Accelerating the Electric Vehicle Market

Potential Roles of Electric Utilities in the Northeast and Mid-Atlantic States

MJB & A

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Executive Summary

The electrification of the transportation sector is viewed by many policymakers and stakeholders as a critical strategy to reduce greenhouse gas emissions while at the same time providing substantial economic and environmental benefits to electricity consumers and society as a whole. Historically, many consumers have been discouraged from purchasing electric vehicles due to their initial purchase price and “range anxiety” (concern that the range of the vehicle will limit the distance a driver can travel). Despite these obstacles, the electric vehicle market is rapidly approaching a tipping point as vehicle purchase prices continue to fall, public charging stations become more commonly available, performance improves, and auto manufacturers develop models with ranges over 200 miles. However, more needs to be done to accelerate the adoption of electric vehicles in line with state zero emission vehicle targets and to achieve medium- and long-term state greenhouse gas reduction goals.

Electric utilities are well-positioned to help transform the electric vehicle market through the development of transportation electrification programs in partnership with other market participants. Utilities have the potential to accelerate market transformation and pave the way to widespread transportation electrification.

Electric utilities can partner with others to conduct outreach and education campaigns to improve consumer awareness of electric vehicles and the benefits of ownership.

There is no coordinated educational campaign around electric vehicles from auto manufacturers, car dealerships, electric utilities, and state agencies. Utilities could work cooperatively with auto manufacturers and dealerships to provide current information to consumers about vehicle purchase incentives and charging options. Electric utilities could also be instrumental in providing consumers with information about charging rates and programs that benefit the grid and provide energy cost savings. Utilities have been successful in transforming markets in the past by harnessing existing customer relationships and forging new partnerships. For example, direct utility outreach to customers, together with coordinated energy efficiency campaigns, have proven to be instrumental for the adoption of energy efficiency and the development of the energy efficiency market itself.

Targeted investments by electric utilities can start to make public charging infrastructure ubiquitous.

Increased availability of charging stations will make electric vehicle ownership more attractive to a broader population and accelerate uptake of the technology. Consumers will require convenient away-from-home charging options at workplaces, public shopping centers, and along high traffic corridors. Electric utilities could play a critical role in accelerating the deployment of vehicle charging stations. Utility investment in charging infrastructure can vary from a “make-ready” approach to an “owner–operator” approach. Under the make-ready approach, the utility invests in the electrical infrastructure and upgrades necessary at the site, while the site host is responsible for the procurement, installation, and ownership of the charging station itself. Alternatively, with the utility owner–operator model, the utility invests in all the electrical equipment and infrastructure upgrades, as well as the station itself.

Utilities can provide customer incentives to manage charging load and design rates that will lower energy bills for consumers.

The market for electricity as a transportation fuel lacks clear and transparent charging rates and programs. Electric utilities can design and implement appropriate rates and pricing for electric vehicle charging that will benefit the utility and customers. Currently, most electric vehicle charging occurs at home, but as electric vehicle ownership grows from early adopters to the broader market, workplace and public
charging will become more important. Utilities can provide rates and program options for residential charging to occur during off-peak hours as well as pricing options and programs for public charging sites. Public charging locations will also need to determine customer-facing pricing systems. To offer these programs, utilities will need to determine who will set the rates and how rates will vary by host site and charging type (i.e., different energy capacities and charging rates).

In reviewing infrastructure proposals, utility commission cost-benefit analyses should consider benefits to the owner, all customers, and society as a whole.

Ultimately, in order for the utility to invest in charging infrastructure, their costs will need to be recovered while earning a fair return on the investment. Due to the uncertainty of charging infrastructure usage levels, a traditional cost-benefit analysis for utility infrastructure investment may show costs outweighing benefits. However, this analysis should include additional benefits, including electric vehicle driver energy and maintenance cost savings and the societal value of greenhouse gas emission reductions. For example, electric vehicle drivers will spend less money to power their vehicles with electricity and save money on vehicle maintenance. Tailpipe emissions can be dramatically reduced or eliminated by switching to hybrid electric and all electric vehicles, including ozone precursors and greenhouse gas emissions, providing local air quality and climate benefits. Cost-benefit analyses should also account for higher revenues associated with increased electricity sales and improved overall system utilization, which puts downward pressure on electricity rates for all utility customers.
Introduction
The transition to plug-in electric vehicles (PEVs) promises numerous economic and environmental benefits to consumers and society at large.\(^1\) Research shows that PEVs already produce lower air pollution emissions than conventional gasoline vehicles, and as electricity sources become cleaner the benefits of PEVs compared to gasoline vehicles will grow and provide broad environmental benefits.\(^2\) In addition, increased electricity sales associated with charging PEVs will spread utility distribution costs across a larger volume of electricity sales, putting downward pressure on electricity rates, benefiting all electricity consumers. Despite these broadly shared advantages, however, PEV adoption rates continue to be hampered by insufficient consumer education and awareness, suboptimal charging rate design, and inadequate public charging infrastructure.\(^3\)

While auto manufacturers are offering an increasing number of vehicle models, with longer range and competitive prices, current sales are highly dependent on situational factors, such as dealer promotions, customer familiarity with the technology, and local inventory levels. Utilities can play a supportive role in broadening PEV adoption. Utilities are already offering charging rate pilot programs, largely to residential customers, and evaluating how to best manage any possible distribution-level impacts associated with charging during different times of the day. They are working in collaboration with charging station providers, automakers, private businesses, and other partners to develop electric vehicle charging networks. And they can use existing networks and relationships to help improve customer awareness of electric vehicle benefits, purchasing programs, and opportunities. To further expand and build upon these initiatives, policy action is necessary to put frameworks in place to transform the market for electric vehicles.

All of the New England states, New York, New Jersey, and Maryland have established economy-wide goals for reducing greenhouse gas (GHG) emissions, with most aiming to cut emissions 80 percent below 1990 levels by 2050. This implies a major transformation in the region’s energy system, including transformations to the electricity and transportation sectors. Eight northeast states are also implementing the California Zero Emission Vehicle (ZEV) regulations, which aim for having over three million ZEVs on the road by 2025.\(^4\) It is unlikely that states will achieve these goals without sustained efforts to educate consumers, promote charging rate designs that increase benefits for customers and the grid, and build out public charging infrastructure to address range anxiety.

State policymakers have leveraged the scale and scope of utilities to advance public policy goals in the past (e.g., in energy efficiency and renewable energy) and can once again to achieve near-term ZEV targets as well as medium and long-term economy-wide climate goals. Utilities are an ideal partner for states in these efforts: they are a trusted and reliable provider of electricity; have access to capital; and have unmatched expertise in electricity infrastructure, grid operation and management.

This white paper is intended to serve as a resource for Northeast and Mid-Atlantic policymakers and stakeholders on the current status of the PEV market, market barriers, and the potential role of electric utilities in transportation electrification programs.

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1 The term PEV is used throughout the document for plug-in hybrid electric vehicles and battery electric vehicles.
3 High electric vehicle purchase prices and low vehicle range are also largely cited as major barriers to market growth, but are not directly addressed in this paper.
4 Mid-Atlantic and Northeast ZEV states include: Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Rhode Island and Vermont.
State Climate and ZEV Goals

All of the New England states, New York, New Jersey, and Maryland have established economy-wide goals for reducing GHG emissions, with most aiming to cut emissions 20 to 40 percent from 1990 levels by 2030 and 80 percent by 2050. This implies a major transformation in the region’s energy system, including transformation of the electric and transportation sectors.

