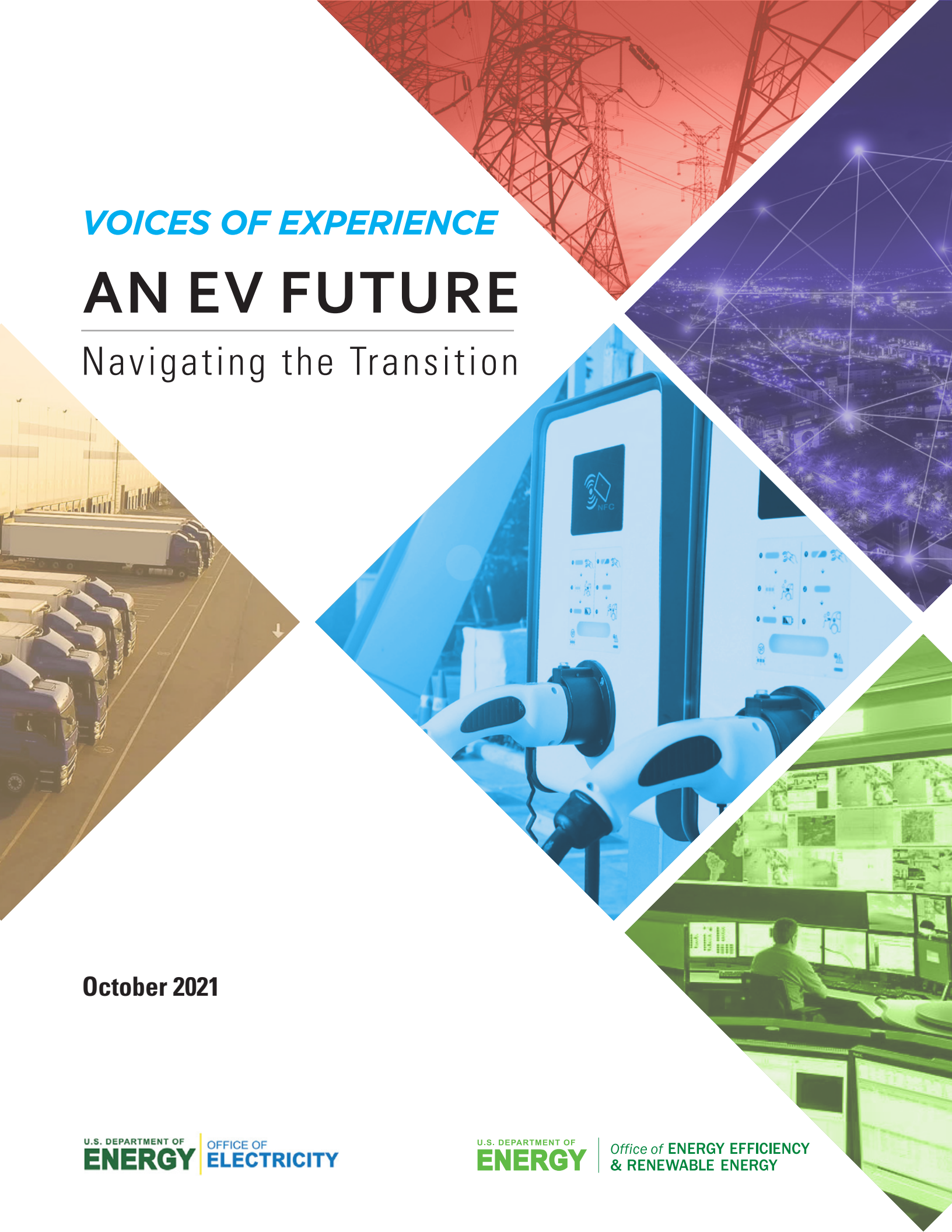

VOICES OF EXPERIENCE

AN EV FUTURE

Navigating the Transition

October 2021

U.S. DEPARTMENT OF ENERGY | OFFICE OF ELECTRICITY

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

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The Wave of Transportation Electrification

The wave of electrification is on the horizon. With millions of personal and commercial electric vehicles (EVs) set to hit U.S. roads in the coming decade, that wave may be more like a tsunami. Merging the transportation and electricity sectors has the potential to fundamentally transform how customers fuel vehicles and how goods are transported across the country.

Conversations about transitioning to electric vehicles have shifted from "can we do it?" to "how do we do it?" While on the surface it might seem straightforward – replace petroleum fuel with electricity – the reality is not always so simple and it won't happen overnight. Utilities will be called upon to provide hundreds of terawatts of power for these mobile, highly variable loads. Supplying power for commuting, travel, freight, and public transit could, in some cases, create significant increases in local electricity demand. Yet at the same time, every EV has potential value to the local utility and the grid as a storage device and load management tool, creating system benefits that must also be factored into planning, pricing, and infrastructure investments.

Utilities have a long history of building infrastructure and providing safe, reliable electric power. However, the transition will not depend on utilities alone. The interdependence of transportation and electricity will introduce new dynamics. It will involve myriad stakeholders across the sectors. It will redefine relationships, introduce new partnerships, and require new thinking to tackle not only the technical challenges but the cultural, institutional, and policy barriers that will arise.

> "Zero emissions will be here from coast to coast."
>
> Russ Musgrove, FedEx Express

Electric vehicles offer exciting opportunities with numerous environmental and economic benefits, but change isn't always easy and the road ahead will have many twists and turns as the nation begins to embrace this emerging, transformative technology.

About the Initiative

The U.S. Department of Energy (DOE) has researched electric vehicle technologies for over three decades. In that time, there have been many changes, not only with vehicle technologies, but with charging technologies. At the same time, DOE has funded research to help utilities modernize the electric grid. Utility customers today want more information, choice, and control over their energy usage. They want information at their fingertips, they want cleaner fuel choices, they want options, and they want it to be simple. These changes are driving new interactions, new technologies, and new operating procedures.

DOE has long understood the importance of peer-to-peer dialogue for uncovering fresh perspectives and enhancing learning. Recognizing the magnitude of change that the adoption and integration of electric vehicles will present for utilities, business, and other stakeholders, the Office of Electricity's Advanced Grid Research and Development (AGR&D) Division, in partnership with the Office of Energy Efficiency

and Renewable Energy's Vehicle Technologies Office (VTO), launched *An EV Future: Navigating the Transition (An EV Future)* in July 2020. The initiative utilized the Voices of the Experience approach that AGR&D pioneered over a decade ago. The effort brought together stakeholders from across the transportation electrification ecosystem to explore what the buildout of the electric vehicle charging infrastructure and its integration with the electric grid will mean from different stakeholder perspectives.

DOE hosted a series of 33 two-hour virtual meetings covering 15 topics. An industry steering committee provided feedback and input into the scope and topics to ensure alignment with stakeholder needs and interests and to avoid duplication of other efforts. All calls followed a similar structure: two speakers from different parts of the industry shared their insights and experience to set the stage for a facilitated discussion or 'conversation' that allowed all call participants the opportunity to share their observations, discuss challenges, and learn from each other. The first nine topics had three calls each, scheduled at optimal times for specific regions. An additional six calls were added to cover themes that emerged through the preceding 27 stakeholder conversations. Two topics were utility-to-utility specific so that participants could speak more candidly about internal operations and the challenges utilities face.

Nine Initial Topics:

- Forecasting
- Managing Load
- Designing the Infrastructure
- Service Requests
- New Technology Implications
- Deploying the Infrastructure
- Understanding Future Requirements
- Resilience and Reliability
- Economic Feasibility

Additional Special Focus Topics:

- Multifamily Housing and Underserved Communities
- Lessons Learned from Pilots (Utility-specific)
- Long Haul Fleets and Travel Centers
- Regional and Local Trucking
- Conventional Retail Fueling
- Programs and Processes (Utility-specific)

The initiative had broad reach. More than 3500 individuals, representing 700 unique entities, registered for calls. Participants included utilities, commissioners and staff, charging network providers, state and local agencies, advocates, academia, and vendors that spanned not only the U.S. but also included organizations from 18 other countries. (More information about participation is provided in Appendix A.)

What You'll Find in This Document

This document represents the collective voice of stakeholders. The information captures the insights and learnings from sixty-six hours of stakeholder discussions and attempts to maintain the voice of participants where possible. Conversations were compiled and edited into collective insights, advice, and learnings that emerged, but does not attempt to cover areas that did not surface during calls. DOE introduced topics and guided conversations, but the actual direction and flow of the roundtable discussions were determined by participants themselves. The examples and quotes attributed to a specific company or individual are included with permission from the source.

This document is not a roadmap nor a technical report on what to do. Conversations were not meant to provide technical specifications, but a broader, more informal collection of experiences and observations from a variety of perspectives. The effort explored successful approaches as well as not-so-successful ones. It attempted to uncover unanticipated challenges or barriers. Often, the most valuable insights emerge when things don't work out exactly as intended.

Solutions and perspectives differ. The aim of the effort was not to build consensus nor to offer official DOE opinions about any given approaches, roles, or programs, but rather to provide a forum to exchange ideas, share experiences, discuss challenges and barriers, and come together for productive, constructive conversations. The hope is that these conversations help illuminate the opportunities, identify challenges or gaps, and provide inspiration for stakeholders as the nation moves towards electrifying transportation.

One size does not fit all when it comes to electrification. The fueling needs of customers are not all the same and the reason and motivation to shift to electricity as a fuel will differ. Utilities have different operating and regulatory or governing structures. Numerous solutions will emerge to fit the varying needs of customers while meeting the operating constraints of each utility. Examples and additional resources do not represent an endorsement from DOE but are included to illustrate the many approaches and resources that participants found helpful in their journey.

Each section of this guide is meant to stand alone. This document is not meant to be read cover-to-cover. It is designed to be easy-to-read and skimmable. The hope is that readers with different backgrounds and roles can easily find the information they seek for their area of interest.

Contents at a Glance

Transforming Industries

What the Transition to Electrification will Mean

Electricity as a fuel source will bring together two sectors – electricity and transportation – that are essential for economic success and maintaining the American way of life. Electric vehicles are not new but they will be disruptive. The transition will be more revolutionary than just a simple switch to a new fuel source. It will create interdependencies that didn't previously exist. It will require new partnerships. It will require creativity, innovation, and collaboration. The transition will offer new opportunities but also place new demands on the electric grid and the utilities that operate and control it. Following are key themes that emerged.

> "During the nascent phase, there will be hybrid or parallel market development that will converge as the new industry emerges."
>
> Phil Jones, Alliance for Transportation Electrification

The pace of change is unparalleled.

The electricity industry hasn't seen this level of technological change since electricity was discovered in the mid-1700's. Changes are not only related to electric vehicles, such as battery technology, charger technology, and increasing power levels, but also to the transmission, generation, and distribution of electricity – two-way flow of electricity, distributed resources, renewable generation, new market entrants. It is changing interactions and creating new roles.

Utility size and governing structure could drive different solutions.

Challenges, solutions, and motivations will vary depending on the utility's size, regulatory environment, and operating structure. Smaller utilities might be better equipped to nimbly develop innovative solutions and respond to customer preferences and needs. On the other hand, some aspects might pose more challenges for utilities that have a smaller customer base among which to spread costs and fewer numbers of personnel to incorporate sophisticated technologies and tools.

The transition is about more than sustainability and a low carbon future.

For businesses, sustainability may be a component, but the transition must make economic sense. For consumers, motivations will vary. For some it might be zero-tail pipe emissions, for others, it might be having a fun car to drive or the convenience of fueling at home. In addition, new revenue generated by the increase in load from electric vehicles offers the potential to reduce rates for all customers when new revenue exceeds implementation and infrastructure costs. Focusing on sustainability alone may dilute other benefits and may leave value on the table or lead to unintended consequences.

Business will rely on utilities in new ways.

For many businesses today, interaction with the utility may be limited. But as electricity replaces gas or diesel in company vehicles, and companies become reliant on electricity for more aspects of their business, the utility will become an essential partner. For large companies with locations in more than one utility's territory, this can mean multiple—in some cases, literally thousands of—new partners, each with its own language, policies, and regulations.

New market dynamics can create tensions.

Viewing the transition through traditional business lenses and thinking of electrification as simply swapping out electricity for gasoline or diesel can create tension between longstanding interests. Decisions around ownership models, rates, infrastructure investments, and customer interactions can have a significant impact on revenue and profits and may illicit strong opinions and reactions. Reimagining business models and developing mutually beneficial solutions can put such tension to constructive use.

Uncertainty can hamper deployments.

As companies make plans and buy vehicles, there must be assurances that the infrastructure will be there and that costs will be stable. Whether it's rates, taxes, charging infrastructure, or connector technology, all are decisions that factor into the economic viability of a project and the decision to convert a fleet to electric.

Industry announcements are signaling a commitment to transportation electrification.

Each week corporations, government offices, and community leaders announce commitments to EVs and charging networks. Car makers have announced new electric models or electric versions of established models, and new manufacturers are emerging. However, optimism is balanced with measured hesitancy. The transition represents tremendous opportunities but also possesses the risk of installing technology that might be underutilized, become outdated, or could increase costs.

Change is inevitable but not always easy.

There will be organizational and institutional changes as well as technology changes – and change is seldom easy. Cultural change within an organization, and within society as electric vehicle adoption becomes more commonplace, will play a significant role. Recognize that the transition won't be perfect and there will be hiccups along the way. Things won't necessarily work as expected the first time so be mindful of impacts to customers, employees, and the organization at large.

DELIVERING CHANGE

Electricity has to compete with fossil fuels both economically and in terms of efficiency for fleet managers to make the transition. And for FedEx, **electricity is an amazing fuel for the last mile delivery, especially for hub and spoke models**.

"We're energy agnostic," stated **FedEx Express** managing director Russ Musgrove. "FedEx sells its customers certainty, and electrification has to support that goal." With that in mind, FedEx Express has recognized the efficiency of EVs. Drivers have logged millions of electric miles already. **By 2025, 50% of FedEx Express global spending on vehicles will be on EVs, and that will rise to 100% by 2030**. It is also partnering with sister company FedEx Ground to share charging facilities.

For a company that operates in every zip code in the U.S., the transition to EVs has some added complications. "There's a thousand different utilities and they have a thousand different ideas about how to approach electrification," Musgrove laughed. **"Utilities need dedicated fleet programs, people who know the language we're speaking and can tell us what we can expect in planning, installation, and rates."** With plans to install 2000 charging stations, FedEx Express is looking for options to factor infrastructure costs into its rates while also finding stability in its energy bills. "The models are different, the language is different, but when you boil it down, you want to sell electricity and I want to buy it."

Key Takeaways

Emerging Themes from Participant Conversations

EVs loads are mobile and unpredictable.

Utilities are accustomed to powering a building where peak energy usage is predictable and becomes more efficient over time. This is not necessarily the case with transportation electrification. Approaches, regulations, and processes may need to evolve to address the differences and to respond to customer requirements.

Unanswered questions remain.

Stakeholders throughout the ecosystem (utilities, vehicle manufacturers, charging network providers, commissions, state energy officials, etc.) are universally looking for more information, be it about technology, lessons learned, or partnerships. Even industry experts are having to learn new pieces of the puzzle. While there are many unanswered questions, stakeholders are eager to understand, learn, and look for new solutions.

Social justice requires special attention.

As the nation moves from the early-adopter phase, equity and inclusion move to the forefront. Solutions that are equitable and inclusive will be about more than just the technology. They will need to weigh considerations that promote social values, encourage innovation, lead to economic development, and promote workforce education and training.

Collaboration is paramount.

The merging of two important sectors of the economy will require stakeholders to reimagine long-held processes and customs. It will require different interactions and new partnerships. Stakeholders who have worked together in the past will likely work together differently in the future. Segments of the economy that might have previously been siloed will become partners. Collaboration can bridge perspectives, uncover new opportunities, and overcome challenges that require collective solutions. Open dialog will be essential as the nation moves forward.

Creative thinking needs to be balanced with reasonable constraints.

With so much enthusiasm about electrification, there's a tendency to shoot for the moon. While optimism and creativity are to be encouraged, solutions must be based on cost and technology capabilities, using economics and science to ground ideas is essential.

A robust, visible charging network is critical.

Not all drivers will be able to charge at home. And even those drivers who can charge at home want the comfort and security of knowing they can charge *when* they need to, *wherever* they are. Public charging will need to be convenient and easy. And range anxiety isn't just a factor for residential customers. Fleets feel it too!!

Solutions will evolve over time.

Electric vehicles are more than just "cars fueled by electrons instead of gasoline." EVs are a disruptive technology, and electrifying transportation is more than a technology challenge. The transition will include psychological and cultural components as well. What works today will likely change as the number of EVs on the road grows over the next five, ten, or 15 years.

Utilities are the nexus.

The transition depends on them. With a mandate to serve all customers, they may be suited in the near-term to deploy and maintain the backbone infrastructure, necessary for charging station deployment, especially in less-economically viable areas. While the role of the utility may change as the market develops, there was one recurring piece of advice throughout the effort: embrace the local utility as a partner.

The utility-customer relationship is changing.

Modernization of the electric grid initiated a change to the nature of the utility's relationship with its customers. Electric vehicles will amplify this change. EV projects require more touchpoints and more interactions. Policy, process, and even regulatory changes may be required for utilities to respond as quickly as necessary to meet the fast-evolving nature of the market and to serve changing customer needs.

Fleets are a much greater challenge.

Supplying power to neighborhoods – even neighborhoods where more than half the households have an EV or two – will likely pose fewer challenges than supplying power to a fleet of electric delivery trucks or a bus depot. Converting a fleet could increase site load requirements by double or triple digits. It might even require new substations or transmission lines. Solutions may not be fast, easy, or inexpensive.

There is a shortage of skilled workers.

Training workers and enhancing skill sets is essential for deploying infrastructure. Utilities and businesses trying to install infrastructure and keep pace with fast-growing demand are facing workforce shortages, including positions from trained electricians (which can require apprenticeship programs of up to eight years) to meter technicians to contractors that can work with higher voltage levels.

Note: Rate reform is an important issue that needs specific attention; however, while this report touches on existing rate structures, this effort did not specifically explore rate reform alternatives due to the enormity of the topic.

Regulating the Pace of the Future

The influence of policy and regulations

New electric vehicles and charging technology are being developed and deployed at an accelerated pace, but the transition to electrified transportation will depend on more than just science and technology. As regulated entities, utilities can only implement programs and invest in infrastructure approved by their state commission or governing body. Effectively, on the road to EV transition, regulators can be the gas or the brakes depending on the policies put forth. Mandates and incentives at the state and local levels can serve as a green light that accelerates the move towards mass use of electricity as a fuel, while permitting hurdles or endless studies and pilots can limit acceleration.

The U.S. utility industry is complex, operates differently than other businesses, and has its own language. There is no singular market structure, ownership model, or regulatory framework. This can be difficult and frustrating for outsiders to understand and navigate. Complicating matters is that utilities require approval prior to implementing new plans, and those approval processes also vary across the country, introducing differing timelines and requirements.

The reach, effects, and timelines of utility policies and programs will depend on how the utility proposes them, how stakeholders present their own opinions, and how governing bodies view both. Hearing perspectives from stakeholders across the ecosystem provides policymakers with information and context to grasp the sometimes competing or conflicting needs of each side. Information and education that provides varied and often clashing perspectives of diverse parties will be vital as regulators are called upon to make key decisions about how and where infrastructure will be deployed, who will own and maintain it, and the rates and demand charges that might be needed to pay for it.

> "Balancing creativity and reasonable constraints can promote social values and further development and innovation in electrification. This is the balanced sweet spot for a measured approach to growth and success."
>
> Commissioner
> Maria S. Bocanegra,
> Illinois Commerce Commission

WHAT WE HEARD

Planning and Economics

Broad guidance encourages more creative solutions Guidance and direction about the goals to accomplish, as opposed to codifying prescriptive decrees and strict edicts, can give utilities and businesses flexibility to develop solutions that accomplish objectives while accounting for operational constraints.

Short- and long-term context matter. Policies that encourage or incentivize a nascent industry might not be effective, or could even have negative implications, when the market matures. It is important to consider what a policy will mean both in the short- and long-term.

Industry needs certainty. While allowing the market to evolve on its own has merit, the market needs certainty. Participants noted that the time for nudging by policy and regulatory decision makers is now to facilitate broader adoption and reduce stranded assets.

EVs are one piece of a large puzzle. Investments will need to be made and aging infrastructure will have to be replaced, not only for the transition to electric vehicles, but to accommodate emerging technologies, to allow for greater participation by both customers and third parties, and to integrate distributed energy resources, such as solar power and battery storage. A holistic, long-term approach can provide context for infrastructure and rate discussions.

The size, shape, and speed of fleet electrification is uncertain, but unavoidable. Companies will be converting their fleets, some sooner, some at a faster pace, and some at a greater scale than others. Utilities can't precisely quantify the power needs of these customers nor the effect that outside factors may have on the speed of fleet conversions. Regardless, regulatory support is essential so that utilities can proactively anticipate and plan for these needs because failure to do so will render a customer's electric vehicles meaningless.

Government mandates can reach beyond state borders. Even utilities in states that don't adopt mandates for reducing greenhouse gas emissions or electrifying transportation may find fleets pressed to convert because of neighboring state regulations. For example, if a national distributor in one state makes deliveries to another state, fleet owners will need to meet the stricter standards of the two.

Learn from others. Once a company determines EVs make economic sense, it will want to make the switch quickly, and likely in more than one area. Having to repeat research or pilots from utility to utility can derail the practical realities of achieving results for businesses and curtail sweeping implementation.

Taxes to fund highways need to be addressed. Federal, state, and local governments impose taxes on petroleum-based fueling. Many are investigating or implementing similar taxes for electric vehicles. In fact, jurisdictions across the US have electricity sales taxes and some have imposed registration fees specific to electric vehicles. Approaches vary widely and not all are considered equitable. Stakeholders are eager to be part of the conversation about developing new approaches.

California Assembly Bill No. 841, enacted into law in September 2020, authorizes utilities to rate-base all distribution infrastructure required for line extensions to dedicated EV charging equipment on the utility side of the customer's meter. The New Jersey Shared Responsibility Model is another example where the utility's role is to "make ready" a site for publicly accessible EV infrastructure (including installation of transformers, conduit, and other equipment), while non-utility entities are responsible for installing, owning and/or operating, and marketing charging equipment using private capital.

Be mindful of negative externalities. Development of new programs, rates, and incentives will require a balancing act of the many variables involved. Whether its programs to encourage adoptions or to build out the charging infrastructure, a holistic approach can help to avoid unintended consequences. For example, new rate structures might may require balancing the costs to build and operate the grid along with the impact on adoptions or new station economics; or the need for utility investments might require balancing the desire to build out a charging backbone while also allowing for market competition.

Effective mechanisms have emerged for utilities to invest in backbone infrastructure. Building out the charging infrastructure to support mainstream adoption and fleet conversions will require significant infrastructure investments that could be prohibitive for any single entity. If electrified transportation is seen as necessary for supporting societal benefits and customer preferences, discussions about how infrastructure is funded are essential. Several approaches have emerged, such as line extension and contributions in aid of construction (CIAC) allowances.

Questions to Consider

- How are investments in new capabilities and infrastructure balanced with mandates for just and reasonable rates?
- Who pays for infrastructure upgrades and how are utility investments recovered?
- How can public-private frameworks incorporate societal values to provide a balanced, measured approach for EV charging infrastructure and grid investments in both the short- and long-term?
- How do businesses, utilities, and commissions move beyond pilots?
- What taxes or fees will be imposed on electric vehicle drivers and operators?

Deployment and Maintenance

Infrastructure upgrades will be needed regardless of whether they're used right now. Typically, infrastructure investments require benefits to customers on day one, based on demonstrated load growth. Meeting timelines for government mandates, industry demand, and the emerging EV market, might require utilities to replace aging, but still operational infrastructure, upgrade conductors or transformers, or make additional investments that traditional load growth can't justify. This is especially true in rural areas, inner cities, and underserved communities whose current infrastructure (e.g., 4 kV conductors) may be ill equipped to meet the new load demand of EVs.

Policies and procedures need to stay ahead of demand. Introducing new rates and incentives to spur adoption can support and encourage the transition. However, sometimes incentives can outpace expectations. Procedures or processes might need to be updated or modified to handle the surge and limit frustrations or delays that could impact EV deployments or customer perception.

Utility business models can influence interest. In states where utilities' profits are decoupled from volumetric energy sales, utility revenue is based on capital expenditures rather than electricity sales, as such increasing load from vehicle electrification might not be as big of an incentive as expected. Understanding motivations in order to align interests will prove crucial for achieving desired outcomes.

Late adopters may face infrastructure challenges. . Some businesses are at the forefront of EV conversion because they recognize the value of being an early adopter under current regulatory policy. By tapping into excess capacity, early-movers will likely need smaller utility upgrades, allowing for faster, lower cost implementation. Companies that convert later may find limited available capacity, extending the timeline to convert.

Regulatory cycles are not aligned with the "speed of industry." The regulatory approval process which may only consider a rate case every three years rarely matches the speed with which businesses make decisions and implement projects. Businesses that convert their fleets will be long term customers whose revenue could contribute to a stronger, more resilient grid. Long timelines and high costs, however, could lead some to develop behind the meter solutions. Utilities are looking for regulatory flexibility that allows for creativity in responding to and meeting fleet needs.

Infrastructure can outlive a company. Emerging markets will have new companies that invest in the technology based on projected costs and revenue over the coming years. Reality, however, is that those projections can be wrong, economic trends can change, and businesses can collapse. If a business goes bankrupt after installing public charging infrastructure, questions arise over who will be responsible for ongoing operation and maintenance. Similarly, if a company with a large fleet goes bankrupt, other utility customers may wind up paying for the infrastructure if the new tenant has less demand.

Supply chain issues are a concern. A transportation sector increasingly reliant on electricity raises concerns about reliability and resilience. COVID-19 acutely demonstrated the impacts on supply chains to customers, businesses, and the nation. It has heightened stakeholder awareness and concerns, especially in the face of current shortages.

Data access frameworks can provide clarity and protect interests. Electric vehicles introduce new data streams that can have monetary implications for those who possess the data and those who want it. Frameworks (i.e., the EU's General Data Protection Regulation) that define the roles, rights, and responsibilities of various parties in this new data landscape can provide direction on the ownership, sharing, access, and protection of data.

Metering accuracy needs resolution. Billing customers requires accurate measurements whether for retail commerce or utility billing. Accuracy requirements and equipment certification are two important but unresolved issues. It will be necessary to consider the negative implications of applying new standards to the many existing charging stations that have already been deployed. Some states provide exemptions for existing equipment.

Questions to Consider

- Who has responsibility for a charging station if the third-party goes out of business?
- What strategies can limit the impact of supply chain disruptions (e.g., stocking long lead items, such as transformers)?
- Who has access to what data and how is it shared and protected?
- What are the broader implications around responsibility and litigation in customer billing disputes related to EV-only rates?
- Do answers about charger meter accuracy change in the context of increased adoption numbers for EVs and other distributed energy resources (e.g., PV, battery storage)?

THE WORD ON THE STREET: SUBMETERING

For utilities, the meter – and its data – serves as the cash register to measure and bill for customer usage. To offer a rate that applies solely to vehicle charging, utilities require a submeter to measure that usage separately from that of the entire home. Pilots are underway to examine different approaches and determine their cost and value to customers. Ultimately, submetering questions will be decided by state commissions.

Elements of the Discussions

Accuracy standards are different. Different meter types have different accuracy standards and certification requirements, and these can vary from jurisdiction to jurisdiction. This difference is at the crux of many submetering discussions.

Customer charging data has value. Measuring charging data with an AMI meter gives utility engineers more visibility into specific load requirements and operational characteristics rather than having to depend on calculations based on other operating data. This is especially important during blackstart conditions. Charging companies, however, see this data as an asset they can monetize, raising questions about who owns and has access to the data as well as its value.

Billing disputes are no small matter. Utilities contend that responding to customer billing complaints will be difficult to defend if usage isn't recorded using a utility meter, especially in litigated cases. Capturing data with the charger meter means that utilities will not have the ability to test the meter for accuracy nor replace it if it isn't functioning properly.

Separate meters can increase costs to consumers. Requiring a separate meter, which may, in turn, require an additional panel and/or separate service, to measure, manage, and bill for vehicle charging can increase installation costs to the point of being a barrier for some customers.

Different Utility Approaches

Great River Energy, a co-op in Minnesota, uses deductive metering for water heaters and electric vehicles. It has associated costs and increases installation complexity, which can impact the overall payback period for switching to the reduced rate and decrease participation among EV drivers.

Burlington Electric Department (BED), a municipal utility in Vermont, established accuracy standards for Wi-Fi enabled smart chargers that are allowable for BED's EV rate. BED has near universal deployment of AMI meters, and uses a set of test meters at its main office to determine if the charger meter meets the accuracy limits before being accepted as an eligible device. Once eligible, BED uses customer AMI meters to monitor the accuracy of the energy data from the Wi-Fi enabled smart chargers enrolled on the EV rate.

Baltimore Gas & Electric (BGE), an investor-owned utility in Maryland, uses the charger meter to measure and bill for their EV rate to help defray customer and program costs. The Maryland Commission granted the utility a COMAR (Code of Maryland Regulations) waiver regarding meter accuracy through December 2023 to protect the utility during billing complaints. BGE anticipated challenges with Wi-Fi disruptions, but hasn't found it to be an issue. What was unanticipated is that some chargers don't send charging data until the car is unplugged, even if the charging session has ended. In some instances, this can be days or weeks.

