whether third-party ownership should be favored to avoid passing along costs to nonparticipants in electric rates and to promote competition, are open questions. In general, we believe that it is in the public interest to take an approach that limits utility investments and the resulting financial impacts on low-income ratepayers. However, there are approaches to each model that could help achieve the policy objective of assisting low-income consumers and communities.

Any utility investment, whether in make-ready infrastructure or in the ownership and operation of charging stations, will need careful scrutiny to ensure that investment costs do not add an unaffordable burden for low-income ratepayers. Several approaches could help lessen the impact on low-income consumers:

- Bill payment assistance programs to reduce the burden on vulnerable customers (see responses to questions 4 and 6 in this essay)
- Separate EV charging rates, possibly accompanied by separate meters, to spread a manageable amount of early or initial costs among EV drivers, but at a rate that is not so high that it would serve as a disincentive to low- and moderate-income drivers as they consider whether to drive EVs
- TOU rates and other rate design options that would optimize charging times and help lower the cost of electricity for all consumers
- Incentivizing infrastructure for public transportation and school buses, as a way to spread benefits to vulnerable communities
- Where beneficial, installing charging stations that can be used by low-income communities and low-income residents of multi-family dwellings

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163 M.J. Bradley & Assoc. (2017).

164 Fitzgerald et al. *(*2017).

165 For instance, Massachusetts law allows utilities to seek cost recovery for infrastructure investments, and the Department of Public Utilities would approve such proposals "only if a proposal is in the public interest, meets a need regarding the advancement of electric vehicles in the commonwealth and does not hinder the development of the competitive electric vehicle charging market." Mass. Gen. Laws c. 25A, sec. 16(f).

166 National Resources Defense Council (2017).

Programs to increase private installation and ownership of charging stations, such as rebates or subsidies for installations at homes or businesses, could include incentives to serve the needs of low-income communities. Such initiatives could include:

- Targeted subsidies or incentives to install charging stations in underserved areas
- Fair pricing of electricity at privately owned charging stations
- Providing charging station access to all EV drivers without requiring subscription fees[167]
- Promoting interoperability, so that purchasers of used EVs have access to these charging stations
- Other programs to increase access to vehicles for low-income consumers, such as subsidized car-sharing programs[168]

Public utility commission orders, regulations or legislation may be needed to advance these policies.

2. b. What infrastructure investments are others making, and how should utilities complement those investments?

Electrify America plans to invest $2 billion by 2027, with $800 million invested in California and the rest to be invested nationally. The charging stations will use non-proprietary charging technology.[169] In contrast, Tesla's national network of DC fast charging (DCFC) stations use proprietary technology, and at this time the charging stations cannot be used by non-Tesla vehicles.[170]

Over $2.9 billion from the Volkswagen emissions settlement is allocated for states to use for non-consumer purposes such as school buses, freight trucks and industrial equipment. Of these funds, 15 percent may be used to install, operate and maintain publicly available EV charging stations as determined by each state.[171] Plans for these settlement funds, which are in addition to funds used for the Electrify America investments, are still being developed by individual states.[172] States may choose to use the settlement funds for investments that will further access, equity and environmental justice policies.

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[167] Mass. Gen. Laws c. 25A, sec. 16(b).
[168] Illinois Citizens Utility Bd. (2017).
[169] Electrify America. https://www.electrifyamerica.com.
[170] Tesla. https://www.tesla.com.
[171] *U.S. v. Volkswagen AG et al.*, Case No. 3:16-cv-00295, Environmental Mitigation Trust Agreement for State Beneficiaries, Appx. D-2: Eligible Mitigation Actions and Mitigation Action Expenditures (Oct. 2, 2017).
[172] National Assoc. of Clean Air Agencies, Volkswagen Settlement Information State and Local Agency Links and Programs, http://4cleanair.org/Volkswagen_Settlement_Information.

Other sources of infrastructure investment may include states that opt to use funds from emissions cap and trade programs for EV infrastructure.[173] For example, Delaware has used a portion of its Regional Greenhouse Gas Initiative funds for EV infrastructure, though on a relatively small scale.[174] California's governor has proposed using the state's cap and trade funds for charging infrastructure, in addition to utility and other investments being made in the state.[175]

Federal government funding for infrastructure, available through the American Recovery and Reinvestment Act, supported infrastructure investments until the program expired in 2013. Elsewhere, local and national governments have funded or supported charging stations in a number of countries, including China, Japan, France, the Netherlands, Norway, Germany, the United Kingdom and Canada.[176]

Utility investment should be deployed in ways that will maximize the societal benefits of these other investment sources. The equitable allocation of resources to benefit low-income communities, communities with environmental justice concerns, and other vulnerable communities could be accelerated by combining utility resources and private resources with these other sources of support.

3. Who will use EVs — and how?

Many potential variables that are difficult to predict may influence EV adoption and usage such as fuel prices, improvements in EV technology, subsidies for EV acquisition or operating costs, interest rates, taxation, the rise of AVs, regulatory or legislative requirements, and general economic conditions. These and other factors will not only influence who uses EVs — and how — but could also influence the speed of EV adoption and demographic differences in adoption.

A review of existing vehicle ownership and usage, emerging trends in transportation, and the speed and demographics of adoption of EVs to this point can provide insight into some of the more likely possibilities of EV usage in the future. It is also helpful to become familiar with the current inequities and abuses in the private ICE vehicle market in the United States, to support efforts to minimize such problems in the EV market.