Figure 1  Region at a Glance

To date, shifting from coal and oil to natural gas has been the primary source of carbon dioxide (CO₂) emissions reductions for the electric sector in the Northeast and Mid-Atlantic. The transportation sector is now the leading source of CO₂ emissions within the region, representing 30 to 40 percent of total economy-wide emissions in these states. Figure 2 depicts historic economy-wide CO₂ emission trends from Northeast and Mid-Atlantic states. As the electric system continues to decarbonize, electricity will provide opportunities for achieving emissions reductions more broadly across the economy by switching from gasoline-powered vehicles to PEVs.

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Throughout this paper, we use the following classifications of charging station types:

- **Level 1**: a typical home outlet (120 V); does not typically require additional charging equipment to deliver charge
- **Level 2**: a charger that can provide up to 240V, typically providing output at 6 – 19 kW
- **DC Fast Charging (DCFC)**: charge provided through a 480V direct current (DC) plug, typically with a max output at around 50 kW; multiple models commercialized

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*Includes fuel cell, all-battery, and plug-in hybrid electric vehicle sales from January 2011 through August 2016

Source: DOE Alternative Fuels Data Center
Recent studies have concluded that deep reductions in transportation sector emissions are only achievable through a dramatic shift away from gasoline vehicles to low-emitting, plug-in hybrid electric vehicles or battery electric vehicles.  

Sections 209 and 177 of the Clean Air Act allow California to implement its own motor vehicle emissions standards and other states to adopt these standards, respectively. California has adopted standards that include ZEV targets, requiring an increasing share of vehicles sold to be ZEVs. ZEVs generally include battery electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles. Currently, nine states in addition to California are implementing the ZEV regulations: Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont. In addition to adopting California’s ZEV requirements, the Governors of California, Connecticut, Massachusetts, Maryland, New York, Oregon, Rhode Island, and Vermont in 2013 signed the Zero-Emission Vehicle Memorandum of Understanding (ZEV MOU). In signing the ZEV MOU, the Governors agreed to implement policies and programs that would result in the collective deployment of 3.3 million ZEVs by 2025, along with the necessary charging infrastructure. In order to attain this ZEV target, electric vehicle sales would have to increase 400 percent over 2014 levels over the next decade. The MOU also established a ZEV Task Force which has been successful in developing and implementing actions to encourage alternative vehicle adoption, including state vehicle purchase incentives, focusing on workplace charging, promoting infrastructure deployment at public sites, and working towards equitable access to charging stations. Figure 3 below provides the 2025 ZEV targets and levels of PEV registrations for each of the ZEV MOU states.

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While many states have programs to encourage ZEV adoption, including financial rebates and incentives for purchasing electric vehicles and installing charging stations, these programs will need to be complemented with other targeted initiatives to build customer awareness, optimize charging rates, and accelerate the public charging market in order to achieve the level of market transformation necessary to achieve the ZEV goals.

In an effort to help the region meet its transportation-related climate goals, the Transportation Climate Initiative (TCI) developed the Northeast Electric Vehicle Network in 2011 as a platform for PEV stakeholders in Northeast and Mid-Atlantic states to collaborate on goals and strategies to break down barriers to PEV adoption in the region. Specifically, the Network serves to create public-private partnerships focused on PEV issues, streamline PEV infrastructure permitting, identify optimal charging station locations, and enhance PEV driver experience. The U.S. Department of Energy provided the Network with a PEV readiness grant of almost $1 million which is shared among TCI states and helps fund actions to support Network initiatives. In November 2016, the U.S. Department of Transportation designated several interstate highways in the TCI region as Electric Vehicle Corridors. The corridor designation is expected to both accelerate private investment in electric vehicle infrastructure and bring additional federal support in the future.

Current State of the PEV Market

In 2016, just over 160,000 electric vehicles were sold in the U.S. This brought total PEV sales since 2010 to over 556,000 vehicles. However, PEVs still make up less than 1 percent of total vehicle sales in the U.S. Consumer demand for electric vehicles has risen as more people have come to appreciate the benefits of PEV ownership: lower maintenance costs, falling retail prices, and cheaper per-mile travel, as well as the environmental benefits of supporting low-emission travel. Similarly, federal and state policies and incentives are becoming more common and serve to encourage investments in electric vehicles and infrastructure to help support national and local

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8 The TCI is a regional collaboration of 12 Northeast and Mid-Atlantic jurisdictions that seeks to develop the clean energy economy and reduce GHG emissions in the transportation sector. Transportation, energy, and environment agency heads from the following jurisdictions participate in TCI: Connecticut, Delaware, District of Columbia, Maryland, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.
climate goals while bringing economic benefits. Vehicle manufacturers have begun to respond to this growing demand as a business opportunity (especially in the luxury segment) and have invested capital and resources to develop more attractive options for consumers.

In response to the growing demand and local policy actions, the automotive industry has made significant progress in developing viable PEVs in the last 5 years and continue to offer new models with better performance. In 2010, there were only two PEV models commercially available from major auto manufacturers. Today there are more than 25, with 32 models to be available by the end of 2017. Moreover, car manufacturers, including Ford, Toyota, BMW, Volkswagen, Hyundai, Jaguar, and General Motors, have announced investments in electric vehicle research and development and additional releases of new electric models in the 2020-2025 timeframe, making a future centered on electric transportation a viable near-term reality.

While the current generation of electric vehicles has proven to be reliable and appealing to a number of early adopters, more widespread adoption continues to be hampered by comparatively high upfront costs (despite an often lower total cost of ownership compared to a gasoline vehicle), as well as perception of their limited range. Nevertheless, Bloomberg New Energy Finance projects that by 2040 electric vehicles will make up 35 percent of annual new vehicle sales and will cost less than $22,000, largely due to declining battery costs. Figure 4 depicts the historic cost trend of lithium-ion batteries and Bloomberg’s estimated price trajectory.

Research and analysis conducted by the International Council on Clean Transportation finds that multiple factors, including electric vehicle model availability and consumer financial incentives, are statistically linked to increases in PEV sales. As these conditions improve in the coming years, significant growth in PEV sales can be anticipated. U.S. federal and state policies and incentives will help boost the likelihood for widespread consumer adoption of electric vehicles by providing the resources to help residents and businesses take the leap to electric vehicle transportation and encouraging stakeholders to make investments to support early adoption. These


incentives play a key role in raising awareness and in making PEV adoption more accessible to average consumers or businesses.

According to data from the PEV Project, 80 percent of all PEV charging occurs at home, typically overnight. The remaining 20 percent occurs away from home during trips throughout the day. However, this charging profile reflects the early-adopter population which largely consists of single-family homeowners with limited access to convenient charging outside the home. To grow the PEV market, convenient charging will likely need to be available at a wide range of public locations, and multi-unit residential dwellings where a substantial portion of potential urban PEV drivers live. Engagement on making public charging more widely available can increase consumer confidence in PEV charging.

According to DOE, there are now 14,417 public electric vehicle charging stations (36,172 charging outlets) in the U.S., with about 20 percent of these stations located in the Northeast and Mid-Atlantic states. The vast majority of these charging outlets are Level 2 (82 percent) followed by DC fast chargers (DCFC) (11 percent) and Level 1 (7 percent). Figure 5 depicts the number of charging stations by type in Northeast and Mid-Atlantic states. Some of these states have incentives in place to encourage electric vehicle supply equipment (EVSE) deployment and reduce the capital costs which are a major barrier in charging station deployment for potential site hosts.

![Figure 5: Charging Stations Installed in the Northeast and Mid-Atlantic States by Type](source: DOE Alternative Fuel Data Center, MJB&A Analysis.)