Demand Charges

Demand charges are highly nuanced and vary from utility to utility. Demand charges are typically a component of a commercial electricity rate that are separate from, and in addition to, the standard volumetric (kWh) rates for utility customers. They vary from utility to utility – some utilities may have more than one – and must be approved by state commissions or utility governing boards. Intervals for recording load can range from five to 60 minutes and can apply for a single billing cycle or even an entire year.

DEMAND CHARGE – (noun) a fee levied on a utility customer based on the highest recorded load that a customer uses during a stated interval over a specified period. Originally developed as a mechanism to recover costs for infrastructure investments from high-energy users, even if that infrastructure is used infrequently.

Demand charges are a hurdle charging stations can't overlook. Building an EV charging station is an expensive and time-consuming endeavor. Once a charging station is built, demand charges can account for the majority of operating expenses, and can, on their own, exceed the revenue generated. In fact, a single higher usage event can nullify a station's financial viability for the month, or even a year.

EV loads are pulsating loads. Demand charges were developed based on building load profile characteristics. EV load characteristics, however, are different and won't necessarily flatten out over time. This raises questions of whether the traditional demand charge structure fits the nature of EV charging.

Pricing needs to reflect system conditions. Aligning pricing mechanisms with system conditions can communicate to customers times when there is additional capacity or excess renewable energy. This can encourage charging at times that are good for the grid and limit negative impacts.

> "High demand charges represent a truly existential threat to the high powered ultra-fast charging industry's economic viability."
>
> Matt Nelson, Electrify America

Higher utilization or throughput may limit impacts in some instances. With low utilization rates, demand charges can be a significant portion of the electricity bill. Utilities contend that as charging station utilization increases, demand charges will account for a smaller percentage of the bill. Charging station operators, however, point to recent studies that show the electricity usage characteristics of DC fast charging and high power chargers may not fit approaches designed for other traditional load types and may require additional examination and new approaches.

Demand charge credits can support market development. Mechanisms such as demand charge credits or temporary moratoriums, especially for circuits that are not near capacity, can improve station economics until the market can support higher utilization rates. Phasing them back in as utilization rises can reflect the temporary nature of the underlying issues related to low charger utilization.

Exelon is piloting demand charge credits for new EV charger installations for non-residential customers in Maryland that offers a discount of up to 50% of the nameplate capacity.

Technology can help mitigate the impacts of demand charges. Some charging network providers are installing onsite batteries that store energy during off-peak hours to later use to supplement demand during on-peak hours. However, this approach isn't universally seen as beneficial by utilities, and some treat the battery as additional load rather than considering it a tool to offset demand. This can lead to the requirement of what is seen by station owners as a larger-than-necessary transformer and additional interconnection costs for stations with batteries. This can create a barrier for battery storage deployment as a demand mitigation strategy. Participants highlighted the importance of an industry-wide standard on the treatment of battery storage for offsetting peak load. This could enhance deployments of battery storage as a demand mitigation strategy.

Questions to Consider

- Does the traditional demand charge structure fit the nature of EV loads?
- Is there an alternative approach that could achieve the same objective?
- If demand charges are eliminated, what are the consequences when utilization rates increase?

EXPERIENCES FROM THE FIELD

The Impact of Fleet Electrification on Infrastructure

Oncor, an electric utility serving the Dallas-Fort Worth area, quickly recognized that with 13% of all freight in the nation passing through its service area annually, **fleet electrification could have more significant impacts on its grid than residential electrification**.

"We determined there are 21,600 fleets in our service territory. That's everything from Amazon with thousands of trucks to a local laundry that has two," explained David Treichler, Oncor's director of strategy and technology. "But what really opened our eyes was the realization that we have four pockets of concentration for logistics and distribution centers. They're clustered very closely together."

One distribution center outside Dallas talked to Treichler's team about converting their fleet of 435 Class 8 trucks. **Providing enough power to charge that fleet would require Oncor to add 40 megawatts of capacity for that one facility alone.** For context, the typical electrical load for warehouse centers in Dallas is around 100 to 250 kilowatts to power some lights and a small office. Logistics centers may have larger electrical loads – around 500 kilowatts to accommodate the large number of people packing boxes for shipping – but still significantly lower than an electrified fleet.

Bottom line: Oncor could meet the demand to convert about 10% of the fleet right away, but only because the utility had recently built a new substation in the area. Anything more would require a new substation and more than a year of preparation.

Revel Overcomes Low Utilization with Ridesharing

Utilization rates can make or – unfortunately, more often – break a charging station's profitability. Demand charges destroy the operating economics at stations that only get a handful of customers per day. The high fixed cost of the demand charges means that at low utilized stations, the electricity cost of each session costs the operator somewhere upwards of $50, much more than a customer is willing to pay. **Revel's solution to combating low utilization is a simple one: using the chargers for its own fleet of electric rideshare vehicles.**

The all-electric rideshare company opened its first Superhub this June in Brooklyn, NY. It is the largest universal public charging station in the Americas, with 25 75kW DC fast chargers. While the station is open 24 hours a day, Revel uses the site in the off-peak hours at night to charge its own fleet. "There's this nice complimentary aspect to this," reflected Revel's Tobias Lescht. "Utilization from our rideshare fleet supports the up-front development costs and demand charges, and having a lot of plugs available – ten, 15, 25 instead of just two or three – provides a good public customer experience. **Economies of scale are very strong when you're developing large sites."**

Revel's rideshare vehicles cover about ten times as many miles per day as the average vehicle. Their demand is predictable and perfectly positioned for off-peak charging, which is why Lescht believes Revel's rideshare EVs will be a crucial factor in the success of urban fast charging and will also help offset the negative impact of demand charges.

Revel's position about demand charges is somewhat unique in industry discussions. The company sees their value in helping to reduce carbon emissions and in promoting grid stability. Without demand charges in place, utilities may need to rely more on peaker plants. Lescht pointed to a report from the New York Public Service Commission that found peaker plants around the city emit twice as much carbon dioxide and 20 times as much nitrogen oxide per unit of electricity as regular power plants. Emergency rooms near peaker plants in the Bronx experience nearly triple the rate of asthma-related visits for children as other hospitals in New York City.

Insight from Revel: Current pricing models incentivize EV operators to build out charging infrastructure and develop and invest in solutions that work within the constraints of how the grid is built and operated. This helps avoid negative externalities that could otherwise arise.

Insights on Pricing from Electrify America

There are two camps on how to charge customers for public charging: by time or by energy delivered. As DC fast charging is becoming more common, the latter seems to be gaining more support. "Charging for the volume of energy delivered is the method that will be most familiar and commonsense for customers," Electrify America's Matt Nelson explained, "and some market participants believe it will be important for achieving wide-scale acceptance of EVs."

The charging speed of an EV can vary greatly depending on the battery capacity, which can range from 50 to more than 300 kW with current EV models. **The time it takes to "charge up" depends on two main variables, the battery temperature and the state of charge (SOC)**. When a battery is very hot or cold, it accepts a charge more slowly. In addition, most EVs begin to slow down the charging speeds once the SOC reaches 80% in order to protect the battery. This means **there are situations where drivers paying for charging on a per-minute basis are getting different quantities of energy,** which is why regulators and standards organizations are increasingly showing preference for charging by the kilowatt hour.

Regulators at the California Division of Measurement Standards have taken the position "that the primary commodity delivered by EVSE is electricity, not parking space accessibility, parking space rental time, or accessibility to the EVSE itself" as these are "'other services' of the transaction". In fact, a majority of states have granted EV charging operators the ability to charge on a per-kWh basis, including Oklahoma, South Carolina, and Texas, which each adopted legislation or regulation in 2021 permitting sales by the kWh.

Utilization Rates Matter

Holy Cross Energy (HCE), a small electric cooperative in Colorado, developed a time-of-use (TOU) rate for transit authorities and DCFC owners as part of its Electrify my Ride program. The cost is a four-to-one rate – six cents off-peak, 24 cents on-peak – and has no demand charge.

While buses typically start charging about a half-hour after on-peak pricing ends, **HCE has found that the rate also works well around the clock for DC fast-charging stations with low utilization**. **Rather than the commercial rate that would impose a demand charge** when the first electrons start flowing, the higher on-peak rate proves to be less costly. **That remains true until a station handles around 280 charging sessions per month. At that point,** the station has high enough utilization that the demand charge is a smaller percentage of the total bill, so **the commercial rate is more advantageous**.

Bottom line: For Holy Cross Energy customers, once utilization rates reach a certain threshold, the demand charges are more beneficial than HCE's higher on-peak pricing structure with no demand charges.

Resources

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- *MA order 15-120-121-122_Order_5-12-2020*, The Commonwealth of Massachusetts Department of Public Utilities, https://www.eversource.com/content/docs/default-source/investors/d-p-u-15-120-15-121-15-122-order-(5-10-18).pdf?sfvrsn=a49fc262_0
- *Decision Setting: Near-Term Priorities for Transportation Electrification Investments by the Electrical Corporations*, California Public Utilities Commission, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M392/K347/392347949.PDF
- *California Statewide PEV Submetering Pilot -Phase 1 Report*, California Public Utilities Commission, https://www.cpuc.ca.gov/-/media/cpuc-website/files/legacyfiles/p/6442453395-pev-submetering-evaluation-report-phase-1.pdf
- *California Assembly Bill No. 841*, California Legislative Information, https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB841
- Dan Cross-Call, Becky Xilu Li, and James Sherwood, *A Review of Alternative Rate Designs*, Rocky Mountain Institute, https://rmi.org/insight/review-alternative-rate-designs/
- *Analytical White Paper: Overcoming Barriers to Expanding Fast Charging Infrastructure in the Midcontinent Region*, July 2019, Great Plains Institute, p. 6 https://www.betterenergy.org/wp-content/uploads/2019/08/GPI_DCFC-Analysis.pdf
- *NIST Handbook 44 – 2020: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*, National Institute of Standards and Technology, U.S. Department of Commerce, https://www.nist.gov/pml/weights-and-measures/publications/nist-handbooks/other-nist-handbooks/other-nist-handbooks-2-2
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- *Electrical Vehicle Fueling Systems CCR Title 4, §§ 4001 and 4002.11: Final Statement of Reasons*, California Department of Food and Agriculture, https://www.cdfa.ca.gov/dms/pdfs/regulations/EVSE-FSOR.pdf
- *EV Market Regulatory Report,* Fuels Institute, April 21, 2021 https://www.fuelsinstitute.org/Research/Reports/EV-Market-Regulatory-Report

Understanding the EV Customer

A Key for Success

Customers have always been central to a utility's mission of providing safe, reliable electricity. For nearly 140 years, that relationship remained largely unchanged. Electric vehicles highlight the changing dynamics of the utility-customer relationship. In the context of EVs, the term "customer" may take on new, different meanings–such as a residential consumer, a fleet manager, a charging network provider, or a neighborhood home owners association (HOA). This will present new interactions, change long-established relationships, and introduce new partnerships.

As attention shifts from early-adopters, inclusion and diversity move to the forefront. Customers of all types are looking for information and assistance from their utility. The guidance they need may be very different from traditional inquiries about setting up service at a new location. Utilities are likely to find that business-as-usual won't fit some of the needs of electrified transportation. Electricity as a fuel source requires many more touchpoints and dedicated customer service. Manual processes that work with a handful of customers now might be unsustainable with larger numbers later.

The transition to electrified transportation will be an educational journey to understand new customer behavior and preferences and to learn what processes or programs best serve these new customers' needs. Residential drivers, retail fuel providers, fleet managers, regulators, and others will need to unlearn old habits and become familiar with redesigned policies and procedures. Utilities are in a unique position to support the customers' journey but education will be a team effort and stakeholders across the ecosystem have a role.

> "We have a better understanding of customer's businesses than we ever had before."
>
> Kathy Knoop,
> Arizona Public Service

WHO IS AN EV UTILITY CUSTOMER?

- Residential customer
- Fleet manager
- Charging network provider
- Commercial property owner
- Home Owners Association
- Trucking/Freight Companies
- Travel Plaza Owner
- City Governments

WHAT WE HEARD

A New Relationship

The customer base will become more diverse. Early adopters tended to be well-to-do, steadily employed homeowners, and may not necessarily be representative of the general public as a whole. Future EV programs and services will have to meet the needs of a more diverse customer base. Policies and plans tailored around the needs of early adopters are likely to fail drivers from underserved, lower-income communities.

Customer surveys can provide useful insights. Utilities may find that customers don't always think about EVs the same way the utility does. Surveys can help uncover what customers know, how they think about EVs, and what they are planning. Some utilities have established forums for EV drivers to learn more.

> "We're just getting started on this journey. We're trying to understand what changes we have to make as a utility and how to work with our customers as they start exploring these opportunities."
>
> Ed Hedges, Evergy

Providing electricity is no longer a one-way street. Information flow needs to be bidirectional. EVs and other emerging technologies are capable of interacting with the grid in a more symbiotic manner to maximize efficiency. This will require utilities to understand a customer's operational needs and for customers to provide utilities the information they need to provide service.

Rappahannock Electric Cooperative (REC) sent an email survey to all their residential members asking if they had an electric vehicle; if so, what type; and if not, whether they were thinking about getting one. REC was surprised both at how many people said they were seriously considering purchasing one in the next three years, and at the larger-than-expected number who already identified as EV drivers. Surprisingly, the survey highlighted a key difference between the utility's and the customers' thinking: many customers identified their EV make and model as "golf cart."

Customers want more personalized support. Many customer initiatives are moving to processes or apps that allow the customer to self-help rather than having to call or talk to someone at the utility. Until EVs become more prevalent, customers might need more personal help, which can be time consuming.

Customers are looking for help from the beginning to end. Selecting vehicles, installing a charger, identifying a site, and managed charging are all new experiences for most customers. This can be a barrier and they are looking to the utility for assistance.

Mapping the customer experience can identify bottlenecks and pain points. Electric vehicles require more touch points to get to "yes" than other projects. Mapping the various steps that are required can help a utility identify process challenges that might not have existed with other utility service.

Centralize requests in one department that has a variety of expertise. This way customer requests can be easily routed to the correct person. Establishing SWAT teams can help implementation happen much more quickly. The team can help to standardize procedures, documents, and gateways, so installation and deployment become more routine as long as customers check the boxes and do the right things at each step along the way.

When **BGE's** EV department implemented a pilot, the team found out firsthand the challenges customers have when navigating the utility process. This helped the team identify bottlenecks and develop more customer-friendly processes.

Customers need clear, easily accessible information. The cost of EV ownership is not an easy question to answer. Clear, transparent information about utility rates, processes and timelines for interconnections can facilitate a customer's decision to go electric.

Don't bury rates. Fleets need information that is easy to find. Machine readable rates make information more accessible than a large tariff book posted on a website.

Customers don't want to have to make every decision. Automation can benefit the customer and the utility alike, and will be essential for making it easy for customers to charge at times that are beneficial for the grid. Manufacturers are responding by allowing customers to program their charger or vehicle to begin charging at a specific time.

Customers need a plan and utilities need specifics. Providing the utility with the information it needs to efficiently process the request can help avoid delays. But it's important to note that it's not enough to only tell the utility how much power will be required. The utility needs details such as the number and type of vehicles and the charging schedule and power level. Utilities can help customers by providing information requests in a way and language that are easy to understand and respond to.

Educate customers on who does what. Sometimes the customer's impression is that the utility will do everything. Customers will need help understanding their role in the process versus the utility's role.

The utility's role will be different. Contrary to requesting utility service for a new building, companies converting their fleets don't necessarily know what they need. Utilities have found that sometimes they even have to provide guidance on how the customer can interact with other departments within the customer's own organization to get the information the utility needs.

Questions to Consider

- What approaches can foster open, collaborative dialog between customers and the utility?
- How can information on rates, timelines, and processes be clearly communicated to customers?
- How can utilities best assist customers in their decision to convert?
- What policy or institutional barriers create bottlenecks for EV customers?
- How can utilities better understand new customer needs and preferences?

Frequent and transparent dialog can help utilities and customers alike. The electricity industry is complicated with its own language and operating characteristics. Regular dialog between the utility and the customer can improve understanding of each other's needs and constraints. Commercial customers want continued communication throughout the process.

Utility policies and procedures will need to become more "business friendly." Collaborating with customers as they plan their EV future — such as helping to weigh the pros and cons of site selection — is more beneficial than just providing binary yes/no responses to service requests.

The meaning of flexibility can differ. When working together, one side may think they are helping when they are actually hindering their partner. For example, a charging network provider may consider its willingness to evaluate multiple locations for a site as flexible. For a utility, however, it means more studies to perform, more work, and more costs. Understanding each other's perspective can lead to approaches that benefit both.

Education and Awareness

Education remains a major barrier to EV adoption. Despite the progress made over the last several years, there remains a general lack of awareness on the part of consumers regarding EVs. Outreach and engagement are crucial to moving customers to widespread adoption. Programs should reflect community values and include metrics that determine their success and reach.

A positive experience is crucial to long-term success of EV growth. Positive experiences with electric vehicles are one of the most effective drivers of EV adoption. Negative experiences, on the other hand, can cripple efforts before they gain any traction. Chief among these may be charger reliability and availability, which can be exacerbated by low return on investment for charging stations that may end up leaving them under-equipped or poorly maintained.

Utility education and outreach programs can be instrumental. Customers can be hesitant to switch to electric vehicles because they are new and unfamiliar. Utilities' trusted relationships with customers about all things related to electricity may put them in a unique position to educate drivers. Utility tools, such as those that help determine total cost of ownership, calculate fuel and maintenance savings, and compute emissions reductions, can support the customers' decision process. Some utilities are providing information about available models to help customers find the EV that best suits their driving habits.

Austin Energy created a community EV buyer's guide that includes real-time EV inventory (with color, model and price for dealerships in Austin), EV incentives, tax credits, programs, rebates, and more.

When doing outreach, simplify! Avoid industry terms. Potential EV customers search for "electric **cars**." "Vehicles" is an industry term. It's easy to fall back into jargon, but when dealing with customers, understand and speak their language.

The kilowatt and kilowatt-hour are not familiar terms for filling up the tank. With gasoline or diesel, customers can easily see the price for fueling in dollars-per-gallon on large signs as they drive past the station. That's not the case with electric vehicle fueling. The kilowatt and kilowatt-hour, historical utility pricing units, don't easily translate for customers. Trying to find the rate requires customers to navigate utility webpages or tariff books, which isn't always an easy task.

Signage is not one-size-fits-all. Level 2 charging spots have traditionally been very clearly a parking spot. The customer parked, plugged in, then went to work or to do their shopping, and stayed plugged in the entire time. DC fast charging is contradicting that whole concept, and it can be confusing for customers. Locations that also require parking fees can exacerbate that confusion. Different locations will need different signage.

In conversations with stakeholders, an important message that **AEP (America Electric Power)** strives to tie into their communications is that transportation electrification is an opportunity to help reduce rates for *all* customers. It is an important message that is sometimes glossed over. AEP's Electrified Transportation Mission Statement helps them to focus their external and internal engagement efforts on this important aspect of transportation electrification.

AEP Mission: *Increase adoption* of electric vehicles and provide customer charging options that *optimize the use of the grid* for the *benefit of all customers*.

At the Eagle County Airport, near Vail Resort, a popular ski destination, arriving passengers who rent a car have the option of an electric vehicle. **Holy Cross Energy's** program is based on the EV Perks program at Orlando's airport, and it increases awareness and familiarity with EVs through hands-on experience. The program plans to charge the vehicles' batteries up to 80% on a 175kW rapid charger. After that, the vehicle is moved to a Level 2 charger until it's rented. It provides the customer the experience of unplugging and re-docking the plug.

Messages matter. Choosing appropriate messaging can help customers understand how the transition will have a positive impact for them. For example, some gas station owners may have a tendency to view electricity as a replacement fuel rather than an additional fuel – and revenue – source. Likewise, workers that might be displaced by the transition could benefit from hearing about skill shortage opportunities.

Information changes quickly. Providing customers with up-to-date information about electric vehicles can be highly beneficial, but also highly time-consuming. Utilities may find it easier to outsource education and awareness tools.

Questions to Consider

- What is the utility role in education and awareness efforts?
- How can education and outreach efforts enhance a utility's strategic goals?
- What additional signage is needed for electric vehicle "fueling"?

Photography provided by Austin Energy

JOIN STEVIE THE EV-LOVING T-REX FOR A CELEBRATION

Austin Energy mascot, StEVie the EV-loving T-Rex, is a fun and social-media savvy campaign (#loveStevie, #saygoodbyetogas) that engages the community with EV outreach and awareness activities and promotes brand awareness. The city of Indianapolis recently launched their own EV-loving T-Rex in collaboration with Austin Energy to include StEVie cameos. Karl Popham, manager of electric vehicles and emerging technologies at Austin Energy, would love other cities to launch similar campaigns to create a national movement and, in the tradition of Austin's "Keep it Weird," host an EV T-Rex celebration and 5K fun run.

Partnerships and Collaboration

EV adoption is a team sport. The electric vehicle ecosystem includes many facets and participants, each with their own expertise and knowledge. No one has all the answers, but building partnerships and harnessing the breadth of knowledge among stakeholders can bridge communication and lead to out-of-the-box ideas or tools that result in more successful programs and win-win solutions.

Agency	WIIFM	Role	Risk
Federal government	GHG reduction	EV investment tax credits for vehicles and infrastructure, block grant funding for infrastructure	Loss of U.S. jobs to foreign manufacturers
State	GHG reduction, growth in state revenue	Regulations, state sponsored contracts, highway infrastructure, emergency evacuation	Road tax loss
Cities	Improving air quality and public health, local economic development, city fleet transition	Public destination charging, permitting	Escalating cost of GHG
Utilities	Revenue	Public charging, education, fleet infrastructure, demand control	New demand peak
Charging companies, network providers	Revenue	Provision of EVSE, network management	Technology change, stranded assets
State Commission	Consistency	Rate approval	Allowing rates that deter EV adoption
Planning agencies	Steamlined consistent process	Insuring the right locations, consistent design, regional infrastructure planning	Making it too hard for EV charging installations

Source: Orlando Utilities Commission

Oncor has worked closely with North Texas Council of Governments. The partnership has been valuable for getting insight and brainstorming about what to do and what's important.

Partner with community-based organizations. These organizations are community insiders who understand the lay of the land. They have built trusted relationships and can help identify elements that will be most beneficial to the community.

Car dealerships can be good partners. It might be hit or miss whether customers can find electric vehicles on dealer lots. Helping customers navigate that process and providing car dealers with the information they need can increase adoption. In some instances, like school bus purchases, dealers understand the capabilities and limitations of both petroleum and electricity fuel types, which can provide vital information for school districts or transit authorities evaluating fleet conversion plans.

> "It's really going to take a village. To figure all this out, it's imperative we all work together."
>
> Bill Combs,
> Penske Transportation Solutions

Reach out to nearby auto manufacturers. EV manufacturers in or near a utility's service territory can prove a beneficial partner. They can provide information about upcoming models and their requirements, as well as opportunities to run pilot programs that can serve both the utility and the original equipment manufacturer's (OEM) needs.

Involve architecture and building firms. This can establish electric vehicle charging early in the design process. It can also facilitate a more collaborative process when proposing new building codes or mandates.

Questions to Consider

- Are there auto manufacturers or dealerships in the area that would make good partners?
- What are effective mechanisms for developing new partnerships with new participants?
- What is an effective approach for bridging perspectives among multiple agencies and parties?

EXPERIENCES FROM THE FIELD

Southern Company Involves the Entire Organization

Meeting the needs of electrified transportation will be a major undertaking for utilities in the coming decades. Southern Company recognized this huge challenge required an ability to respond quickly across the enterprise.

Traditionally within Southern Company, electric transportation was located within the sales and marketing department. "**It became apparent**, though, especially as the topic of fleet electrification arose, **that it was bigger than sales and marketing. It was going to be an opportunity for the entire organization**," Electrification Policy Manager Lincoln Wood said. "It involves power delivery, regulatory, innovation and new ventures, long-term planning, and sales and marketing. Each of us have a role to play." Southern Company decided on a very different approach than they might typically have taken because they needed to get the whole organization behind it.

The utility adopted an agile approach and involved senior leadership from all departments in biweekly meetings with the team. This kept the team moving forward identifying roadblocks, getting answers quickly, and adjusting strategies when things weren't working as planned. **"Whatever happened, we were able to keep moving forward**," Wood explained. "The journey has taken over a year and a half, and it's been very successful."

Territo Information Systems Leads by Example

Greg Territo, president of **Territo Information Systems**, recommends that municipalities and companies experience EVs before making final policy decisions. His family's electrical contracting company, **Territo Electric, Inc., began converting its fleet to electric in 2012**. **This has given them a great deal of firsthand experience with EVs in the last decade.** While Territo confidently tells those who ask that his fleet has had minimal maintenance issues and none of his employees have found themselves stranded due to range issues, he points out that EVs are not a perfect solution for everyone. Territo has found that EVs are still generally more costly over the vehicle lifetime than comparable gasoline vehicles, especially without early-adoption tax credits. In addition, he notes that many municipalities are struggling to fairly rectify fuel taxes levied on electric vehicles.

"EVs encourage more efficient driving, which may lead to safer drivers and less wear and tear on the vehicles," Territo states. That, in turn, could lead to reduced insurance and maintenance costs, **although currently insuring EVs is generally more expensive due to their higher costs of purchase and repair.** Working in technology and construction, the EVs are a great marketing tool for the family's businesses.

Insight: EVs have advantages beyond typical environmental considerations as well as their own unique drawbacks. Understanding the best strategies to capitalize on the advantages while mitigating the drawbacks will come more easily with experience. It is important that municipalities and businesses get first-hand experience with EVs to better inform decisions.

Volta Charging Partners to Drive EV Awareness and Adoption

Volta Charging works with utilities and other environmentally conscious brands to accelerate EV adoption with messaging and media supported EV charging. Using a data-driven understanding of the community and driver behavior, **Volta identifies underserved locations where EV charging will fit into drivers' daily routines.** These everyday locations are perfect for reaching people with messages about the benefits of driving electric and illustrate the availability of public EV charging at the same time. One example utility campaign on Volta stations increased the utility brand awareness by 24% and their environmental stewardship perception by 14%.

Insight: The partnership with utilities increases both charger deployment and EV awareness in underserved areas by reaching people where they go.

Austin Energy Invests in the Future

Photography provided by Austin Energy

When asked, **"What one program would you implement nationally?"** Karl Popham of Austin Energy quickly chose the ***EVs for Schools program***. **It is a program that teaches kids in grades six through 12 about electric vehicles and sustainable transportation**. "It's an investment in the future. Helping to inform and inspire our future leaders."

"*EVs for Schools*", part of Austin Energy's larger equity program, "*EVs are for EVeryone*", began as a pilot program that **prioritized deployment and outreach for economically disadvantaged students at title-one schools**. The program initially launched at four schools in English, but it is now offered in Spanish, and has a companion Virtual Reality (VR) experience. In response to COVID-19, the curriculum is now available online, free-of-charge to families nationally to support at home learning.

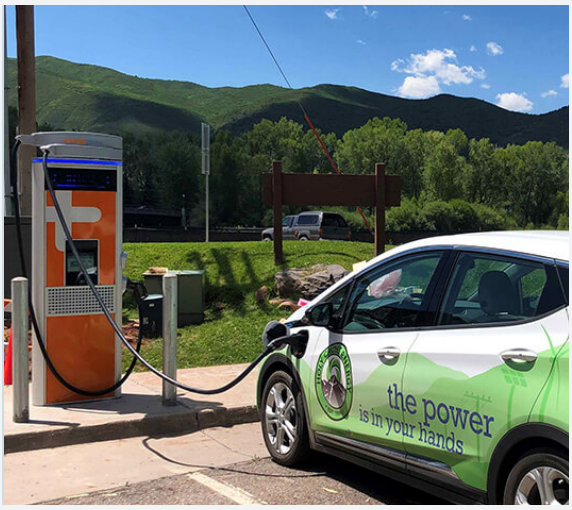
The program is now deployed in 122 schools in Central Texas and expanding with nearly 800 teachers in Central Texas utilizing the EV lessons and **more than 6,850 students experiencing the living lab – 65% of those students live in economically disadvantaged communities.** Utilities and other organizations are also incorporating the curriculum into their efforts.

Rappahannock Electric Cooperative on Developing a Website

When **Rappahannock Electric Cooperative (REC)** began developing a webpage about EVs on its site, **it quickly became apparent that maintaining the page would be a full-time job. REC decided to partner with ChooseEV,** a digital toolkit that provides up-to-date EV information for utility websites. REC's content is on www.myrec.coop/PowerYourDrive. Some of the functionality includes a gasoline comparison with REC's electric rates, a list of available electric vehicles, and a guide to car dealers in the area that sell EVs.

Holy Cross Energy Works with the Community

Holy Cross Energy's *Charge at Home. Charge at Work.* program started with calls from towns and counties asking to identify good charging locations to provide local service and relieve range anxiety. In fact, **one employee dedicated 25% of his time to site visits and talking to the communities.** Through collaboration with local communities and partners in HCE's territory, the program evolved. Now HCE is in conversation with gas station owners, Tesla, restaurants, and others trying to get into the DCFC business. Ultimately, interested parties reach out because they see that with HCE's time-of-use rates **can achieve a return on investment with DC fast chargers.**



Insight: Working with members is essential and takes time and commitment, but it's worth it.

SMUD's Employees Get Involved with the Community

Sacramento Municipal Utility District (SMUD) has a sustainable communities initiative team that partners with community-based organizations to develop projects. Bill Boyce, Manager of Electric Transportation, Distributed Energy Strategy **also participates in the Sacramento Plug-in Electric Vehicle Collaborative (PEV Collaborative) an informal entity that brings together EV-oriented organizations, agencies, and stakeholders from around the area.** At the monthly meetings, participants share experiences, bring in educational speakers, look for cross hatch funding, and discuss ongoing EV projects and new opportunities for bringing clean transportation into the region, including underserved or priority communities. Sacramento also has an active EV Drivers group (Sac EV) that is an active chapter of the national Electric Automobile Association (EAA).

