WHITE PAPER

# A Utility Roadmap for Transportation Electrification

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D+R International

# About US

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# Executive Summary

As electric vehicles (EVs) take a larger share of miles driven in the U.S. every year, utilities are beginning to wake up to both the challenge and opportunity presented by transportation electrification. Developing a transportation electrification plan is a necessary first step for utilities interested in preparing for, and advancing, EV adoption in their service territory. This white paper lays out a roadmap for utilities interested in creating their own transportation electrification strategy but unsure where to begin. Examples from utilities across the U.S. are used to demonstrate how utilities can integrate separate EV programs into an inclusive and cohesive transportation electrification program that benefits all customers.


Five key areas of focus are essential to a successful utility transportation electrification plan: A coordinated policy strategy, expanded EV charging infrastructure, EV purchase incentives, market engagement and education, and grid reliability.

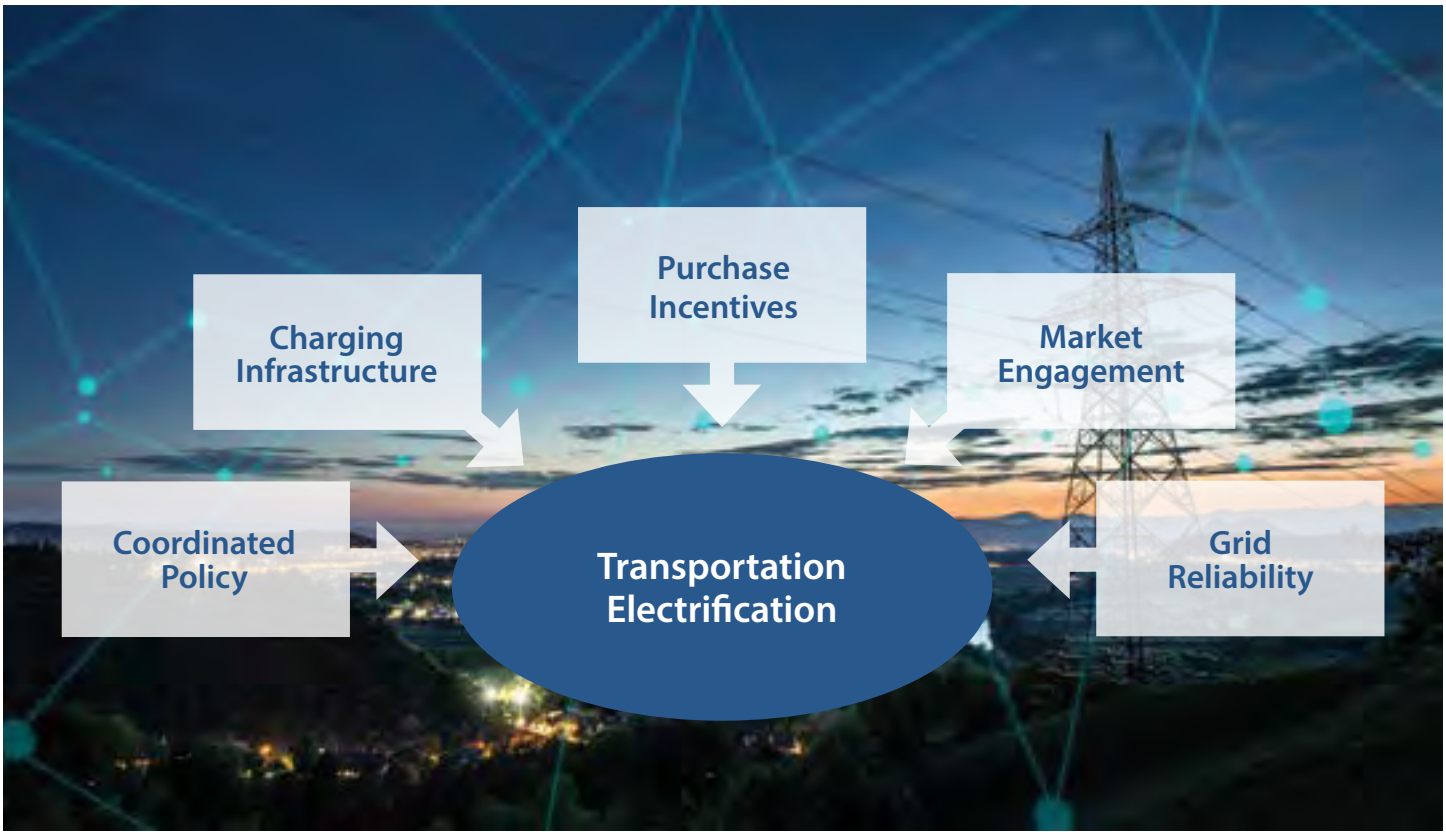
| | | |
|---|---|---|
| 1 | **Coordination with Policymakers and the Public** | How to create an EV-friendly policy infrastructure aligned with state and local policy and community needs. |
| 2 | **Expanding Electric Vehicle Supply Equipment (EVSE) Infrastructure** | Explore the central role utilities play in supporting a robust public charging infrastructure in their service area. |
| 3 | **Electric Vehicle Rebates and Other Purchase Incentives** | Examine the efficacy of well-designed EV rebate/incentive programs in helping utilities meet their transportation electrification goals. |
| 4 | **Market Engagement and Education** | The vital role of customer education in furthering EV adoption. Why it is necessary to engage with, and educate, a broad range of stakeholders: customers, local auto dealers, and the manufacturers, distributors, and electrical contractors that supply and install EVSE in homes and businesses. |
| 5 | **Grid Reliability in an Electrified Transportation Future** | Transportation electrification will add significant load to the grid, and utilities can manage the impact with a variety of programs. Review examples of EV time-of-use (TOU) rate, smart charging, and vehicle-to-grid (V2G) program models. |