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173 While some states could choose to allocate new sources of cap and trade funds in this way, we do not suggest that states shift funds from existing investments in energy efficiency, bill payment assistance, and other beneficial programs. See, e.g., The Regional Greenhouse Gas Initiative (2017).
174 The Regional Greenhouse Gas Initiative (2017).
175 State of California. 2018–2019 Governor's Budget Summary, Climate Change (January 2018). http://www.ebudget.ca.gov/2018-19/pdf/BudgetSummary/ClimateChange.pdf.
176 Hall and Lutsey (2017).

Vehicle Ownership and Usage

The United States has more than 250 million vehicles on the road,[177] exceeding its roughly 220 million licensed drivers.[178] The ratio of vehicles to households has been roughly two to one over the past 20 years, with between 20,000 and 25,000 miles driven per household annually over the last 30 years.[179] This existing fleet of vehicles averaged 11.6 years old in 2016, reflecting a relatively steady increase in vehicle age since 1996, when the average age of vehicles was 8.5 years old.[180] Roughly 62 million vehicles are at least 16 years old.[181] Among low-income households with access to a vehicle, the vehicle is likely to be older than those in higher-income families.[182] The age of vehicles currently in use indicates that any transition to EVs will proceed slowly as cars are replaced at the end of their useful lifespans. Because low-income families often drive older vehicles, they are likely to be among the last adopters.

Current Vehicle Ownership Among Low-Income Households

Although there are more cars than drivers, over 10 million U.S. households do not have a car available for use.[183] Low-income households are much less likely to own a vehicle.[184] As figures 3-4 and 3-5 show, very low-income households are the most likely to lack a vehicle.

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[177] National Transportation Statistics, Table 1-11: Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances, Bureau of Transportation Statistics. https://www.bts.gov/content/number-us-aircraft-vehicles-vessels-and-other-conveyances.

[178] Federal Highway Administration, Highway Statistics 2016. www.fhwa.dot.gov/policyinformation/

[179] Sivak (2017).

[180] U.S. Dept. of Transportation, Bureau of Transportation Statistics, *National Transportation Statistics* Table 1-26: Average Age of Automobiles and Trucks in Operation in the United States. https://www.bts.gov/content/average-age-automobiles-and-trucks-operation-united-states

[181] IHS Markit release. http://news.ihsmarkit.com/press-release/automotive/vehicles-getting-older-average-age-light-cars-and-trucks-us-rises-again-201

[182] See Yurko (2009).

[183] See Tomer (2011).

[184] See Maciag (2015) (Low-income families often remain carless due to unaffordability rather than by choice).

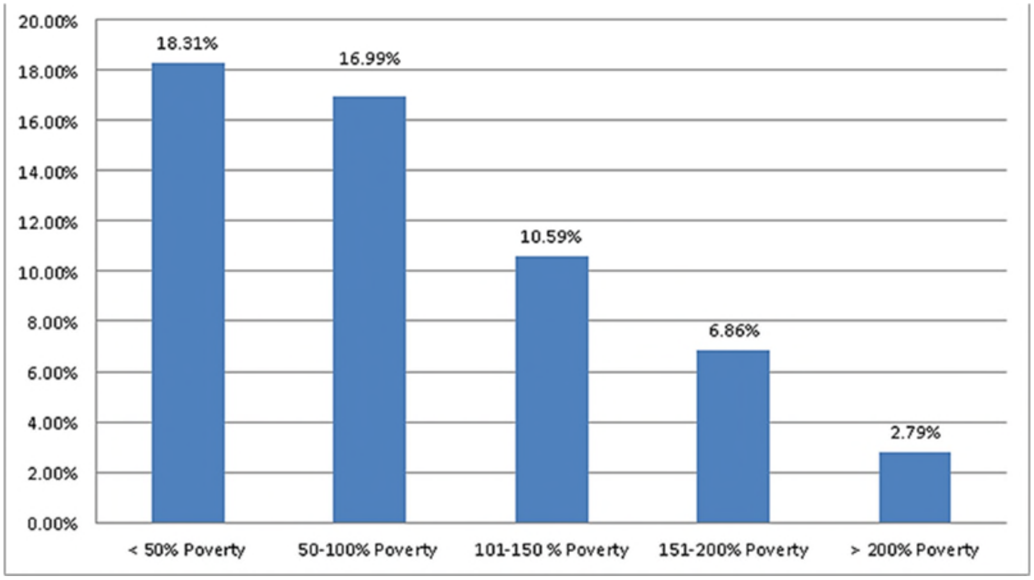

Figure 3-4. People in Households Without a Vehicle, 2016.

Source: Steven Ruggles, Katie Genadek, Ronald Goeken, Josiah Grover, and Matthew Sobek. Integrated Public Use Microdata Series: Version 7.0 [dataset]. Minneapolis, MN: University of Minnesota, 2017. https://doi.org/10.18128/D010.V7.0