JF Petroleum Reframes the Message

JF Petroleum Group, a provider of fuel handling systems, works with station owners and helps to educate them about the benefits of installing charging infrastructure. For John Keller, Senior Vice President, Southwest, "it's an educational journey with convenience store owners. Sometimes it is necessary to reset their thinking. EVs aren't a competing technology. Adding charging stations expand the fuel portfolio to bring in all drivers." EVs can increase value in three ways: 1) revenue at the charger, 2) indirect revenue to an onsite store or quick serve restaurant, and 3) customer retention. Cortes projects that with changing emissions standards, electric F-150 trucks alone will take out 165,000 gallons of revenue

Bottom Line: Reframing the message can help owners see the value and benefits of electrified transportation rather than viewng it as a threat to their business.

Resources

- EV Connecticut, Connecticut Department of Energy and Environmental Protection, https://portal.ct.gov/DEEP/Air/Mobile-Sources/EVConnecticut/EVConnecticut---Electric-Vehicles-101
- Austin Energy EV Buyer's Guide, Austin Energy, https://ev.austinenergy.com/
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- *Charging Ahead: Deriving Value from Electric Vehicles for All Electricity Customers*, Citizens Utility Board of Illinois. https://www.citizensutilityboard.org/wp-content/uploads/2019/03/Charging-Ahead-Deriving-Value-from-Electric-Vehicles-for-All-Electricity-Customers-v6-031419.pdf
- Electric Vehicles, Smart Energy Consumer Collaborative, https://www.whatissmartenergy.org/electric-vehicles
- Volta Charging, https://voltacharging.com
- School Charging, Austin Energy, https://austinenergy.com/ae/green-power/plug-in-austin/school-charging
- Electric Vehicles, Rappahannock Electrical Cooperative, https://www.myrec.coop/PowerYourDrive
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- Projects, SacEv, https://www.saceva.org/projects
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- *Electric Vehicle Adoption: Focus on Charging*, Fuels Institute, June 1, 2020, https://www.fuelsinstitute.org/Research/Reports/Electric-Vehicle-Adoption-Focus-on-Charging

Anticipating the Future

A Daunting Task

Utilities have long planned for and built out electrical infrastructure to supply customers and businesses the power they need. Electric vehicles, however, have many variables that make anticipating and planning for them a change from business-as-usual. Many factors determine where, when, and how much electricity will be needed.

Utilities consider planning and forecasting from two perspectives each with different implications. At the macro level, national assessments can help estimate the potential bulk power system's ability to generate and transmit electricity for transportation in aggregate. On the other hand, at the micro or distribution circuit level, the impacts and the infrastructure investments needed will be highly localized. Utilities use both assessments to anticipate future needs and constraints.

Most utilities have had little trouble accommodating plug-in cars charging in early adopters' garages – in most cases, it amounts to no more load increase than adding an air conditioner to a home. The challenges can become more significant when dealing with higher power chargers and medium- and heavy-duty vehicles because the infrastructure may be insufficient where the vehicles need it to charge, and infrastructure with sufficient capacity may too far away to cost-effectively supply the necessary power. But even incremental load increases from low penetrations of light-duty charging can add up and have the potential to overload individual grid components.

It's impossible to know exactly how quickly the transition will occur, but nonetheless, utilities must forecast and plan now to ensure the electric infrastructure is available when customers want it because adding a new substation or upgrading lines takes time.

> "In distribution, everything is local. Due to equipment vintage and configuration, impacts may not be limited to the highest concentration areas."
>
> Richard Mueller, DTE Energy

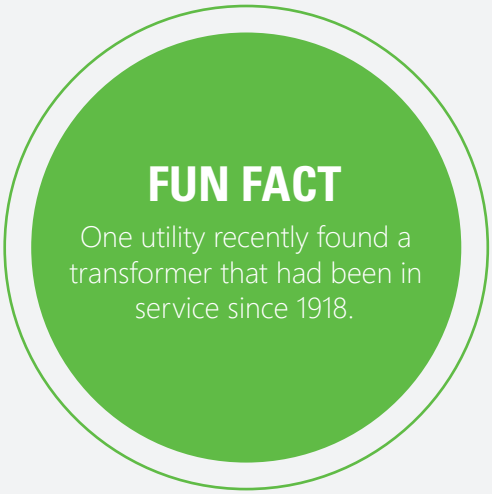
WHAT WE HEARD

Determining Impacts

Macro-level and micro-level planning are not the same. EV studies evaluating the impacts of transportation electrification often focus on the bulk power system. However, impacts will show up more quickly on the distribution system because transmission has more diversity in the system and higher voltage lines. As EVs become more prevalent on the system, impacts from the distribution could migrate up to transmission, making coordination and planning across the system essential.

Everything in distribution is local. Impacts will be different for different utilities, and even from circuit to circuit. The same vehicle with the same use case but in a different location will have different impacts from a grid standpoint.

No single penetration level will cause impacts. Even at low penetrations, there is the potential for overloading of individual grid components. The threshold for what will cause issues varies by circuit, feeder, and location. Analysis of distribution level feeders can help utilities understand the penetration thresholds, affording them insight into timing for new investments or technology solutions.



Last mile distribution impacts are easy to underestimate. Vehicle charging, especially residential charging, might not seem significant, but aging infrastructure can be a limiting factor. Lower voltage conductors or older transformers that are still functional might not be able to accommodate additional load. Some utilities are beginning to install larger transformers that can accommodate load increases.

Impacts don't necessarily show up on the highest concentration feeders. Distribution planners must consider how charging may affect voltage parameters, protection schemes, transformer sizing, and other design constraints. In some instances, even a low number of EVs connected to the system can introduce feeder imbalances and lead to current overload.

Clustering can't be ignored. The grid is a system that delivers electricity to increasingly smaller partitions down to the final end point, with nodes where circuits come together. One such node is the distribution transformer that feeds neighborhood homes or commercial buildings. Transformers are sized based on anticipated load. If clusters of customers (i.e., multiple homes or business) buy electric vehicles or convert their fleets, the transformer might not be capable of handling the additional load.

Growth rates may be non-linear. Aggregate impacts for utilities with low adoption numbers might be manageable but incentives, mandates, or vehicle announcements can create accelerated growth that might be larger and quicker than anticipated.

Load impacts from larger vehicles will be step function increases. The magnitude of a customer's load could change overnight. Traditionally, a utility might be aware of a new five-megawatt customer years before the building is constructed. Soon, five megawatts of load will be able to drive up without warning if a 100-kilowatt distribution center decides to electrify a fleet of 20 to 30 Class 8 trucks.

Advice to utilities: Start collecting load and demand data to share with transmission and distribution planners. It's difficult for them to build anything without accurate information.

Distribution capacity varies and depends on timing. Circuits on the grid do not operate at full capacity around the clock. The grid is built and designed for peak demand, even if that peak demand occurs only for a short duration or happens just a handful of times per year. This means circuits will have available capacity for electric vehicle charging, but the amount of available capacity will depend on when the vehicle charges.

Utility use case – (noun) the condition or circumstances under which a piece of technology or a utility policy would be used or implemented in order to identify functional requirements

Load projections and forecasting go beyond vehicle types and number of parking spaces. Each charging scenario brings its own variables. On street charging differs from multifamily which differs from residential charging. Each type of charging has multiple use cases to consider. Workplace charging can include employee as well as customer charging. The time of day a driver plugs in and for how long will vary.

Low power charging can lead to surprises. Low power loads are typically easier to integrate into the grid. The challenge, though, is that utilities likely won't know when these loads are being added – customers don't always notify the utility – and small loads can compound to have a large impact.

Distribution planning could require new tools, processes, and standard approaches. Traditional forecasting tools may be sufficient when EV adoption levels are low, but uncertainty increases as adoption numbers grow and higher power chargers are introduced. This may require more sophisticated tools and approaches to account for the numerous variables – such as behavior, policy, economics, and charging use – to determine load impacts to specific feeders.

Questions to Consider

- What loading level will require distribution system design changes?
- What does true scale look like and what are the inflection points?
- How do the inflection points change based on different vehicle types, the different use cases, or different locations?

VARIABLES FOR ASSESSING DISTRIBUTION-LEVEL IMPACTS

- Charging Power Level
- Length of charge
- Vehicle class (LD, MD, HD)
- Use Case
- Location
- Greenfield versus Brownfield site
- Facility load versus vehicle load

Planning for What's Coming

Uneasiness grows with increasing scale. Utilities, customers, and vehicle manufacturers are testing and learning from EV pilot programs nationwide. As benefits are demonstrated and proven, however, utilities are grappling with what scale will look like and the implications for their grid. Scale may require changes to engineering processes, distribution planning, or large account management. Utilities are working to translate that into a sustainable, long-term model.

FUN FACT

In Texas, three average EV drivers have a greater impact on the grid than adding a new home consuming 1300 kWh per month.

Source: Oncor

Businesses' plans still hinge on utilities' implementation. Currently, a company can buy an internal combustion vehicle, send it anywhere in the world, and be certain the driver can find someplace to fuel up. An electric vehicle, however, is useless to a fleet operator if the infrastructure to charge it is not in place. Being able to respond to customers in a timely manner and make sure the infrastructure is deployed requires utilities to plan ahead.

FedEx Express found that while the passenger side of the airport might have available electrical capacity, the freight side might not.

Businesses need to communicate plans early. Each company will phase in electrification at its own pace, but if utilities aren't looped into the company's timelines and strategies, the infrastructure might not be ready when the vehicles are. Utilities need information about company plans in order to incorporate them into five- and ten-year projections.

Serving large customers takes more than flipping a switch. Meeting significant load increases is rarely quick or easy. Building a new substation or reconductoring a line cannot happen overnight. Utilities must anticipate and forecast requirements years ahead of when the electricity is needed. Substantial load increases could require significant infrastructure upgrades, especially if the increase is a sizable percentage of a facility's overall load.

EVs will shift the focus to new planning metrics. Traditionally, utilities relied on metrics like population growth to determine future load growth projections. Now, forecasts will need to include factors like business plans and customer buying decisions. Thinking in current terms of load growth implies more of the same, but EV charging loads are not the same. They are not seasonal like air conditioning or heating and can move around and charge at unpredictable times.

Questions to Consider

- What are the trigger points that will create scaled adoption in an area?
- What information or data do utilities already have that can help to anticipate future changes?
- How many vehicles do businesses have? What is their timeline for fleet conversion?

Greenfield versus brownfield locations make a difference. When a customer adds charging infrastructure, it matters whether it's being added to an existing site or a brand-new site. The impact to the grid, and, therefore, how a utility plans, will be different.

Advice to Utilities: It's important to spend some time looking at relevant data for your service territory and try to understand what is going on behind the numbers.

Making Forecasts

Utilities need load profiles. Utilities need charge data to build accurate load profiles that will ensure sufficient capacity and system reliability. Lacking actual data, utilities must depend on calculations and projections.

EVs don't have standard approaches or rules of thumb. EVs don't have a track record for predicting load growth that traditional utility methods do, so projections can vary widely. A consistent method that translates adoption forecasts into charging infrastructure needs could provide assurances during state commissions reviews. It would also help keep regional transmission operators and utilities on the same page so that inadvertent system imbalances aren't created due to inconsistent forecasting approaches.

FUN FACT

One typical Tesla Semi Truck (class 8) can be the equivalent of 38 typical Texas homes... or 114 Tesla Model 3 personal vehicles... or 50,000 kWh/mo.

Source: Oncor

Forecasting load requires new data types and insights into customer behavior. EV usage, charging patterns, and driver practices can all vary. To make sure forecasts reflect local conditions, utilities need to combine data from a variety of sources and evaluate it in the context of their own service territory, demographics, and market. Developing accurate forecasts can require data that utilities didn't need previously, such as vehicle registration data and customer driving patterns. Privacy rules may prohibit utilities from gathering this data.

CREATIVE WAYS UTILITIES ARE GATHERING DATA FOR FORECASTS

- Performing pilots
- Installing utility-owned chargers
- Writing regression analyses on county registration data to project future load requirements
- Building an EV community through periodic emails
- Offering a $50 Amazon gift card to customers willing to share their data
- Monitoring publicly stated sustainability goals

Identifying EV owners and fleets is fundamental for good planning. In order to best anticipate and plan, utilities need to know where EVs are plugging in. This can require creative thinking. Identifying fleet locations can be a lengthy and time-consuming endeavor, and developing relationships with fleet owners can pose challenges for both sides.

Data from earlier studies might be outdated. As the EV market matures and electrification becomes more commonplace, driving patterns will change. The demographic makeup of early adopters, who were largely homeowners in higher income brackets motivated by environmental consciousness, can skew conclusions when attempting to apply them to a wider, more diverse populace. A large percentage of drivers live in multifamily or older homes with no garages. These scenarios are not addressed in older studies. Drivers with different motivations and situations may charge differently.

Don't underestimate the effect of new model announcements on adoption rates. One popular vehicle can influence the number of EVs being sold in a utility's service territory. For perspective, Austin Energy was experiencing around 150 EVs sold per month. That practically doubled overnight when the Tesla Model 3 became available. Karl Popham predicts a similar bump with the upcoming F150 Lightning and other high-demand EVs on the horizon.

Transportation will introduce charging in unexpected places. Vehicle charging is often framed solely in terms of residential charging or traditional business fleets, but transition to electrification may have electrical loads showing up in new places, such as in agriculture or landscaping.

Questions to Consider

- How much time and money will companies be willing to spend managing charging?
- How does the load of vehicle charging compare to load of the facility?
- Will public charging use more Level 2 or DC fast chargers?
- What data do utilities need for accurate projections and how do they obtain access to it?
- What is the role of the regulatory process when data streams fall outside the commission's jurisdiction?

THE WORD ON THE STREET: DATA HAS VALUE

As in any emerging market, there are many unknowns, and stakeholders are looking for data to provide answers. **Data is fundamental for decision making and understanding new customer preferences.** It is also important for managing and controlling the grid. Electric vehicle data will be spread across the ecosystem and no single entity will have all of the data it might need or want. **This means it has real value – monetary value – for the entity that has it.**

What Stakeholders are Saying

- EVs present a data fragmentation challenge
- Utilities may have limited data on residential EV charging because customers don't always inform the utility when they purchase an EV
- Utilities have concerns about grid control and visibility without access to charging data
- EV rates and rebate programs can provide utilities with access to charging data
- Data access needs to be balanced with privacy
- Bridging data silos can benefit all stakeholders
- Clear direction can allow data privacy and access to be addressed in the design phase; factoring it in later can be difficult
- Data access frameworks can identify roles, rights, and responsibilities between various parties
- Handling the large volumes of interval data will require the communications, systems, and tools to collect, manage, and analyze it

SOME WAYS UTILITIES CAN IDENTIFY FLEETS IN THEIR AREA

Do a "white roof survey" – Using Google Maps, locate transportation and distribution centers by their large, white rooftops. (Termed by David Treichler of Oncor.)

Check the airports – Many airports are now specifying zero-emission requirements as part of their tenant lease agreements. Utilities with major airports in their service territories may find fleets looking to electrify here.

Join a trucking association – State trucking associations offer opportunities to network with local trucking industry leaders.

UNEXPECTED ELECTRIC SERVICE REQUIREMENTS

- Lawn Service
- Snowplowing
- School, church or youth activity buses
- Farms

Source: DTE

UNIQUE CHARACTERISTICS FOR AGRICULTURE ELECTRIFICATION

- Multiple heavy duty pickup trucks (minimum 20KW Level 2 AC)
- Multiple small and large tractors (likely all DC 50-150KW under daily use)
- Heavy duty tractors and harvester combines with long duration use (DC 150KW – 1MW)
- Loads are highly seasonal to meet harvest, pumping in spring; processing, grain drying in fall
- Time-critical planting, harvest, and hauling of fertilizers, agricultural products with heavily loaded Class 9 vehicles

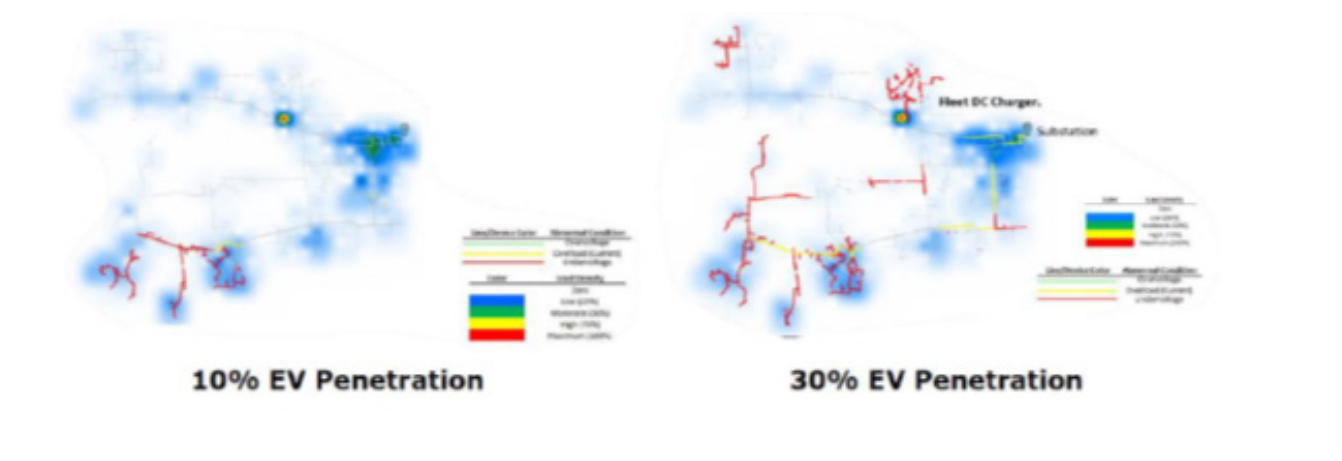
Source: DTE

EXPERIENCES FROM THE FIELD

Results are Local: Two Different Utilities, Two Different Results

Green Mountain Power performed saturation testing analysis on ten circuits spread across the state. **The analysis showed that due to significant capacity on their system**, which is a result of low-to-diminishing load growth over the past several years, **there were minimal impacts for residential adoption rates** of 50% or even 100%, even with no load control.

However, **DTE's propensity analysis** of adoption impacts to their distribution system **found that on some circuits, even a 10% EV penetration would introduce feeder imbalances and lead to current overload**. And those impacts wouldn't necessarily be seen in the highest concentration areas.



DTE Summer Night Circuit Impacts

Bottom line: Results from two different utilities demonstrate the highly localized impacts of electric vehicle charging.

Uncontrolled Charging Can Impact Transmission

Using aggregated load data, **Burlington Electric Department** (BED) found that when EV or PHEV drivers were charging at home uncontrolled, there were **several incidents that would add load contribution from EV use during peak transmission periods**. EV charging could increase the peak contribution of a residential account by as much as 60%.

Evergy on Workplace Charging

Workplace charging is a perk many employers offer. It could become a challenge, though, as businesses decide to install more chargers to meet employee demand. As Ed Hedges of Evergy explained, **"It depends on the ratio of charger to building load.** A business putting in a half dozen chargers might require capacity upgrades if the charger load represents a large percentage of the building load. But if the increase in load is a small percentage of the building load, there will likely be grid capacity."

Oncor's Green Fleet Planning Tool

With more than 21,000 fleets in its service area, Oncor wanted to understand the impact of commercial EV adoption. So, **an effort was made to tell the story from a data point of view.** The goal was to collect load and demand data to share with Oncor's transmission and distribution planners, **which led to the creation of the Green Fleets Planning Tool.**

Oncor set out to answer several questions when developing the tool: If 25% of Oncor's service area fleet vehicles electrify, and each facility currently has an average monthly consumption of 50-60 kilowatt hours per year, what would it mean if, after the conversion, the average increased to 50,000kWh consumption monthly? What might the load curve look like? When would they be charging? On peak? Off peak?

The tool uses internal data like Oncor's customer base and infrastructure with data from external sources like FleetSeek, vehicle and charger data, Leonard's Guide data, and data from the North Central Texas Council of Governments to determine internal and external data relationships, create calculations for stimulating business growth, calculate aggregate load, and determine the potential impact. **Oncor can create "what if" scenarios that cross reference site specific data**, like equipment information and charger constraints, with internal data asset maps. The output displays the impacted facilities and provides additional data sets.

Inspiration for Oncor's planning tool

Bottom line: The tool helps Oncor be part of the solution when someone wants to build and operate in the service area. "We don't want companies to fear working with the utility, so we're really trying to drive home that customer experience," said Eric Daniels, new construction management engineer. "Doing that brings innovation and creativity… because, at heart, engineers are really creative. "

Rocky Mountain Power Gathers Rideshare Driver Data

Rocky Mountain Power's (RMP) Westsmart EV project developed a car share program in a solar powered housing complex. **It also teamed up on another program with Lyft drivers to gather data** to help determine where to best locate chargers. Volunteers downloaded apps that tracked their EV usage and charging patterns. **The utility quickly recognized that while early adopters didn't rely on fast charging, many in the next generations of EV owners would.**

"High volume users, like rideshare drivers, definitely need public DC fast charging," said James Campbell, Director of Innovation and Sustainability Policy. "So do people in more underrepresented neighborhoods who don't have access to charging at home, maybe because they're renting." When RMP concluded that early adopters tended to live in wealthier communities and could afford to install a charger in their garage or convince their employers to install one at work, it came into focus that **fast charging was actually an issue of equity.**

Bottom line: Rocky Mountain Power's data driven approach to its pilot programs cleared up misconceptions and introduced new perspectives that the utility has been able to apply to its next phase of up to $50 million in utility-owned-and-operated infrastructure investment.

Resources

- Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite, Department of Energy Office of Energy Efficiency & Renewable Energy, https://afdc.energy.gov/evi-pro-lite
- FleetSeek | Fleet Lead Generation, Trucking Contacts, CSA Scores, FleetSeek, https://fleetseek.com/
- Texas EV Registration Tool, Dallas-Fort Worth Clean Cities https://app.powerbi.com/view?r=eyJrIjoiYTR-lY2M2MTctZDYwZC00MDNjLThkZDMtZjY5N2Y1YzlkNzA5IiwidCI6IjJmNWU3ZWJjLTIyYjAtNGZiZS05MzRjL-WFhYmRkYjRlMjliMSIsImMiOjN9

Building out the Charging Infrastructure

Groundbreaking Tech Starts with Breaking Ground

One of the most acknowledged barriers to EV adoption for many drivers is the fear of running out of power far from anywhere to charge. This has commonly been called range anxiety. As battery ranges have increase, though, many in the industry are beginning to use the term fueling anxiety, shifting focus to the availability of charging options. A key to countering range or fuel anxiety is a visible, robust charging infrastructure that gives consumers confidence that they can fuel their electric vehicle wherever and whenever they need it.

> "People think of it like plugging your phone into the wall, but you have an entire ecosystem that has to be factored into the implementation."
>
> Chris King, Siemens

As the market moves from early-adopter into a mature market, drivers will require a multitude of charging options to meet their differing needs and preferences. From low-power, long-dwell charging to high-powered fast chargers, the infrastructure must support multiple use cases. But building and installing charging infrastructure is expensive and can take considerable time, especially since the current low adoption rates of electric vehicles can mean low use of the infrastructure and low revenue streams.

The utility will likely play a central role in deploying a backbone charging infrastructure, not only because fueling requires electricity, but also because utilities can encourage adoption and provide accessibility in areas where the business might not be viable for commercial participants. Utilities are a key partner for charging providers, but, at the same time, utilities, as regulated entities, have processes and timelines that can be confusing and frustrating to outsiders.

WHAT WE HEARD

Moving from Early-Adopter

New technology means a new learning curve. Charging infrastructure is relatively new and still developing. In many areas, when a charging station is installed, it may be the city's first. Siting a gas station is standard practice, but siting a charging station still has wrinkles to be ironed out. Even after siting and installing one, new unanticipated unknowns may pop up. It will take time for it to become run-of-the-mill.

Utility and commercial charging can be complementary. Utilities can have the luxury of time. While needing to make prudent investments, they won't need an economically profitable capital investment on day one. Investments on the utility side of the meter can build a charging backbone that helps to develop a sustainable market by providing consumers with confidence and by reducing the capital costs to fill gaps that might not initially be served by commercial entities, especially in underserved and uneconomic areas.

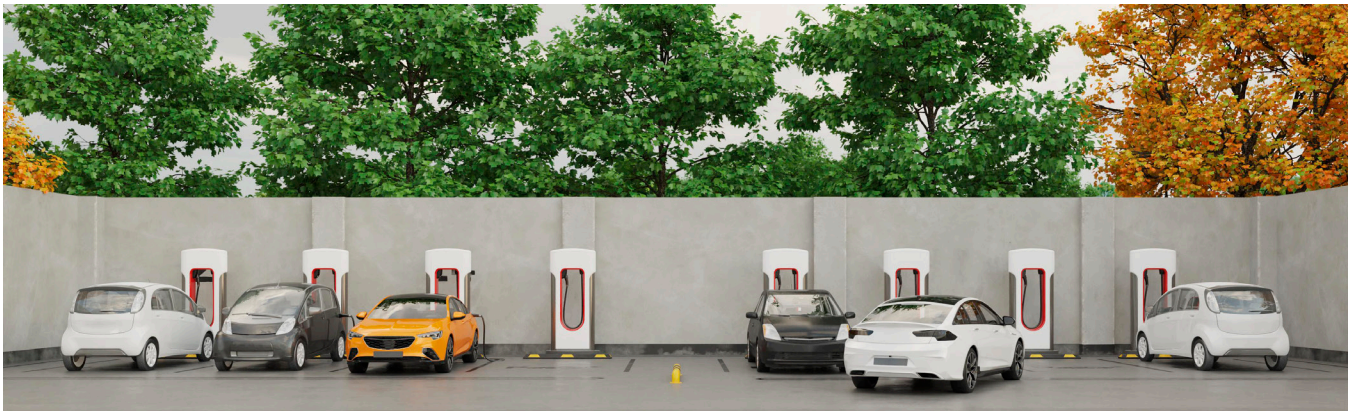
More drivers equal more design considerations. At the initial stage of the electric vehicle market, charging station designs were based on limited vehicle models and the habits of early adopters. As the market emerges, designs will have to take into account a wider pool of customer preferences and vehicle types. Ideas that weren't considered – or at least weren't at the forefront – such as stall configurations that can accommodate pick-up trucks with tow trailers or bike rack extensions – may disrupt the idea of "standard" charger design.

Accessible design requires adherence to multiple federal, state, and local regulations. The Americans with Disabilities Act (ADA) and accessibility for multifamily housing regulations require equal access to goods and services, and that includes EV charging. However, these federal requirements do not specify the details about how to do it. That is interpreted at a local level. Accommodations approved at one site may be rejected at another 25 miles away.

ADA compliance can be particularly challenging. Not only can requirements for ADA vary from one location to the next, but they are not always clear, and local specifications are also subject to change without notice. This can force project changes after installation is complete, and in some cases, compliance can conflict with charging station design and operation. One project had to change out a charger connector to a newer model. Another had to lower the handle cord four inches, which required removal of the cement pad. Even something seemingly simple like re-striping parking spaces can be expensive and time-consuming, so it's important to design with enough space for changes.

Fueling retailers have knowledge that can help serve customer needs. Fueling retailers have long served customer needs for fuel and services on the go. They understand customer behavior as well as the community needs and have adapted their business model as fueling habits and customer preferences have changed. This knowledge can be instrumental as the nation's fueling preferences evolve.

> "Retailers' relationship with customers and their prime locations make them well-situated to meet growing demand for fast charging, especially in communities that lack at-home charging or for customers traversing highway and interstate roadways."
>
> Jeff Hove,
> Fuels Institute



Standardization can be beneficial. In recent years, an emerging consensus on the CCS DC fast charging connector type and Open Charge Point Protocol (OCPP) for charger to network communication has developed. Many OEMs are equipping their vehicles with the ability to communicate directly with chargers via ISO 15118. These developments can lead to lower costs and a better driver experience, demonstrating the benefits of standardization.

Even the best plans don't equal certainty. A question that came up repeatedly was: "What charger power is best to install?" Given the pace of technological change, deciding on power levels isn't easy when trying to install a charger that won't be rendered obsolete or practically useless in the eyes of the consumers a few years down the road.

When asked whether it was better to install a 175 kW or a 60 kW charger, one participant remarked, "175 is the new 60."

Design with expansion in mind. Retrofitting a charging station to accommodate higher power chargers can pose a great challenge. Preemptively designing with room to scale to a higher charge rate or add additional ports or charger pedestals can pay dividends in the future. Having to dig up conduit to lay a larger line can be expensive.

> "Futureproof is a tall order, but future *planning* can save real time and money."
>
> David Eckels, EVIA

Right sizing might be preferable to fast charging. Not every charger needs to deliver power at top-speed. Considerable savings can be had both upfront and over the lifetime of the charger if lower-powered charging is acceptable for the location and anticipated usage.

Not everyone agrees on what data is most valuable for selecting charging sites. Studies performed by cities or municipalities to identify the best locations for charging sites may go unused by charging providers who have their own proprietary formula for making the decision.

Vehicle electrification requires new skillsets. There is large variability in expertise among contractors that can install chargers, especially higher power chargers. Installation of a high-power charger requires a different set of skills than a lower powered charger. Contractors who have the expertise and can handle the throughput will be important as the market transitions.