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11 The EV Project is a public/private partnership partially funded by the Department of Energy which involved the deployment of over 12,000 AC Level 2 (208-240V) charging units and over 100 dual-port DC fast chargers in 20 metropolitan areas over two years. Approximately 8,300 PEVs were enrolled in the project. During the data collection phase of the project (January 1, 2011 - December 31, 2013), EV Project researchers collected and analyzed data from participant’s vehicles and/or charging units, capturing almost 125 million miles of driving and four million charging events.

12 PEV charging stations typically have more than one port to connect to a PEV.
**Current Market Barriers**

Although federal and state-level policies and incentives are in place to help encourage PEV adoption, there are still market barriers impeding the widespread adoption of electric vehicles today. The three considered here are: (1) lack of consumer awareness; (2) lack of reliable and convenient vehicle charging infrastructure; and (3) issues related to load management and electric system impacts.

**Consumer Awareness**

As a relatively new technology, consumers are often unfamiliar with the ins-and-outs of PEV ownership, including the vehicle models currently available, financial incentives offered at the federal and state levels, the costs of PEV ownership, and charging options and locations. Increased adoption of PEVs will require that all of these elements be well understood by consumers, especially as automakers continue to expand their electric vehicle offerings and 2025 ZEV targets approach.

Recent studies conclude that electric vehicles can be more cost-effective than internal combustion engine (ICE) vehicles on a per-mile basis, taking into account the purchase price and lifetime operation and maintenance costs of vehicles of all fuel types.\(^{13}\) For example, with incentives, the total cost of ownership of a conventional 2015 Toyota Camry is $0.58 per mile, and the all-electric Nissan Leaf is $0.45 per mile. Without incentives, the Nissan Leaf would have a total cost of ownership of $0.65 per mile.\(^{14}\) Figure 6 shows the output of a tool created by the Massachusetts Institute of Technology (MIT) that helps compare the per mile costs of various vehicle types.\(^ {15}\)

A function primarily of avoided cost of gasoline and lower vehicle maintenance costs, this lifecycle cost advantage for electric vehicles may be obscured for some customers by the higher average purchase price for a new electric vehicle compared to that of a gasoline vehicle. This is being addressed through federal tax incentives and multiple state programs that offer rebates for the purchase or lease of a PEV. Informing consumers on the available PEV purchase rebates and incentives is thus often critical to encouraging the purchase of an electric vehicle.

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**Figure 6**  
MIT’s Vehicle Comparison Tool Allows Comparison of Per-mile Costs and Emissions by Vehicle Type

MIT’s Institute for Data, Systems, and Society released a report, “Personal Vehicles Evaluated against Climate Change Mitigation Targets” in 2016 finding that transportation emission reduction goals in line with climate change mitigation targets through 2050 are only achievable through a dramatic shift away from internal combustion vehicles, to low-emitting, all electric vehicles. The report also finds that low-emission vehicles are the most cost effective on a per-mile basis and developed the interactive Carbon Counter tool to compare and visualize cost and emissions of various vehicle types. In this graphic, yellow dots represent battery EVs.

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\(^{14}\) Bloomberg New Energy Finance. Advanced Transport Presentation. November 30, 2016. Total cost of ownership is based on $0.125/kWh electricity and $2.50/gal fuel prices. 10,100 miles driven per year, and is calculated over the first 5 years of ownership.

\(^{15}\) MIT’s Carbon Counter tool is available at [http://carboncounter.com/](http://carboncounter.com/).
In some cases, financial incentives can bring the initial price of a PEV down below that of a comparable gasoline vehicle. For example, a new 2017 Chevrolet Volt in Massachusetts has a retail price of $33,220, but would be eligible to receive the federal tax credit of $7,500 as well as a $2,500 rebate from Massachusetts’s MOR-EV program.16 This brings the final price of the vehicle to $23,220, comparable or even significantly less than a comparable gasoline-powered vehicle. Raising awareness of these financial offerings and highlighting the immediate savings, as well as the potential lifetime savings of PEV ownership, can help more customers see the value in switching to an electric vehicle.

While current models of electric vehicles do have less driving range than gasoline cars, plug in hybrid vehicles provide drivers with the security of added range, and automakers are extending electric vehicle range as battery technology and costs continue to improve. Realizing a future where electric vehicles with extended ranges are available at lower cost is in part dependent on a growing supply and demand of PEVs that can support both better economies of scale and additional technology research. And yet, as discussed in more detail below, lack of public electric vehicle supply equipment is still at the root of some hesitation in convincing customers to take the leap to electric transportation—the classic “chicken-and-egg” dilemma. Compared to the ease of pulling up to any gas station and knowing exactly how to refuel your car, electric vehicle fueling can also appear complex, especially in this early stage of adoption, leading potential consumers to feel apprehensive about purchasing an electric vehicle. Education and outreach from vehicle manufacturers, EVSE suppliers, utilities, auto dealerships, and owner clubs can help to ease these concerns and increase familiarity with how electric vehicle charging works and how it can easily be integrated into daily life.

Availability and Confidence in Public Charging Infrastructure

Many consumers have concerns about the range limitations of the current generation of electric vehicles, particularly as a factor limiting their ability for long-distance travel.17 Addressing “range anxiety” through installation of adequate public charging infrastructure is a broadly recognized requirement to support the transition to electric transportation. Effective mitigation of range anxiety will require (1) widespread deployment of charging stations so drivers can be confident in their ability to access a charging station, and (2) vehicle models with longer driving range.

While residential charging is foundational for any transportation electrification system, non-residential charging options will also be necessary to address range anxiety issues and enable long-distance travel. In addition, public charging infrastructure in apartment complexes and other multi-unit dwellings have been identified as a critical issue for increased PEV adoption.18 Strategic placement in each of these targeted locations is needed to improve accessibility and ensure that location specifics such as pricing structure and participation model are optimized for the likely customer base.

Pilot programs designed to test the feasibility and effectiveness of various business models have shown that location is a key factor in influencing charging behavior and making PEV ownership more practical. For example, placing DC fast chargers along main highway corridors gives drivers greater confidence in taking long-range trips. Installations at long-dwell locations such as workplaces provide drivers the ability to charge or top off their vehicle as necessary to further extend vehicle range, as well as providing options for customers who lack charging at their home.

Finally, the reliability of the EVSE is of paramount importance. Consumers will at least occasionally depend on

16 The Massachusetts Offers Rebates for Electric Vehicles (MOR-EV) program provides rebates of up to $2,500 for the purchase or lease of zero-emission and plug-in hybrid light-duty vehicles. More information is available at https://mor-ev.org/
18 Ibid.
public charging infrastructure to sufficiently charge their vehicle. Therefore, consumers must have the confidence that the EVSE network is maintained and will function when needed. Different business models applied here create a situation in which ownership of the charging station may differ from the entity who maintains the station, and these entities may be separate from the site host. This disconnect could pose a risk down the road to meeting charging needs and providing a positive experience for PEV owners.

**Load Management and System Impacts**

In the near term, the impacts of PEV charging on the electric distribution system are likely to be small. However, as PEV penetration increases, the added demand for electricity (load) could increase grid costs if certain locational concerns are not anticipated and addressed. Even at lower vehicle penetration levels, impacts could occur in neighborhoods where multiple PEVs are charging simultaneously (called “clusters”). These concerns increase as electric vehicle battery sizes and EVSE charging capacities increase over time.

As electric vehicle technology advances, the market may also include a larger number of public fast charging stations (50kW per port, or even higher). Because DC fast charge stations draw significantly more power, these stations can add significantly to electric system loads at host sites. Many observers have identified this issue as a potential barrier to DC fast chargers and some are evaluating alternative rate structures, technologies such as storage, or demand response opportunities and configurations to mitigate demand charges for electric vehicle owners.