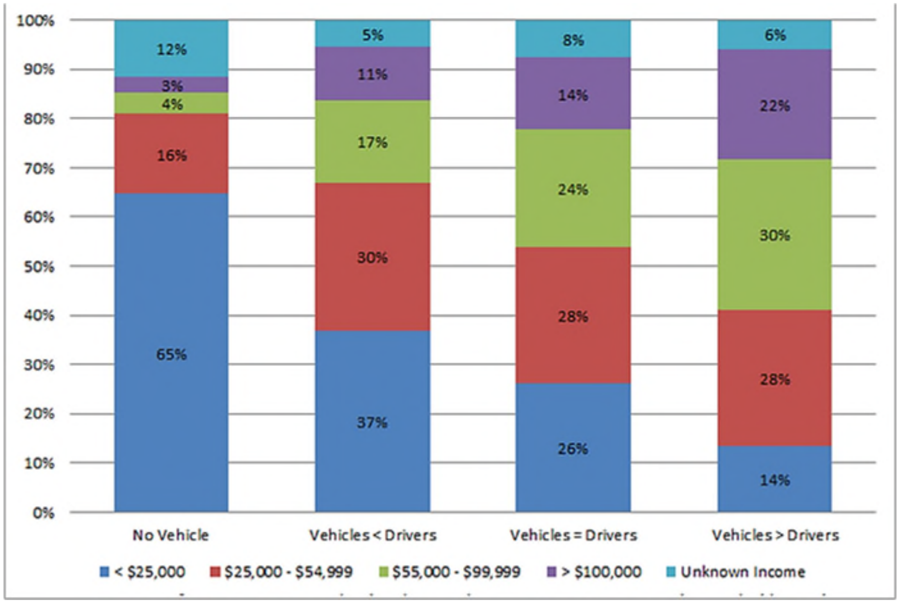

Figure 3-5. Number of Vehicles and Drivers by Household Income, 2009.

Source: U.S. Department of Transportation, Federal Highway Administration, 2009 National Household Travel Survey, household file as of April 2013. http://nhts.ornl.gov

Lower rates of vehicle ownership for low-income families is not surprising given the high cost of cars. The average transaction price for new light vehicles for January 2018 was $36,270[185] and the average retail price for a used vehicle in the third quarter of 2017 was $19,402.[186] The American Automobile Association estimates that the average annual cost of a new vehicle driven 15,000 miles per year is $8,469 and that the average annual cost of an EV is slightly lower, at $8,439.[187]

These costs are often greater for low-income families. Vehicle-related expenses not only represent a greater portion of household income, but they are often greater on an absolute dollar basis as well. Lower income families tend to drive older, less fuel-efficient cars with higher fuel costs. These families often pay much higher vehicle financing costs, with interest rates sometimes as much as 20 percent or 30 percent, even in the current low-interest rate market. And lower income families often live in neighborhoods with higher car insurance rates.

Current Vehicle Ownership and Usage by Income, Race and Geographic Location

While ownership and usage of vehicles varies by income, it also varies by race (Figure 3-6). Households of color have fewer assets than white households, but this difference is also due to a market where people of color are charged higher interest rates to finance cars even when they have the same credit worthiness,[188] are charged more for add-ons sold with vehicles,[189] are charged more for insurance,[190] and are likely charged more for the vehicles themselves.[191] The impacts of racism and poverty are likely to leave disproportionately more people of color without access to a vehicle.

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[185] Average New-Car Prices Rise Nearly 4 Percent for January 2018 On Shifting Sales Mix (Feb. 1, 2018) Kelly Blue Book. https://mediaroom.kbb.com/2018-02-01-Average-New-Car-Prices-Rise-Nearly-4-Percent-For-January-2018-On-Shifting-Sales-Mix-According-To-Kelley-Blue-Book

[186] Edmonds Used Vehicle Market Report Q3 (2017). https://static.ed.edmunds-media.com/unversioned/img/car-news/data-center/2017/nov/used-car-report-q3.pdf .

[187] These figures include financing costs (interest) and depreciation but exclude payments made toward the capital cost of the vehicle itself. American Automobile Association (2017).

[188] See, e.g., Ayers (June 2004), Cohen (2006), and CFPB enforcement activities at http://www.consumerfinance.gov/about-us/newsroom/consumer-financial-protection-bureau-to-hold-auto-lenders-accountable-for-illegal-discriminatory-markup/. See also Davis (2014), (documenting the self-reinforcing nature of discriminatory pricing: if non-white customers are charged higher prices at many dealers, then Finance & Insurance managers may have less reason to negotiate with them as they may be forced to accept higher prices out of necessity). See also Rice and Schwartz *(*2018) (testing showed that non-whites were more often offered more costly pricing options than their white counterparts despite being more qualified, whites were offered more financing options than non-whites, and dealers offered incentives, rebates and phone calls to personal contacts to lower interest rates and car prices for white testers more often than they did for non-white testers).

[189] Van Alst et al. (2017 (finding Hispanic shoppers were charged higher prices than non-Hispanics for vehicle add-ons).

[190] Angwin et al. (2017) (major insurers charge minority neighborhoods as much as 30 percent more than other areas with similar accident costs).

[191] Ayres and Siegelman (1995).