Photo Credit: NACFE

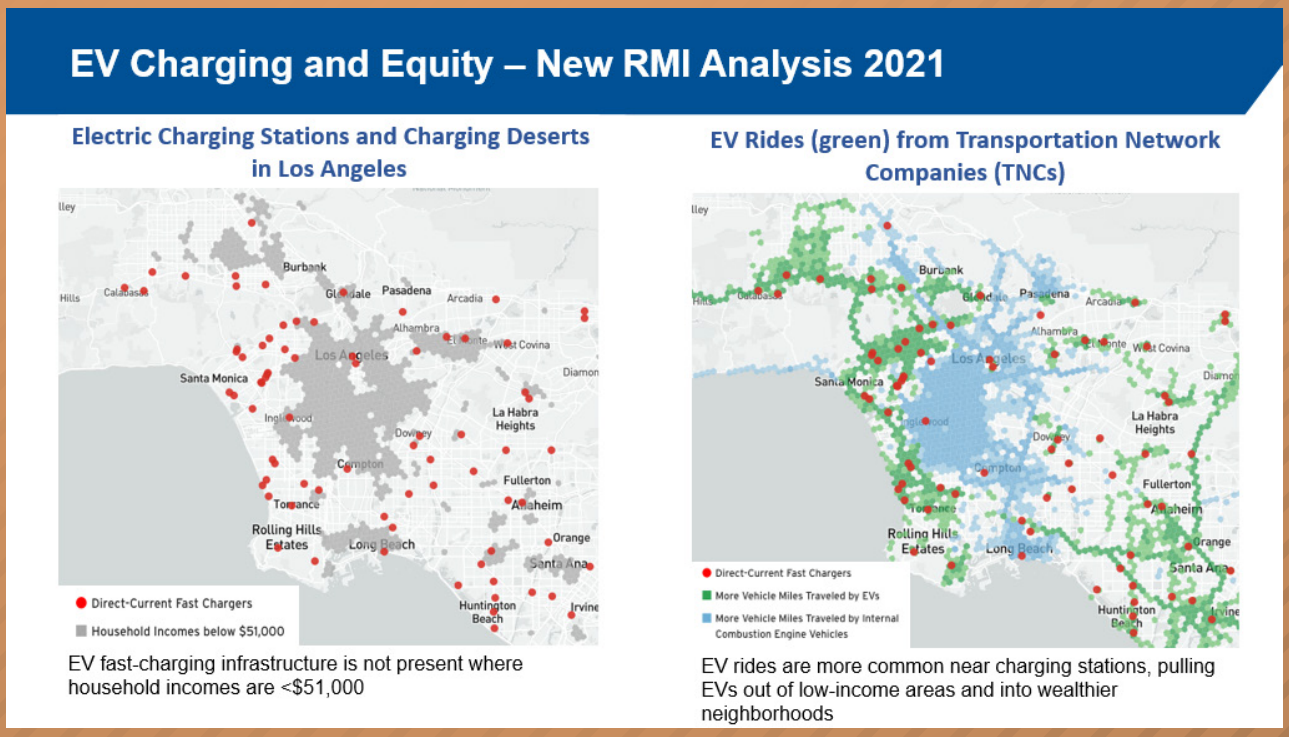
Workplace charging can align well with system peak and solar generation. Most people work – and their cars are parked – when the sun is shining. This makes them a good match for solar generation. However, strategies are needed to avoid big draws when everyone arrives at 8 or 9 a.m. and to discourage customers from 'camping out' at a charger. The shift to more remote working will affect potential benefits as well.

Questions to Consider

- What is the 'right' charger power to install?
- Is electrifying one or two parking spots at a time a sustainable economic strategy given installation costs? What is the most economic path forward?
- Will the charging station design accommodate a wider variety of vehicle types?
- How can skill gaps and shortages be addressed?

ROCKY MOUNTAIN INSTITUTE ON MEETING DIVERSE DRIVER NEEDS

Rocky Mountain Institute found that **the current DC fast charging network in Los Angeles** fails to serve low-income communities. The infrastructure is **well-suited to the driving patterns of early EV adopters but doesn't match the driving patterns of ridesharing drivers**, who tend to live in neighborhoods where households earn less than $51,000/year.



Cost Considerations

The business case is challenging but companies are getting creative. Charging stations require a certain level of usage to break even, a level that can sometimes be difficult to reach even in densely populated urban areas, much less sparse, rural ones. Further complicating the matter are demand charges. Creative solutions are emerging. For example, coupling overnight fleet charging with daytime public charging, relying on advertisement revenue, or using charging as an amenity to draw in customers or renters.

Costs can add up and some are unpredictable. The cost of building a charging station includes many factors. Some are easier and more straightforward to calculate than others. Slightly less obvious are the costs associated with complex building codes, variability in permitting and ADA requirements, and even credit card readers for public chargers. The time and resources for the utility interconnection process, to both develop the application and follow it through the process, is another cost that might be overlooked.

SOFT COSTS THAT CAN SINK A PROJECT

- Communication Between Utilities and EVSPs
- Future-Proofing
- Easement Processes
- Complex Codes
- Complicated and Inconsistent Permitting Processes

Source: Rocky Mountain Institute

Battery value is site specific. To reduce demand charges, station owners may install batteries, which will sometimes have grid benefits depending on the locational capacity of the circuit. In areas without grid constraints, battery installations can represent a waste of capital and foregone distribution revenue that the utility would receive under a volumetric rate.

Sometimes utility investments can be preferable to on-site solutions. Beyond rate reform, utility investments may help offset the need for demand charges. Utility-grade storage or other grid investments may be more cost effective overall than independent, site-specific solutions. Developing solutions that are a win-win for both parties can help to meet the needs of EV customers more effectively.

SMUD launched the Energy StorageShares® pilot program with **Electrify America** as the first customer. The program allows companies to invest into a utility-owned energy storage program to reduce demand charges without having to purchase and capitalize a battery themselves. SMUD consolidates funds from program participants to build utility-scale storage located where it is most useful to the grid, and passes the benefits back to the participants. The program attempts to align customer benefits with grid benefits.

Operating expense is often underestimated. Electricity rates might be at the forefront of charging operators' mind, but it can sometimes be eye-opening when the utility bill actually arrives. Electricity and demand charges along with networking and communication expenses like software, cellular service, payment processing, rent or loan payments on the location, insurance, and taxes all add up and can impact the revenue.

Don't overlook repair and maintenance costs. Maintaining charging equipment, repairing it when it breaks and replacing it when it can't be fixed or when it becomes outdated, are other costs of doing business. Some protective measures include bollards and wheel stops, or incorporating features like cable management systems to reduce the potential for charging cable damage, but there's no way to eliminate them altogether.

> "Look for grass. The grass is easy to fix. When you start breaking up asphalt, gutters, or concrete, those costs start adding up."
>
> Chris Bilby,
> Holy Cross Energy

Civil work is expensive. Trenching can be a significant contributor to project cost. Cutting through concrete or asphalt, digging a trench and putting in conduit and conductors, then closing it back up can quickly balloon costs. Planning for future expansion will avoid having to do it twice.

Shared infrastructure can increase value. There is a veritable laundry list of costs and hassles one must navigate to install a charger. Co-locating multiple chargers at a single site can save time and money. Hubs, rideshare locations, multiunit dwelling chargers, and other approaches can mitigate zoning complications, plus it is almost always less expensive to lay one large conduit to a single location than several smaller ones to multiple sites.

Questions to Consider

- How can interconnection studies for site selection be streamlined to reduce costs?
- What are the implications of connectivity lapses for Wi-Fi enabled chargers?
- When are utility investments preferred to site specific solutions?

Standard equipment and contractors can reduce installation time and costs. Developing standard equipment designs and having them installed by approved contractors can facilitate installation and ease the permitting process.

When installing infrastructure for a bus depot, there was additional capacity on the transformer. So **Rocky Mountain Power** decided to utilize the infrastructure to add some passenger DC fast charger to the site. The utility found that to be an effective and successful approach.

Working with the Utility

Talk to the utility as soon as a specific site is in mind. Working with utilities early in the process can provide an understanding of their processes and timelines. The utility can also provide insight on available capacity, the costs of running service to a location, as well as alternative site suggestions. In some cases, it's actually possible to save thousands of dollars by moving just 500 feet down the road.

Utilities and developers benefit from a more collaborative approach. Some utilities are willing to have informal conversations for determining site locations, while others require submission of an interconnection request for each possible location, even if it is on a single site, such as a Walmart parking lot. A binary yes/no response can increase time, costs, and frustration.

Utility tools can provide decision support. For developers and commercial customers, the first step in determining site viability is evaluating whether it has enough electrical capacity. Obtaining this information is often not available without submitting an interconnection application. That can mean pouring time and resources into preparing a request, only to be told no. A tool or a mechanism that provides visibility can assist in narrowing down options.

SOUTHERN CALIFORNIA EDISON PROVIDES DATA TO CUSTOMERS

Southern California Edison has two data analysis tools that are available for customers through their Distribution Resources Plan External Portal (DRPEP):

- **Integration Capacity Analysis (ICA)** evaluates the system's ability to host additional load based on current configuration
- **Grid Needs Assessment (GNA)** predicts circuit-level upgrade needs using a five-year forecast based on growth assumptions adopted in the distribution planning process

Capacity maps offer some – albeit potentially outdated – insight. Capacity maps can provide some insight into available capacity, but instead of showing where capacity is available, they reflect where it *was* available and might still be, depending on how regularly they are kept up to date. They often represent a snapshot in time and don't represent real-time conditions or incorporate future utility infrastructure plans. Developing these maps requires an investment in time and money from the utility, which needs to be weighed against the value to customers.

Project developers need to be able to rely on utilities. Charging infrastructure installation can offer risky business prospects that require hefty investments up front and significant paperwork that takes a long time to complete. Charging network providers need clear timelines, follow through, and consistency from utilities.

Peak load definitions may not fit charging operations. Utilities' design parameters dictate that the size of a transformer be sufficient to meet the anticipated peak load of a site, which is calculated based on simultaneous maximum charging. This can add thousands of dollars to the installation costs of a site because of requirements for a larger transformer, even though the probability of the chargers ever all operating at peak load, now or in the future, is very slim.

Battery storage value depends on the lens in which it is viewed. On-site battery storage can be used as an asset to level out load at charging stations in an effort to ward against demand charges. Some utilities, however, may use traditional design criteria to calculate interconnection requirements, which means the total load is based on the battery charging while the DC fast charging station is at full load. This can lead to significant upgrade costs for transformers or prohibitive fees, and, on congested circuits, line upgrade fees. Station owners note this is an unlikely scenario that can be prohibited through battery charging management. An industry-wide standard that recognizes battery storage as an asset to reduce peak load would be beneficial.

Questions to Consider

- What is the value of on-site storage?
- What tools or approaches can reduce time and costs for site selection by providing customers with information they need to select charging station sites?

Permitting and Interconnection

Permitting is a real wild card. Building a site requires much more than equipment and a construction crew. Lining up the permits and zoning can require significant time. Permitting codes are local and can change without warning. Approvals may be required all the way down to neighborhood HOA covenants that often have the ultimate authority on what a resident can – or can't – install.

The permitting process is improving but there's still work to do. In some areas, the permitting process has gotten much better, but other areas have seen no change. In California, the legislature passed Assembly Bill No. 1236 regarding local ordinances for electric vehicle charging stations, and the California Governor's office developed a map and guidebook to streamline permitting and homogenize approvals by authorities having jurisdiction (AHJ). In New Jersey, the legislature passed S3223 which streamlines the permitting process for EV charging stations.

Government or utility partners don't guarantee a smooth ride. With many states offering incentives or passing mandates to increase EV adoption, it might be expected that projects that are supported by important political leaders or under the government's own purview would find an easier path through the permitting process, but that's not necessarily the case.

Utility procedures and protocols can hinder the best laid plans. Utilities establish processes and procedures to ensure safe, reliable operation of the grid. Even when utilities are willing and excited participants on a project, these design specifications and approval processes can limit progress and cause delays. After some utility departments had to navigate their own processes, which were developed to provide utility service to a building, they identified unnecessary hurdles that led to process changes for electric vehicles.

> "We might get the permit the same day in one jurisdiction, and in another, it may take 13 months."
>
> Dave Eckels, EVIA

Industry doesn't work on 30 day or fiscal year intervals. Commercial businesses have to make incremental progress every day and are held accountable for results. Establishing project leads or special teams that have authority to make gateway decisions rather than waiting for monthly meetings would help support business efforts. At times, projects have waited on approval for a specific item to be discussed at a monthly meeting, only for that issue to be tabled until the following month's meeting, causing additional delays.

"First in, first out" might be a barrier to the transition. Regulations specify that utilities must serve new business loads equitably. That means that all new requests for service are evaluated based on their position in the interconnection queue along with other commercial building service requests. This could lengthen the time frame for implementing electrification projects, and has raised questions as to whether processes or procedures require modifications to support transportation electrification efforts.

Customers need clear instructions about the interconnection process. Commercial businesses need clear and explicit instructions about how to enter the line for obtaining interconnection approval, and well-defined timelines so they can plan projects. Participants indicated they didn't mind getting in line, but need to know how to do that and how long it will take.

Interconnection equity is an important element in the regulated environment that can be challenging for customers. The grid has locational and temporal variability for available capacity, and utility service (or interconnection) requests operate on a first in, first out basis. While the utility might receive three inquiries from three different fleets that operate on the same block today, the customer that submits its request first has first priority for available capacity.

Interconnection standards may limit backup power options. Connecting with the grid for safe, reliable charging requires codes and standards that address the integration of multiple communication mediums, including cybersecurity and interconnection standards. Bidirectional charging, in which the car can export energy back to the home or grid, requires even more complex codes and standards. Without those in place, a customer's ability to use their EV for backup power to the home may be limited.

Interconnection with smaller utilities can introduce new twists. Charging providers may have a different experience dealing with rural co-ops and public power utilities. These utilities often have a smaller, more agile team of workers that knows their system inside and out and can quickly respond to questions. However, in some cases, determining available capacity at a site may require a technician to physically visit the location. Many times, equipment such as a distribution transformer may need to be upgraded to serve the new and unanticipated load.

Interconnection costs aren't insignificant. The cost for determining a site and receiving utility interconnection approval require investments in time and money. Often charging service providers have to evaluate a number of sites before making a final decision. Paying the utility to evaluate multiple interconnection locations on the same site can add significant costs. Hence the advice, talk to the utility as soon as you have a site location in mind!

Questions to Consider

- Do electric vehicle projects need a different interconnection process?
- Could a temporary fast-track process meet accelerated timelines during the transition?
- How can interconnection requests become more collaborative?

SUGGESTIONS FOR IMPROVED UTILITY INTERCONNECTION PROCESSES

Making the following information more accessible could help facilitate interconnection requests and reduce costs:

- The available grid capacity at a site
- The cost to increase capacity, if needed
- The length of time interconnection approval will take
- The total cost for the interconnection application
- The status of the application throughout the process

Source: Rocky Mountain Institute

ELECTRIFY AMERICA ON BATTERY STORAGE INTERCONNECTION STUDIES

Adding battery storage to an existing energized site requires a full grid interconnection study. "The fees are astounding," remarked Matt Nelson with Electrify America. "I'm not exaggerating, we got a $10,000 fee for a single battery system interconnection study."

Timelines for the studies can also lead to additional delays. Even in states with programs to accelerate battery deployment, utilities can be unwilling to use those processes for EV charging stations. "Connecticut's fast track process for batteries is inclusive of our stations. It has allowed us to get a 15-day approval at a site in Eversource's territory."

EXPERIENCES FROM THE FIELD

Rocky Mountain Power: A Data Driven Approach

In 2017, **Rocky Mountain Power's** Westsmart EV project **had bipartisan legislative support to deploy EV infrastructure**, **and $10 million to fund it**. It had eager partners in communities, universities, local air quality groups, and Idaho National Laboratory to install DC fast chargers along the I-15 and Level 2 chargers, primarily at workplaces.

To determine the DC fast charging locations, Rocky Mountain Power gave a summer intern a ruler to plot out stations every 50 miles, but it quickly became apparent that it wasn't the right approach. The grid infrastructure wasn't there to support it, especially in the rural areas. **The utility then took a step back, deciding to perform a modeling exercise that overlaid the geography with the grid infrastructure to identify deployment priorities.**

Data from the project has shown that the fast chargers were primarily being used by people who live outside of the area – drivers who lived about 30 miles or more away. "What we saw when we mapped out where the drivers lived and where they came from," says James Campbell, "was kind of from *Field of Dreams: if you build it, they will come*. We're pretty excited about that."

Insight: Rocky Mountain Power found that installing chargers in rural Utah brought drivers from Las Vegas and Los Angeles, achieving the goal of enabling EV through the state of Utah.

What Electrify America Learned from Building 500 Charging Stations

Building more than 500 DC fast charging stations nationwide required Electrify America to work with 200 different utilities. Utility interconnections are one of the most time-intensive aspects of their process. Even in the best of circumstances, Electrify America has found it takes more than nine months from first requesting service to a site, through design and construction, before a charging station receives power. The variety of business practices from one territory to another has given the company significant insight into practices that are most helpful.

1. **Provide a single point of contact.** Someone within the utility who knows the requirements of the project(s) in the territory, can interact regularly, handle the scheduling, and take charge of the account.
2. **Collaborate on project selection.** Often four to six sites might be evaluated before selecting a final site. Collaboration facilitates this effort but it can be seen as a burden if not understood.
3. **Validate power and capacity availability upfront.** Utility input in the design process early on can save hundreds of thousands of dollars simply by locating a charging station on one side of a parking lot or another. And permits require a specific location, not just *somewhere* in the store parking lot.
4. **Flexibility around projected peak loads and usage for EV charging.** Current design considerations calculate peak load based on all chargers being run at full power simultaneously. However, the chance of that occurring is negligible. The ability to take this into account can translate into project savings.
5. **Dedicate an agent to identify third-party easements.** Someone familiar with navigating the time-consuming process can help speed it up.
6. **Provide clear construction timelines and expectations.** Customers need a fixed schedule! Both for utility interconnection design delivery as well as construction and energization. Often energizing the site will be canceled or delayed with limited notice.
7. **Allow stakeholder engagement on potential EV rates.** Collaborative discussions can help balance economic considerations for the various parties.
8. **Standardize timelines for battery interconnection applications.** When utilities see batteries as a benefit instead of a burden, approvals can be fast tracked, reducing costs and installation time.

Evergy on Easing Installation and Permitting

Evergy pre-engineered six charger pedestals with various configurations that are easy to install with their equipment. Having standard equipment had two real advantages. **It made installation repetitive** so contactors knew what they were doing at each location. **It also helped with permitting.** EV charging was new to the many permitting agencies and electrical inspectors that Evergy had to work with in the Kansas City area. Educating them on the standard design made it easy when submitting permits for the 400 host sites where Evergy installed chargers.

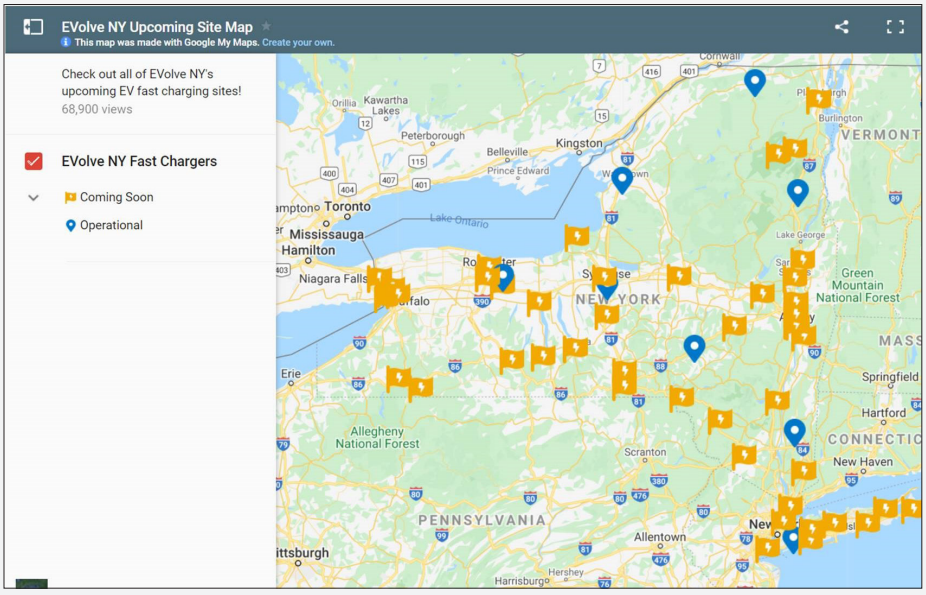
New York Power Authority Emphasizes Reliability

NYPA, the largest state public power organization in the nation, **is taking on one of the most ambitious electrification projects in the U.S.** Up to $250 million has been earmarked through 2025 to build out a DC fast charger backbone along key travel corridors and in urban areas to advance New York State's EV adoption goals. EVolve NY, the dedicated business unit within NYPA that focuses solely on public DCFC stations (150kw – 350kw), has plans to deploy up to 200 stations by 2022, and up to 800 by 2025.

Once complete, New Yorkers will be able to drive any EV from New York City to Montauk, from Albany to Montreal, and from Binghamton to Buffalo with fast chargers capable of recharging their vehicles in 15-30 minutes located every 50 miles or less. "Combating range anxiety and removing risk from the EV charging market is our guiding premise," said Rajiv Diwan, director of E-mobility Strategy and Business Development. "We must focus on the customer to ensure that public DC fast charging remains accessible and reliable at every charging site. **There should be no excuse for a customer not to receive a charge** other than issues with the vehicle or a grid outage."

NYPA's approach at each of its sites is to upsize the backend transformer capabilities, giving headroom to ensure a megawatt site can deliver a megawatt of power and not have to throttle the charging capacity. **The utility is also working with vendors to find backup solutions so drivers aren't stranded in the case of equipment failure.** Options under consideration include assessing the need for intervals even closer than 50 miles on corridors, to account for expected EV range and charging curve characteristics, as well as including a Level 2 charger at sites that can be toggled on if the DC fast charger is down.

A typical site has four DCFC's per site (150kw – 350kw), credit card/mobile pay at each charger, a dual CCS with Chademo support, and a Tesla adaptor at select sites. EVolve New York's cellphone lot at JFK Airport is the site of the largest non-Tesla charging hub in New York.



A live map on NYPA's website shows up-to-date charging site locations. The goal is to provide as much transparency as possible to the public and the developer market.

Massachusetts Weighs in on Station Reliability

In Massachusetts, 140 public chargers were installed at 22 stations from 2011 to 2012. Steve Russell, Alternative Transportation Program Coordinator for the Commonwealth of Massachusetts, noted the importance of longtime support of EV chargers because drivers have to be able to count on units being in working order. Of the installed chargers, **the third-party chargers began breaking down as their warranties expired**, leaving no way to get them repaired. On the other hand, **utility-installed stations were well maintained, though each one required new service.**

EVIA on Questions to Ask when Designing Stations

Many conversations about EV charging stations begin with the question of what kind of charger will be installed. Electric Vehicle Infrastructure Advisors suggests that the better approach is to ask, "How many miles of range do you need to supply and in what period of time?" EV charging has no one-size-fits-all solution, so **EVIA recommends considering the goals for each specific project in each specific location individually** with the following in mind:

- Designing for the vehicle
- Designing for the driver
- Designing to reduce costs

Most vehicle charging for the past several years has been for short range, compact commuter vehicles. As the market expands to include high-performance sports cars, vans, and various heavy- and medium-duty vehicles, **more thought must be given to inclusivity to serve a wider variety of vehicles.** "We've got this compelling group of electric pickup trucks coming to the market," EVIA founding partner David Eckels noted. "You know those folks are going to want to tow trailers, and very little of the currently deployed charging infrastructure is capable of meeting that need."

Driver experience must also be taken into consideration when designing a charging station, beginning with safety. "When I'm doing a site assessment," Eckels said, "**one of the first questions I ask myself is would I want to be charging here at two in the morning?** Would I want a loved one here for 15 or 20 minutes?" That longer charging time, relative to gassing up, also begs for another driver amenity: something to do. In the case of DC fast charging, that may be fast food or coffee and a restroom break, while grocery shopping or a sit-down restaurant would be more appropriate for slower chargers.

Greenlots on Getting Serious about Standardization

There are multiple EV models on the market with many more coming and an impending infrastructure build out. **Without standardization, it can drive up infrastructure development and technology costs and significantly hamper the driver and charging experience.**

Greenlots recognizes the importance of standardization in making charging easy for customers, stressing that **there's significant need and opportunity for greater industry coalescence around communication standardization, in particular, to facilitate hardware and software interoperability.** "Beyond just the technical protocols, however, ensuring that chargers have the hardware capability to communicate with vehicles is critical to making charging easy for drivers and for facilitating vehicle-grid integration," emphasized Erick Karlen, Senior Advisor for Policy & Market Development at Greenlots. **"The industry and regulators have a ways to go to get this right, and the window to meaningfully do so is closing."**

Resources

- Chris Nedler and Emily Rogers, *Reducing EV Charging Infrastructure Costs*, Rocky Mountain Institute, https://rmi.org/wp-content/uploads/2020/01/RMI-EV-Charging-Infrastructure-Costs.pdf
- Charging Station Permit Streamlining Map, California Governor's Office of Business and Economic Development, https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/
- *Electric Vehicle Charging Station Permitting Guidebook*, California Governor's Office of Business and Economic Development, https://static.business.ca.gov/wp-content/uploads/2019/12/GoBIZ-EVCharging-Guidebook.pdf
- *California Assembly Bill No. 1236*, California Legislative Information, https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1236
- *National ZEV Investment Plan: Cycle 3*, Electrify America, June 2021, https://www.electrifyamerica.com/assets/pdf/cycle3_investment_plan_epa.a19109d1.pdf
- *Utility Best Practices for EV Infrastructure Deployment*, Smart Electric Power Alliance, https://sepapower.org/resource/best-practices-for-utility-ev-infrastructure-deployment/
- *New Jersey Senate Bill NJ S3223*, State of New Jersey 219th Legislature, https://www.njleg.state.nj.us/2020/Bills/S3500/3223_R1.PDF
- *Installing and Operating Public Electric Vehicle Charging Infrastructure*, Fuels Institute, August 6, 2021, https://www.fuelsinstitute.org/Research/Reports/Installing-and-Operating-Public-Electric-Vehicle-C

Integrating with Utility Operations

Connecting to the Network

Much of the exploration into electrification of transportation focuses on what utilities will need to do to meet the load demands of these vehicles. But while asking what the grid can do for EVs, there are also questions of what EVs can do for the grid. The answers will vary from utility to utility, but EVs present opportunities to increase load and improve asset utilization while lowering rates for all customers.

Integration takes the EV conversation beyond using electricity for fuel to the broader topic of shifting to a more distributed, interactive grid that gives customers more choice and control. EVs have the potential to be grid resources, and vehicle grid integration (VGI) technologies have the potential to provide grid reliability and resiliency services and to create new customer revenue streams.

> "It's important to align the interests of the grid and the interest of the electric vehicle driving public."
>
> Matt Nelson,
> Electrify America

> "Compared to many other places around the world, the U.S. has really reliable electricity. We're going to make sure that as infrastructure to support electrification grows out, we maintain that reliability."
>
> Jordan Smith,
> Southern California Edison

Electric vehicle load management programs can look and feel like traditional demand response programs, but can go beyond that. Vehicles have a completely different load profile from other traditional loads giving them a unique capability to dynamically shape, shift, and discharge energy at optimal times for grid management. Utilities are exploring options and investigating the benefits of different approaches.

While utilities might start with a fairly basic or straightforward approach, growing adoption numbers may require more sophisticated strategies, like vehicle-to-grid (V2G) services, in the years to come. Regardless of what the future brings, close collaboration among stakeholders will be essential for overcoming barriers and unlocking the value of vehicle integration.

WHAT WE HEARD

Preparing for the Future

The grid is a system and requires a holistic approach. EVs are going to have a large impact on how business is done both for utilities and the transportation industry. But they are still just a part of a whole when it comes to the electric infrastructure. EV investments need to be considered in conjunction with other DERs (e.g., PV, battery storage) rather than evaluating each in isolation.

EVs have cross-organizational impact. Electrifying transportation is not a niche project that can be pigeonholed into one office. As adoption numbers grow and as companies electrify their fleets, it will become an enterprise-wide endeavor. It will involve everyone from top executives in the boardroom to linemen on the streets. Each unit needs to know what's coming and be part of the discussions. Cross-functional input can lead to better solutions, improved process, and reduce surprises and complications later.

Pilot programs provide value but don't answer all questions. Pilots can provide valuable information, but their scope can be limited. Control with 10 EVs can be vastly different than with 100. Pilots can provide valuable insights but they won't necessarily uncover areas that will result when operationalized at the utility or at the customer's business. Pilots need clear pathways to scale.

Don't narrow in on solutions too soon. Utilities will learn a lot over the next three-to-five years that will help answer many of the questions being raised now. Committing to decisions too soon can limit capabilities in the future. Solutions can evolve and implementing new technologies, such as DERMS, can enhance capabilities and lead to more optimal solutions.

Leveraging existing infrastructure can benefit all utility customers... Encouraging and incentivizing customers to charge in a manner that aligns with already available capacity can increase utility revenue and put downward pressure on rates for all customers.

... but not everything can be managed without additional infrastructure. Using rates, managed charging solutions, and other approaches utilities will be able to minimize infrastructure investments. However, infrastructure investments will be needed, not only for meeting additional load but also for technologies to manage and control the grid. The impacts from EVs will vary by utility, feeder, and circuit, but might be most acute with medium- and heavy-duty vehicles and in rural or congested areas.