# Introduction

The days of internal combustion engine (ICE) dominance in transportation are numbered, with EVs comprising a larger percentage of vehicle sales every year. Bloomberg New Energy Finance's latest forecast shows EV sales increasing from a record 2 million worldwide in 2018, to 10 million in 2025, and then surging to 28 million in 2030 (Bloomberg NEF 2019). We are only beginning to understand the implications of this shift towards electric transportation. For utilities, the stakes are much higher. Transportation electrification is an unprecedented financial opportunity for electric utilities at a time when load growth is slowing compared to previous decades. Residential electric sales have actually declined nationwide since 2010 (Forth 2019). However, big hikes in electricity demand resulting from more EVs on the road will affect the stability and efficiency of the grid if utilities don't plan for it.

To prepare for the EV revolution, utilities should develop a **transportation electrification plan**. Transportation electrification plans can help utilities acquire valuable new and flexible load, grow service offerings to customers, lower customer fuel costs, and satisfy customer demand for sustainable energy options. This paper will focus on the five key areas that should form the basis of any utility transportation electrification plan and provide examples of successful utility EV programs from across the U.S.

**Figure 1: Five Key Areas of a Transportation Electrification Strategy**



# I. Coordination with Policymakers and the Public

Utility policy does not take place in a vacuum. State and local governments, businesses, and the public all have a stake in transportation electrification. Collaboration between utilities and these stakeholders can create a supportive environment for accelerating EV ownership, while helping to ensure everyone benefits (Khan and Vaidyanathan 2018). While not all utilities will have the bandwidth to be actively involved in shaping legislation, they should at a minimum be aware of existing state/local policies related to EVs. Utilities should aspire to create transportation electrification plans that fit into state and local policy frameworks, which typically include creating beneficial incentive/rebate programs that further EV adoption and enabling EVSE infrastructure development in their service territory.



To ensure transportation electrification benefits everyone, utilities should actively engage with low-income and historically marginalized communities during the strategy development process. Start by soliciting feedback from the community to find out what major barriers can be addressed through policy, and take special care that low-income and minority customers' voices are heard. Historically marginalized communities have been disproportionately exposed to air pollution from transportation; therefore, these communities stand to benefit from improved air quality thanks to transportation electrification (Schefter and Knox 2018). However, early adopters of EVs are typically wealthier and more likely to live in single family homes than the average U.S. resident (Allen et al. 2017). Although the higher purchase cost of a new EV is the primary barrier for low-income residents, there are other barriers, such as a lack of adequate charging infrastructure and access to reliable information on EVs that utilities can help address. Some utilities have also experimented with supporting car sharing models, for example:

- In Portland, Oregon, Pacific Power is supplying charging infrastructure to support an EV car sharing program at an affordable housing location.
- The city of Los Angeles recently set up an EV car sharing pilot that would serve more than 7,000 residents in marginalized communities (Schefter and Knox 2018).

Many utilities recognize the importance of regional, state, and local stakeholders in furthering EV adoption and have taken a multi-stakeholder approach to transportation electrification. In states with environmentally progressive governments, there is an opportunity for utilities to get access to additional funds for transportation electrification programs. For example:

- Volkswagen's (VW) Zero Emission Vehicle (ZEV) Investment Plan, created as a part of VW's lawsuit settlement with the U.S. government, requires them to spend $2 billion on ZEV infrastructure and programs.
- Several utilities in Oregon participate in the Clean Fuels Program, which provides financial incentives to utilities based on the number of EVs registered in the utility's service area (Forth 2019).
- The California Public Utilities Commission (CPUC) recently authorized $41 million for California utilities to spend on EV programs (Mulkern 2018).
- In Nashville, the SmartCharge Nashville program was created to prepare for increased EV adoption. It is a collaboration between FleetCarma, Tennessee Valley Authority, Nashville Electric Service and Middle Tennessee Electric Membership Corporation. SmartCharge Nashville's coordinated approach between utilities, municipalities, and the private sector has been well-received locally and extremely successful in achieving its goal of understanding EV charging patterns in Nashville thus far (FleetCarma 2019).