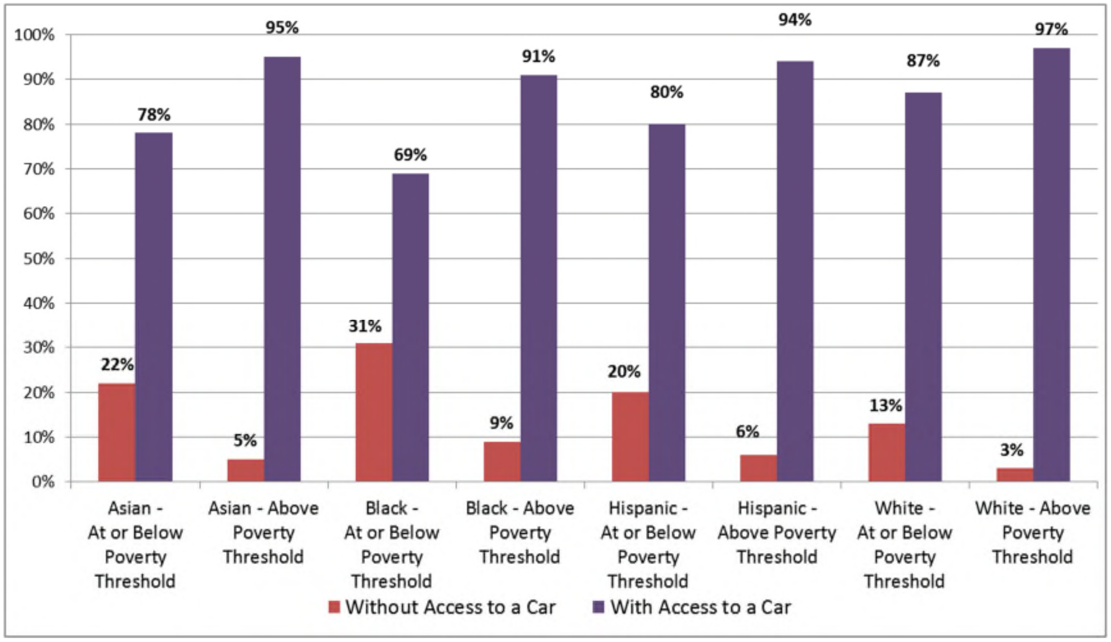

Figure 3-6. Households Without Access to a Vehicle by Race and Poverty, 2016.[192]

Source: Ruggles et al. (2016).

Rural households are less likely to be carless households[193] and may lack access to public transportation. Drivers living in rural areas tend to drive more miles per day than those in more populated areas.[194]

Trends with the potential to impact EV adoption and usage include:

- *Car sharing* - The growth of car-sharing services like Zipcar and Car2Go have made it easier for some households to own fewer or no cars.
- *Ride hailing* - The growth of ride-hailing services has the potential to dramatically change the way people use transportation. So far, ride-hailing appears to decrease use of public transportation and increase VMT.[195]
- *AVs* - When they arrive in earnest, AVs may decrease individual vehicle ownership, increase VMT, make charging infrastructure easier to develop, and decrease use of public transportation.

[192] Poverty thresholds are updated each year by the Census Bureau. For more information, see ASPE: https://aspe.hhs.gov/frequently-asked-questions-related-poverty-guidelines-and-poverty.

[193] Summary of Travel Trends, Vehicle, Use and Availability, Table 18., Distribution of Households by Household Vehicle Availability and Population Density, 1990 and 1995 NPTS and 2001 and 2009 NHTS.

[194] U.S. Dept. of Transportation Trends in travel behavior, 1969–2009, Federal Highway Administration (June 2011).

[195] See, e.g., Clewlow and Mishra (2017) and Metropolitan Area Planning Council (2018) (documenting "transit substitution").

- *Potential shifts to regressive fees and taxes to pay for transportation infrastructure* - Today the costs of building and maintaining roads is almost evenly split between driver-specific taxes and fees and general tax revenues, but this funding has been insufficient to maintain traffic infrastructure. Funding through user fees and taxes such as sales taxes, driver taxes and other fees tends to be more regressive. Increased reliance on toll road increases, user fees, private roads, congestion pricing, fuel taxes and other fees could impact EV adoption and the cost of both EV and ICE vehicle usage.

If there is a transition from ICE to EVs, no matter what the speed of adoption, absent substantial subsidies, it is likely that low-income consumers will be the last to switch. If EVs become demonstrably cheaper to own and operate than ICEs, it will lower the value of existing ICEs, making them more likely to be the vehicles purchased by low-income families.

Public Transportation

The amount of private VMT on public roads is at a record high,[196] while ridership on public transportation is declining despite increases in the U.S. population.[197] In many areas of the country, public transportation riders are more likely to have lower incomes and to be people of color.[198]

The decline in public transport ridership is probably attributable to falling fuel costs, the rise of ride-hailing and other factors. Since one of the expected benefits of EVs is reduced fuel costs, it is especially important to ensure that efforts to speed the adoption of EVs are not detrimental to public transport. Indeed, electrification of public transport and subsequent reductions in fares through reduction in fuel costs, maintenance cost and outright subsidization could help reverse public transportation declines.

4. What types of infrastructure will be needed to serve EV users, who should pay for it, and how will utilities recover their fixed costs?

Consumer infrastructure needs

If the transition to transportation electrification is to proceed in an equitable manner, policymakers, market participants and stakeholders must assess the need for charging infrastructure in low-income and underserved communities and make sufficient and cost-effective investments in these areas. Charging stations may not be the most immediate way to

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196 3.2 Trillion Miles Driven on U.S. Roads In 2016, New Federal Data Show Drivers Set Historic New Record, U.S. DOT, Federal Highway Administration (FHWA) Feb. 21, 2017.

197 American Public Transportation Association. Ridership Report. http://www.apta.com/resources/statistics/Pages/ridershipreport.aspx

198 See, e.g., Anderson (2016). (Americans who are lower-income, Black or Hispanic, immigrants or under 50 are especially likely to use public transportation on a regular basis). See also Hess (2012) (stating that in Los Angeles, 92 percent of bus riders are people of color and their annual median household income is $12,000).

help many low-income communities; the electrification of public transportation and school buses, and the expansion of other transportation options, may be more pressing needs in some communities.[199] Identifying likely needs, and sustained attention to the anticipated needs for charging infrastructure in low-income and underserved communities, are required.

As low-income households are more likely to live in multi-family or multi-unit dwellings, EV drivers who are tenants or residents of these buildings will need access to EV charging at home. Younger households, low-income households, and people of color are more likely to rent than are other demographic groups.[200] Only about 56 percent of cars have an off-street parking space,[201] and it is likely that an even lower percentage of low-income drivers have a dedicated off-street parking space. To facilitate transportation electrification, there is a need for home charging options in multi-family dwellings, and possibly sidewalk installations in some communities.

These needs have been addressed in many utility commission proceedings throughout the country, which have examined the utilities' roles in installing infrastructure and serving low-income consumers.