DERMS (distributed energy resource management systems) is a peer to **ADMS** (advanced distribution management system). While an ADMS is a grid controller and manages the network, DERMs focuses on the management and control of distributed energy resources (DERs). Inputs into a DERMs platform include weather, data, pricing, historical load, and generation data. The data is then fed into a load and generation forecast engine that is input into a dispatch optimization module. Outputs from the module then go through the secondary layer of dispatch and command.

Generation needs to be green to get full environmental benefits. Many drivers want electric vehicles because they have no tailpipe emissions. This is good for improving local air quality, but to reap the full environmental benefits electric vehicles offer, the electricity powering the car needs to be from a low-or-zero-carbon emitting source.

Electric vehicles present a large opportunity for optimization. While optimizing vehicle charging is an overarching objective, there will be a push and pull between flexibility and optimization. Operators will need to optimize the grid for a variety of constraints.

In some of America's underserved communities, environmental benefits of driving an EV may fail to manifest if the electricity comes from inefficient coal or peaker plants that introduce significant carbon into the local air. It moves emissions from the tailpipe to where the electricity is generated, making the source of the power important.

Utilizing EVs for resiliency and blackstart may not be in lockstep. Alongside megawatt-level and utility-scale DERs, medium- and heavy-duty EVs may offer the potential to serve small, well-planned microgrid islands during grid disturbances for the community and for critical infrastructure resiliency. However, it is another large step from there to relying on them as resources for blackstart capabilities.

Blackstart – (noun) The capability to provide power into a completely de-energized grid. Due to power surges when machines turn on (e.g., A/C units powering on after a blackout in a heatwave), blackstart can require significantly more initial capacity.

Utilities are looking for partners. Utilities are exploring options and learning from each other as they try to anticipate future challenges. Many are seeking private sector partners and vendors outside the utility industry to accelerate the learning curve. For some smaller utilities that may not have an EV department or a dedicated EV person, partnering can be helpful.

Questions to Consider

- What technology or processes are needed to prepare for the future?
- How are blackstart situations handled if the utility has no visibility or control of those resources?
- What does the reliability of the electric grid need to be as the transportation and electric sector become linked?
- Is a system reliability of "five nines" (99.999%) good enough for a fully coupled system?

Technology Implications

Utilities need visibility and the capability to process data. Visibility and data can help utilities develop more exact approaches, but often utilities are blind beyond the point of interconnection. They don't know exactly what resources are connected to the system. There are a variety of ways to collect data (i.e., AMI meter, vehicle charger, smart home devices), but the utility may not have access to them. If it does, the ability to process, aggregate, and analyze the data will be limited without a robust, reliable communication system to transmit it to back-office systems.

AMI and its associated data can serve multiple functions. Meter data on vehicle charging can assist with planning and forecasting, understanding operational impacts, and designing new rates and programs. AMI interval data can also help fleet customers calculate the cost implications of switching to electric. AMI data can also be used to perform sensitivity analysis for different charging scenarios.

> "It's managing the complexity of integrating existing software and hardware components that yield techno-economic solutions to benefit multiple stakeholders – starting with the energy consumer."
>
> Alex Rojas,
> Ameren Services

Telematics data requires data scientists. Data analysts paired with EV program managers yield the most value. Domain expertise in energy will add to actionable intelligence around data inference.

Utilities are investigating innovative approaches to serving DERs. As EV adoption rates increase along with solar photovoltaic (PV) and other DERs, utility engineers are exploring new approaches that utilize the operational characteristics of these new devices. **Ameren** is exploring the benefits of offering DC as a service to customers. The DC line would serve vehicle chargers, PV, and energy storage.

Management and control of DERs have different temporal requirements. The monitoring, analytics, and dispatch of EV chargers as grid assets requires three levels of control: real-time analytics or primary control, mid-latency or secondary control, and high-latency or tertiary control.

Importance of DERMS increases with growth of EVs in a service territory. DERMs is a highly customized tertiary control system that allows a utility to analyze the specific mix of DERs in their service territory and to optimize for several objectives. Integrating vehicle charging data – when charging occurs, for how long, and how much energy is required – into the platform gives the utility visibility and information to manage and control the grid more effectively.

SOFTWARE CONTROL TEMPORAL REQUIREMENTS

Utility Analytics (Control Hierarchy)	Temporal Requirement	Typical Functions
High-Latency (Tertiary Control)	Minutes	More forgiving from a temporal requirement. Includes functions like EV load forecasting and advanced optimization.
Mid-Latency (Secondary Control)	Seconds	Includes a neighborhood or feeder. It is the way a utility deploys energy. Typical functions are SCADA, EV charging control, batteries, and backup generators.
Real-time analytics (Primary Control)	Micro- to Milli- Seconds	Used for protection, AC and DC switching. Control is local to the device (e.g., DER converter, protection relays) due to the required reaction times.

Source: Ameren

New innovative technologies will help automate load management. Technologies are emerging that will allow the utility to keep charging levels below a capacity threshold. Software can manage the charging module according to how much available capacity is on a fixed system. These tools can help utilities support some limited-capacity retrofit situations without needing to spend significant money to bring in a larger service.

Grid design requirements may change. Utilities are initiating exercises to upsize transformers and evaluate protection schemes, as well as updating design manual equipment specifications to prepare for added EV loads. The last time the utility underwent a major change like this was when air conditioning became a staple in American homes in the 1950's. Lessons learned then can be applied to electric vehicle adoptions today.

Utilities are looking for more information about emerging products. There are innovative startups that are entering the EV market. Utilities are looking for ways to learn more and connect with these companies.

Even when there are associated IEEE and SAE standards, it doesn't necessarily mean that the latest versions of the two standards are harmonized.

Standards are anything but standard. Auto and charger manufacturers can self-certify. Utilities need independent third-party certification. Utilities and state regulators typically use IEEE standards; whereas, vehicles typically use SAE standards. The two standards are not necessarily in agreement, but safe and reliable one-directional and bidirectional charging will depend on reconciling them along with utilities' NERC standards for all market participants. FERC 2222 brings urgency to harmonizing standards between utilities, aggregators, and charging network providers.

Standards do not equal interoperability. Just because a technology meets a given standard it does not mean that it will be interoperable (or can integrate) with utility systems. Even when different vendors implement the same standard, the chargers may operate and vehicles might react differently.

Questions to Consider

- What is the best approach for identifying the areas on the utility's system that could most benefit by managed charging?
- What are the oscillatory or harmonic effects of EVs on the electric grid?
- What data do utilities need regarding vehicle charging to manage and operate the grid?
- When does an investment in DERMs become essential?
- How much control over vehicle charging do utilities want or need?

Vehicle Grid Integration (VGI) Categories

- V1G = Unidirectional Charging
- V2X = Bidirectional Charging
- V2G = Vehicle-to-Grid
- V2P = Vehicle-to-Premise
- V2B = Vehicle-to-Building
- V2H = Vehicle-to-Home
- V2M = Vehicle-to-Microgrid

With V1G (i.e., smart charging), the rate of charge can be dynamically modified and customers will be compensated for providing services to the grid. V2G has the same capabilities, but can also dynamically modify a rate of discharge back to the grid, potentially allowing a larger magnitude or longer duration of the grid service. V2P encompasses V2H and V2B.

Managing Load and Grid Services

Managing load spans a spectrum of approaches. Approaches for managing load run the gamut from smart charge management through time-of-use (TOU) rates to more sophisticated approaches such as vehicle-to-grid (V2G). No singular approach will be appropriate for every customer or scenario, and the lens through which solutions are viewed may change over time as adoption rates rise, third parties enter the market, and as charging behavior become more established.

The objective of load management is managing infrastructure costs. Uncontrolled charging (i.e., customers charge whenever and wherever they want) has the potential to significantly increase electricity demand and force new infrastructure projects. Managing customer charging can lead to better asset utilization and avoid, or at least postpone, the need for infrastructure upgrades that could lead to price increases to customers.

Managed charging – (noun) Utility, customer, or third-party control of vehicle charging that intelligently integrates electric vehicles with the grid.

Time-of-use rates are a good starting point... Much of load management will depend on customers making good decisions, and one of the most straight forward ways to incentivize good charging habits is TOU rates. Beyond influencing customer behavior, going through the process of developing the rate can be the first step within the utility to start thinking about how to engage in the managed charging space. It can also demonstrate to customers the utility's commitment to transportation electrification. They are, however, easiest to implement when the utility has AMI.

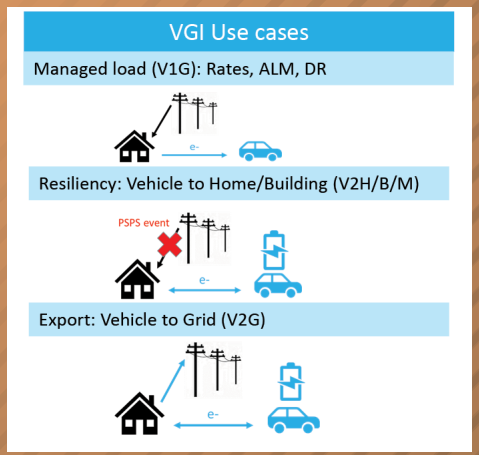
... but TOU rates don't solve everything. Unfortunately, while TOU can dissuade drivers from charging at peak times, it can inadvertently incentivize a surge in charging when rates drop, creating "*timer peaks*." At some point, the utility may need more advanced methods to optimize multiple variables. And for some utilities with low electricity rates, it might be difficult to increase on-peak rates enough to create a price differential sufficient to discourage on-peak charging.

HIGH VALUE USE CASES FOR VGI

Managing Load: Use rates, automated load management, and demand response to lower customer costs, avoid grid upgrades and support renewable energy integration

Resiliency: EV backup power and zero emissions temporary generation using V2H, V2B, V2M

Export: Peak load management using V2G to export to the grid to flatten the duck curve, create new revenue streams and lower EV ownership costs



Source: Pacific Gas & Electric

What is proposed in theory may not be as simple in practice. There are many compounding variables that make the reality of optimized or managed approaches much different from the possibilities and ideas put forth by its advocates. One of the biggest might be utilities' lack of real-time visibility on secondary transformers and last line feeders. Both technology and regulations restrict the ability to deliver accurate, individualized price signals for control, and customers often express that they don't want to respond to them minute-by-minute every day.

There will be a balance between grid needs and customer needs. Engineers who study and work on the grid every day, who know it inside and out, are going to have a different perspective from the customers who rely on it to run a business or household. It will be necessary to find the sweet spot between the two with creativity that is weighed against practical constraints and considerations.

> "A Freightliner truck isn't like a red convertible that's only taken out on sunny weekends. The only reason you own a commercial truck is to make money."
>
> Rustam Kocher,
> Portland General Electric

Trucks are tools and owners don't want them idle. Commercial vehicles aim for the highest utilization rates possible. While truck batteries may be able to provide grid services, utilities shouldn't bank on it.

Roles in the EV charging ecosystem are evolving and will continue to evolve. Players and roles in EV charging are still being defined, with new additions emerging all the time. The boundaries across different parts of the ecosystem are quite elastic, and the roles of different constituents will evolve as the market matures. This evolution has utilities trying to determine protocols for when they need to exercise control versus letting the vehicle or a third-party do it.

Implementation costs need to be considered. Managed charging is only beneficial if utilities have ways to manage the charge when and where it's needed, and if the cost to implement it isn't greater than the benefits it provides. Studies on smart charging often fail to include the cost to implement the program.

Grid services will evolve in waves. The first wave of managed charging programs focused on more passive solutions to test out the technologies and to understand how much load could actually be shifted. The second wave is now focusing on more active managed charging. It will require utilities to think much more critically about their operations.

INSIGHTS ABOUT PILOTS

- Small pilot programs need clear pathways to scale.
- Utilities need an appropriate amount of flexibility.
- Pilots can provide insights into customer implementation challenges.
- Results achievable in pilots might not scale.

Don't forget to consider what's in it for the customer. Current conversations tend to focus on grid value rather than the value to the customer. They also tend to overlook the primary function of the car: *transportation*. If customers aren't compensated sufficiently or don't see the value for themselves, they won't participate.

Open API access could lead to more economical long-term solutions. To communicate with vehicle chargers, utilities need API controls. They have to either develop their own in-house or pay a monthly service fee to a third-party. Third-party services can be expensive – even cost prohibitive for smaller utilities or rural co-ops – and limit a utility's ability to work with multiple charger manufactures. Open API access to be able to send signals directly to an app on the customer's phone could be both more economical and preferable.

> "You get into this nightmare of 'software as a service' where everybody wants to charge you per month for access to their API. As a utility - and especially as co-ops – we need to stand up and demand open access APIs."
>
> Chris Bilby,
> Holy Cross Energy

Vehicle-to-grid (V2G) is technically feasible but... There is interest in and even excitement about V2G technologies. Pilots have shown that the technology is responsive and works well. However, certified, commercially available products are lacking, there are concerns about voiding the vehicle battery warranty, and current devices can be somewhat noisy and bulky for a residential customer's garage.

...Market mechanisms to compensate customers do not exist. Without market mechanisms that pay customers for providing services, customers won't have interest in participating, so auto manufacturers lack an incentive to develop the vehicle technology. However, opportunities exist. School buses may be better short-term candidates for V2G and FERC Order 2222 may stimulate market interest.

For **Green Mountain Power (GMP)** in Vermont, V2G efforts are grounded in storage and resilience efforts to transition lessons from its stationary storage program and use them to develop a V2G program for residential customers. While it's technologically feasible to implement, GMP needs a certified commercially available product to roll out a formal V2G program.

Other distributed resources may pave the way. Programs that utilities develop to manage and interact with other DER resources, like customer-owned solar or stationary storage, can provide insights and facilitate learning for future V2G programs.

Vehicle-to-home (V2H) or vehicle-to-building (V2B) might be the place to start. Many homeowners purchase generators to provide backup power in case of a blackout. V2H may offer them the potential of using their car instead. Consumers could power critical appliances, like phones, microwaves, or a small heater, or even their entire house when outages occur. V2H and V2B could be a first step to demonstrating value of V2G. V2H is a major selling feature built-in to the soon to be released Ford F150 Lightning.

The value opportunity for V2G is customer specific. Fleet customers may have a higher comfort level with managed charging because the incentive could be greater and they tend to be more energy savvy. However, they may be reluctant to add complexity to logistics if the resulting benefit isn't great enough. Similarly, school bus schedules and their larger batteries seem like a good fit, but those too depend on bus routes and schedules.

Questions to Consider

- What adoption levels will require more dynamic load management strategies?
- What opportunities do predictable and influenceable vehicle loads create?
- What use cases offer the most value?
- How are customers compensated for providing services to the grid?

EXPERIENCES FROM THE FIELD

Oncor: The Value of a Strategy Council

Oncor **recognized that EVs, similar to other DERS, represent a cross-organizational project.** Wanting to bring in new insights and ideas and provide broader awareness of new strategies, **Oncor established a strategy coordination council**. It meets for 90 minutes once each month to vet and coordinate the more than 30 strategies being implemented across the organization. The council, which isn't EV specific, had forty employees, including 16 VPs, to discuss transportation electrification, the first strategy it tackled.

"The council is a good place to vet a strategy before taking it to senior leadership," reflected David Treichler. "**We're getting feedback from across the enterprise**, saying, 'have you thought about this, have you considered that, or could you explain why?' The council gives the teams a chance to further refine their strategies by sitting down with stakeholders to work out improvements."

Overall value: The council broadens perspective, fosters inclusive discussions and dialogs, and increases institutional awareness across departments before requesting senior leadership implementation approval.

AVANGRID Optimizes Charging

AVANGRID turned to mathematicians for its managed charging pilot in its NYSEG territory. In a partnership with Cornell University, the utility launched a plan to optimize usage of 35 Level 2 chargers in and around Ithaca, NY. **Customers enter information into a Web-based UI**, such as their desired battery charge level and their desired departure time. **A scheduling algorithm adjusts the power level and timing** to optimize charging and flatten the overall EV load.

When is the Best Time to Charge? Midnight

Midnight may be the witching hour, but for EV drivers in **Holy Cross Energy's** territory, there's nothing scary about it. **When EV customers ask, "When is the best time to charge?"** Chris Bilby will tell them to **plug in when the clock strikes twelve**. This is when the wind blows in HCE territory, and there is excess capacity on the system. Charging data shows that customers are following the recommendation.

When asked if midnight will still be the best time even when most customers have EVs, Bilby responded, **"I'm happy with the midnight charge. Having people turn stuff on in the middle of the night is fantastic – to load shape, to flatten out that that evening curve."**

AEP Determined the Value Opportunity for Residential Managed Charging

When **considering the value opportunity of managed charging, AEP** considers the cost to run the program and the cost (i.e., the incentive) to reward customers for participating. AEP also **prefers to allow for some value to achieve downward rate pressure so all customers benefit.** It does this by designing programs that utilize existing assets – like meters – and approaches that do not require billing system upgrades.

Result: AEP found the value opportunity for residential managed charging to be of significant value.

Holy Cross Energy Manages its Fleet of Home Chargers

Holy Cross Energy found early on that its *Charge at Home. Charge at Work.* members plug in for much longer than what is needed to fully charge. That gives the utility a considerable **window to manipulate the charging through its distribution flexibility credit program.** Members are typically allowed to charge whenever they want. **However, during peak events**, **HCE can decrease the charge as needed to avoid demand spikes** via API commands to the member's utility-provided smart charger.

The plan isn't to turn the charger off completely, but rather to throttle it back, using a strategy similar to those a fleet manager might employ. HCE's "fleet," in this case, is 250 home chargers. A grid operator can assign a limit and spread, for example, 200 KW across the whole system, and the chargers will proportionally curtail the power.

Dominion Energy Partners with School Districts to Explore V2G

Dominion Energy is helping 15 school districts in Virginia remove millions of pounds of GHG emissions from the air by electrifying their school buses. In early 2021, 50 buses with a 130-mile range were deployed among the districts, including one of the largest in the nation. The number of buses at each district ranges from two to ten, and they are integrated into the regular routes.

Photo Credit: Dominion Energy

Electric school buses offer an intriguing potential for bidirectional vehicle-to-grid charging, and exploring the possibility of using the batteries as resources will be one aspect of the project. Dominion is using DC fast chargers rather than Level 2 chargers because the standards for bidirectional charging are more established for DC fast charging to enable V2G.

While exploring V2G is an important element, student transportation is the number one priority. There may be certain routes or school districts where V2G doesn't make sense. In fact, Dominion has found **school districts want to maximize the use of the electric buses to take advantage of the operational cost savings compared to diesel.**

Photo Credit: Dominion Energy

Dominion uncovered several insights while developing the project. **Key among them is to engage with stakeholders**. Every district has its own policies and procedures, and the ultimate decision makers may sit in different departments or agencies. In some districts, it could be up the finance department, while others need the school board to sign off, and in others the transportation office might make the decision. And not all districts buy their buses, some lease them. Electrification Manager Kate Staples noted, "You can lose credibility if you say, 'When you buy this bus…' when they lease it or if they aren't the decision maker."

In Virginia, districts buy their buses through a dealership instead of directly from the manufacturer. **Staples and her team quickly realized the value dealership support brings to the project. Dealers have a wealth of information** about both electric buses and diesel models and were able to help with route planning as well as maintenance and first responder training.

Insights from Dominion: 1) Engage with key stakeholders within school districts. 2) Dealership support is invaluable given their wealth of knowledge about both bus types.

Burlington Electric Department on Managing Level 1 Charging

Installing a Level 2 charger in one's home can cost around a thousand dollars, more than some EV drivers want to spend. Unfortunately, **with only Level 1 charging, utilities can't offer those customers EV rates.** "The Level 1 smart charger has been a particular frustration of mine," says Burlington Electric Department General Manager Darren Springer. "There haven't really been any affordable solutions for it."

Many Level 2 chargers are Wi-Fi enabled, but that feature is rarely seen at Level 1. When it is, the accuracy is not up to the same standard. BED has been testing the use of a standard outlet as part of its goal to find a cost-effective solution for managing Level 1 charging so customers can benefit from the EV rate.

Resources

- Austin SHINES whitepapers, Austin Energy, https://austinenergy.com/ae/green-power/austin-shines/final-deliverable-reports;
- *EV360 Whitepaper: Austin Energy's Residential "Off Peak" Electric Vehicle Charging Subscription Pilot Approach, Findings, and Utility Toolkit*, Austin Energy, https://austinenergy.com/wcm/connect/b216f45c-0dea-4184-9e3a-6f5178dd5112/ResourcePlanningStudies-EV-Whitepaper.pdf?MOD=AJPERES&CVID=mQosOPJ
- *A Comprehensive Guide to Electric Vehicle Managed Charging*, Smart Electric Power Alliance, https://sepapower.org/resource/a-comprehensive-guide-to-electric-vehicle-managed-charging/
- Vehicle Grid Integration Working Group, Gridworks, https://gridworks.org/initiatives/vehicle-grid-integrationwg/.
- *Final Report of the California Joint Agencies Vehicle-Grid integration Working Group*, California Public Utilities Commission, https://gridworks.org/wp-content/uploads/2020/07/VGI-Working-Group-Final-Report-6.30.20.pdf
- *Guidelines for Selecting a Communications Protocol for Vehicle-Grid Integration*, Smart Electric Power Alliance, https://sepapower.org/resource/guidelines-for-selecting-a-communications-protocol-for-vehicle-grid-integration/

Powering the Future

A Range of Options

Customers have long built habits based on how they fuel their gasoline or diesel-powered cars and trucks. These habits will likely evolve and change. Businesses will develop new solutions in response. No one knows exactly what the future holds, but it's likely vehicle "fueling" will look very different from today's fueling experience. There will be similarities but there will be fundamental differences as well.

Electric vehicle charging has roots in residential and workplace charging – research and pilots have focused efforts here – but as battery and charging technology has improved, transportation electrification is becoming more interesting to more customers. It has the potential to meet a broader range of customer driving needs.

Conversations are now moving to other fueling models, including retail fueling, multifamily, travel plazas, and more. It is attracting new players to the market and upending the longstanding buyer-seller relationship. As is often the case with emerging markets, new business models are surfacing and past models will have to adapt. Collaborative, transparent, productive dialogues will be essential.

While a large percentage of charging will be done at home – though the final percentage is yet unknown – there will always be charging on the go, whether it's a destination, hub, or some other option. Transportation electrification offers exciting opportunities, but it will also bring change. Change is never easy but focusing on the positive and what's possible can lead to innovative solutions that meet driver needs.

> "Stay positive. Think of what's possible instead of the knee jerk reaction of 'no, that's not going to work here.' We need to hit the reset button and overcome legacy friction to move forward."
>
> John Thomas,
> TA Petro

WHAT WE HEARD

Public Charging

The buyer-seller relationship is fluid and elastic. Roles are adapting and changing. There won't likely be a uniform buyer-seller relationship like with gas or diesel fuel. The evolving relationship raises questions about who "owns" the customer experience. The answer will likely be different for different scenarios.

Drivers need assurances. When low on "fuel," customers need to know that a nearby station will work for their car. Multiple connector options, proprietary communications protocols, and unreliable stations may leave a driver stranded and unable to fuel.

Customers demand reliability. The reliability of chargers might not have been at the forefront of charger owners' minds, especially with tight profit margins and low customer adoptions. But for electric vehicles to take hold, reliability needs to be a top priority. Customers have to know a charger will work when they pull up. It may be time for utility grade reliability analysis for charging infrastructure.

> "A charger that doesn't 'fuel up' because of a mismatched connector, bad communications protocols, or need for repair negatively impacts the customer experience. Established networks need to prove reliability and inspire confidence within the local EV driver community"
>
> Rajiv Diwan,
> New York Power Authority

Inconsistent pricing can frustrate drivers. Drivers that pull up to a public charger might be shocked by the wide range of "fueling" prices they encounter. Gasoline prices are clearly visible with small price differentials from station to station, while charging prices can vary widely from one utility to another. Customers on long trips will have to fuel when the "tank" gets low, and few are likely to consult maps of utility service territories before they do.

Rideshare drivers can be good ambassadors. The rideshare market is enormous. Rideshare drivers average around ten times as many miles per day as the average driver. Their switch to electric could have a substantial impact on air quality. Combining that with the high visibility of their cars and their numerous passenger interactions make them good ambassadors for going electric.

Charging spaces and parking fees may go hand-in-hand. Space on public right-of-way is highly valuable and generally falls under the jurisdiction of local government agencies. Chargers in those locations typically take up a paid parking space. Seamlessly integrating parking fees into charging apps can reduce confusion and complexity for consumers.

Fees or reminders can help establish good charging habits. Getting drivers to move their vehicles when their session is done to allow access to others can be difficult. Options to motivate drivers include pricing structures based on time, assessing fees, and/or sending reminders.

A multiunit dwelling in San Diego gives drivers two hours of free charging. If the driver fails to move the vehicle after that, an additional fee begins to accrue. The penalty for failing to vacate the charger isn't large, but those few dollars can add up.

Different locations may require different signs. Signage is important but it's not one-size-fits-all. The signage for a grocery store needs to be different than the signage for a public right-of-way. Signs that say *EV Charging Only next to Pay to Park* can cause confusion. Boots on the ground can be helpful for understanding the location as well the how customers interpret signage.

A full charge might not be necessary. Vehicle battery charge rates slow as the battery reaches full charge. That means the time it takes to charge the last 20 percent could take as long as charging the first 80 percent. For drivers needing just enough charge to get home, that last 20 percent might not be worth the wait. Educating the public will take time.

Demand charges and fast charging might not be a good short-term fit. Some station owners insist rate reforms are necessary. Others are turning to on-site storage or other solutions to mitigate demand charges because of the variability from utility to utility and the spikey nature of fast charging.

Demand charges and the way they differ from one utility to another can be among the toughest challenges for public fast charging providers. For example, **Electrify America's** Matt Nelson noted that an electric bill for one Kentucky station resulted in an effective rate of $3.36/kWh when taking into account demand charges, the gas price equivalent of $23.91 per gallon. He also pointed out that the Colorado Public Utility Commission recently found that demand charges result in the annual cost to operate a DCFC station in one Colorado utility territory being 35 times higher than the cost in a neighboring service territory.

Batteries could offset the time variability of rates. Third party operators who install on-site storage to combat price fluctuations might be able to take advantage of rate variability through various pricing models. Charging batteries when rates are low and discharging them when rates are high can allow for more levelized prices for consumers.

Sequencing may be better for public charging. The challenges that public charging site owners face are maximizing utilization, keeping the load level, and avoiding peaks. Sequenced charging might be better suited than managed charging for some locations. Managed charging might be unfeasible for EV drivers stopping at a public station to quickly "refuel" and move on. Managed charging with DC fast charging will be use-case dependent and might be more suitable for fleets that have longer dwell times. Fleets can then "sequence" charging so the chargers are not drawing power simultaneously but one right after another.

Electrification projects will involve different agencies. Not all agencies that will have a role in the transition to electrified transportation understand utility operations and constraints. Therefore, they might be unaware of the impact of their decisions on grid reliability and resilience.

Vehicle charging along highways in rural communities pose funding challenges. In the long run, rural charging might serve both community and pass-through travelers, but in the short term, co-ops must justify their investments to their boards and members. With community EV penetrations at extremely low levels, that case is hard to make. This is magnified when considering that over-highway charging points are likely farther away from transmission or distribution assets. Charging infrastructure could be viewed as an economic development opportunity to bring EV owners, who currently tend to have higher-than-average incomes, to rural areas for tourism and business development.

> "There can and should be managed charging with DCFC, despite a common narrative that it isn't appropriate. Why wouldn't drivers want pricing options and the ability to save money by charging earlier or later, for a shorter or longer period, or elsewhere to save money, just as many shop around for the best deal on gas?"
>
> Erick Karlen, Greenlots

Interstate and intrastate corridors are gaining momentum. State agencies and regions are announcing initiatives, performing road mapping exercises, and signing memoranda of understanding. They are coming together to investigate and develop pathways to corridor charging for interstate and intrastate travel. Corridor charging will not depend on fast charging alone. Level 2 charges may be suitable – or preferable – for some locations.

Questions to Consider

- Who is responsible for the customer charging experience?
- What duty cycle on the on charger is feasible or reasonable while maintaining the quality of service needed?
- What approaches will influence the users' behavior such that public infrastructure is highly utilized?
- Will incorporating parking fees into public charging cause drivers to charge less because of the premium pricing?

Hub Charging

Charging hubs may lead to better customer experiences. Inconsistent charger reliability can lead to a bad customer experience. A single charger at a site represents a single point of failure.

Electricity complements a station owner's portfolio. Often station owners see electricity as a competing fuel rather than one that expands their fueling portfolio. Messaging electricity as an additional fuel option and a way to retain customers who decide to convert may increase station owner receptiveness.

> "Right now, if you get 10 cars charging per day, that would be good traffic. For context, conventional fuel has around 30-50 fuelings per hour."
>
> Paul Nichols, Shell

Vehicle charging isn't the only tough business models. Profit margins for vehicle charging are razor thin, but that's also true for traditional fueling. Wrapping in other businesses, like advertising and convenience stores, can help profitability. Charging, like gasoline fueling, can even be a loss leader to promote other products. Bringing in drivers to fuel – no matter their fuel choice – might result in purchases of higher margin products.

Hubs are charging sites with more than one charger, capable of serving more than one customer at a time. Gas stations are one type of hub, but for traditional fueling. Hubs can offer benefits for long-distance fueling locations, multiunit dwellings, underserved communities, rideshare, and fleet charging.