At the local level, utilities should work with municipal governments, local/regional public transportation organizations, school districts, and businesses in their service area to ensure all new buildings are equipped to install EV charging infrastructure. Building codes that mandate new construction incorporate EV charging readiness will go a long way towards making it easier for building owners and employers to offer EV charging capability to their tenants and employees. Recognizing this, Seattle City Council recently passed a measure requiring all new buildings with off-street parking to have EV charging infrastructure (Pautz 2019). An EV charging readiness requirement would also remove the need to retrofit buildings in the future, which can be costly and burdensome for building owners.

In addition, utilities should consider the role of large fleet operators in the future of transportation. Ride-sharing companies (such as Uber and Lyft) and delivery services are taking a larger share of urban traffic every year. Recognizing this trend, a few utilities have partnered with ride-sharing companies to encourage EV adoption.

- Uber and Sacramento Municipal Utility District (SMUD) partnered to offer Uber drivers an extra $1.50 ($1.25 from SMUD, $0.25 from Uber) per trip completed in an EV (SMUD 2018).
- Portland General Electric, Duquesne Light Company, and Rocky Mountain Power have all announced collaborations with ride-sharing companies to help educate their drivers about the benefits of EVs (Khan and Vaidyanathan 2018).

# II. Expanding Electric Vehicle Supply Equipment (EVSE) Infrastructure

Utilities can make the biggest difference in furthering EV adoption by ensuring there is a robust charging infrastructure in their service area. A recent global study concluded that charging infrastructure was the best predictor of a country's EV market share (Baumhefner et al. 2016). However, utilities often argue that it is not financially prudent given the small number of EVs currently on the road. Consumers then cite lack of adequate public charging infrastructure as one of the main reasons they are hesitant to purchase an EV. By taking an active role in deploying EVSE infrastructure, utilities can alleviate consumers' perceived risk and break the cycle.


## CHARGING INFRASTRUCTURE OPTIONS

Over 50% of low to moderate-income households live in multi-family and/or rental units, which often have limited PEV charging options.

**—US Census Bureau 2017**

A robust public charging infrastructure can also ensure that transportation electrification benefits everyone. Over 50% of low to moderate-income households live in multi-family and/or rental units, which often have limited PEV charging options (US Census Bureau 2017). Since most EV charging is currently done at home, customers without driveways, easy access to electrical infrastructure, or the ability to make modifications to existing structures may find it difficult to charge an EV. Furthermore, private companies typically assess locations for charger installations based on metrics such as past EV purchasing patterns, leaving low-income communities off the list of priorities (Schefter and Knox 2018).

Utilities can help address the lack of available charging options in many low-income communities by investing in public charging infrastructure and working with local building owners to install EVSE in their units. Utilities should consider requiring that a certain percentage of new charging infrastructure go to areas designated as low-income. In California, all investor-owned utilities are required to deploy a minimum of 10% of their EV charging infrastructure in disadvantaged communities (Schefter and Knox 2018).

There are a variety of charging infrastructure deployment models available to utilities to match their local circumstances and budget. In areas where private charging companies are not meeting customer demand and providing adequate public charging coverage, utilities will likely need to invest more to fill the gap in coverage.

Allen et al. summarize the four different charging infrastructure deployment options in Georgetown Climate Center's report on utility investment in charging infrastructure:

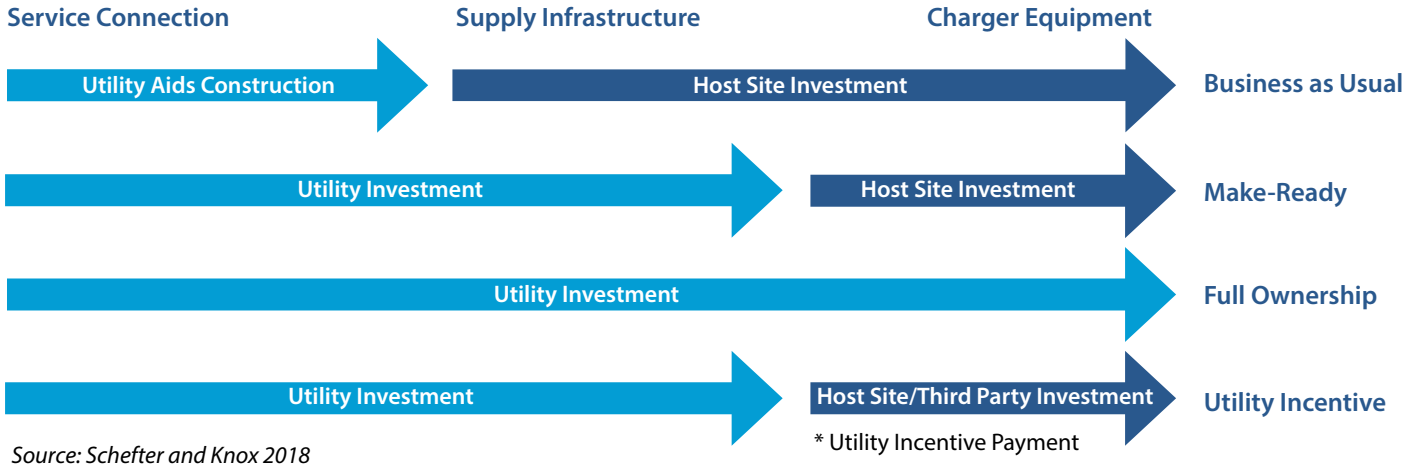
1. **Business as Usual -** Utility provides the service connection but nothing else related to EV charging infrastructure. Third parties are responsible for the costs of the EV charging infrastructure and/or the make-ready portion of the infrastructure.