Many new or potential PEV owners with home charging will likely plan to do most of their charging at home, expecting this energy consumption to increase their monthly electric bill—but by an unknown amount. Simply adding additional PEVs to the system, without managing when vehicles charge, has the potential to dramatically increase the costs to the broader electric system. A recent report evaluating the effect of PEVs on California’s electric system found that without charging behavior management, PEVs could increase the afternoon ramp-up of demand by up to 1.6 percent in 2020.\(^{19}\) This period of peak demand is when electricity costs are generally at their highest.

Instead, effective load management can help utilities flatten the daily load curve by shifting PEV charging to fill in troughs in demand (and avoid stressing the grid or adding to existing peak demand). This is good for both the PEV customer and all electricity customers, regardless of the type of vehicle they own. Properly managed, this added load on the system can improve overall utilization of the system, putting downward pressure on electricity rates. Indeed, the same California report found that deploying demand control strategies such as time-based pricing can significantly or entirely mitigate PEV impact on afternoon ramp.\(^{20}\) Numerous other studies have evaluated the potential impacts of PEV charging on electricity load profiles and various strategies utilities can deploy to manage charging times and charging rates in residential and public settings.\(^{21}\)

Shifting PEV charging load to off-peak hours, thereby mitigating impact on the distribution system, can be accomplished with a combination of price signals, customer education and outreach, the use of scheduling functionality included in the EVSE or the vehicle, and engaging PEV drivers in dynamic peak load management programs. For example, these could include demand charges, which ensure that higher-use customers compensate utilities for the added electric system infrastructure required because of those customers’ contribution to the electric system peak. They can also act as a price signal to customers who, instead of continuing to use electricity


\(^{20}\) Ibid.

at such high rates, may choose to lower or spread out their usage and obviate additional distribution infrastructure. Other utilities offer residential time of use (TOU) rates and other pricing programs to manage load by shifting electricity use to off-peak hours. Some states and utilities are exploring managed charging pilot programs, either through the EVSE or vehicle, to develop best practices to mitigate potential increases to distribution grid costs. These pricing structures are discussed more below.

**Potential Roles for Electric Utilities**

Electric utilities are well-positioned to aid in addressing the market barriers identified above in order to enable a shift to electric transportation. If addressed strategically, this transition may increase charging convenience and affordability for electric vehicle drivers, manage system-wide impacts for all electric customers, and create a new source of revenue that helps fund the distribution system. Electric utilities have the capabilities to support infrastructure deployment on the scale needed to improve charging station accessibility and support a robust PEV market. They are also in the position to design rate structures that will benefit customers and society by ultimately reducing the cost of electricity and the cost of PEV ownership. This section discusses the potential roles of electric utilities along with specific examples of utility pilot programs and other initiatives.

**Customer Education and Awareness**

Developing the resources necessary for consumers to make informed decisions can play a critical role in encouraging electric vehicle deployment. Electric utilities can serve as a reliable and trusted source to provide understandable and relevant information on electric vehicle options and benefits. The utility-customer relationship can be leveraged to provide education on charging needs and available rates and programs. When utilities make this information readily available, customers become more familiar with the concept of electric vehicles and can gain a more comprehensive understanding of their benefits.

Utilities have numerous advantages over other market participants in increasing customer education and awareness. To begin, electric utilities already have the necessary relationships with customers to support their evaluation of PEVs, rate plans and programs, and charging infrastructure. Direct contact through the billing process also provides opportunities for the utility to educate the consumer through bill inserts and other customer service channels. In addition, many utilities already have account managers who work with medium and large customers on a number of fronts including rates and tariffs, energy efficiency, and renewable energy purchases.

**Energy Efficiency Program Success**

Utilities serving regions across the Northeast and Mid-Atlantic states have administered energy efficiency programs to customers for years now and can leverage the experience and outreach fostered through the deployment of these programs to educate customers and manage successful transportation electrification programs. Massachusetts has been recognized as a leading state in Energy Efficiency, largely due to the success of the Mass Save program, a collaboration of 11 Massachusetts gas and electric utilities offering energy conservation services to residential and commercial customers. Through this program, sponsoring utilities provide services such as home energy audits, energy saving incentives and rebates, trainings, and educational materials promoting energy conservation. Companies reach customers through social media, ongoing customer education via in-person communication and online means, as well as conducting targeted advertising of specific energy efficiency products. In 2016, over 5 million customers (residential, low-income, and commercial) participated in Mass Save and achieved over 1.5 GWh of annual electricity savings and over 28 million therms of annual natural gas savings, reducing CO₂ emissions by over 700,00 short tons.

*Source: Mass Save Data*
As part of state transportation electrification programs, some electric utilities are developing new, electric vehicle focused resources. These include comprehensive websites to educate the public, information hotlines and call centers to answer questions from their customers, and direct mail, radio and print advertising. Others are sponsoring “ride-and-drive events,” which give potential buyers the opportunity to test drive multiple vehicle models, and also include information on tax rebates and other incentives.

Across all customer classes (residential, commercial, industrial), utilities can serve as a resource when customers are evaluating PEV technology, vehicle charging, and costs and benefits. While residential customers may be interested in owning one PEV and at-home charging, commercial and industrial customers may be interested in fleet opportunities and providing charging for their employees.

Consumer education does not need to be undertaken exclusively by utilities. Consumer education and awareness efforts should be conducted in collaboration with automakers, dealerships, state and local governments, employers, and community groups, offering an opportunity for electric utilities to engage with broader market participants to expand their reach and increase customer exposure. For example, Plug In America, a non-profit advocacy group, provides consumer information on PEVs through websites, seminars, ride-and-drive events, and other outreach. They also founded National Drive Electric Week, which for six years has been held to heighten awareness of PEV and PHEVs and connect potential drivers with resources. Similarly, the Massachusetts Department of Environmental Protection and National Grid jointly sponsor the Mass Drive Clean campaign, which partners with interested businesses and organizations to hold free ride-and-drive events. The campaign strives to increase consumer exposure to electric vehicles by reaching targeted audiences and providing resources and information about available vehicles. Participant surveys have found that the events increase interest in PEV ownership.

Charging Infrastructure

The role for utilities in the development of public charging infrastructure traditionally is limited to connecting other parties’ charging platforms to the grid. In this capacity, utilities determine the costs of establishing new service connections and then construct the distribution service that interconnects public charging infrastructure to the electric system. Utilities then bill public charging sites for the applicable volumetric and demand rates. However, a major question facing the charging market today is whether the electric utility should have a larger role in the development of charging infrastructure. Equally important is how the costs of any increased investment should be recovered and from whom. As outlined below, there are many options currently being explored and demonstrated by leading utilities to stimulate the electric vehicle charging market that work to

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22 See https://pluginamerica.org/

23 Mass Drive Clean, “Goals for Events.” Available at http://www.massdriveclean.org/goals/
achieve increased investment in infrastructure, a balance in market participation, and fairly recover investment costs. With the right level of investment, utility involvement in the deployment of charging infrastructure can help accelerate electrification of the transportation sector and spark growth across the market.

Utility Investment Models

There are three primary ways that utilities can invest in charging infrastructure. First, it could invest in “make-ready” installations, which include the electrical infrastructure required up to, but not including, the EVSE. This may include upgrades to transformers and service capacity and/or running new service drops. In some cases, it may also mean trenching and running conduit and cable to specific areas of a host site, such as in a parking lot at a workplace. Second, a utility could fully own and operate infrastructure, which would include the make-ready components as well as the EVSE itself, resulting in a single regulated entity building out and owning the electric and vehicle charging infrastructure. Third, utilities could provide host sites with financial incentives, such as rebates for the costs of the EVSE and/or the make-ready infrastructure portion.