Reviewing long held assumptions may lead to more constructive conversations. Often experts in their field hold onto beliefs and assumptions they don't realize they have. In the face of disruptive change, letting go of preconceived notions can be a key to innovative, possibly out of the box, solutions.

Balance ambiance and space optimization. Vehicle charging can take longer than gasoline fueling. Offering a pleasant atmosphere that's enjoyable to frequent can draw customers in, such as lounges, quick-serve restaurants, or workstations.

Retailers are unsure when and where to invest. The fast-evolving technology and the uncertainty around customer preferences can make investment decisions risky. Business owners looking to install equipment are doing their best to determine where their investments will most readily pay off and how to design stations so expansion or upgrades have the fewest regret costs.

Surprises and delays are...well, surprising. Station owners reported unanticipated surprises such as the size of system losses, the timeframe for grid upgrades, and the amount of demand charges. These factors can lead station owners who installed equipment early on hesitate at the thought of dipping their toe in again. EV charging also requires compliance with ADA requirements, which can also create surprises for prospective owners, businesses, and contractors who are just getting started.

New technology requires new contractor competencies. From electric contractors that install equipment to third parties that assist in the day-to-day operations of a site, all will require new skill sets for installing vehicle charging at a site. Formal training for certified electricians, which can require an apprenticeship of eight years or more, will be needed to support anticipated growth, while additional EV electrician specialty certification programs are also evolving. For EV charging station owners, third-party certification of chargers and integrating billing into back-office software are two elements that are complicated to make work. National standards for the metering aspects of charging are also evolving and being integrated with state and local weights and measurement policies, which protect consumers.

Questions to Consider

- How can reluctant gas station owners be provided assurances?
- How can workforce shortages be addressed to meet accelerating demand?

Utilities need workers too. The acceleration to electricity as fuel will also leave utilities feeling a workforce crunch. Skilled utility workers are already in short supply and transportation electrification will drive even more jobs in this area. Utility line workers, metering technicians and grid design staff take years of apprenticeship program training. Utility commitments to hiring staff that can handle the growth depends on realistic market projections, which are now starting to materialize as EV adoption increases.

Emergency protocols need attention. First responders, like firemen and police officers, need to understand what this new technology means for them. They will need training on procedural differences between electric vehicles and gasoline or diesel engines.

Multiunit Dwellings

"Multifamily" isn't a homogenous term. Trying to concoct a single best approach for multiunit dwelling is unlikely to happen. Residents spans countless demographics, income levels, and geographical areas. And new construction can be very different than for buildings that have been standing for decades.

Finding a dedicated spot isn't easy. Charging requires somewhere for the car to park. Some building owners who lease out parking spaces are reluctant to give up a source of revenue because even unused spaces can be written off on taxes. While it may be easier to install charging at a complex without assigned spaces, limited parking areas are already a common contention for many residents.

Multifamily dwelling – (noun) A residential property that consists of separate units which house independent residents with some shared common spaces, such as parking areas. Different types of multifamily dwellings include apartment complexes, town houses, condominiums, or rowhouses. Also referred to as multifamily housing, multiunit dwelling, or multi-dwelling unit.

"Fairness" can be an issue for HOAs. Most HOAs operate with the intent that any construction or additions to the property must benefit every resident. If one townhouse owner gets a charger at his personal spot, it raises questions about equitable treatment of each resident, as well as what happens to the charger when the resident moves out.

Community chargers may make more sense than on-site charging. Multifamily charging can be tough. Each HOA has its own rules, parking might be at a premium, installation costs can be alarming, metering each spot is often unfeasible, and property owners may be unwilling to maintain the charger. Nearby community or hub charging may make more sense in the long run.

> "When we installed chargers at the San Diego Zoo, residents of surrounding multiunit dwellings would charge their vehicles overnight. It wound up being a service both to visitors during the day and nearby EV drivers at night."
>
> Lee Krevat,
> Krevat Energy Innovations

Move over pools, gyms, and in-unit washer-dryers. EV charging is becoming a highly desirable amenity for multiunit dwellings to offer residents. Amenities for apartments can have a domino effect: once one has it, others want it too.

Marketing campaigns require new contacts. Utilities looking to install charging at an apartment complex or other multiunit dwellings may not know where to begin. Existing relationships at the property are typically with the accounting office, not the property owners or other decision makers who would authorize charger installations. Individual marketing is essential to connect with the right person.

Resident push may move the needle. Some utilities have found more success marketing to residents than targeting property owners and developers. Tenants can grab the ear of managers more easily and their opinion carries more weight than a utility representative's suggestion that residents will want charging at some point in the future. This approach will likely be unsuccessful in low-income or affordable housing properties.

Offsetting HOA or board resistance may require ordinances or legislation. Some states have enacted legislation to overcome what some see as heavy-handed decisions by HOAs and condominium boards that prohibit a resident from installing an EV charger at their own expense.

Questions to Consider

- Will community rather than on-site charging be a more effective long-term approach?
- What is considered equitable treatment for residents wanting to install charging?

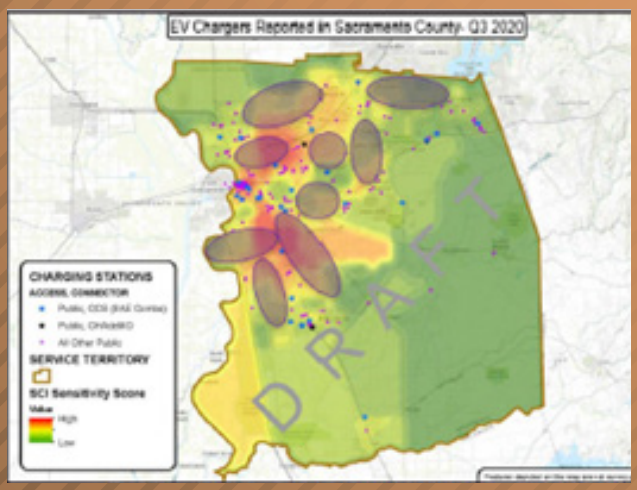
Underserved Communities

Low-income customers care about the environment too. A common misperception is that environmental concerns are for upper- and middle-class customers because low-income workers are too busy to worry – or to even be informed – about such subjects. In fact, they are keenly aware of them, often because their neighborhoods are disproportionately affected by air pollution and other effects of GHG emissions.

> "Equity has to be baked in from the beginning of a project."
>
> Terry Travis, EVNoire

Air quality is a major benefit. Many underserved communities are near ports, airports, and other locations where medium- and heavy-duty vehicles operate or sit idle. Electrifying those sectors is an opportunity to have a large impact. Efforts to reduce emissions such as electrifying public transit or offering EV car share programs can receive overwhelmingly positive responses.

Utilities have a critical role and responsibility related to accessibility and social equity. Utilities are mandated to serve all customers, not just areas where the economics make sense. This puts them in a unique position for providing charging in disadvantaged communities.



SMUD identified priority zones by overlaying its service territory map with socioeconomic conditions to create a "sustainable communities" heat map that shows the most impacted and under-resourced areas. This helped identify charging desserts and key areas to prioritize for charging installations to address equity and air quality needs. Now, one of the first things SMUD staff do when discussing a new project, is to look at the sustainability heat map to determine how a new facility will support the community.

Don't overlook grid modernization. The benefits of electric vehicles might be hard to achieve if aging infrastructure or lower voltage conductors limit the type and amount of charging the grid can accommodate. Many underserved communities have not had significant load growth, so they may not have seen the same grid upgrades as other areas. Access to broadband for chargers that use Wi-Fi-enabled technologies is another barrier.

Engage the community first and often. Collaborate with residents to gain an understanding about their attitudes, knowledge, and beliefs. Don't "parachute in" to deliver solutions devised in a conference room.

Don't have a singular focus. Start with understanding the real-life problems the community is trying to solve. Projects are more than a standard infrastructure project. Projects may need to include other aspects beyond EVs, such as workforce development, to help address inequities and community needs.

Messengers matter. Someone on the project team who has worked within the community is important for building trust and bridging communications. Projects will move at the speed of trust.

> "One of the very first things that people in the communities said was, 'Cars are interesting. But if you really want to help, we need jobs.' And if we can figure out how to turn these new technologies into jobs for people in our community, that would be the best thing."
>
> Bill Boyce, SMUD

Community-based organizations (CBOs) are valuable for project teams. It takes partnerships to get all the funding in line to support and execute the project. CBOs have developed relationships in the community. They can provide insights and connections and bring in workforce training elements.

Be culturally authentic. Underserved communities may have fewer associations with – and therefore less information about – electric vehicles. When reaching out, try to look through the eyes of community, try to walk in their shoes. Developing messaging and outreach programs that resonate with each community is critically important.

EVNOIRE ON DIVERSITY, EQUITY, AND INCLUSION

EVNoire emphasizes the importance of having diversity, equity, and inclusion at the core of transportation electrification programs. If it isn't, it can cause overarching problems and lead to unsuccessful outcomes. Terry Travis, Chief Disruptor and Managing Partner at EVNoire explains, "Our organization has experienced many instances where companies or organizations have reached out to our team after a program or pilot has been launched requesting that we, 'sprinkle equity on this project.' Our experience and best practices clearly illustrate that it doesn't work like that. It has to be well thought out and centered in from the beginning."

Education is more than explaining the technology. Telling someone about the benefits is not nearly as impactful as seeing EVs on the street, riding in one, or knowing someone who owns one. Hands on experience and EVs driving around can increase familiarity and reduce apprehension about the technology. Rideshare and car share programs or converting fleets for organizations that work in the community can increase awareness and help demystify the vehicles.

Lower cost options are important. For EVs to become mainstream, they can't only be luxury items. Programs that provide rebates are only beneficial if the people who qualify for them, know they exist, and realize that EVs are even an option. One suggested strategy was for OEMs to make formerly leased models available in the community when leases expire.

> "When people talk about $1500 rebates on an EV... well, for low-income workers, an affordable car might *cost* $1500."
>
> Susan Buchan, E4TheFuture

Bureaucratic paperwork and delays can break a budget. The paperwork required for incentives and rebates can be cumbersome and time consuming. It may require language and reading skills that customers don't have. Furthermore, rebates can take a long time to process – time that someone on a fixed budget might not have. Whether or not the rebate was received that month may be the deciding factor on whether a customer can pay rent.

Explore other options. In some underserved communities, rideshare is a more viable option than EV ownership. Some utilities, when they were exploring infrastructure needs, found that even rideshare was beyond some community members' reach. One participant reported that for residents in one community, who were unbanked with no internet, an e-bike program was more helpful. Other e-transit options include electric buses, trollies, and light rail.

Change the vantage point away from privileged mobility. Currently, those who have access to financial capital are the ones able to benefit from electric vehicles at multiple levels. Early adopters have set many policies and procedures into motion for how EVs "should" be handled. It's time to consider a future where all customers can benefit.

Questions to Consider

- What are the community's needs?
- What role can transportation electrification play to solve those needs?
- Who are trusted community partners?
- Would vehicle chargers increase adoptions or would another solution be more effective?

Use data to direct decisions. Data-driven research and analysis can facilitate infrastructure deployment, education and outreach, vehicle utilization, and the effectiveness of rebates and incentives. Follow up and monitoring needs to include metrics that evaluate the impacts, successes, and where improvement can be made.

Insurance costs for car sharing can end a program before it starts. Insuring a vehicle that's part of a car sharing program can be prohibitive and kill the business case for car sharing. Legislation and regulation can influence rates.

In Massachusetts, E4TheFuture reported that legislation helped bring down insurance costs (which were originally around $25,000 per year) for projects focused on low-income and underserved communities. Because such businesses often rely on grant funding to get off the ground, high rates can prevent them from ever being green lighted.

Electrifying Buses

Electric buses provide a visible example. Electric buses are the most common representation of EV technology and serve as a gateway for many people's first experience riding in electrified transportation. Utility fleets also serve as ambassadors to the public.

School bus schedules make them a prime candidate for V2G. School buses often don't travel great distances and tend to have long breaks between morning and afternoon runs. Pilot programs that allow engineers to demonstrate the capabilities and the benefits of providing grid services could then serve as examples for other use cases. Their large battery sizes might also provide opportunities as backup power sources for local communities.

Grant funding is great but projects have to get metal in the ground. Agencies will need turnkey consulting support to help understand the different facets for upgrading depots, selecting vehicle model types, and integrating the electric buses into routes. Because electrical capacity is an enormous aspect of the project, a letter of support from the utility in the grant application can go a long way.

Austin Energy is working closely with its local public transit, **Capital Metro**, on charging infrastructure and deployment for a goal of 100% electrification. In addition to cost and emissions savings, surveys demonstrate a better customer experience riding an electric bus, citing improvements in noise, heat, and smell over diesel buses.

Employees need workforce and safety training. Converting buses will require competencies with high voltage systems. Transit agencies will need to train workers on safety protocols and hire electricians or contractors with the knowledge to maintain, operate, and repair these new systems.

Planning for and integrating electric buses is not quite standard operating procedure. Transit agencies recognize the value of electric buses for their customers and communities. Agencies must determine charging structures that fit their operations, develop commissioning documents to ensure the buses and chargers work together, and specify communications protocols between the utility and other partners.

Location can make all the difference. Working with the utility to find excess capacity on the system is essential since infrastructure investments to support high-power charging at a location might be more expensive than moving to a new one.

Satellite bus barns can add flexibility. Battery range will deteriorate in cold weather and over the life of the vehicle. Adding satellite charging can help mitigate issues. Good locations might be where multiple routes meet or where drivers typically take scheduled breaks.

Questions to Consider

- What support will transit agencies and schools need to convert their bus fleets?
- What are the considerations for integrating electric buses into operations?

Megawatt Charging

The trucking industry senses change. Travel centers and fueling providers acknowledge the need to transition to next generation fuels. Major travel center companies are aggressively pursuing plans to install electric charging at their sites, as well as exploring other alternative fuels.

Companies are keeping a watchful eye. Heavy-duty trucks can't use the same chargers already installed for light-duty cars because the plugs won't fit, and there's no consensus on what plugs they can use. Issues of complexity and incompatibility leave many trucking companies waiting for a single industry standard to emerge.

FUN FACT

Trucks typically leave the terminal around 4:30 or 5:00 a.m. to beat morning traffic and return back to base around 3:00 or 4:00 p.m.

Fill-up times need to be equivalent to current fueling times. For commercial vehicles, time is money. Trucks have to be back on the road as quickly as possible after fueling. Longer charging sessions may not fit operational logistics, but they might be acceptable for some instances, such as during driver rest times.

MAGNITUDE OF HEAVY-DUTY TRUCK TRAVEL MARKET

- 15.5 million registered Class 3-8 trucks in USA
- 2 million Class 8 Trucks
- 6,000 truck stops in US. A few large firms owning 28% with rest owned by a fragmented market
- ~39 billion gallons of diesel are sold to the trucking industry in America each year
- Typical site refueling traffic pattern shows peak from 4-7pm

Source: TravelCenters of America

Unavailability of trucks and chargers create a conundrum. Electrifying trucking needs both infrastructure to be in place and truck models to be available. A truck without a charger is immobile and a charger without a truck to power serves no purpose. Both investments are necessary to advance the marketplace.

Permitting can be sluggish in the best of circumstances. Site enhancements to transformers, switch gear, or other hardware can be daunting, even when everything is in order and everyone is supportive. One travel center received a grant to add electric vehicle chargers to a site, but found some of the requirements and paperwork could take between nine to 12 months for approval.

Public-private partnerships can help offset enormous investments. No entity, public or private, can finance the macro shift to electrification alone. The current nationwide petroleum infrastructure to supply and distribute fuel was built using investments from the past 100 years. Electrifying transportation in a matter of decades will demand similarly significant financing.

Companies need a way to fast track new technologies. There is a lot of conversation about 500 kilowatt and even one megawatt chargers that are under development. Challenges remain, but if proven, manufacturers will want to fast track the approval for the technologies. However, certification of the technology might not be ready. Some utility-qualified equipment lists stop at 250 or 450 kilowatts.

Questions to Consider

- How can new technologies be fast tracked?
- How can standardization efforts be accelerated?

Skepticism regarding the utility role persists with commercial entities. Utilities have a role to play in advancing the market as it emerges but there are concerns about the specifics of that role and how it will evolve as the market matures. Travel centers, as a distributed entity, will need to participate in the monetization of the electricity that is generated, shared, and stored. Electricity arbitrage will become commonplace.

The West Coast Clean Transit Corridor Initiative identified sites along I-5 from the southern border of California to the northern border of Washington that are good candidates for medium- and heavy-duty vehicle charging. The project looked at available land, current truck stops, and locations where truck stops could be sited. Most importantly, it targeted areas where the grid can support charging and where infrastructure is needed.

EXPERIENCES FROM THE FIELD

BGE on Multifamily Program Challenges

To promote charging at multifamily housing, BGE initially offered rebates to property owners who want to install chargers. The rebate covered 50% of the cost of equipment and installation for eligible Level 2 and DC Fast Chargers up to $25,000 ($5000 per L2, $15,000 per DCFC). Applicants needed to agree to share charging data with the utility and the rebates could only be applied to new installations of equipment purchased after June 2019.

Response to that program was underwhelming to say the least. The total number of applications received represented roughly 2% of the available rebates (15 applications for 700 rebates). BGE's challenges in rolling out the program are representative of the difficulties others in industry have faced or are facing. **Many owners couldn't afford to pay upfront for the charging equipment and then wait for a rebate.** There were also questions about who would be billed for the electricity and how. Limited and/or assigned parking complicated where the stations could be located. And lastly, the utility was limited to contacting developers one at a time.

Building on what they learned, BGE requested and received approval from the Maryland Public Service commission for an own-and-operate model. This gives owners a second option. **BGE will own, operate, and maintain the dual-port chargers branded with BGE and EVsmart® with no cost to the site host.** Drivers pay 18 cents per kilowatt hour to charge with the station metered separately from the rest of the property.

RS Automotive has the First All Electric Service Station

In 2019, **RS Automotive in Tacoma Park, MD became the first gas station in the United States to convert to all-electric service.** The project, a partnership with the Governor's Office of the State of Maryland, the Maryland Energy Administration (MEA), and the Electric Vehicle Institute (EVI), took about a year and serves as an example of the value of public-private partnerships in electrifying transportation.

Tanks had to be removed from underground, and then electrical infrastructure was installed with effort made to reuse or repurpose as much as possible. That included some conduit, the awnings that covered the old station, and the concrete mounts where the pumps used to stand. The chargers themselves were placed in nearly the same positions as the pumps that were removed.

The station boasts a 200-kilowatt power cabinet that feeds four chargers, but the equipment is all modular, which helps to future-proof the set up. Currently, most EVs can't charge at higher than 50 kilowatts, but upgrading in the future will be relatively easy. Each station is capable of providing the full 200 kilowatts that are normally divided among the four, and adding more power cabinets if needed is another adaptation that can be done without too much trouble.

The station also built a lounge for drivers to sit and watch TV or use the internet in the air conditioning in the summer or the heat in the winter. Drivers can monitor their car's charge status from the lounge as well without needing to keep going outside to check.

Insight: While the design has gotten attention, it's unlikely most gas stations will undergo a similar complete transformation. Bolt-on EV charging, the addition of chargers to a site with existing gas and diesel pumps, is more likely to be the norm, with incremental steps to phase out fossil fuel and replace them with EV chargers.

Austin Energy on Why Charging for Time Makes Sense

When **Austin Energy** decided how to charge for public DC fast charging – by the hour or by the kilowatt hour, time versus power – it looked at the big picture. "**Per minute aligns better with traditional cost-recovery methods** as you are trying to recover the $100,000 per port asset depreciation, not necessarily the eight cents or so per kWh," Karl Popham suggested. "Just as important, **we think per-minute provides an overall better positive customer experience by maximizing station availability.** We want to make sure we encourage people to plug-in and quickly plug-out to avoid customer wait times."

Thus, the utility went with a per-minute pricing plan, this encourages drivers to typically park in a DC fast charging stall for less than 20 minutes. Because of EV charging protocols, EVs slow down their connected fast charger (75-250kW) significantly (6kW) once reaching 80% charge in order to protect EV battery packs. **Without per minute pricing, customers typically occupy charging stations longer**, about 45 minutes versus a 20 minute per session on average.

Southern California Edison's Multifamily Charging Program

To encourage multifamily properties to provide EV charging, Southern California Edison (SCE) offers property owners and operators three different Charge Ready programs**.** The programs fund the design and installation of the electrical infrastructure on the utility-side of the meter. Participants then have two options for the customer-side infrastructure: SCE can perform the work at no additional cost (referred to as the customer-side make-ready) or customers can do the work themselves. If they choose the latter, they can qualify to receive a rebate for up to 80% of the estimated costs that SCE would have incurred for performing the work.

To qualify, multifamily property owners must sign up for a time-of-use rate plan and enroll in a qualifying demand response program. They have to install four or more Level 1 or Level 2 EV charging stations (selected from the utility's approved product list) with a separate, dedicated meter to measure EV charging load, and share pricing information with SCE. The charging equipment also needs to have network service to share usage data with SCE.

Shell has its Eye on the Future

There are many variables in the EV charging game, so standardizing as much as possible can help reduce some of the unknowns. Shell has embraced the transition from fossil fuels to electricity for powering vehicles and is developing and testing EV hubs.

"The design piece is fairly straightforward, but every site is very different," said Paul Nichols. "There are space challenges, the way customers use the site, and **one of the biggest challenges for us has been how to take existing businesses that are doing well and integrate in a new business**." The best approach, Shell has found, is building safe, robust, resilient, reliable sites with the **goal of making EV drivers' lives and simple as possible.**

Good2Go's Car Sharing Program Supports Underserved Communities

No matter how robust a city's public transit system, there are times when a bus or a train cannot match the convenience of having one's own vehicle. "It can be a vicious cycle for low-income families, especially if you don't have good credit and can't get a loan," explained Susan Buchan, Director of Energy Projects for E4TheFuture. "You have to grab whatever clunker you can afford, and those keep you poor because you spend so much to maintain and repair them, plus they're probably gas guzzlers."

E4TheFuture, with funding from the Massachusetts Clean Energy Center, is behind Good2Go, a Boston-based all-electric car sharing service that develops operational hubs in low-income neighborhoods, including some in the parking lots of affordable housing complexes. For a fee, drivers can rent a vehicle. With a standard rate of $10 an hour, the price is competitive with other car shares, especially since Good2Go charges no monthly fee. **Drivers on any type of government assistance can rent an EV for half price,** $5 per hour.

The program requires drivers to join as members to use the cars. **While the membership carries no fees, it does require drivers to attend an information and orientation session. This provides an important education component and helps drivers realize an EV isn't that different to drive.**

Because many of the neighborhoods served are known as food deserts, a common use of the cars is to drive to suburban supermarkets, though they serve many purposes. Other uses are for work or school. "One of our first super-users was a nursing student who needed to got to trainings three times a week," recalled Buchan. "The bus wouldn't get her there in any reasonable amount of time, and she couldn't afford to buy her own car so she signed up for Good2Go. Now she's a certified nurse's aide."

Providing Education to Low Income Families Using an Electric Bus

Magic Bus provides early childcare and pre-kindergarten education to low-income children in and around Vail, Colorado. In fall 2020, the Vail Valley Foundation's **YouthPower365 added an all-electric Winnebago to its Magic Bus fleet.** The vehicle, which will be traveling to neighborhoods throughout Eagle County, delivers up to 100 miles on a full charge. **The nonprofit projected that the bus would save it up to 85% in operation and maintenance costs over its gas-powered counterpart.**

Adopt a Charger Program Helps Expand Charging

Adopt a Charger is a nonprofit organization aiming to accelerate widespread adoption of plug-in vehicles through the proliferation of public, fee-free electric car chargers, particularly in areas where low EV penetration makes charging difficult to commercialize. "The stations that we install in Kentucky, Arkansas, and Indiana are equally important to the ones that we installed at the Getty Center in Los Angeles," noted executive director Kitty Adams.

Corporations, organizations, or individuals can donate funds to install and maintain a charger at a "destination" location such as a zoo, beach, or museum. Such locations tend to be places that don't have the budget to install EV charging on their own, but can be lynchpins in a network to support zero emissions driving. As an example, Adams cited a charger at Gus Hess Community Park in Lee Vining, California (shown to the right), which is crucial for EVs in the Eastern Sierra, and enables zero emission travel to the Eastern entrance to Yosemite and Tuolumne Meadows.

SMUD's EV Community-Based eMobility Del Paso Project Support

Addressing issues of equity and environmental justice takes more than dropping some EV chargers in a disadvantaged community. When SMUD started supporting the Del Paso Heights eMobility Hub project, the most important lesson was to listen to communities and work with other agencies, community-based organizations, and partners to find the funding and get the support to create a successful project. **Too often, projects aimed at helping those in need ignore the communities themselves in favor of what's easy or avoiding risk.**

EVs offer relief from pollution that disproportionately affects low-income neighborhoods, but utilities have a chance to provide more by letting community leaders call the shots and develop the projects. SMUD worked with several CBOs, but its primary partner was GreenTech, a nonprofit that gives young adults technical training in electronics, coding, and agriculture, but didn't have any infrastructure experience. The project provided that workforce-building element SMUD was looking for to help build awareness around EV's and EV charging infrastructure development as job creation opportunities.

Talking to community members, it was clear that electric chargers wouldn't be enough. That put a focus on making Del Paso an asset beyond its charging capabilities. **The site design evolved into a mini-park with green spaces to gather.** Plans to make it a regular site for community service events, a regular stop for an electric bookmobile, and a site for other transportation options took shape as the project progressed.

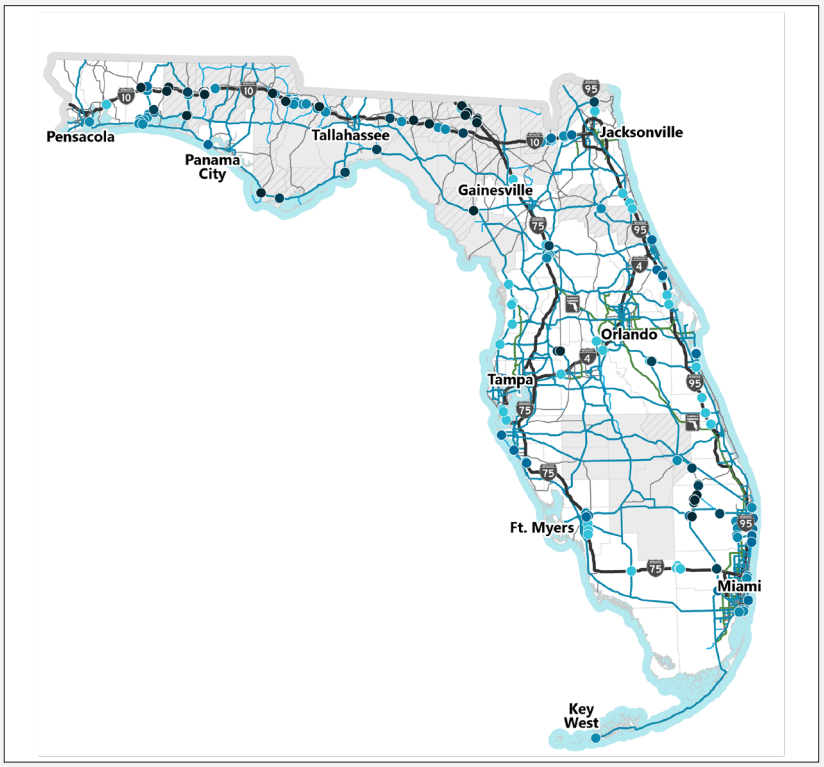
The heart of the project is still charging stations, but EV charging has little value to people without electric vehicles. This is why SMUD, working with other partners, **has also focused on getting electric vehicles in the form of electric shuttle vans and cars to the site to help build awareness on EV's in the community.** The charging stations have also opened the opportunity for electric car sharing to operate in the neighborhood providing more transportation options.

Florida DOT Has a Master Plan

Florida's legislature has been proactive in its support of the transition to electric vehicles. Lawmakers passed Florida Statute 339.287, which requires the Florida Department of Transportation (FDOT) to coordinate, develop and recommend a for the development of electric vehicle (EV) charging station infrastructure along the State Highway System (SHS). **The FDOT**, in consultation with the Florida Department of Environmental Protection, the Florida Public Service Commission and other state agencies, **developed the EVMP with extensive public engagement.**

The development of the plan focused on four key areas: the impact of charging stations on the grid, policy outreach and education, projecting potential revenue shortages to the state transportation fund, and analyzing GIS maps to identify potential station locations. Prime locations for charging stations were chosen using weighted criteria, the most important of which was intersection proximity, finding spaces that were within a one-, five-, or ten-minute drive of SHS intersections. The other criteria, which each were weighted equally in the decision-making process, were traffic volume, proximity to other EVSEs, and whether the roadway was designated as an evacuation route.

The plan looked at major corridors like interstate highways and U.S. routes, as most states do. **The difference from many other states' planning is that those corridors are often evacuation routes for Floridians.** Resiliency of the charging sites along these routes is critical, so FDOT wants to support a variety of technology options, such as battery storage and backup generation technology or mobile charging semi-trucks, to make sure EVs able to charge even in the worst cases.



The regulatory structure of the plan calls for electric utilities and third-party owners to be involved in the charging station marketplace with a focus on flexibility to adopt different business models. With those suggestions in place, attention shifted toward implementation, which was organized around four initiatives: Adapt, Facilitate, Educate, and Coordinate. The FDOT submitted the final plan to the Governor's office in July 2021.