2. **Make-Ready -** Utility invests in make-ready installations, which include the electrical infrastructure required up to, but not including, the actual EV charging equipment.

3. **Full Ownership -** Utility fully owns and operates installations, including the make-ready components and charging equipment itself, resulting in a single regulated entity building out and owning the electric infrastructure and vehicle charging equipment.

4. **Utility Incentive -** Utility provides host sites with financial incentives to install EV charging equipment, such as rebates for the costs of the EV charging infrastructure and/or the make-ready portion of the infrastructure (Schefter and Knox 8, 9).

## Figure 2: Utility Charging Infrastructure Deployment Options




*Source: Schefter and Knox 2018*

Each option has advantages and disadvantages, and utilities should fund pilots to evaluate different approaches in their service area. Important factors to consider include location, state of the existing distribution system, current local EV charging infrastructure market, and likely customer characteristics (Schefter and Knox 2018). While more expensive upfront, full ownership models give utilities greater flexibility on location, pricing, and the ability to collect charging data. Utilities such as SDG&E, PG&E, ConEd, and KCPL have announced utility-ownership charging installation plans in the last few years (Schefter and Knox 2018). Utilities should note that many states do not currently permit utility investment and cost recovery for charging stations. There have also been examples of ratepayer advocates blocking utility-owned public infrastructure projects. These policy barriers can be identified and addressed early in the process with proactive coordination with government and community stakeholders.

# III. Electric Vehicle Rebates and Other Purchase Incentives

Well-designed EV rebate and incentive programs are the most effective ways to encourage consumers to consider EVs. As previously discussed, the high upfront cost of purchasing an EV and installing EV charging infrastructure (either residential or commercial) is prohibitive for many consumers and businesses. Many utilities recognize this fact and offer incentives to reduce the upfront costs. One recent study found that 44 U.S. utilities are currently offering EV-related rebates or other incentives, up from 28 utilities in 2015 (McDonald 2017).

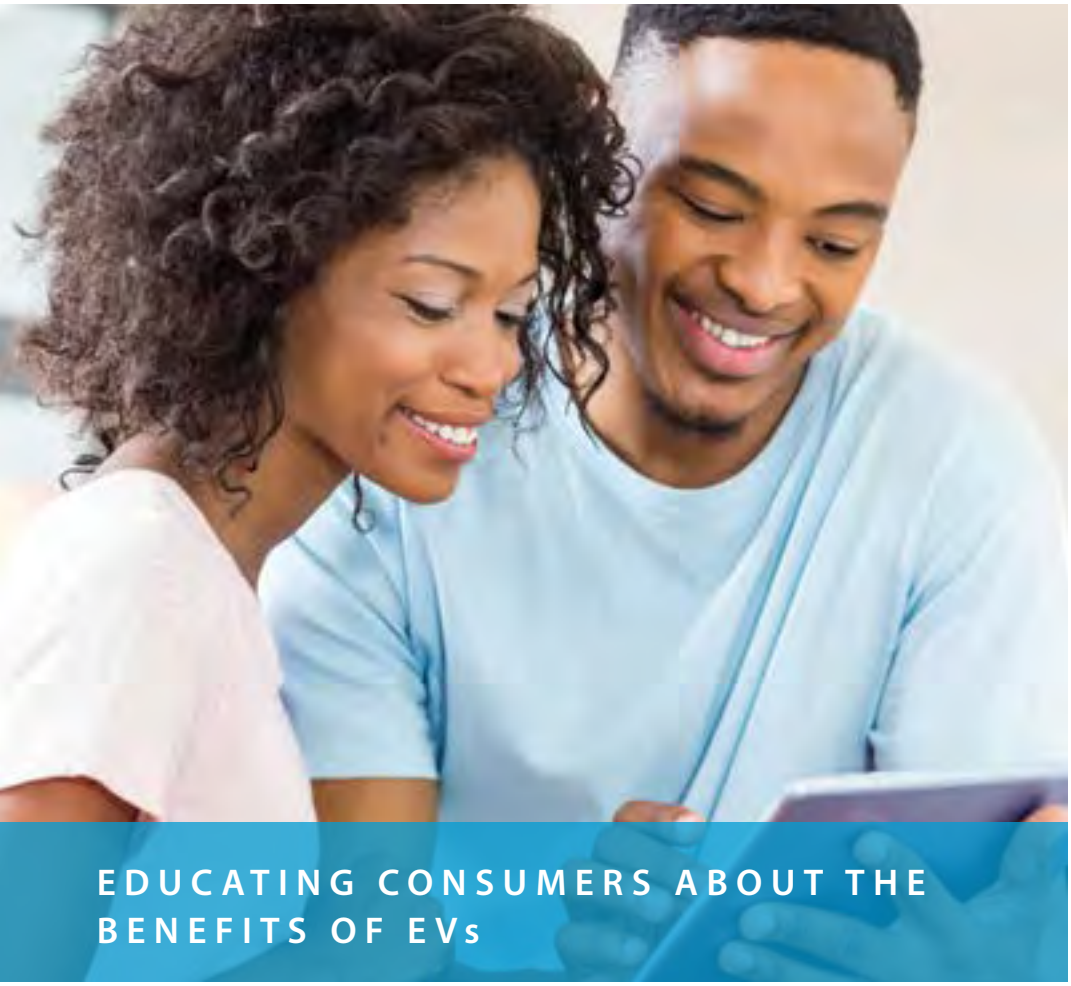
Rebate and incentive programs vary in scope from small EV charger incentives to large rebates for new EV purchases. Some examples are presented in Table 1 below. For a complete list of EV incentives across the U.S., see the Alternative Fuels Data Center (AFDC) Electricity Laws and Incentives web page.