The investment model appropriate for a given location is a function of multiple variables, including location (e.g., both type, such as residential building or shopping mall, as well as distance from existing infrastructure), the state of the existing distribution system, the state of the local EVSE market, and likely customer base (including income level). Below, we summarize additional general considerations for each option. Table 1 summarizes these potential approaches to utility EVSE investments.

<table>
<thead>
<tr>
<th>Utility Investment Options</th>
<th>Description</th>
<th>Implementation Attributes and Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Make Ready</strong></td>
<td>Electric grid infrastructure enhancements and upgrades to enable EVSE installations at host sites.</td>
<td>Can take advantage of utility access to capital to lower costs and increase pace of development. Utility will need to determine how investment costs will be recovered and who will pay. Approach enables flexibility of host site to choose EVSE provider and driver charging pricing plan.</td>
</tr>
<tr>
<td><strong>Owner and Operator</strong></td>
<td>Electric grid enhancements and upgrades as well as full build out and operation of EVSEs at host sites.</td>
<td>Streamlined program administration: utility would use experience with previous programs in all stages of developing and operating EVSE: marketing and recruitment, planning and permitting, construction and interconnection, and ongoing operation and maintenance. Could crowd out alternative providers from the market Could result in stranded cost for utilities if utilization is lower than expected, putting customer dollars at risk.</td>
</tr>
<tr>
<td><strong>Rebates for Private and Public EVSEs</strong></td>
<td>Cash rebate to private and public locations for the purchase and installation of EVSEs.</td>
<td>Reduces the upfront EVSE costs to all developers and customers. Can be structured to incentivize certain EVSE functionality (e.g., two-way communication capabilities). May not provide as much development support and fail to develop necessary EVSE for market.</td>
</tr>
</tbody>
</table>
Make-Ready Model
The make-ready approach limits a utility’s investment to the equipment necessary to connect the EVSE to the grid. Since this can often be a large part of project costs, utility investment here can increase the pace and lower the costs of infrastructure investment by opening new sources of low-cost capital. The utility could then possibly recover some of these costs from all electricity customers, as is the case for other infrastructure investment. Utilities can also utilize their familiarity with the design, operations, and maintenance of the distribution system, permitting requirements, and interconnection process to efficiently identify and develop appropriate connection infrastructure. This model retains the actual EVSE installations and ownership in the competitive marketplace, encouraging the flexibility of driver pricing structures and other customer options that may arise from third parties. A commonly cited downside of the make-ready approach, however, is that it does not go far enough to take advantage of utility expertise and funding. Critics of the approach argue that, in some situations, keeping utilities out of actual EVSE development puts inefficient and unnecessarily costly barriers between utility customers and electric vehicle infrastructure.

Utility Ownership Model
Under the utility ownership model, a utility owns and operates all components of the EVSE. This could further take advantage of the primary benefits of make-ready utility investment (i.e., experience with infrastructure and access to capital) to streamline and increase the scale of EVSE development. Utility ownership may also allow the utilization of long experience to oversee other program components including marketing and host site recruitment, pricing and programs, and ongoing operations and maintenance—all areas in which utilities have operated for decades. In addition, utilities could be required to directly collect EVSE usage and charging data and transparently report this information to their utility commissions to inform future development efforts. Critics of utility ownership, however, argue that the market should remain open and competitive. While it may be appropriate for utilities to develop EVSE in some situations, utilities could exercise undue market power if allowed to fully develop charging infrastructure, limiting development and raising costs. Furthermore, there is concern with regards to stranded assets with utility investment in EVSE given the early stage of the market and the fast-paced evolution of charging technology.

Eversource and National Grid Charging Infrastructure Proposals
In Massachusetts, both Eversource and National Grid submitted proposals in January 2017 for PEV infrastructure programs utilizing a make-ready approach. Both utilities propose to provide the electric distribution equipment required at the site to support the installation of a charging station and allow the host site to choose their EVSE from a pre-approved list of providers. The host sites will commit to owning and operating the EVSE for a minimum amount of time, and National Grid will require participants to provide utilization data collected at the charging station. Eversource proposes to deploy over 4,000 Level 2 ports over five years and nearly 70 DCFC stations. National Grid proposes to deploy 1,200 Level 2 ports over three years and 80 DCFC stations. In addition, National Grid will provide site hosts with a rebate for the purchase of a Level 2 charging station, up to 50 percent for workplaces, up to 75 percent for multiunit dwellings and public entities, and up to 100 percent for disadvantaged communities.

Rebates for EVSE and Make Ready
Another way for utilities to support investment in charging infrastructure would be through administering and providing rebates for EVSE installation and make ready investment costs in both public and private locations. For example, a home Level 2 EVSE can cost $1,500 or more for materials and installation. To mitigate these upfront costs, utilities can leverage their successful track record in administrating energy efficiency programs and incentives to develop and offer EVSE rebates. The rebates could be administered and paid for by the utility or funded through government resources such as state allowance auction revenues from the Regional Greenhouse Gas Initiative. The rebate programs could also be structured to encourage installation at certain locales and certain EVSE capability (such as WiFi connectivity) to facilitate development of utility rate offerings or other
incentive programs for vehicle integration. The rebate would have to be designed to allow the utility to recover costs and earn a fair rate of return. While appropriate in some situations, a rebate may not allow for strategic planning of locations or charging types available under other utility investment options.

### PSE&G’s Workplace Charging Program

PSE&G is helping to jump-start New Jersey’s electric vehicle market with a pilot program that places charging stations at workplaces and other customer locations across the company’s service territory. Under PSE&G’s pilot program, the utility provides the charging equipment, and partners pay for installation and electricity. Per a U.S. Department of Energy survey, workplace charging stations will be critical in encouraging more people to purchase electric vehicles: when a workplace installs a charging station, employees are 20 times more likely to buy a PEV.\(^\text{24}\) PSE&G’s pilot program has installed 60 PEV charging stations at 11 customer locations around New Jersey, halfway to the company’s goal of 120 charging stations in the program.

### Cost Recovery and Potential for Cost-Sharing

The impact of charging infrastructure investment on electricity rates is a key concern of utilities, regulators, advocates, and customers. There are several approaches to recovering the costs of infrastructure investments that will also honor the regulatory requirement that a utility earn a fair rate of return on its investment. For example, utilities could recover a portion of the investment costs from electricity customers, a portion from the EVSE host, and a portion from the drivers that use the EVSE through charging rates. Alternatively, utility infrastructure programs may be designed to cover only a portion of the infrastructure cost, with cost sharing required by the site hosts in order for projects to proceed. See below for more detail on considerations for pricing structures at EVSE locations.

Utilities could also recover a portion of the costs of the make-ready approach from all electric customers through standard rates. Recovering costs from all customers through rates is a well-established utility practice, employed for the development of the renewable energy and energy efficiency markets in many states. In the near-term, cost recovery from all customers may be a useful tool to overcome uncertain revenue potential from charging site hosts and drivers. In particular, in low gasoline price conditions, drivers may be less willing to pay a premium for charging, limiting the potential for driver contribution to infrastructure costs. Recovering costs through customer rates rather than directly through charging stations can help lower barriers to PEV adoption.

Utilities outside the Northeast and Mid-Atlantic states have established pilot programs with a range of cost recovery mechanisms, providing insight into the receptiveness of regulators, customers, and the public to different pricing models. Specifically, California utilities have developed pilot programs to help accelerate the electrification of the transportation sector and deployment of PEV infrastructure and have proposed to ratebase all investments for these programs. The California Public Utilities Commission (CPUC) has approved this cost recovery approach for San Diego Gas & Electric (SDG&E) and Southern California Edison (SCE), and Pacific Gas and Electric (PG&E).