- In Florida proceedings, Duke Energy Florida agreed to install at least 10 percent of charging stations in low-income communities.[202]
- The California Public Utilities Commission (CPUC) authorized Pacific Gas and Electric Company (PG&E) to install and own make-ready infrastructure for most of its EV charging investments, but approved utility ownership of up to 35 percent of charging stations if located in disadvantaged communities or at multi-unit dwellings. The CPUC determined that this utility incentive was reasonable since disadvantaged communities and multi-unit dwellings have been more difficult to serve.[203] PG&E also was allowed to recover costs through retail rates of all utility customers.
- The Massachusetts Department of Public Utilities (DPU) allowed Eversource to invest up to $45 million in infrastructure, directing the company to prioritize publicly accessible locations and to apply environmental justice criteria when choosing sites, and agreeing to the company's proposal to deploy up to 10 percent of chargers in environmental justice communities. The DPU allowed these expenses to be rate-

[199] Specific transportation needs could be identified through a community mobility needs assessment, and by reviewing existing community needs assessments. See Greenlining Institute (2016).
[200] Joint Center for Housing Studies of Harvard University (2017).
[201] Traut et al. (2013).
[202] Florida Public Service Comm., Docket No. 20170183, Order No. PSC-2017-0451-ASEU (Nov. 20, 2017).
[203] California Public Util. Comm., Application 15-02-009, *Decision Directing Pacific Gas and Electric Company to Establish and Electric Vehicle Infrastructure and Education Program* (Dec. 15, 2016).

based after determining that bill impacts were reasonable given the potential benefits, in accordance with state law.[204]

Who should pay?

To the extent possible, infrastructure investment and related costs should not be passed along to utility ratepayers.[205] Private investment, government funding, settlement funds from the Volkswagen case, and other sources should be used first to pay for infrastructure. One argument to the contrary is that EVs will benefit everyone; therefore, it is fair to spread the costs to all ratepayers. For the reasons set forth earlier, it is not feasible or equitable to pass these costs along to low-income ratepayers who are the least able to afford higher utility bills and who, even with the increasing number of transportation electrification programs designed to serve vulnerable populations, are more likely to be late adopters of the new technology. It is in the public interest to seek other avenues of funding where possible. In addition, the argument about spreading the costs more broadly in order to advance climate and sustainability goals may be more appropriately addressed by a state legislature, in the context of considering budget allocations to support the transition to transportation electrification.

There will be instances when utility involvement may be the solution that best serves the public interest. Installation of make-ready infrastructure is a core responsibility of utility companies. And where adequate funding is not available to build and maintain infrastructure in low-income communities or multi-family housing, there may be more of a need for utility companies to step in.

Where utilities are involved, utility costs should be kept as low as possible while still providing sufficient infrastructure to support the transition to transportation electrification. Costs may be contained by limiting utility investment to make-ready infrastructure, unless access and equity concerns require otherwise (for instance, where private investment has not adequately served low-income communities and multi-family dwellings, as noted above).

Level 2 chargers may be installed at a relatively reasonable cost. These chargers may be the most useful type for home and workplace charging, as EVs can remain plugged into the charging station for hours to charge sufficiently. They also create a manageable amount of load and are less likely than fast chargers to cause grid management problems for the utility companies.[206]

In contrast, DC fast chargers (DCFC) may need to be deployed sparingly. These chargers are much more expensive to install and operate.[207] Ideally, DCFC infrastructure could be installed

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[204] Mass. Dept. of Public Util., D.P.U. 17-05, *Order Establishing Eversource's Revenue Requirement* (Nov. 30, 2017).
[205] For further discussion of costs, see Comments of the Maryland Office of People's Counsel on the Petition for Implementation of a Statewide Electric Vehicle Portfolio, Maryland PSC Case No. 9478 (March 27, 2018).
[206] Fitzgerald and Nelder (2017).
[207] Edison Electric Institute (June 2017).

and maintained without passing those higher costs along to ratepayers, and the costs could be borne by the consumers and commercial operators who use DCFC charging.

How will utilities recover their fixed costs?

Where initial utility investment will be significant, these early costs should be recovered in a fair and equitable manner, in light of the significant financial hardships already faced by low-income ratepayers. Low-income ratepayers continue to struggle to pay utility bills along with other necessities, even with help from bill payment assistance programs and benefits such as the Low Income Home Energy Assistance Program (LIHEAP). While transportation electrification offers broad societal benefits, the upfront costs of EV charging infrastructure must not exacerbate poverty and homelessness among our most vulnerable residents.

When attempting to allocate costs equitably, there are a number of utility cost recovery options. An EV-only tariff is one option for regulators to explore. Where cost-effective, dedicated rates for EV charging could spread a fair proportion of costs among early adopters, who are more likely to have higher incomes and are also receiving most of the benefits of EV ownership at this point. In order to make EV-only rates available to lower-income consumers, utilities could seek permission to allocate part of their infrastructure budgets to defray the costs of adding additional meters or Level 2 charging ports for low-income customers. Further, utility cost recovery could be amortized in a way to help ensure that added sales and revenues keep ahead of rate impacts, thus protecting the interests of those who do not purchase or operate EVs in the earlier years of the transition. Finally, "used and useful" cost recovery principles may be applied to ensure that ratepayers do not absorb all of the risk associated with utility investment in charging and grid-related infrastructure.

Where rate design cannot mitigate rate impacts for low-income ratepayers, regulators may consider additional bill payment assistance programs to keep electricity bills affordable for them. Discount rates already are offered in California, Massachusetts, Indiana and other states. Additional assistance programs could include percentage of income payment programs, arrearage management programs, and shut-off protections for vulnerable populations.[208] These programs could soften the impact of rate increases for the most vulnerable households, while allowing infrastructure investment to move forward.