Utilities Collaborate on Electric Highway Coalition

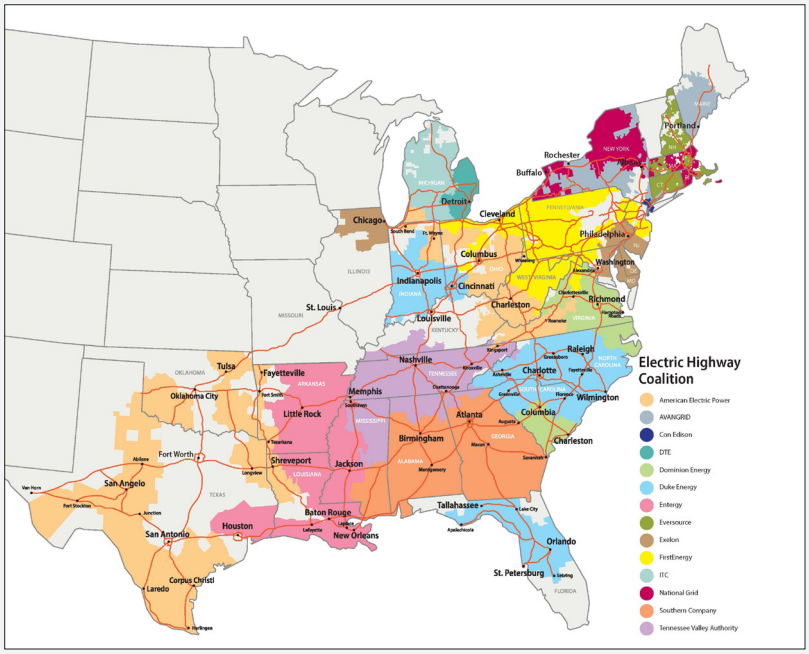
Range or fuel anxiety is possibly the biggest barrier between many potential EV drivers and purchasing an electric vehicle. Drivers want to be confident that they can get where they are going. While that's rarely a concern for local commuting or errands, the perceived limitations of travel distances and fears of being stranded on a lonely highway with nowhere to charge can be enough to keep some from pulling the trigger on an EV purchase. In March 2021, six utilities announced a plan they hope will alter those perceptions and ease some of those fears.

The Electric Highway Coalition is committed to the development of a network of DC fast charging stations on major highway systems along the Atlantic Coast, through the Midwest, into the South, around the Gulf, and across the Central Plains. The coalition has more than doubled in size since the initial announcement. Eight more utilities have joined, each committed to providing more EV charging solutions in their own territories, which will reassure customers in other territories that long-distance EV travel can be done effectively with convenient charging options far from home.

"The coalition isn't a separate organization doing this on behalf of the utilities," AEP's Jeff Lehman explained. "It's a collaboration where each individual utility is pursuing deployments in their own footprint. We work together on planning, which is a big part of the value that we see." Participating utilities are also leading by example. AEP has committed to transitioning about 40% of its total fleet, including 100% of its light duty vehicles to electric by 2030. The Electric Highway Coalition network will also support the member utilities' fleets as they're deployed.

"By working with other utilities, we are learning lessons on the best methods to deploy the technology and how to navigate the regulatory environment," said Scott Barrios, Manager of Electric Mobility Sales and Partnerships. "It also allows us to use our resources efficiently as we analyze the interstate corridors in our territories."

Utilities taking part at the time of this report's publishing were: American Electric Power, Dominion Energy, Duke Energy, Entergy Corporation, Southern Co., the Tennessee Valley Authority, Consolidated Edison, DTE Energy, Eversource Energy, Exelon, FirstEnergy Corp., ITC Holdings Corp., National Grid, and AVANGRID. Together the 14 members serve more than 60 million customers across 29 states and DC. The Electric Highway Coalition continues to recruit to other utilities interested in helping extend the network's reach.



Resources

- *NATSO Outlines Principles for Advancing Alternative Fuels in the Market*, National Association of Truck Stop Owners, https://www.natso.com/topics/natso-outlines-principles-for-advancing-alternative-fuels-in-the-market
- CharIN – Empowering the next level of e-mobility, CharIN, https://www.charin.global/
- West Coast Clean Transit, https://www.westcoastcleantransit.com/
- Edward J. Klock-McCook, Shenshen Li, Ross McLane, Dave Mullaney, and John Schroeder, *EV Charging For All: How Electrifying Ridehailing Can Spur Investment in a More Equitable EV Charging Network*, Rocky Mountain Institute, https://rmi.org/insight/EV-charging-for-all/
- Michigan-to-Montana program funded by a grant from utilities along the route https://southshorecleancities.org/wp-content/uploads/2018/02/M2M-Flyer-Indiana-UPDATED-04.30.20.pdf
- State Zero-Emission Vehicle Programs: Memorandum of Understanding, Northeast States for Coordinated Air Use Management, https://www.nescaum.org/documents/zev-mou-10-governors-signed-20191120.pdf/
- *Electric Vehicle Roadmap for Connecticut*, Connecticut Department of Energy and Environmental Protection, http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/f7ed4932eec438d0852585520001c81b/$FILE/EV%20Roadmap%20for%20Connecticut.pdf
- *Installing and Operating Public Electric Vehicle Charging Infrastructure*, Fuels Institute, https://www.fuelsinstitute.org/Research/Reports/Installing-and-Operating-Public-Electric-Vehicle-C
- *Colorado PUC Electric Vehicle Working Group Report*, Colorado Public Utilities Commission, https://evcharging.enelx.com/images/azura-pages/utilities/2019-01_CoPUC_Electric_Vehicle_Report.pdf
- *EV Infrastructure Master Plan*, Florida Department of Transportation, https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/fto/fdotevmp.pdf?sfvrsn=2bf9e672_4
- Charge Ready Opportunities for Multi-Family Property Owners and Operators, Southern California Edison, https://www.sce.com/evbusiness/chargeready/multifamily
- Electric Vehicles, Baltimore Gas and Electric Company, https://www.bge.com/SmartEnergy/InnovationTechnology/Pages/ElectricVehicles.aspx
- *Electric Highway Coalition Grows to 14 Members, More Than Doubling Participation*, American Electric Power, July 26, 2021, https://www.aep.com/news/releases/read/7190

Electrifying Fleets

A Challenge of a Different Magnitude

Both the utility and trucking industries operate differently from other commercial businesses. Utilities operate under unique regulatory environments, have well-defined service territories and a myriad of operating structures. Fleets have complex schedules and logistics that operate nationwide and internationally. Both businesses can be incomprehensible to outsiders.

> "Historically, our commercial customers have been office buildings and industrial sites. We understand their energy footprint and have demand certainty. But the energy footprint and load profile of their fleet is a whole new ball game. We're looking forward to the opportunity to serve them."
>
> Sarah Olexsak,
> Duquesne Light Company

With all that has been said about utilities' new and changing relationships and the impacts of transportation electrification on the grid, the most notable examples of both may be fleets. Until now, the two have had little interaction outside of fleets needing power for facility operations, which can often be only a few hundred kilowatts. As fleets convert to electric, however, utilities will become essential partners. And for fleets covering distances outside regional deliveries, it will mean dozens, even hundreds of new partnerships. Fleets and utilities will have to work together to determine feasible rates, where to locate chargers, and how charging integrates with fleet operations.

Some fleet managers may see electrification as an added layer of complexity, but once the business case makes sense – not just environmentally but economically – the conversion to electrification can be expected to be fast and furious. Together, fleets and utilities must be proactive in reaching out to discuss plans, needs, and constraints to make sure the infrastructure is in place when needed.

WHAT WE HEARD

The Fleet Utility-Connection

Megawatt charging is coming. Planning for the future is a utility's strength, and fleet electrification is the future. Utilities that wait for electric trucks to show up in their territory before they begin planning will be too late. Adding infrastructure and building substations take time. A large distribution company like UPS electrifying a single depot can have a bigger impact than a 20% penetration of light-duty passenger vehicles.

It is a business decision above all else. Carbon footprints and sustainability goals can be important factors, but the final decision to electrify depends on the bottom line. Unfortunately, total cost of ownership is difficult to calculate. Vehicle attributes and constraints are known, but fuel costs include numerous variables and unknowns.

Fleet electrification will come in waves. Though electrification is expected to come quickly, it won't happen all at once. Once one fleet demonstrates the viability of the business case, other fleets will follow as rapidly as truck availability allows. Medium-duty trucking operating in hub and spoke models will transition more quickly than heavy-duty long-haul trucking.

Each fleet is unique. Fleets come in all different shapes and sizes. They can range from multi-national companies that deliver products nationwide to small business owners with a couple trucks in a gravel lot. Their end objective may be the same – serve customers and increase profits – but how each fleet accomplishes it will differ. Fleets need rates and programs that reflect their specific requirements and operational environment.

> "Every fleet is a snowflake!"
>
> Sila Kiliccote, elQ Mobility

Know who is in your backyard. Undertaking an effort to identify fleets in the utility's territory before they show an interest in electrification will help with short-and long-term planning. This isn't an easy nor quick task though. **Oncor's** effort to identify all the fleets in its territory took more than a year.

> "There are over 3000 utility companies in the country. And a lot of them probably aren't up to speed on trucks yet."
>
> Dave Schaller, NACFE

Start build relationships now. Utilities need to proactively engage with fleets, and fleets need to talk to their utilities. Currently, most fleet owners are practically invisible to utilities, but they are set to become key accounts in the near future. Building relationships will put the utility in a better position to serve fleets as they go electric and give them more insight into the work being done to support their desire to convert.

State trucking associations can help. There's no easy way to look up and determine what truck fleets are in a utility's service territory, much less anticipate their power requirements. Fleet managers are accustomed to dealing with only a handful of fuel providers that they have built relationships with over many years. Joining a trucking association can facilitate face-to-face conversations and provide insight into the world of fleet customers.

Utility industry fragmentation poses challenges. A key hurdle for national fleets is the sheer number of utilities across the country, each with different processes, rates, timelines, and regulations. For gas or diesel, national fleets typically deal with a corporate supplier, consolidating logistics and decision making. Electrification will require communication and collaboration with hundreds of utilities.

Make finding the right person easy. Often, when fleets "do the right thing" and try to include a utility in their electrification plans early, they find themselves unsure of *how* to do that. Many wind up calling a 1-800 number and talking to a customer service representative, who then transfers them to the individual who manages the *utility's* fleet! Publishing contact information on the utility website and making sure call centers are aware of transportation electrification initiatives are essential steps.

Provide clear and simple guidance. Transparent rates and interconnection procedures can make the process to convert more "fleet friendly." Employees – or a multidisciplinary team – who are well prepared with an understanding of fleet needs, who speak the fleet's language, and who understand utility operations will make initial conversations more productive.

A fleet manager's experience and knowledge will differ from a facility manager's. Past interactions with fleet companies were probably through a facility manager or other administrator rather than the fleet operator. Facility managers are more likely to have a construction background and more familiarity with infrastructure projects. It will be a whole new world for fleet managers, who will likely need education, patience, and an entirely new type of customer service support. They'll need help understanding rates, demand charges, and the many variables the new fuel source will bring.

> "There is a need for customer education on what the utility's role is and the importance of beginning the conversation as early as possible. Education seminars can be helpful."
>
> Randy Boys, Oncor

Fleets need structured rate programs. Rates are a big component in managing a fleet's energy costs. A rate that works for one fleet, might not work for others. Fleets have different duty cycles and are looking for more customizable rates. This is contrary, however, to how electricity rates are traditionally structured. Regulators generally frown upon individualized rates for specific customers.

Don't hide rates. Machine readable rates can be immeasurably more useful than rates tucked away in tariff books somewhere on the utility's website in PDF format.

Not all fleets are ready to talk about electrification. Oncor found several customers didn't want to talk about electrification plans. In many cases, small fleets in the territory were owned by companies in other parts of the country that have roll up strategies. Managers were unable to look into EVs until the owner made the decision to move forward based on dealers having suitable, cost-competitive vehicles readily available.

Flexibility and resilience are major priorities. Fleet operators will require low cost, high reliability, and resilience in the energy supply. Trucks only make money when they are on the road, and 2020 highlighted the importance of adaptable, nimble operations. A lack of charge due to an outage or grid service requirements will cost fleets precious time and money. The ability to store and even generate electricity on-site may be not only desirable but necessary.

Questions to Consider

- How can the close communication that is taking place with initial fleet conversions be maintained as the fleet market begins to scale?
- How can fleets work through the maze of different utility rates, processes, and regulations to scale more quickly?

The Decision to Convert

Start the dialog with utilities early. A natural tendency for truck fleets will be to start the electrification process by picking their vehicles at a truck show. Instead, step one should be talking to the utility (or utilities) that serve their region of operation.

Infrastructure needs to be in place. Currently, fleets know they can send a vehicle anywhere in the nation, and be able to fill its tank. The same is not true for electric vehicles and trucks. Anticipating the magnitude of their electrical needs and the infrastructure necessary to generate and deliver that power, may be puzzling or even unfathomable to fleets. Early discussions can inform and set realistic expectations.

> "If we can bring a solution that is economical, it's efficient, it makes a lot of sense to our clients, then they can focus on what they do best, which is making and delivering products to their customers."
>
> Sean Gouda, DTE Energy

A vehicle deployment plan can facilitate the process. Utilities need specifics, not just total energy requirements. A plan that specifies the number of vehicles, when the vehicles will charge, at what power level, and for how long will give utilities the information they need to design the infrastructure and recommend programs that meet the fleet's needs and operational constraints.

Timing is everything. There is a mismatch between the process timeline for infrastructure upgrades and the timing for fleet conversion decisions. "Rapid" deployment could mean 18-36 months to a utility, while most commercial businesses would rarely call anything that takes more than a month "rapid." Leases add an additional complication. Grid investments that take 15 years to recoup may not work for a business with a ten-year lease.

Clustering can add a lot of load. Current fleet depot electrical loads are relatively low (e.g., 100-250 kW for lighting, computers, and maybe air conditioning), so a utility will connect multiple facilities to the same transformer. If a single fleet decides to electrify, it could mean a load increase of as much as nine megawatts or more overnight. This definitely means a new transformer, maybe even a new substation.

First movers may have advantages. Fleets that are first to electrify will be able to utilize excess capacity on the system, shortening timelines and reducing costs. Some fleets have identified this as a strategic opportunity. Early conversations allow utilities to integrate fleet plans into their long-term forecasts and planning processes. Line extension allowances may allow utilities to plan for building capacity at the needed points on the grid to support further fleet electrification.

What's possible is changing quickly. Utilities are governed by regulators and boards that approve rates and funding for infrastructure investments. The current environment for transportation electrification is changing quickly. California's Assembly Bill No. 841, signed in September 2020, allows rate basing of vehicle charging infrastructure.

FedEx Express sees value in an early adopter/fast follower strategy. The company understands that upgrades may be smaller because they can use available excess capacity. It also supports faster implementation rather than having to wait for utility upgrades.

It's still an emerging market. While electric vehicles are not new, the technology is still evolving. This means that it might not work perfectly or as expected right out of the gate. Supporting technology or alternative practices may emerge to handle issues that weren't considered or weren't apparent in early stages.

Scaling from pilot to an all-electric fleet is not linear. Pilots provide information on a vehicle; they aren't necessarily meaningful for what it will mean to integrate electric vehicles into full-scale operations. Complexities that come into play at scale likely won't show up in a pilot.

Fleets need programs, not just pilots. Pilots are good early on for providing valuable information, but national fleets looking to scale operations often find themselves having to start over with each new utility. This slows the scaling up process to a crawl, raising questions of what can be done to improve that timeline by sharing and operationalizing pilot results more broadly.

National fleets need a standard, defined process to scale with any speed. Differences across jurisdictions, varying rates and procedures at different utilities create barriers for national fleets to electrify on a grand scale. Fleet managers agreed that, while it might be a tall order, standardization of documents, procedures, and rate structures would make infrastructure implementation more routine and allow scaling to happen more quickly.

Questions to Consider

- How can processes be streamlined to better assist fleet electrification?
- How can industry move beyond pilots?

CHALLENGES FOR FLEETS

- Calculating total cost of ownership
- Navigating the large number of utilities across the country
- Understanding the many interconnection processes
- Locating the right person at the utility to talk to
- Scaling from pilots to full scall operations
- Obtaining rates that meet their specific needs
- Establishing timelines that meet operational needs

Managing Energy

Energy management will factor into logistics. Currently, energy management is solely about the facility – lights, computers, maybe refrigeration or some electric forklifts. A fleet manager's and a facility manager's job don't necessarily overlap today. Electrification will change that. Energy management will become a significant piece of the logistics pie.

The role of the account manager may change. Managing electricity as part of fleet logistics may require more assistance and guidance initially. Tools that help fleets manage charging and electricity costs will be essential.

Charge management may not be sufficient for some commercial fleets. Ultimately, trucks need to keep rolling, and fleets will be reluctant to cede that control. Fleet charging solutions must fit into normal workflow without operational compromises.

Rules for drivers may provide charging windows. Regulations on commercial driver service hours require mandatory rest periods. These could offer opportunities for longer dwell time chargers and managed charging options. Unfortunately, this will not be the case for team driving situations – where two drivers sleep in shifts to keep the truck moving – which will require fast charging at high power.

Questions to Consider

- What use cases are the best for fleet managed charging?
- What tools will fleet managers need to reduce demand charges and manage energy costs?
- Are new, customizable rate structures needed for fleets?

THE FOUR W'S UTILITIES ARE ASKING

- Who are the fleets?
- Where are the fleets?
- What are their plans?
- What are the fleet charging characteristics?

EXPERIENCES FROM THE FIELD

NACFE Run-on-Less Event

In the past decade-plus, **the North American Council for Freight Efficiency (NACFE)** has analyzed more than 85 different technological advances to improve fuel efficiency in the trucking industry. And whether it's trailer skirts, tire pressure, powertrains, or anything else its experts have studied, there is one common fact that applies to them all. **"Nothing goes from zero to 100% in under a decade,"** said Dave Schaller, NACFE's Industry Engagement Director. "Transition takes a long time, and electrification isn't going to *just happen* by 2030."

Photo Credit: NACFE

NACFE conducted an *all-EV Run on Less* event in September 2021 **to better understand the current technology's capabilities and limitations as well as some of the specific challenges facing electrified fleets.** "The diversity in the type of work done in the trucking industry complicates any sort of universal transition to electrified fleets," Schaller explained. "**There's no such thing as an 'average truck.'** It may look the same to an outsider but transporting steel coils is dramatically different from carrying eggs or feather pillows or livestock."

To address some of the diversity in industry, the Run on Less - Electric event involved long haul tractor trailers, vans, and box trucks. Trucks from 13 different OEMs from 12 fleets that operate in six U.S. states and two Canadian provinces provided daily, real-time case studies from September 3-28 with reports to follow through 2022.

Southern Company on Scaling Up Fleets

Sitting down to look at what electrification of last mile delivery fleets might mean for the grid, the team at **Southern Company** decided one truck might not be a big deal. "Maybe 10 isn't either... but 50, that might be a little bit bigger deal," Electrification Policy Manager Lincoln Wood explained. "We quickly learned how vital power delivery would be for the discussions. Both transmission and distribution, depending on the level required. It might even just be straight transmission service."

American Electric Power: Learning Together with Fleets

Fleet electrification is new for fleets and utilities alike. Since both must learn how this transition will change their respective businesses, it might help to try to learn together. AEP is making an effort to understand the needs of fleets in its territory, as well to educate fleet managers about processes and requirements that, at largely regulated utilities, are pretty rigid and must be followed.

"Kilowatts, kilowatt hours, amps. Those might as well be a foreign language to fleet managers right now," Jeff Lehman laid out. **"We have an opportunity to make it easier for customers looking to electrify their fleets,** to make it more approachable." One of AEP's goals, which is a key to the whole effort, is to **provide a single contact that has a background in fleets and transportation electrification**, someone who can be responsible for coordinating things on the utility side.

The idea is that the person can help the fleet navigate new service requests. They can ask the right questions to prompt feedback that can help improve efficiency. "If you have 500 vehicles and they can all charge at 100 kilowatts, do you really need 100 kilowatts per vehicle or can you stagger charging to get by with less to lower your cost?" Lehman offered as an example. "Is that the operational profile? Are you going to be using any load management? Are all 500 coming tomorrow or is it 500 over the next three years? Answers to these questions all make a difference."

Insight: Someone with fleet and operational experience can help fleets navigate utility processes and assist the utility in developing programs and designing services that are more effective and efficient.

Rush Enterprises on Doing Business with Trucking

Part of the difficulty of creating a simple, straightforward way to handle the electrification of trucking operations is that **there's no simple, straightforward way that trucking operates.** There are fleets that own their tractors and their trailers, fleets that own tractors but no trailers, and fleets that own trailers with no tractors. There are people who lease trailers, people who lease tractors, and as many other business models as you can imagine. "There are so many ways to structure a business in the logistics world," Ryan Baker of **Rush Enterprises** said, "and there are new companies out there with new business models."

For electrification, that same variety is likely to apply. Companies will offer to supply trucks, or charging systems, or both. There will be companies that offer to help build infrastructure or handle power bills. Companies will charge a monthly fee, and a fleet can put a driver behind the wheel and let the company handle everything else.

Bottom Line: All this is why **it's so important for utilities to get to know the fleets in their territories** and their business practices. and efficient.

Portland General Electric's Electric Island

"Megawatt charging is coming for commercial vehicles. Utilities need to get ready," Rustam Kocher, who leads the Transportation Electrification team at **Portland General Electric (PGE),** warned. "We need to understand what that load shape will look like and how to develop rates." The very idea of megawatt public charging can be overwhelming. There are countless questions about generating the power, transmitting it to the site, and distributing it to a truck, and there are countless more when trying to serve five or ten trucks. Different varieties of chargers and other equipment can complicate things further.

To understand megawatt charging from a hands-on perspective, **Daimler Trucks North America (DTNA) and PGE partnered to open a first-of-its-kind, heavy-duty electric truck charging site called "Electric Island"** in April 2021. **The site will help illustrate what it takes to provide public charging for commercial EVs** like the ones manufactured by DTNA with the hope that it will accelerate their development, testing, and deployment.

"When the idea came up, there was a question of why something like this would be important," Kocher, formerly with DTNA E-Mobility, recalled. "The 'why' ended up being because there weren't currently any in existence, and it's important to show that public charging for commercial trucks is viable." **The plan is to share information from the site with others in order to prepare for the next level of charging for commercial trucks.**

Before Electric Island opened, both the OEM and the utility had already learned several things, some of the "what not to do" variety. For example, an early design would have required trucks to back out of the charging spot when finished, something that's never fun in a class 8 truck. Instead, trucks now pull straight through the charging area.

Transformers on the site are capable of up to five megawatts. There is a fenced off area referred to the power garden, which is where all the power cabinets for the charging pedestals go. **Rather than burying the conduit, designers laid a precast cement trench that allows chargers to be changed out in hours instead a week-long process jackhammering cement.**

The objective of the site is to try different equipment, to determine what works best with commercial trucks, and to test interoperability between chargers and vehicles. PGE can investigate sequential charging or what Kocher called "power sloshing," ramping up charging power on one vehicle as another ramps down because it is close to full. Through all these experiments and more, the utility can monitor demand curves on the site to see how spiky they get or how smooth they can be with on-site storage. All of this will help PGE decide on the best rate structure for megawatt level charging.

SMUD: Fleet and Building Service Requests Differ

As companies electrify their fleets, **both they and their utilities are struggling with the challenge of how to build enough infrastructure to support them without overbuilding.** This can be even more complicated as many companies' plans for electrification may stretch over a decade or more. "It's a unique situation," said Bill Boyce of SMUD, "because usually a building gets built, you get your electric service request, and you're up to full load within six months. For a large fleet transition, some things won't be up to full load for a decade."

With many fleet owners buying a few EVs with plans to purchase more in a few years as current vehicles are retired, **the question arises whether it makes more sense to install all the infrastructure up front** with the knowledge that much of the equipment or infrastructure backbone may lie dormant for years, or to **do staged, costly construction upgrades with each rollout of new EVs to the fleet.**

Boyce doesn't like the idea of going back multiple times to do what could be done in all at once, projecting that the cost for two or three upgrades over the course of a decade would be greater for both the customer and the utility. **However, much of the utility industry has penalty structures in-place if the load doesn't materialize within a specified time frame** as it's essentially asking a utility to overbuild the grid, without having a full cost recovery mechanism in place. "That's a lot of business risk on the utility side," Boyce said. "We need to find better solutions for this problem in the industry. At a minimum, we need to recommend getting oversized conduit in the ground for these situations early on in the first construction phase so we can avoid costly trenching operations later on."

King County Metro on the Cultural Change

Transitioning to an electric fleet requires more than new vehicles and chargers. It will also take some new outlooks and business practices. King County Metro's goal of zero-emissions operations hinges largely on EVs replacing diesel buses.

Making the shift may be easier for the transit agency than for others because it has a culture that already embraces electrified transportation and has for decades. "We've operated the [fully electric] trolley system for over 75 years," Strategic Planning Manager Danny Ilioiu noted. "The rest of our buses are 100% diesel hybrid, and then we have our ferry, light rail, and streetcar operations. So we have a lot of electricians on staff, and they all work on high voltage systems."

Agency culture can be as big a hurdle to overcome in EV adoption as any technical issues. Even King County Metro has had questions about where electric buses fit in because the agency's business model is designed around two types of vehicles: trolley buses that can practically operate 24/7 and diesel-hybrid buses that need to return for fueling once a day. "The battery electric bus is a different type of animal," said Ilioiu. "Agency culture needs to change and consider how it compares with the existing equipment, how do you involve various parts of the organization, and when are you going to involve them?"

Resources

- *Preparing To Plug In Your Fleet: 10 Things to Consider: A Guide to Working with Your Electric Company*, The Edison Electric Institute, the American Public Power Association, and the National Rural Electric Cooperative Association, https://www.cooperative.com/programs-services/bts/Documents/PreparingToPlugInYourFleet_FINAL_2019.pdf
- NACFE Guidance Reports, North American Council for Freight Efficiency, https://nacfe.org/report-library/guidance-reports/
- *A Utility Company Primer on Commercial Truck Electrification*, North American Council for Freight Efficiency, https://nacfe.org/wp-content/uploads/2020/07/NACFE-Utility-Electrification-Primer-072120.pdf
- *A Trucking Fleet Primer for Commercial Truck Electrification*, North American Council for Freight Efficiency, https://nacfe.org/wp-content/uploads/2020/07/NACFE-Fleet-Electrification-Primer-072120-1.pdf https://www.publicpower.org/resource/preparing-plug-your-fleet
- *High-Potential Regions For Electric Truck Deployments*, North American Council for Freight Efficiency, https://nacfe.org/downloads/high-potential-regions-for-electric-truck-deployments-technical-appendix/
- Run on Less Presented by NACFE and RMI, https://runonless.com/
- Oncor: Planning for The Future of Texas Electric Vehicle Fleets [video file], Oncor via YouTube, https://www.youtube.com/watch?v=52lDzb6-QoE
- *Medium- and Heavy-Duty Electrification Process*, California Electric Transportation Coalition, https://caletc.com/assets/files/CalETC-UtiltyElectrificationProcessSummary-HyperlinksOnly.pdf
- *Daimler Trucks North America, Portland General Electric open first-of-its-kind heavy-duty electric truck charging site*, Portland General Electric, April 21, 2021, https://portlandgeneral.com/news/2021-04-21-daimler-portland-general-electric-open-electric-charging-site
- Federal Motor Carrier Safety Administration Census File, Federal Motor Carrier Safety Administration, https://ask.fmcsa.dot.gov/app/mcmiscatalog/d_census_mcmis_doc
- Summary of Hours of Service Regulations, Federal Motor Carrier Safety Administration, https://www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations
- Assembly Bill No. 841, California Legislative Information, https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB841

Designing Utility Programs

A Variety of Approaches

Utilities that haven't dealt with an EV customer yet will soon. Enthusiasm for electric vehicles is growing as are the number of announcements by automakers for both new EV models and electric versions of established top-selling models. Before that first customer comes with questions about charging – and certainly before thousands do – utilities are working to have answers with rates and programs in place.

While it may be a new experience for some utilities and many customers, electric vehicles aren't new. Utilities across the nation have been designing EV programs and experimenting with various rate plans for years, and commissions and boards have offered their opinions and approvals. There are success stories and lessons learned of what to do differently next time. Experience varies across the country. Some utilities are well into their EV journey, while others are just forming teams.

> "SDG&E designs their EV rates based on EV's unique attributes: they don't consume energy when in use and charging stations have relatively low load factors compared to other commercial customers. We want to encourage charging at grid friendly times and help customers save money."
>
> Taylor Marvin,
> San Diego Gas & Electric

Utility programs and rates will evolve with the changes in charging and battery technology. New approaches will emerge as customer charging behavior becomes more firmly established and as utilities, vehicle manufacturers, and charging companies implement technology to control charging and flatten load curves in real time – taking advantage of the value as well as the costs associated with EV load. For the moment, though, rates are perhaps the most effective method of encouraging beneficial charging behavior from drivers. Utilities are learning ways to incentivize infrastructure projects, maximize available capacity, and align customer habits with grid conditions so that all customers, not just EV owners, benefit.

This chapter provides examples of what utilities are doing. It is not meant to illustrate what *should* be done but what *is* being done. The intent is to provide ideas that others can use to develop their own programs that fit the specific needs and interests of their customers and operating systems.

WHAT WE HEARD

Getting Started

Step outside the box. Think differently. When developing a program, consider how a new program can overcome barriers to adoption. Understanding the roadblocks or struggles customers or stakeholders have can illuminate what could be different, how the utility is uniquely equipped to address them, and reveal opportunities.