### Table 1: Utility EV Programs Across the US (March 2020)

| Sacramento Municipal Utility District (SMUD) | PG&E, SCE, and SDG&E | Georgia Power | Burlington Electric Department | Omaha Public Power District (OPPD) |
|---|---|---|---|---|
| Two years of free charging for EV owners or a free Level 2 charger for new EV customers | EV purchase rebate of $200-$500 | Business customers can qualify for a $500 rebate for each new Level 2 workplace charger, while any residential customer can qualify for $250 rebate for a Level 2 home charger | $1,200 rebate on the purchase or lease of a new EV or a $600 rebate for the purchase or lease of a new plug-in hybrid EV | $4,500 rebate with the purchase or lease of a new EV and the purchase of a ChargePoint Home™ charging station |
| **Columbus Ohio (City of Columbus Division of Power)** | **Holy Cross Power (HCP)** | **Gulf Power** | **Eugene Water and Electric Board** | **City of Ashland, Ore.** |
| $500 rebate for each Level 2 charger installed at a residential property | $650 rebate for Level 2 chargers to customers who own or lease an EV | $750 rebates for Level 2 chargers | $300 toward buying a new or used EV or installing a Level 2 charging station at workplace | $300 for new or used battery electric vehicles, $200 for new or used plug-in hybrid vehicles and $500 to install a workplace charging station |

*Source: Alternative Fuels Data Center (AFDC)*

# IV. Market Engagement and Education




Educating consumers about the benefits of EVs is the simplest and most cost-effective way utilities can increase EV adoption in their territory.

## Consumer Engagement

Consumers do not traditionally look to their utility for information when purchasing a vehicle. However, major misconceptions about EVs – from battery range concerns to maintenance costs – continue to create barriers to broader EV adoption. In the absence of clear, reliable information from the market, utilities can establish themselves as trusted resources for prospective EV customers. A survey of consumers conducted by the Edison Electric Institute found that almost two-thirds of respondents wanted their electric utility to take a leadership role in encouraging a shift toward electric transportation (Edison Electric Institute 2011).

Educating consumers about the benefits of EVs is the simplest and most cost-effective way utilities can increase EV adoption in their territory. Utility consumer education plans typically include a dedicated EV section on the utility's website, outreach campaigns in print and social media, and EV-focused events. EV education also gives utilities an opportunity to establish a relationship with their customers that can lead to broader participation in smart charging programs, rebates, and other pilot programs.

Currently, most large utilities include some information on EVs on their website, but providing comprehensive information and keeping it up-to-date can require significant effort. To help, a number of third-party vendors offer turn-key software-as-a-service (SaaS) platforms. The ChooseEV platform, which is operated by the Yenter Group and distributed by D+R International, is one such example. ChooseEV provides information on carbon and financial savings, incentives, and EVs currently on the market. Many of its tools are customizable and user-friendly, in addition to offering basic information on EVs for customers interested in learning more about EVs.