- SDG&E’s “Power Your Drive Program” is a three-year, $45 million program to install, own, and operate 3,500 Level 2 stations at workplaces and multiple unit dwelling locations. The projected increase in consumer electric bills is 0.02% per year, or about $0.18 annually. SDG&E is required to address appropriate cost recovery in a future general rate case but will also be charging a participation fee as a percent of EVSE installation cost to site hosts. SDG&E will offer two billing options, one that directly

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charges the PEV driver (Rate-to-Driver), and the other that charges the site host (Rate-to-Host). The site host will be allowed to change between these billing options each year if desired. Under a Rate-to-Driver plan, PEV drivers will swipe a card at the charging station that will add the cost accrued at the station to the customer’s SDG&E electric bill.

- SCE’s “Charge Ready Pilot” is a $22 million program to install up to 1,500 Level 1 and 2 stations at workplaces, multiple unit dwellings, destination centers and fleet sites. At the conclusion of the pilot, SCE will seek authority from the CPUC to expand the program to bring the total number of charging stations to about 30,000 for a total estimated cost of $355 million. SCE will ratebase the cost of new utility service and make-ready customer premise investment, while also providing rebates for installation of EVSE equal to 25 to 100 percent of the cost, dependent on charging station market and location. SCE received approval to recover costs through rates and estimates that over the course of the five-year pilot, the cost of the Charge Ready program will result in a 0.1% to 0.3% increase on an average consumer’s electricity bill, or about $0.001/kWh.

- PG&E received approval in December 2016 for its “PEV Infrastructure and Education.” The CPUC final decision approved PG&E for the deployment of 7,500 Level 2 charging stations over a three-year period and provides for rate recovery up to $130 million. The program only allows the utility to own EVSE at multiunit dwellings and in disadvantaged communities and limits utility ownership to 35 percent of all charging stations deployed under the program. A tiered (based on the site location type, i.e., multiunit dwelling, workplace, disadvantaged community) participation payment and rebate provision requires the site host to pay a percentage of the EVSE cost where PG&E owns the infrastructure, and provides a rebate for site hosts claiming full ownership of the EVSE. PG&E will offer site hosts the option to pay a time-of-use rate themselves or pass on the cost to the driver.

Utilities, regulators, and stakeholders will also need to determine how to analyze potential utility investments. It will be important that any cost-benefit analysis include all benefits of transportation electrification, including electric vehicle driver energy and maintenance cost savings and the societal value of greenhouse gas emission reductions. Cost-benefit analyses should also account for higher revenues associated with increased electricity sales from charging infrastructure, which will put downward pressure on electricity rates for all customers. M.J. Bradley & Associates has published several cost-benefit analysis of electric vehicle deployment scenarios.

Charging Rates and Programs
Through rate design, electric utilities can influence charging behavior, and in turn, minimize costs to operate the distribution system while maximizing economic and environmental benefits. In states with high solar or wind generation, utilities may also be able to manage load in a way that coordinates peak renewable generation with increased demand from PEV charging, using excess power to support this new load and reduce the need for curtailment. In addition, utilities may be able to help avoid the need for additional generation capacity by utilizing available generation and strategically influencing charging behavior.

Residential Charging Rates
Utilities have three primary options to manage residential PEV charging: whole house TOU rates, PEV TOU rates, and rebates or bill credits. Below we describe these in more detail and examine utility pilot programs that have tested the impacts of these approaches.

PEV TOU rates will create varying costs to charge based on the time of day, with the intent of encouraging off-

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peak charging with lower rates and discouraging charging during peak hours by imposing higher rates during these times. Proper rate design can provide useful load management as PEV charging is shifted to off-peak hours where demand troughs are filled and peak demand growth is mitigated, also serving to reduce grid impacts and lower customer electricity bills. These come in two forms: whole house and PEV-only. The former requires that all of customer’s usage be charged at a time-varying rate. In contrast, a PEV-only TOU rate applies only to that electricity used to charge the PEV while the home remains on standard rates; this requires a separate meter to track PEV usage. Both provide benefits to the PEV owner and the grid as a whole.

Customers typically delay charging to align with the TOU rate periods to take advantage of low rates when charging their vehicles. In Figure 7, the graph on the left shows PEV charging load in the Dallas/Ft Worth area where no off-peak charging incentive was offered. The graph on the right shows PEV charging load in the San Diego region, where the local utility offered PEV owners a TOU rate with significantly lower costs ($/kWh) for charging during the “super off-peak” period between midnight and 5:00 a.m.

Figure 7 PEV Charging Load in Dallas/Ft Worth and San Diego

![Graph showing PEV charging load in Dallas/Ft Worth and San Diego]

Source: Idaho National Laboratory

PEV-only TOU rates have been effective at providing the necessary incentives to get customers to charge at off-peak periods for the vast majority of their charging. This option also provides the opportunity for state commissions to work with utilities and other stakeholders to implement solutions involving technologies that can be harnessed through charging station meter compatibility rather than requiring additional equipment to be installed and configured. Although this option does require the installation of a new meter for which the customer may be required to pay, early pilot programs have demonstrated that such TOU rates do result in lower electricity bills for the customer.

While the vast majority of TOU rates work to reduce peak demand, some stakeholders have begun exploring if TOU rates could actually help increase demand during peak times in order to better align with the output of solar resources that generate at those times.
Other utilities offer “whole house” TOU rates, though to date there have been fewer offerings and lower customer adoption. These rates allow the customer to use their existing meter, and can achieve cost reductions across all household usage compared to standard rates. Whole house rates may require more active energy management on the part of the customer, as cost savings are only possible if customers are able to consume a significant amount of total household electricity at off-peak times.

Finally, utilities could also offer a reward or cash incentive program that would provide monthly rewards in exchange for off-peak or controlled charging, analogous to existing demand response programs. This program could be structured as a monthly bill credit provided to customers who charge their vehicle during off-peak periods or for allow the utility to control PEV charging within set parameters (e.g., agreeing to a peak demand level with a limited number of “overrides” per month). A reward program could also provide off-bill credits to customers or other users of charging facilities (see box on SmartCharge New York below for one example). Reward programs require the ability to continuously monitor current in the charging circuit and one-way communication for the utility to collect circuit level data. However, such a program would not require the utility to measure PEV charging electricity use for billing purposes, and thus would not require a second utility-grade meter.

Table 2 summarizes several options utilities have to provide incentives for and manage residential electric vehicle charging.
Utilities can also use public PEV charging rates to manage load and encourage investment in charging infrastructure. The optimal pricing structure will vary from location to location based on a number of site characteristics, including anticipated utilization, charger type, and ownership of charging station (i.e., utility or site owned). Ultimately, stakeholders will need to determine how to set rates in a way that provides appropriate cost recovery and incentives for infrastructure investment while also continuing to support and encourage increased adoption of electric vehicles while fostering broad markets. The rate design levers that utilities, regulators, and others may use to reach this outcome include demand charges, TOU rates, and the pricing applied to users and/or site hosts. Each are described briefly below.

Demand charges are an important tool used by utilities to ensure that those customers who use electricity at high rates pay an appropriate amount to expand and maintain the distribution system that allows for their usage. They also can help to mitigate high peak load by sending a price signal to users to lower their peak demand if possible. These are usually fixed monthly fees that are calculated based on the peak demand of the customer—the higher the peak load, the more robust the distribution system must be able to serve that customer, and the higher the demand charge. However, utilities may need to consider how to apply this model to PEV charging in a way that does not create high rates that may present barriers to building new infrastructure.

Under a traditional demand charge model, a public PEV charging station host site could be more susceptible to high demand fees triggered by demand spikes from multiple PEVs charging simultaneously at a single site. Such spikes could cause large increases in customer bills, even if overall monthly consumption does not increase.