5. What incentives should EV customers face to encourage right-time charging and discharging?

As indicated by the available data, EV drivers do most of their charging at home and during off-peak or evening hours.[209] TOU rates, dynamic pricing for EV charging, and technologies such as

[208] National Consumer Law Center, *Access to Utility Service,* ch. 7 (5th ed. 2011).

[209] Idaho National Laboratory (2015a) and Pepco (2016) (citing data from EPRI, *Pepco Demand Management Pilot for Plug-In Vehicle Charging in Maryland: Final Report—Results, Insights, and Customer Metrics* [May 5, 2016]). However, much of the existing data originates from research on small groups of early EV adopters.

timers may reinforce and continue this type of charging behavior. TOU rates may be structured as rates or as rebates for customers who charge at off-peak times and may allow customers to either opt in or opt out.

Several states have considered or adopted TOU rates for EVs including California,[210] Maryland,[211] Massachusetts,[212] New York[213] and others.

When discussing TOU rates, it is important to note that low-income households tend to differ in significant ways from higher income households, and these differences limit the likelihood that low-income ratepayers can benefit from TOU rates.[214] TOU rates may be confusing to many consumers, particularly to low-income consumers who are unfamiliar with this type of rate design. Further, there is a lack of data to show whether low-income consumers have benefited from TOU rates to date. One of the few analyses[215] of the impacts of TOU rates on low-income and other vulnerable consumers draws upon the Sacramento Municipal Utility District in California and Green Mountain Power in Vermont. This analysis indicates that some vulnerable customers saved money and some reported that they did not suffer discomfort as a result. Other vulnerable consumers reported differing results.[216] Due to limitations of the data, including the small size of the customers and months studied, it is difficult to draw broad conclusions about the impacts of TOU rates on low-income customers.

Since low-income consumers tend to conserve energy to lower their bills as much as possible, these customers have less ability to shift their energy usage to lower-cost periods. Also, low-

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210 California drivers have access to opt-in TOU rates and almost always pay less to charge EVs than they would have paid to fuel a gasoline-powered vehicle. San Diego Gas & Electric EV rates include options for either an EV plus home TOU rate or an EV TOU rate with a separate EV meter, and a rate structure to encourage drivers to charge at off-peak times and at times of high solar production. Union of Concerned Scientists (2017); SDGE, *EV Rates*, at https://www.sdge.com/residential/pricing-plans/about-our-pricing-plans/electric-vehicle-plans.

211 The Maryland Public Service Commission (PSC) had established EV tariffs that apply to Baltimore Gas and Electric and Pepco customers, but the PSC later found that the original time-varying rates, with a modest price differential to encourage off-peak charging, had not generated significant customer interest. The PSC expanded the scope of its grid modernization proceeding in January 2017 to consider EV issues and other rate designs including specific TOU rates for EV charging. Maryland Public Service Comm., *In the Matter of Transforming Maryland's Electric Distribution Systems to Ensure That Electric Service Is Customer-centered, Affordable, Reliable and Environmentally Sustainable in Maryland*, PC44, *Notice* (Jan. 31, 2017).

212 Eversource and the Massachusetts Department of Public Utilities (DPU) deferred creating EV charging TOU rates, determining that the company needs to first collect data before developing a new TOU rate. Eversource sought more data because it was concerned that EV charging at standard TOU rates could create a secondary peak. The DPU also emphasized that the company should be careful to avoid stranded costs as it determines what type of advanced metering to install at charging sites. Mass. Dept. of Public Util., D.P.U. 17-05, *Order Establishing Eversource's Revenue Requirement* (Nov. 30, 2017).

213 In upstate New York, National Grid offers a voluntary EV TOU rate, with on-peak, off-peak, and seasonal "Super-Peak" rates, and a bill credit in the first year if the TOU rate costs the consumer more than the standard rate. Customers who chose the TOU rate need an advanced meter and pay a fee of $3.36 per month for the meter. National Grid, *Nighttime is the Right Time to Charge Your EV*, at https://www.nationalgridus.com/Time-of-Use.

214 See Wood et al. (2016).

215 Cappers et al. (2016b).

216 Ibid.

income consumers are more likely to have irregular work schedules[217] that could affect their ability to shift electricity usage to off-peak times. Some consumers may rely on medical equipment that uses electricity and cannot shift times of use.[218] Low-income consumers also are less likely to own and use central air-conditioning, dishwashers and clothes dryers, which are less essential appliances that can be turned off during peak demand periods. In one pilot of TOU rates in Worcester, Massachusetts, evaluators found that low-income customers had much lower savings than the TOU pilot group as a whole.[219]

For a household that cannot shift its electrical load, TOU rates could result in higher bills. The customer bears the risk of understanding the rate and changing behavior accordingly. The following TOU rate designs could be considered to address the needs of EV drivers and protect low-income consumers:

- Opt-in TOU rates (though such programs tend to attract low numbers of consumers[220])
- Opt-out TOU rates with bill credits for amounts charged over the amount the customer would have otherwise paid
- EV-only TOU rates, which would not directly affect home electricity usage and billing
- Shadow billing, to compare TOU and volumetric rates

Advanced metering may be needed for certain TOU rates, but the cost of such meters for EV charging should not be passed on to nonparticipant ratepayers. Adopting TOU rates for EV charging using a separate meter, such as the National Grid TOU rate for upstate New York, is one possible approach. The cost of the meter could be paid by the homeowner. Where meters would be needed for low-income residences and multi-family dwellings, financial support from state or local governments or other sources could lessen the impact on low-income ratepayers. Utility commissions will need to consider whether standard TOU rates are sufficient, or whether EV-only TOU rates may be cost effective and appropriate in some circumstances.[221]

Utilities and private companies could provide discounted EV charging rates for low-income consumers. Such rates could be made available for home charging in single-family homes or multi-family dwellings where low-income EV drivers reside, and possibly at public charging stations.