### Figure 3: Examples for ChooseEV online platform


Commute calculator

Tax credits and incentives

Vehicle comparison

EV charging station finder

*Source: ChooseEV website*

Utilities should ensure their EV educational resources and events are accessible to all customers. According to the U.S. Census Bureau, more than 20% of U.S. residents speak a language other than English at home (Census Bureau 2017). A relatively simple way to begin this process is for utilities to make sure their educational tools and resources, such as the examples shown above, are available in other languages, particularly Spanish.

## Case Studies

In addition to a consumer-friendly website, utilities can educate and engage with their customers through in-person events and outside-the-box marketing campaigns. Some examples include:

- Kansas City Power and Light (KCP&L) leverages an EV showroom in downtown Kansas City and targeted consumer marketing to drive traffic to their cleanchargenetwork.com website (Kuenzli and Beeson 2019).
- Austin Energy's "StEVie the EV-Loving T-Rex" campaign, a digital campaign that specifically targeted customers they identified as potential "early adopters" of EVs, resulted in over 420,000 impressions and a 22% increase in EV charger subscriptions (Kuenzli and Beeson 2019).
- SMUD's Drive Electric campaign, a community-focused EV marketing campaign that created a series of videos of families driving EVs in residential neighborhoods and advertised SMUD's EV rebates, resulted in a 50% increase in traffic to SMUD's Drive Electric website and over 400 EV charger rebate applications (Kuenzli and Beeson 2019).
- Idaho Power hosted a series of events with a number of local advocacy groups to showcase EV models and educate customers on types of charging stations (Idaho Power 2019).

## Dealer Engagement

Increased demand for EVs will only translate into increased EV adoption if local dealerships sufficiently stock and support EV sales. EV supply is uneven in the United States, with urban and suburban areas more likely than rural areas to have EVs ready for test drive at the dealership. Unsurprisingly, EV sales are dramatically higher in areas with a greater number and variety of EV models available (Forth 2019).

Similar to potential EV customers, many car salesmen are unfamiliar with and unaccustomed to selling EVs. Dealerships may also view EVs as bad for business because of lower margins and fewer lifetime maintenance needs. As a result, sales staff regularly steer customers towards ICE vehicles instead of EVs.

To alleviate this problem and grow the local EV inventory, utilities should reach out to auto dealers and develop open lines of communication to demonstrate their commitment to EVs, with the eventual goal of a multi-year EV promotion effort that will translate into increased sales for dealerships. Dealer engagement can include:

1. Developing open lines of communication with dealerships to learn what is important to them and whether they want to sell more EVs
2. Developing educational and informational materials for auto dealership sales staff
3. Committing to promotions and/or dealer incentive programs

### Case Study

In eastern Washington, Avista partnered with Forth to reach out to local auto dealers to better understand supply in the area and educate dealers on utility incentives. This effort helped Avista build an ongoing relationship to support auto dealers, while also helping the dealerships obtain and sell more EVs. Avista also ensured dealership sales staff were on board by offering them a utility sales promotion incentive for referring customers to Avista's EV program (Forth 2019).

## Electric Vehicle Supply Equipment (EVSE) Supply Chain Engagement

The EV charger (known as EVSE) is the direct connection between the EV owner and the utility. As such, utilities want to ensure that: 1) the equipment installed in their territory is compatible with grid reliability and energy efficiency programs and 2) the technicians who install the equipment for homes and businesses are knowledgeable of utility policies.

Utilities can shape the type of EVSE equipment installed in their territory by offering incentives for equipment with certain characteristics, such as low standby power and connectedness. Utilities can also engage directly with EVSE manufacturers to encourage development of certain product characteristics, and then work with local distributors and technicians to make sure they supply and install the right kind of equipment.

Increasingly, EV owners are choosing to install Level 2 chargers at home – a large expense that often requires the help of a licensed contractor. This touchpoint creates an opportunity for utilities to recruit and certify local electrical contractors to share information and sign-up customers for utility programs. In return, utilities can provide information about contractors in the network on their website. Local electricians will benefit from the increased exposure, and customers can be assured any installations and additional electrical reconfigurations needed are done in a safe and professional manner by a licensed contractor.

# V. Grid Reliability in an Electrified Transportation Future

Utility transportation electrification plans must include a strategy for estimating, measuring, and planning for the effect of increased EV adoption on grid reliability. While the grid as a whole can likely support the increased demand from EV market growth, both the timing and location of charging could create problems for local systems and infrastructure if utilities do not manage the changing load curve (Walton 2018, Engel et al. 2018).

In particular, a report by the National Renewable Energy Laboratory (NREL) explains that EV adoption tends to increase in certain pockets of a population due to a "clustering effect," driven by multiple social and economic factors (Walton 2018). Unless managed correctly, multiple Level 2 chargers in a single neighborhood could strain the power distribution system when many EVs are charging simultaneously (CUB 2017). Adding just one EV to a small network could reduce transformer lifetime to 10 years instead of the normal 30 to 40 years (Walton 2018). Utilities will also need to consider the grid capacity needed for public transit vehicles and other fleets. Boston Consulting Group estimates that if just 40 city buses require fast charging during the day, the increased demand required would be comparable to the capacity needed to power 3,000 homes (Sahoo, Mistry, and Baker 2019). Depending on the location of the fast charging stations and the bus routes, the increased load could put significant pressure on a concentrated network of transformers.