### Table 2: Potential Utility Electric Vehicle Incentive and Load Management Options

<table>
<thead>
<tr>
<th>Charging Rate Options</th>
<th>Description</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard Rate</strong></td>
<td>Standard flat electric rates currently provided. The price per kWh may vary seasonally.</td>
<td>No change in electric rate structure or customer offering or electric meter.</td>
<td>Does not incent customer charging behavior to reduce peak load impact of charging. Does not maximize PEV owner’s cost savings between electric and gasoline.</td>
</tr>
<tr>
<td><strong>Whole House TOU Rate</strong></td>
<td>The price per kWh varies seasonally and time of day – peak and off-peak periods for all household kWh.</td>
<td>Single utility-installed TOU meter for entire household encouraging customer to shift all kWh usage off peak.</td>
<td>Depending on the rate plan, PEV owners may have to shift a substantial portion of household electric load (kWh) in order to save money compared to the standard rate.</td>
</tr>
<tr>
<td><strong>PEV-Only TOU Rate</strong></td>
<td>The price per kWh varies seasonally and time of day – peak and off-peak periods for PEV charging circuit only.</td>
<td>Separate TOU rate allows the customer to understand electricity usage and cost. Provides data to utility on charging behavior.</td>
<td>The cost of installing a second meter and associated customer charges can be prohibitive.</td>
</tr>
<tr>
<td><strong>Incentive / Rewards Programs</strong></td>
<td>Financial incentive provided to customer for off-peak charging, similar to programs for peak demand reduction.</td>
<td>Low cost charging circuit monitoring device avoids the costs associated with purchase and installation of a second meter.</td>
<td>kWh usage data would need to be provided by EVSE, monitoring device or vehicle.</td>
</tr>
</tbody>
</table>

**Public PEV Charging Rates**
Utilities can also use public PEV charging rates to manage load and encourage investment in charging infrastructure. The optimal pricing structure will vary from location to location based on a number of site characteristics, including anticipated utilization, charger type, and ownership of charging station (i.e., utility or site owned). Ultimately, stakeholders will need to determine how to set rates in a way that provides appropriate cost recovery and incentives for infrastructure investment while also continuing to support and encourage increased adoption of electric vehicles while fostering broad markets. The rate design levers that utilities, regulators, and others may use to reach this outcome include demand charges, TOU rates, and the pricing applied to users and/or site hosts. Each are described briefly below.

Demand charges are an important tool used by utilities to ensure that those customers who use electricity at high rates pay an appropriate amount to expand and maintain the distribution system that allows for their usage. They also can help to mitigate high peak load by sending a price signal to users to lower their peak demand if possible. These are usually fixed monthly fees that are calculated based on the peak demand of the customer—the higher the peak load, the more robust the distribution system must be able to serve that customer, and the higher the demand charge. However, utilities may need to consider how to apply this model to PEV charging in a way that does not create high rates that may present barriers to building new infrastructure.

Under a traditional demand charge model, a public PEV charging station host site could be more susceptible to high demand fees triggered by demand spikes from multiple PEVs charging simultaneously at a single site. Such spikes could cause large increases in customer bills, even if overall monthly consumption does not increase.
Utilities and stakeholders may want to consider innovative rate structures or technologies that could help mitigate this risk to DC fast charger deployment, especially in the early stages of EV market development.

TOU rates have been described in more detail above. In essence, these rates help create incentives to charge at off-peak times by charging lower rates, and higher rates during high usage peak periods. Utilities would need to determine if the TOU rate should be collected from the site host directly (rate-to-host programs), with the site retaining the flexibility to collect revenue from customers in other ways, or if the TOU rate should be passed directly to the charging customer (rate-to-driver programs). Both have potential to change charging behavior by incentivizing off-peak charging. If effective, TOU rates could help mitigate some of the demand charge increases described earlier by avoiding adding to peak usage and increasing peak demand. However, many public charging infrastructure locations may have fairly limited hours of operation that align with peak times—most cars at workplaces, for example, will be charging during business hours, which typically aligns at least in part with peak usage. However, in some cases, distributed solar resources and/or energy storage at host sites may reduce the impact of peak period electric vehicle charging.

Electric utilities can develop pilot programs to help them determine the best pricing options to offer drivers while optimizing grid benefits of transportation electrification. Pilot programs will also allow utilities to collect data on how charging behavior is affected as a result of different rates to inform them on how permanent rates can be developed to mitigate grid impacts of PEV integration. Exploring various models will be important in eventually streamlining a payment system to be consistent across all or most public charging stations, therefore improving customer confidence and familiarity with the public charging network.

Customer-Facing Public Charging Pricing

Once the basis for demand and electricity rates is set by the utility, a wide range of customer-facing pricing approaches can be used by public PEV station operators. The service utility, the owner of the EVSE, the entity in charge of maintaining the EVSE, and the business establishing charging pricing and payments may all be individual parties responsible for different aspects of a single charging site, and may each have a say in the way rates are passed on to customers. One option is charging that is free to drivers (with all costs covered by the site host). Others allow PEV drivers to obtain a membership which allows them to pay on a monthly basis and accept standard charging rates, whereas other stations may accept payments via credit card, or through a mobile app. The site owner also faces different payment options. Some charging infrastructure is directly linked to the site host’s utility account and electricity usage associated with PEV charging is added onto their monthly bill. Other host businesses or municipalities work with the third-party suppliers to establish charging rates. The differences in these payment structures may affect how site hosts pass their rates on to charging customers. In total, this range of options creates a complex market to navigate for both the provider and the PEV owner, potentially limiting the efficiency of such programs in achieving intended charging behavior outcomes.

Eversource Charging Pilot

As part of the effort to reach customers and other PEV stakeholders, Eversource developed a two-year charging station demonstration project to collect data on public charging behavior to better inform utility decisions regarding public PEV infrastructure deployment. The utility provided participating municipalities and businesses with Level 2 charging stations in exchange for access to information collected by the meter on charging usage. Site hosts are responsible for charging station installation, maintenance, and the cost of energy consumed, but are able to choose charging rates.
Conclusion
As the electric industry shifts towards transportation electrification, utilities will need to be prepared for the potential grid impacts with strategies to mitigate higher loads and shifting demand. Electric utilities can play a pivotal role in the successful integration of electric vehicles, through distribution of comprehensive information, innovative ratemaking, investment in infrastructure, and collaborative partnerships with stakeholders.
Establishing strategic partnerships with states can open windows of opportunity for utilities to understand how PEV programs can be designed and tailored to maximize contributions towards achieving local and regional climate and ZEV goals. If approached proactively, utilities can help catalyze a future where the economic and environmental benefits of electric vehicles become widespread and support both improved asset utilization and emissions reductions.