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[217] Irregular work schedules and on-call work schedules are more common among low-income workers than higher income workers. Golden (2015).
[218] O'Connor and Jacobs (2017).
[219] Mass. Dept. of Public Utilities, Smart Grid Pilot Evaluation Working Group, D.P.U. 10-82, *National Grid Smart Energy Solutions Pilot, Interim Evaluation Report* (Feb. 22, 2016).
[220] Cappers and Scheer (2016).
[221] For instance, the Connecticut Public Utilities Regulatory Authority found that EV-only TOU rates are unnecessary and determined that existing whole-house TOU rates are cost-effective and provide positive benefits. Conn. Public Util. Regulatory Auth., PURA Investigation into the Implementation of Electric Vehicle Time of Day Rates for Residential and Commercial Customers, Docket No. 16-07-21, Decision (June 9, 2017).

6. What policy and regulatory approaches will:

- **Encourage efficient siting of charging stations — including fast-charging**
  Most EV charging is done at home and at off-peak hours. Efficient installation of charging stations at multi-family dwellings or in other locations in low-income communities may help achieve some equity and access goals, and be effective for encouraging EV adoption within disadvantaged communities.

  Public and workplace charging locations may provide access to a range of consumers, including low-income EV drivers. Charging stations at locations with extended hours that are frequented by low-income consumers and low-wage workers, such as hospitals and grocery stores, may also increase access if carefully chosen with guidance from the community. In some municipalities, charging stations in the parking areas of state and local government offices frequented by the public may help serve low-income community members.

  Data collection and analysis will be needed to make siting decisions that advance equity and access. Sources of data could include current transportation pilot projects, existing needs assessments, new community mobility needs assessments, focus groups, surveys and other sources.[222] For instance, the Maryland PSC allocated a portion of funds from the Exelon-Pepco merger to support an analysis of the gaps in EV charging infrastructure.[223] Other states may consider such creative sources of funding to study infrastructure needs and gaps.

  DCFC stations are more expensive to install and operate than are Level 1 or Level 2 stations,[224] and may not be necessary on a daily basis for most EV drivers.[225] However, as fast charging may be needed for certain applications, careful assessment of the need for DCFC and possible grid impacts will be necessary. To the extent possible, these expenses should not be passed along to ratepayers.

- **Enable utilities to participate in infrastructure deployment**
  Consumer advocates generally would not presume that utility involvement in infrastructure deployment should be promoted, other than instances when utility involvement is in the interest of consumers.[226]

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[222] The Greenlining Institute (2016).
[223] Maryland PSC, Letter Order Regarding Most Favored Nations Funding to Support Public Conference 44 Electric Vehicles Work Group Activities, Case No. 9361, Order No. 88128 (Oct. 6, 2017).
[224] Illinois Citizens' Utility Board (2017).
[225] In one study of workplace charging, employees usually used Level 2 chargers and charged with DCFC mainly for emergencies. Idaho National Laboratory (2015b).
[226] See, e.g., Comments of the Maryland Office of People's Counsel on the Petition for Implementation of a Statewide Electric Vehicle Portfolio, Maryland PSC Case No. 9478 (March 27, 2018).

Utility involvement in infrastructure development can take many forms. Utility company deployment of make-ready infrastructure may limit the costs that are rate-based and passed along to consumers. Where more extensive utility involvement may be needed to reach low-income communities or residents of multi-family homes, regulators will need to carefully consider the benefits of such involvement, weighed against any additional cost to ratepayers. However, depending on the state, cost recovery for infrastructure development and operation may not be permissible in the absence of legislation to define the parameters of utility involvement and any allowable cost recovery.[227]

Depending on needs of the region, regulators may consider directing utilities to allocate significant amounts of infrastructure deployment funds toward low-income, underserved and environmental justice communities. Regulators should consider conducting technical sessions, listening sessions or other means of gathering stakeholder input.

As part of infrastructure deployment, utility investment in advanced metering infrastructure (AMI) should be considered very carefully and should be implemented in the most cost-effective manner possible to minimize residential electricity bill impacts. Additionally, AMI should never be used to remotely disconnect low-income and other vulnerable customers from service for nonpayment, or to limit electricity service for nonpayment. Remote electricity disconnections create serious risks for the health and safety of consumers. Further, remote disconnections should not be used to circumvent legal protections for vulnerable consumers, such as protections from disconnection for elders or for people with serious illnesses.[228] Lower income consumers live with the threat of having their electricity shut off when financial challenges arise, and low-income people of color are at a disproportionate risk for having their utilities disconnected.[229] Low-income consumers who drive EVs and charge them at home will necessarily see higher electric bills and will need additional protections from disconnections, to avoid depriving these households of light, heat, refrigeration, home energy and transportation all at once during financial struggles. Protections from disconnection exist in several states, and some aim to help certain populations such as older consumers or people with illnesses or disabilities. Other states protect low-income consumers during extreme weather.[230] Commissions should consider additional

[227] E.g., Massachusetts General Laws, ch. 25A, section 16(f) (allowing for cost recovery of utility involvement in infrastructure deployment when ". . . a proposal is in the public interest, meets a need regarding the advancement of electric vehicles in the commonwealth and does not hinder the development of the competitive electric vehicle charging market.")
[228] Howat and McLaughlin (2012).
[229] NAACP Environmental and Climate Justice Program (2017); Howat (2015).
[230] National Consumer Law Center, Access to Utility Service, Appx. A (6th ed. 2018), updated at www.nclc.org/library .

protections for low-income consumers who rely on electric service for transportation, and for additional family needs as broader strategic electrification proceeds (for example, for space heating and water heating), possibly by including such protections in utility tariffs.[231] These protections will be even more essential in states that do not currently have strong protections from disconnection.