Several utilities recognize the challenges presented by EVs and are currently seeking creative solutions to address potential future problems before they occur. Utilities can implement strategies, such as time-of-use rates or managed charging, to optimize the location and timing of charging and decrease the estimated transmission and distribution cost per EV by 70% (Sahoo, Mistry, and Baker 2019). A recent study by Jackson Associates found Southern California Edison could save $560 per EV each year, assuming just 10% EV market penetration, by implementing managed charging and vehicle-to-grid policies (Walton 2019). By anticipating the impacts of increased load and investing resources early, utilities can avoid potential challenges related to grid instability and reap the full benefits of EV adoption.

In order to optimize grid capacity and shift EV charging to off-peak hours, utilities have experimented with Time-Of-Use (TOU) rate design pilots. TOU rates set a higher price for electricity during peak hours to encourage customers to shift EV charging to daytime or late at night. Without TOU rates, utilities with higher-than-average EV adoption risk overloading the grid during the evening peak hours when people return from work (IPL 2014).

However, TOU rates can lead to their own challenges, especially for neighborhoods with high EV adoption. If TOU rates encourage EV owners to begin charging at the same time, it could create new local peaks and increase distribution system costs (Allison and White 2017). For these reasons, utilities are studying multiple TOU rate pilots to determine which rate designs optimally shift EV charging behavior. EV TOU rates can also help utilities manage off-peak generation from renewable energy sources and make those sources more viable (Baumhefner et al. 2016).

Before launching a full scale EV TOU rate program, most utilities begin with a voluntary pilot program to better understand EV charging behavior in their service territory. One example of a successful execution of this strategy comes from Indianapolis Power & Light (IPL). IPL, a subsidiary of the AES Corporation, provides retail electric services to more than 480,000 residential, commercial, and industrial customers in Indianapolis and other central Indiana communities. IPL introduced a TOU rate for EVs in its jurisdiction as a part of a broader EV pilot. It provides one rate structure for customers charging EVs at home and another for those using public chargers (see Table 2 below). The high peak rate's primary objective was to discourage home charging at peak hours, and the pilot succeeded in pushing approximately 76% of the electricity demand for residential EV charging to off-peak hours (IPL 2014). Based on the positive results, IPL made the EV TOU rates permanent, and they are still in use today.

### Table 2: IPL EV TOU Rates ($/kWh)

| Charging Type | Summer Peak Rate | Summer Mid-Peak Rate | Summer Off-Peak Rate | Non-Summer Peak Rate | Non-Summer Off-Peak Rate |
|---|---|---|---|---|---|
| Home Charging | $0.12 | $0.06 | $0.02 | $0.07 | $0.03 |
| Public Charging | $2.50 per charging session | | | | |

*Source: Indianapolis Power & Light (2019)*

In California, Southern California Edison (SCE) has already implemented a full-scale EV TOU rate program for its 15 million commercial and residential electric customers. For commercial SCE customers, certain rates apply exclusively to EV users and cover different vehicle and customer types. For residential customers, as shown in Table 3 on the following page, SCE provides three basic rate plans for residential EV customers.

### Table 3: SCE EV TOU Rates ($/kWh)

| Plan | Summer Rate-Weekdays | Summer Rate-Weekends | Winter Rate-Weekdays | Winter Rates-Weekends |
|---|---|---|---|---|
| **TOU-D-4-9PM** | **Off-peak** *8am-4pm, 9pm-8am:* **$0.22**<br>**On-peak** *4pm-9pm:* **$0.41** | **Off-peak** *8am-4pm, 9pm-8am:* **$0.22**<br>**Mid-peak** *4pm-9pm:* **$0.27** | **Super Off-peak** *8am-4pm:* **$0.17**<br>**Mid-peak** *4pm-9pm:* **$0.29**<br>**Off-peak** *9pm-8am:* **$0.28** | **Super Off-peak** *8am-4pm:* **$0.17**<br>**Mid-peak** *4pm-9pm:* **$0.29**<br>**Off-peak** *9pm-8am:* **$0.28** |
| **TOU-D-5-8PM** | **Off-peak** *8am-5pm, 8pm-8am:* **$0.23**<br>**On-peak** *5pm-8pm:* **$0.49** | **Off-peak** *8am-5pm, 8pm-8am:* **$0.23**<br>**Mid-peak** *5pm-8pm:* **$0.29** | **Super Off-peak** *8am-5pm:* **$0.17**<br>**Mid-peak** *5pm-8pm:* **$0.30**<br>**Off-peak** *8pm-8am:* **$0.29** | **Super Off-peak** *8am-5pm:* **$0.17**<br>**Mid-peak** *5pm-8pm:* **$0.30**<br>**Off-peak** *8pm-8am:* **$0.29** |
| **TOU-D-Prime** | **Off-peak** *8am-4pm, 9pm-8am:* **$0.13**<br>**On-peak** *4pm-9pm:* **$0.38** | **Off-peak** *8am-4pm, 9pm-8am:* **$0.13**<br>**Mid-peak** *4pm-9pm:* **$0.27** | **Super Off-peak** *8am-4pm:* **$0.12**<br>**Mid-peak** *4pm-9pm:* **$0.35**<br>**Off-peak** *9pm-8am:* **$0.12** | **Super Off-peak** *8am-4pm:* **$0.12**<br>**Mid-peak** *4pm-9pm:* **$0.35**<br>**Off-peak** *9pm-8am:* **$0.12** |