Green Mountain Power and NRG EVgo Partnership

Green Mountain Power (GMP) partnered with NRG’s EVgo in 2014 to expand Vermont’s PEV charging network. In this case, municipalities own, maintain, and manage the charging stations as well as pay for the electricity consumed at the station(s). EVgo contracts various EVSE suppliers to provide charging stations and as of January 2016, has installed 31 EVSE stations, most with two charging ports combining Level 2 charging with DCFC. GMP pays for the installation of the charging station, and the site host pays for the electricity consumed at the charging station as well as an additional monthly fee to GMP (generally $69 per dual port station, and less for stations offering free charging). EVgo offers three pricing options, one each for Level 2 charging and DCFC, and a third offering options to charge at both types of stations. The DCFC rate is $0.10/minute and the Level 2 charging rate is $1.00 per hour. To use EVgo network stations in Vermont, PEV owners register with EVgo to create a membership with the network, where they are billed by GMP for use of the charging stations. GMP then uses this revenue to reimburse the site host for the electricity consumed for charging at their station.
## Appendix A: Utility Charging Infrastructure Programs

<table>
<thead>
<tr>
<th>Utility/Program</th>
<th>Program cost</th>
<th>Program timeline</th>
<th>Number &amp; type of EVSE</th>
<th>Market segment target</th>
<th>EVSE ownership, O&amp;M</th>
<th>Rate structure</th>
<th>Other incentives</th>
<th>Education/outreach program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Implemented</strong></td>
<td></td>
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<tr>
<td>Kansas City Power &amp; Light Clean Charge Network</td>
<td>$20 million</td>
<td>January 2015-Present</td>
<td>Level 2 with 15 DCFC stations provided by Nissan</td>
<td>Municipally-owned locations</td>
<td>Utility ownership, installation, O&amp;M</td>
<td>Free charging provided by city for first two years</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Avista EVSE Pilot Program</td>
<td>$3 million</td>
<td>2 years (June 2016-June 2018)</td>
<td>265 stations: 120 residential Level 2, 145 non-residential Level 2 chargers, 7 DCFC</td>
<td>Workplace, fleet, MUD, public</td>
<td>Utility ownership</td>
<td>Residential Level 2 charging added to monthly bill; public Level 2 host sites to determine rate charged in coordination with utility; $0.30/minute for DCFC use</td>
<td>EVSE installation reimbursements dependent on location; $100 per customer incentive to auto dealers for PEV sale to Avista customer</td>
<td>No</td>
</tr>
<tr>
<td>Georgia Power Get Current Program</td>
<td>$12 million</td>
<td>2 years, rebates available through 2016</td>
<td>Over 550 Level 2 and DCFC already installed</td>
<td>Workplace, residential</td>
<td>Utility ownership, O&amp;M</td>
<td>$0.25/minute for DCFC charging; $1/hour for the first 3 hours and $0.10/minute thereafter for Level 2 use; TOU rates available to residential PEV owners</td>
<td>$500 rebate for Level 2 installation at commercial businesses; $250 for residential Level 2 installations</td>
<td>Yes</td>
</tr>
<tr>
<td>Utility/Program</td>
<td>Program cost</td>
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<tr>
<td><strong>Austin Energy Plug-In Everywhere Network</strong></td>
<td>N/A</td>
<td>Ongoing</td>
<td>Over 250 charging stations currently in network</td>
<td>Workplace, MUDs</td>
<td>Host site ownership, installation and electricity costs; utility provides maintenance</td>
<td>$25 for unlimited charging with 6-month membership, or $2.00/hour; residential TOU pricing with $30 fixed cost</td>
<td>50% rebate (up to $1,500) for residential Level 2 EVSE purchase and installation, and 50% rebate (up to $4,000) for public Level 2 EVSE</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Green Mountain Power EVgo Network</strong></td>
<td>$150,000</td>
<td>Ongoing</td>
<td>20 Level 2 stations and 11 DCFC stations installed as of early 2016</td>
<td>Municipalities</td>
<td>Municipality ownership, O&amp;M, electricity costs</td>
<td>EVgo pricing options</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td><strong>Southern California Edison Charge Ready Pilot</strong></td>
<td>Phase I: $22 million; Phase II: $333 million</td>
<td>Launched May 2016; Phase I: 1 year; Phase II: 4 years</td>
<td>Phase I: 1,500 charging stations; Phase II: 30,000 stations</td>
<td>Workplace, MUDs, public/retail, 10% DACs</td>
<td>Host site ownership, O&amp;M, electricity costs</td>
<td>TOU rates as applicable, subject to change based on Phase I results</td>
<td>Rebates provided for 25 to 100 percent of EVSE installation costs</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>SDG&amp;E Power Your Drive Program</strong></td>
<td>$45 million</td>
<td>3 years</td>
<td>3,500 Level 2 stations</td>
<td>50% Workplace, 50% MUDs, 10% DACs</td>
<td>Utility ownership, O&amp;M, host site pays electricity costs</td>
<td>Rate-to-Drive or Rate-to-Host pricing options, host site participation fee</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>PG&amp;E Smart Charge and Save Program</strong></td>
<td>$130 million</td>
<td>3 years</td>
<td>7,500 Level 2 stations</td>
<td>50% Workplace, minimum 20% with 50% goal MUDs, 15% with 20% goal DACs</td>
<td>Utility ownership, host site O&amp;M and pays electricity costs</td>
<td>Site host can choose between two options: TOU Rate-to-Drive or TOU Rate-to-Host pricing options, host site participation fee</td>
<td>Site host Level 2 EVSE rebate of 25% base cost for workplace, 50% for MUDs, 100% for DACs</td>
<td>Yes</td>
</tr>
<tr>
<td>Utility/Program</td>
<td>Program cost</td>
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<td>Massachusetts National Grid EV Market Development Program <em>(proposed 1/20/17)</em></td>
<td>$19.7 million for EV Charging Program (over 8 years); $10.2 million for EV Charging Program (over 3 years)</td>
<td>3 years</td>
<td>Level 2: 600 stations; 1,200 ports DCFC: 80 stations; 80 ports</td>
<td>Long-dwell locations for Level 2 sites; High traffic locations for DCFC sites; 10% of EVSE in DACs</td>
<td>Host site EVSE ownership, O&amp;M for minimum of 5 years after installation</td>
<td>Site host to pay for electricity consumed at charging site at current rate for at least first 5 years and decide how driver pays at station</td>
<td>National Grid will provide site hosts with an incentive towards the purchase of Level 2 EVSE as well as reimburse the site host up to a certain amount for any upgrades needed on the customer side of the meter</td>
<td>Yes</td>
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<td>Massachusetts Eversource Electric Vehicle Infrastructure Program <em>(proposed 1/17/17)</em></td>
<td>$45 million</td>
<td>5 years</td>
<td>Phase I: 32 DCFC stations, 1,000 Level 2 ports Phase II: 35 DCFC stations, 3,100 Level 2 ports</td>
<td>Long-dwell locations for Level 2 sites; High traffic locations for DCFC sites 10% investment in DCFC sites; 10% of EVSE in DACs</td>
<td>Host site EVSE ownership, O&amp;M for minimum of 10 years after installation</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
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<td>Pacific Power Public Charging Pilot Program <em>(proposed 12/27/16)</em></td>
<td>$1,850,000</td>
<td>3 years</td>
<td>Total of 7 charging “pods” consisting of both dual-standard DCFC and Level 2 stations</td>
<td>Pacific Power to choose locations based on proximity to travel corridors, MUDs, other charging stations; proximity to existing electrical network; ease of public access; ease of permitting</td>
<td>Utility ownership, O&amp;M</td>
<td>Pacific Power to develop and implement TOU rates to encourage off-peak charging</td>
<td>N/A</td>
<td>Yes, separate outreach and education pilot program</td>
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<td>Portland General Electric Community Charging Infrastructure pilot (proposed 12/27/16)</td>
<td>$3.9 million</td>
<td>About 1.5 years</td>
<td>Six new charging sites, each with 4 dual-head DCFC stations and one dual-port Level 2 station</td>
<td>PGE to choose locations based on proximity to travel corridors, MUDs, other charging stations and transportation networks; proximity to existing electrical network; ease of public access; cost of real estate; potential installation barriers</td>
<td>Utility ownership, O&amp;M</td>
<td>Proposed two pricing option: monthly subscription for PGE customers or pay-per-use for nonsubscribers</td>
<td>N/A</td>
<td>Yes, separate Outreach, Education &amp; Technical Assistance effort proposed</td>
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