- **Foster competition by competitive EV charging providers**
  Consumers might benefit if competition drives down prices at charging stations. Drivers who use charging stations that are owned by third-party companies will need consumer protections such as protections from unreasonable pricing, rules to prevent disparate pricing in low-income communities and communities of color, privacy and security of financial information, and straightforward access to customer service and dispute resolution. Legislation and regulation may be needed where voluntary measures fail.

  Interoperability and eventual standardization of charging plugs will foster competition and benefit consumers.

  Keeping utility development and operation of infrastructure to levels consistent with the public interest would allow private infrastructure investment to proceed concurrently while limiting utility costs that would later be recovered from utility customers.[232]

- **Establish enforceable standards to facilitate consumer adoption of EVs**
  Consumers may begin to use EVs through individual ownership, leasing, car-sharing, public transportation and other methods. To foster individual ownership among low-income consumers, state-supported ownership and leasing incentive programs could be expanded to provide more significant subsidies for low-income consumers, as California has recently done through the increased rebates for low-income consumers made available through the California Clean Vehicle Rebate Program.[233]

  Low-income consumers also could be offered discounted EV charging rates. If cost-effective, separate EV charging rates and billing may also ease the transition for low-income consumers who would charge vehicles at home, at a single-family home or a multi-family dwelling. Commissions and utility companies could consider discounted EV-only electricity rates for low-income ratepayers as a way to incentivize equitable EV adoption.

  Financial assistance and targeted consumer protections could encourage low-income consumers to own or lease EVs where economically feasible. Low-income consumers

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[231] Depending on the jurisdiction, utility commissions could also consider new regulations to protect low-income ratepayers who face disconnection. In some states, legislation might be needed.
[232] See National Association of State Utility Consumer Advocates, Resolution 2018-02, *Urging the Adoption of Policies and Regulations to Protect Ratepayers as Electric Vehicle Adoption Rates Increase* (June 25, 2018).
[233] California Clean Vehicle Rebate Project. Drive Clean and Save. https://cleanvehiclerebate.org/eng

who would be able to take advantage of incentive programs to purchase or lease an EV may need the security of additional protections from utility disconnections.

Low-income bill payment assistance programs, such as payment plans or arrearage management programs that help low-income consumers catch up on bills, should also be considered by utility commissions. These programs can help low-income consumers stay connected to their electric service while paying back arrears.

Rate design should exempt consumers from demand charges. Demand charges present tremendous challenges for residential and other lower-volume consumers. They are complex, difficult to understand, and do not present "actionable price signals to small consumers without investment in demand control technologies or very challenging household routine changes. This results in effectively adding another mandatory fixed fee to residential and small consumer electric bills."[234] Non-coincident peak demand charges in particular are not an appropriate means of incentivizing "beneficial" EV charging. Well-designed TOU rates, accounting for territory-specific generation mix, dispatch, transmission constraints, and other relevant circumstances are preferable from both consumer and transportation electrification perspectives.

- **Address underserved markets**
  The consumer protections, rate design, and bill payment assistance programs discussed above may help increase EV use among low-income consumers and encourage continued EV use by these consumers after they purchase or lease vehicles. But many low-income people, absent a subsidized EV acquisition program, will either not be able to afford to transition to an EV or will be unable to afford a private vehicle at all. Subsidy programs must be designed to meet the needs of low-income drivers, and policymakers may need to consider higher levels of subsidies for low-income drivers. The subsidy must be in a form that is useful to potential low-income EV buyers.[235] It needs to be available at the time of purchase, not at some later date, and must avoid the possibility of dealer capture. Car dealers, through a number of abusive tactics, regularly overcharge low-income consumers for cars, associated add-ons, and financing. Often the scope of the abuses is limited only by how much credit finance companies are willing to extend. An extra amount of money, such as an EV purchase subsidy, can easily become just more money for the dealer rather than serving to make the vehicle more affordable for the consumer.

  Individual ownership or leasing will not be feasible for all low-income and disadvantaged consumers. While these families may not be able to afford a car even with subsidies,

[234] Chernick, et al. (2016), 1; Wood et al. (2016).
[235] For example, the federal Qualified Plug-in Electric Drive Motor Vehicle Credit is a nonrefundable tax credit and so of less or perhaps no real use to a consumer with a lower tax liability.

there may be other ways to meet some of their mobility needs. Subsidized car-sharing programs that serve low-income consumers, such as Sacramento's Community Car Share Program, may increase the use of EVs but are currently small pilot projects. Increased investment in public transit, subsidized car-sharing programs, or subsidized ride sharing programs can meet the needs of some low-income families unable to acquire their own car.

When developing these programs, it is essential to follow the lead of stakeholders in low-income communities, communities of color, communities with environmental justice concerns, and other underserved and vulnerable communities. Stakeholder input, along with data collection from existing pilots and needs assessments, should guide implementation. Environmental justice analysis should also guide decisions about siting charging stations, electrifying public transportation and school buses, and electrifying commercial and industrial transportation.

Conclusion

The transition to transportation electrification must proceed with equity and access for consumers at the forefront. Failure to do so would not only lead to preservation or exacerbation of existing inequities, but may also undermine public support for transportation electrification.

Our suggested consumer protection principles — to increase transportation access and security for low-income consumers, equitably allocate costs and benefits for low-income consumers, and reduce air pollution — provide a framework for this analysis.

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