*Source: Southern California Edison (2019)*

Another example of a successful EV TOU rate program is Georgia Power, the primary power utility for the state of Georgia serving more than 2.4 million customers. Georgia Power's EV rate structure offers EV owners TOU rates in three different time periods: peak, off-peak, and super off-peak (shown below in Table 4). The EV rate is voluntary, but requires a 12-month commitment.

### Table 4: Georgia Power EV TOU Rates ($/kWh)

| Rate Type | Duration | Rate ($/kWh) |
|---|---|---|
| **Peak** | *2-7pm (June-September)* | **$0.20** |
| **Off-Peak** | *7am-2pm, 7pm-11pm (June-September) 7am-11pm (October-May)* | **$0.07** |
| **Super Off-Peak** | *11pm-7am (all year)* | **$0.01** |

*Source: Georgia Power Company (2019)*

IPL, SCE, and Georgia Power all began with limited EV TOU rate pilots then implemented permanent, full-scale programs based on the results. It is notable that although many similarities exist between the three examples discussed above, each EV TOU rate is structured in a slightly different manner. This is to be expected given all three utilities are in different parts of the country and have different needs based on EV adoption in their service territory, resource mix, and other factors. A successful EV TOU rate program will evolve as the conditions change and utilities learn how to anticipate future demand.

## Smart Charging

Smart charging dynamically adjusts charging activity in real time to optimize EV charging behavior for the utility and the customer. This technology opens up a range of possibilities, including vehicle charging based on predefined load limitations within a particular location, or by a change in rates (Khan and Vaidyanathan 2018). Many smart charging solutions can also help utilities collect the granular data needed to evaluate different EV TOU rate designs. Utilities should evaluate which, if any, smart charging methods make sense for them based on their specific needs.

Smart charging includes technologies currently available, such as chargers that operate under constraints set directly by the EV owner (to take advantage of TOU rates, for example). It also includes technologies that may be commercially viable in the future, such as automated smart charging technology that automatically adjusts charging behavior based on grid conditions and the needs of the vehicle. While many smart charging technologies are still in their infant stage, utilities should be ready to take advantage of these technologies as they become widely available, and even partner with EVSE manufacturers to shape the development of smart charging technology.

Utilities with notable smart charging pilots include SCE, Austin Energy, Tennessee Valley Authority and Utah Rocky Mountain Power (Forth 2019). Additionally, FleetCarma is a good example of a smart charging technology provider that many utilities have collaborated with to assist with their smart charging pilot programs.

## Vehicle-to-Grid (V2G)

Vehicle-to-grid (V2G) technology allows utilities to use distributed EV batteries to store excess generation and tap into unused energy when needed. V2G technology could assist in a variety of ways, including regulating renewable energy fluctuations, peak power shaving, and providing an emergency backup power source (Portland Gas & Electric 2017). Customers could benefit from such a relationship by receiving payment for making their vehicle available for V2G programs.

Despite all the potential benefits, V2G technology still has major hurdles to overcome before it is adopted on a wide scale. Most OEMs will void the warranty for EV batteries if they are used for V2G pilots due to negative impacts on battery life. For this reason, no consumer-grade EVs currently on the market are enabled for V2G. However, utilities including SCE and PG&E in California and Portland PGE in Oregon are partnering with large fleet operators on pilots to study this technology.

## Conclusion

As EV sales continue to grow exponentially, it is only a matter of time before EV ownership transitions from the early adoption phase to the mass adoption phase of the technological innovation cycle. This paper lays out a roadmap for utilities to develop a clear and comprehensive strategy for transportation electrification.

Coordinating policy and strategy with state and local partners will lay the groundwork for successful infrastructure projects, incentives, market engagement strategies, and grid reliability programs. Utilities can look to pilot programs implemented by their counterparts across the U.S. as starting points to develop their own strategies.

The topics explored in this paper should be viewed as pieces of the same puzzle, an electrified transportation future, as opposed to separate areas of focus to be solved independent of one another. Utility transportation electrification plans are the first step in creating a more sustainable transportation future.

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