Keep the end goal in mind. Whenever considering a new rate structure or a change to an EV program, consider the strategic driver being addressed. Identify what success would look like, and then think creatively about how to accomplish it.

Outreach and messaging set the stage. The majority of vehicle drivers coming to a utility with questions or requests – at least in the next five to seven years – will probably be unfamiliar with and maybe even confused by many aspects of EVs and managed charging. Outreach efforts will establish a utility's knowledge and competence. Communications that are easy to understand can build trust and generate enthusiasm.

Tailor messages to resonate with specific stakeholders. An electric vehicle strategy will have multiple strategic drivers. Electric vehicle owners aren't all painted with the same brush. Neither are the variety of stakeholders involved in the transition. Focus the messaging for the specific audience being addressed – whether internal or external – and use language that the group understands and can identify with.

As discussions ramp up, it may require organizational resources, staffing, and training. Utilities operating in states with high electric vehicle adoptions have had time to think about what it will mean for the grid and their operations. But electric vehicles might not even be on the radar for utilities where adoption rates are low. As the topic becomes a priority, and customers and businesses begin making the switch, it may require organizational changes and education.

Make the most of what's on hand. Utilizing existing technologies or technology that can be easily integrated with legacy equipment can result in program savings that can be shared between program participants and non-participants.

TOU rates are a first step. Developing time-of-use rates are a first step to engaging customers and internal stakeholders about managed charging. They encourage charging behavior that aligns with grid needs but also demonstrate that the utility is listening to customer preferences for electric vehicles.

Questions to Consider

- What are the organizational or industry barriers or long standing "traditions" that are limiting implementation of successful EV programs?
- What is the end goal and how can new programs help to accomplish it?
- What will success look like? How can it be measured?

Try... *something*. Processes and approaches may evolve. Don't allow pursuit of a "perfect" plan to stand in the way of progress. Any plan is likely to change as people become accustomed to the new way of fueling vehicles. Sometimes the best way to learn is by doing. Start getting engaged, make new friends, leverage the utility's strengths, do something!

Utilities can only do as much as regulators and boards allow. The number of rebates and the value of incentives that a utility can offer depend upon commission or board approvals. While utilities might like to provide more, limitations are out of their hands, and it is incumbent on them to make their case effectively to garner support from regulators and stakeholders.

Once Things Get Rolling

Education is essential. People are extremely price sensitive, which is why rate design can encourage good charging etiquette. But it only works if customers understand how the rate works, when to plug in, and what tools are available to help them. If they don't, and the vehicle isn't charged when they need it or there is an unwelcome surprise on the bill, it will lead to very unsatisfied customers.

Consider the overall costs. The cost of EV programs includes more than the price of equipment installed on the ground. Implementation costs, employee time, and integration with legacy systems are not insignificant costs. Consider as well the grid benefits associated with managed charging and the value those bring to the table.

EV-only rates make it easier for customers to shift usage. Whole home rates can be more cumbersome for EV drivers to manage. With an EV-only rate, the customer only has to be mindful of the vehicle during peak times instead of modifying usage of every electronic device in the household. However, billing for an EV-only rate introduces questions around measuring and billing for vehicle usage. Utilities with EV TOU rates report fewer opt-outs than for traditional utility demand response programs like air-conditioning.

EV-only rate – (noun)
pricing mechanism in which electric vehicle energy usage is measured and billed separately from the remainder of the household energy usage.

Drivers need fast charging, and fast charging providers need a break. Utilities are working to develop rate structures for DC fast charging that mitigate demand charge impacts and that scale with utilization. While it's clear fast charging is needed to help overcome range anxiety, what's not so clear are the rates or fees that are fair to drivers, station owners, and the utility and its broader customer base.

Utilities can play a role in addressing social equity. Utility programs and investments that compliment private investment can support the development of a sustainable EV market, increase accessibility, and break down barriers.

Revenue from increased load can reduce rates for all customers. EV charging will increase electricity usage, creating a major source of revenue for utilities in the years to come. If this load is added uncontrolled, and requires infrastructure investments, it can lead to rate increases. However, when new revenue exceeds implementation and infrastructure costs, it can put downward pressure on rates.

Questions to Consider

- How can program design provide value and put downward pressure on rates for all customers?
- How can rates incentivize customers to develop good charging behavior that become part of the EV culture?

Comparing the cost of charging to the cost of fueling can seem like apples and oranges, but Lee Krevat at **Krevat Energy Innovations** developed a method that helps to better communicate the customer value of TOU pricing. Multiplying the electricity rate by 10 gives the price of an "electric gallon" and provides an easy comparison to gasoline. "At my utility (SDG&E), that's $1.00 per gallon super-off-peak, $2.50 off-peak, and $5.00 on-peak," explained Krevat. "Just two cents more per kWh is the equivalent of 20 cents per gallon. People will drive to a gas station miles away for a lot less."

Bumps in the Road

TOU rates may require a significant cost differential. If a utility's rates are relatively low, TOU rates may present more of a challenge. The utility's board or regulators may be reluctant to increase peak rates just to create a significant enough price differential to influence charging behavior.

Kilowatt-hour isn't a familiar word for fueling. Drivers understand miles per gallons, and are used to seeing prices on signs outside the gas station. EV charging prices aren't quite as visible or accessible yet and don't offer customers the chance to shop around for a better price.

Targeted marketing isn't targeted if all customers receive it. Identifying where all the EV drivers are in a utility's service area can be a full-time job. Blanket marketing to all a utility's customers, including the vast majority who don't have an EV, and likely won't for at least several years, is wasteful and potentially annoying. Vehicle registration data is one method to help better target materials for EV rates, but there are often privacy rules protecting that DMV data.

Breaking old habits may require new motivators. Level 1 and 2 public charging at stores, restaurants, movie theaters, and other businesses encourage customers to stay a while and provides EV drivers dedicated parking spaces. Fast chargers turn that upside down. "Camping out" is no longer desirable. That habit might be hard to break, especially as different charger types are intermingled with faster charging options where customers will need to move their EVs so other owners can use the fast charger. Public charging rates based on time rather than energy usage may be more easily understandable and help customer make the shift.

Be mindful of negative externalities. New programs can sometimes inadvertently create negative long-term consequences. Think about near- and long-term implications and consider what the results might mean in the context of low versus high adoption numbers.

Questions to Consider

- What approaches are helpful for identifying EV owners?
- What education or outreach could help customers understand new rates or programs?

EXPERIENCES FROM THE FIELD

Entergy Offers a Complete Solution for Commercial Customers

Entergy New Orleans is launching a recently approved turn-key EV charging solution for commercial properties, particularly multifamily housing. **Commercial customers who are interested in installing EV chargers can ask Entergy to install, own, and maintain chargers at the customer's site for ten years**. The site owner will pay for the cost of the equipment through a rider on their power bill (i.e., an additional charge).

At the end of the ten-year period, when the equipment has been paid off, the property owner can take over maintenance and operation of the equipment, or Entergy New Orleans will continue to handle it for a monthly fee.

Entergy also provides rebates to customers for installing Level 2 charging stations at their homes or businesses.

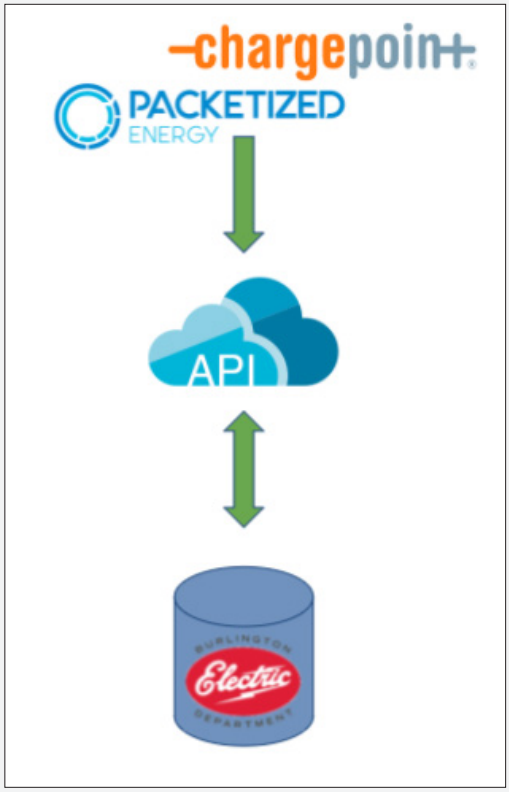
Burlington Electric Department on Charger Functionality

Burlington Electric Department's programs have their underpinnings in Vermont's renewable energy standard that requires utilities to encourage customers to reduce fossil fuel in heating and electricity.

BED offers a residential off-peak charging rate for customers who don't charge between noon and 10 o'clock at night. Customers who manage to avoid the specified hours for the entire month receive a bill credit that lowers the cost of fueling to the equivalent of buying gas for around 60 cents a gallon. **There's no penalty for charging during the window though.** If the customer does, the regular residential rate applies.

To receive the EV rate, customers must register their installed chargers with BED and use one of two approved charger companies. Packetized and ChargePoint chargers were selected from BED's evaluation program that tested chargers on four areas of functionality:

- **Data Access:** allows BED to interface and pull in data from the electric vehicle supply equipment's back-end. API documentation is critical for this step.
- **Metering Accuracy:** must be within +/- 5% of metered accuracy. A BED AMI meter was used to determine the accuracy of time-intervals and energy consumption.
- **User Interface:** The device must give customers the ability to schedule charging under the fixed time-of-use rate option, avoiding noon-10 p.m.
- **Demand Response:** BED offers a flexible demand response option as part of the rate as well as the fixed time-of-use rate option, which was considered in the evaluation.



BED uses APIs to access interval charging data from the Wi-Fi connected EV chargers for billing. This currently requires some manual processing. It is manageable in the short-term because the number of customers enrolled is low. However, BED is working on technology upgrades that will fully automate the process in anticipation of a growing EV customer base.

Bottom Line: BED found that uncontrolled home charging would add 20% - 60% peak contribution by a residential account. The EV Rate has shifted almost all participant charging off-peak.

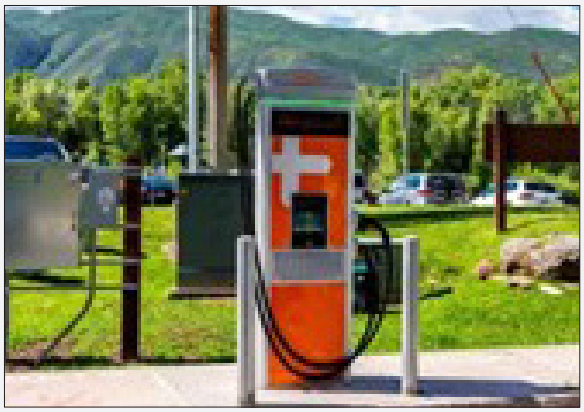
Holy Cross Energy on Its EV Programs

HCE is a highly seasonal utility located on the Western slope of Colorado. Average winter loads are more than double those in summer. Between Christmas and New Year's Day, HCE's demand peaks around 270 megawatts for customers in the corridor from Vail to Glenwood Springs and Glenwood Springs to Aspen.. Summer loads peak around 120MW.

In 2018, HCE developed its transportation electrification plan. The co-op's board approved four categories: Charge at Home. Charge at Work. program, community charging, Electrify My Ride transit charging, and converting HCE's fleet

In 2020, HCE saw a year-over-year adoption growth rate of 34%. To respond to growing EV adoption, the plan was updated in 2020, adding additional programs, allowing members beneficial electrification rebates, an extra 2kW allowance for solar net metering for EV customers, and a new e-bike rebate of $200.

HCE's *Electrify My Ride* Program



HCE's resource plan calls for 100% renewable energy by 2030, which may lead to excess power generation overnight. The wind blows strongly in Colorado, making wind power a low-cost, clean energy option. Except the wind keeps blowing even when demand falls as customers turn out the lights, shut off their TVs, and go to sleep.

This initiative pairs perfectly with the needs of transit authorities and school districts that electrify their fleets. Buses need to charge at night, and most transit buses have only about a three- or four-hour window to do so before they need to be on the road for morning commuters.

HCE collaborates with transit partners to identify the charging constraints for buses and created new TOU rates with no demand charges to encourage off-peak charging that makes the most of Colorado's wind. The off-peak rate is one-quarter that of on-peak charging.

In the spotlight: A model for transit electrification within HCE's territory is Aspen. In late 2019, eight electric buses showed up downtown for the Aspen Filmfest and have been driving around ever since. HCE built out a one-megawatt installation to charge the fleet and to allow capacity for future expansion. Two years later, the utility completed a five-megawatt make-ready infrastructure plan in Vail to support 40 buses.

HCE's *Charge at Home. Charge at Work.* Program

Residential members can sign up online to get a Level 2 charger as part of HCE's ***Charge at Home. Charge at Work.*** **The program doesn't require any upfront costs because HCE supplies the charger,** and the member hires the electrician to install the charger panel, but HCE pays the bill. HCE minimizes the installation cost impacts to customers in two ways.

First, through a DER Service Agreement, installation costs are spread over 36 months through an on-bill charge. Secondly, HCE automatically enrolls customers in the Distribution Flexibility Tariff (DFT). It appears on the same bill as a credit. HCE expects the two to roughly equal out, so the cost to the member is reduced. **HCE's distribution flexibility tariff** combines peak time rewards and dynamic renewable pricing **to incentivize increased demand during times of anticipated oversupplies of renewable energy and load reductions during times of undersupply.**

Peak demand events generally take place between 4 and 9 p.m. and last two to three hours. They can happen any time of year, though they're more common in the winter, especially during the week between Christmas and New Year's Day. On the other hand, peak renewable production takes place overnight, from 11 p.m. to 6 a.m. and in the afternoon between 1 and 5 p.m. These occur year-round and can last from three to ten hours.

Members receive a ChargePoint charger, and HCE issues API commands developed to the level of charge. While HCE has investigated adding other options, doing so would introduce communications complexities and challenges that could increase costs.

When asked, **"What one program would you implement nationally?"** HCE's Chris Bilby didn't hesitate. "Without a doubt the ***Charge at home. Charge at Work. program.*** It allows us to get a tremendous amount of data that we can integrate into our DERMs platform." The project has successfully deployed more than 250 home chargers, representing about 37% of the EVs registered in HCE's territory, with an average of 40 home charging sessions per day in 2020, or just under 16,000 total for the year.

Bottom Line: The value of the data it provides to a utility far exceeds the cost of the charger.

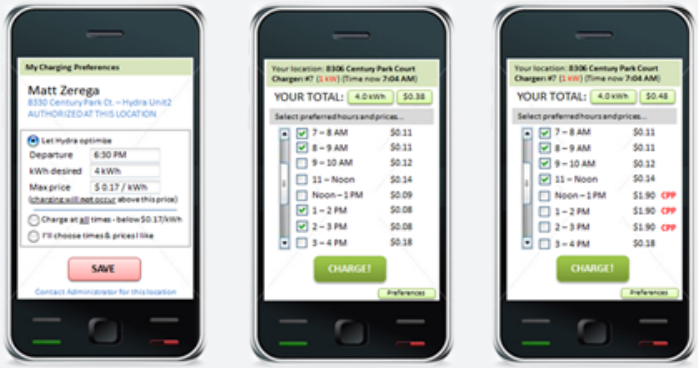
San Diego Gas & Electric Offers a Truly Dynamic Rate

San Diego Gas & Electric (SDG&E) has more than 60,000 light duty EVs in its service territory. Because rate design is an important component to encouraging EV adoption, increasing electricity throughput, and aligning vehicle charging with grid conditions, SDG&E offers a range of EV-specific rates that reflect the unique attributes of electric vehicle loads.

The rate designs vary from standard time-of-use plans to dynamic rates that change by the hour. Each addresses different driver profiles with the goal of reducing demand spikes.

EV-TOU	EV-TOU-2	EV-TOU-5	EV-High Power	Vehicle-Grid Integration Rate
Residential EV TOU rate for separately-metered EV charging and some public charging.	Residential EV TOU whole-house rate. Otherwise identical to EV-TOU.	Residential EV TOU whole-house rate with $16 fixed charge.	Commercial EV TOU rate with subscription charge based on customer's preferred capacity.	Hourly dynamic rate for workplace and multi-unit dwelling charging in the Power Your Drive Program.

Residential TOU rates are one of the most effective methods to manage demand in a utility's transition to electrification. On the other end of the spectrum, SDG&E's VGI (Vehicle-Grid Integration) rate is its most dynamic. It serves approximately 3,000 EV chargers in the **Power Your Drive program**. Customers can set a maximum price threshold they are willing to pay to charge on the utility's app. When the price of energy exceeds that rate, the vehicle stops charging until the price dips back below the threshold. This plan is most suitable for customers with long dwell times.



Basic settings – "set & forget"

Advanced settings – choose hourly prices

Bottom Line: Education is critical to customer satisfaction for more sophisticated rates. For example, if a customer doesn't understand their dynamic rate, they may be frustrated to find that their car hasn't been charged because the price never dropped below the customer's set threshold. Rates work best when customers fully understand them.

Austin Energy's EV Programs

Austin Energy's EV Program is characterized by a wide net of over 25 EV initiatives categorized by their 5 EV Pillars that are aligned with the City's Strategic Drivers (SD23), Austin Climate & Equity Plan, and Austin Energy's Strategic Plan. The five pillars are charging infrastructure, affordability & equity, fleets & new mobility, outreach & education, grid Integration. Some initiative examples include:

Austin Community Buyer's Guide – The program spans the entire customer experience from providing outreach and awareness to training and sales tools for dealers to consumer tools that facilitate the buying process to standardizing charging kiosks for simpler fueling. The website includes information about programs and rebates, real-time inventory (with color, model, and price for dealerships in Austin), EV incentives and tax credits, and more.

EV Infrastructure – Austin Energy's EV charging network has grown to include more than 1,200 charging ports at over 300 locations, including retail, workplace, multifamily, and fleet sites.

Fleet Electrification - City of Austin's plan to electrify its municipal fleets is on track toward its Phase One goal of 330 EVs with more than 250 light-duty EVs already in service. Anticipated savings from the switch during Phase One alone is estimated to be $3.5 million and 12,000 metric tons of CO_2 over 10 years.

Rebates & Tariffs - Other programs include residential and commercial Level 2 charging station rebates, E-Ride, which offers rebates up to $400 for electric bikes and scooters, and the Fleet and EV Infrastructure Pilot Tariff.

EV Readiness - The utility established EV readiness codes as part of the Green Building initiative. There are also programs directed toward assisting low-to-moderate income customers to get into electric vehicles.

Austin Energy's Charging Plans

Public Charging

Austin Energy's Plug-In EVerywhere™ Driver Program allows drivers to get unlimited charging at any of the more than 1,200 public Level 2 chargers in AE's service area for a monthly subscription fee of $4.17. Non-members can still charge at the station, but are charged $2.00/hour. All electricity from public charging is backed by 100% Texas wind energy through the utility's GreenChoice™ program.

DC Fast is a simple 21 cents per minute plug-in to plug-out for all users. The business model is moving toward a full cost recovery rate structure while encouraging quick charging etiquette through pricing signals.

Residential Home Charging

Austin Energy offers residential customers a time-of-use rate, **EV360**, specifically for EV charging as a subscription service. For a flat monthly fee ($30 per month for demands below 10kW, $50 above 10kW), drivers in single family homes can have unlimited off-peak charging at home and the public Level 2 charging network. On-peak times are from 2 p.m. to 7 p.m. on weekdays.

Insight: Through the data from their EV360 pilot, Austin Energy found that customers are much more willing to shift their consumption of electricity for EV charging than they have been for its traditional demand response program, which focuses on air conditioners.

Green Mountain Power's TOU Rate Options

Green Mountain Power works with its DERMS partner to provide two different time-of-use rates for EV customers. Customers that buy a new or used EV can receive a free Level 2 charger from GMP, and the charger app allows them to manage their charger settings remotely. The charger must be Wi-Fi connected and customers must share access with the utility. To bill for GMP's two TOU rates, the utility obtains usage data from the charger and breaks it out into its own line item on the customer's bill.

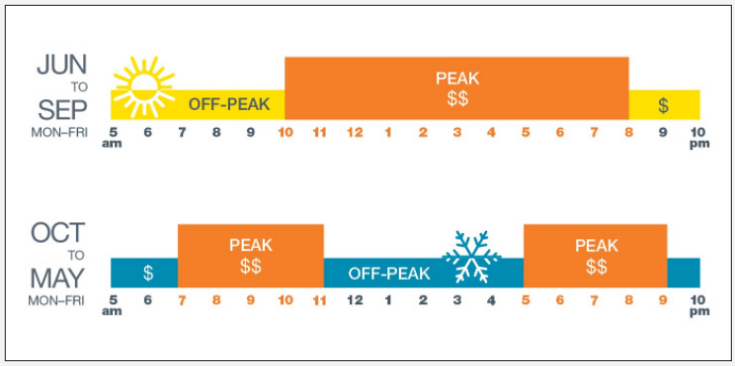
Green Mountain Power's two TOU rates:

- **Rate 72**: The customer receives alerts during peak events to manage their own charging. The off-peak rate is 13.3 cents per kilowatt hour (~$1.03 a gallon of gas). If a customer insists on charging on peak, the rate is 68 cents per kilowatt (~$5.27 a gallon of gas).
- **Rate 74**: A traditional TOU rate with fixed on- and off-peak windows. Costs on weekdays between 1 p.m. and 9 p.m. are 16.8 cents/kWh (~$1.30 per gallon of gas). At any other time, the rate is 12.8 cents/kWh (~$1.00 per gallon of gas).

Baltimore Gas & Electric 's EV-Only Rate

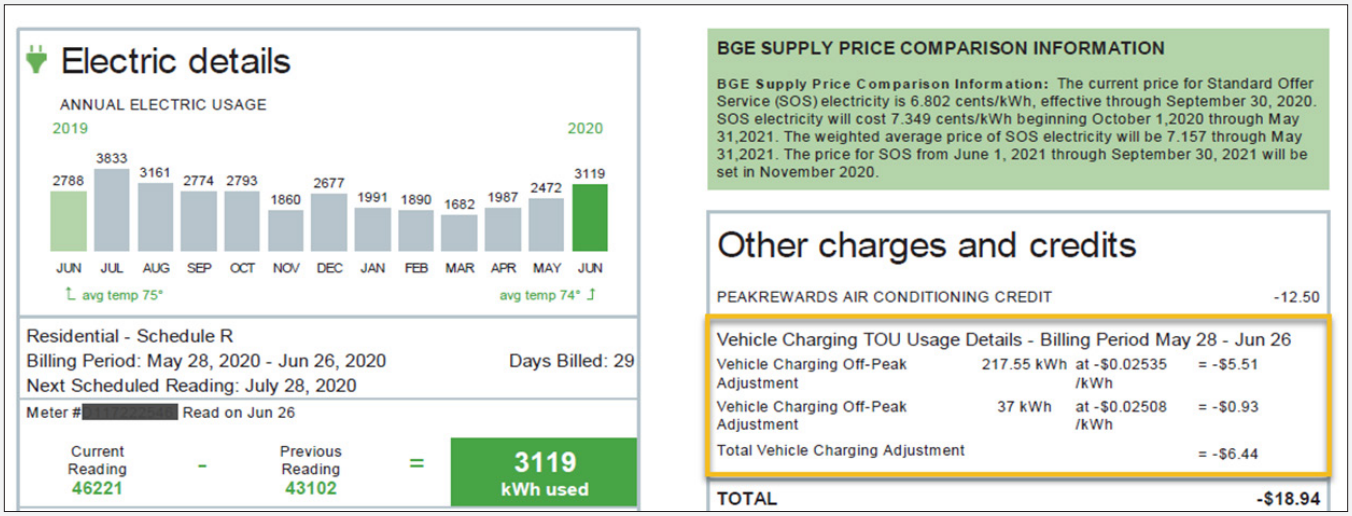
On May 1, 2020, BGE launched its EV-Only Rate for residential customers with an eligible Level 2 charger. The rate's purpose is to provide EV owners with an incentive to charge their vehicles at times when there is excess capacity on the system and to make it easier for them to shift their charging during peak times. This both helps to minimize impacts of incremental load on the system and lowers the overall TCO for EV drivers.

A unique aspect of the program is that BGE was approved to use data from both the smart chargers and EV telematics to bill customers. This allows customers to keep their household usage on a standard rate and their charging on the EV-Only TOU rate without needing a second utility-grade meter. To determine EV usage, BGE collects the data recorded by the smart charger and subtracts it from the whole house usage. BGE proposed this solution because whole house TOU rates have proven unpopular among many customers who've complained about needing to constantly monitor all usage in their homes.



BGE marketed the new rate directly to the 300 customers who had been on the whole house rate as well as around 6000 customers who'd self-identified as EV owners in a survey. Additionally, the marketing campaign included ads on Google, Facebook, and Pandora. Some EV customers elected to stay on the whole home rate. BGE suspects that may be because they drive plug-in hybrids that use Level 1 charging, which isn't eligible for the rate.

By the end of 2020, 60 customers had signed up, which is done by enrolling their charger online through BGE MyAccount. Customers then see their EV usage displayed as a separate item on the website. **After Tesla eligibility was added, enrollments increased. There were 500 customers enrolled at the end of August 2021.**



BGE's Charger Incentives & Rebates

BGE's EV Smart program was created in July 2019 in response to the Maryland Public Service Commission's (PSC) appeal to the state's utilities to help meet Maryland's goal of having 300,000 EVs on the road by 2025. Commissioners felt BGE and other utilities were in a unique position to encourage EV adoption through educating customers on EVs, providing rebates on home charging, and installing a reliable public charging. Thus, the program's main components are a residential charger rebate, rebates to multifamily customers, and public charging.

Residential customers can get a $300 rebate on any of the eligible Wi-Fi enabled Level 2 chargers, while multifamily dwellings may receive $5,000 on a Level 2 charger or $15,000 on a DCFC, with a cap of $25,000 at any individual site. Eligible chargers, which are listed on BGE's website, have been vetted by the utility as being capable of providing the data necessary to meet PSC reporting requirements. The PSC wants to make certain that as EV adoption grows, the installed devices can communicate with utilities in way that allows BGE and others to offer managed charging programs when needed.

The rebates have been approved to run through 2023 or until the available rebates are all claimed. As of September 2021, **100% of residential rebates had been claimed, but applications for only 8% of the multifamily rebates had been submitted.**

Plans for BGE's public charging network call for 500 chargers to be installed on state, county, or local government property. The strategy is to put them at sites where people go every day – libraries, parks, rec centers, schools, community colleges – to assure customers that reliable charging is available outside their homes. BGE owns, operates, and maintains the mix of Level 2 and DC fast chargers. **At the time of this report, 150 public chargers have been installed and an additional 419 have been sited.**

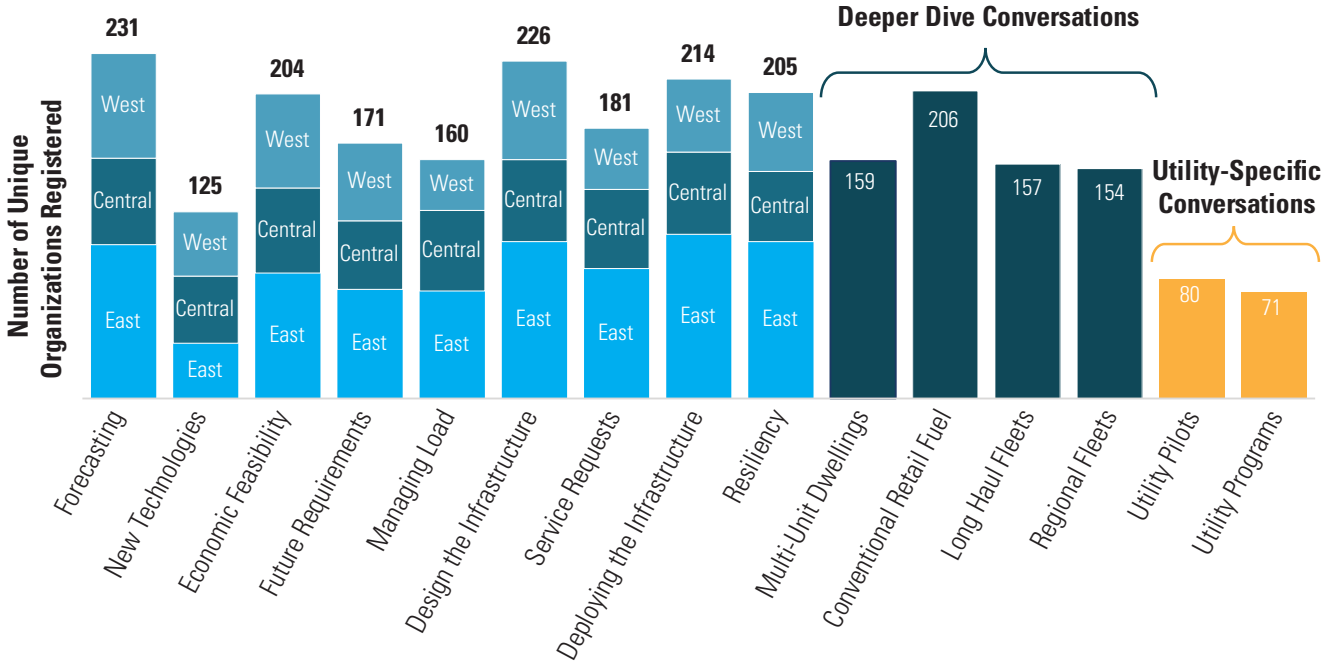
Resources

- *Principles for Utility Investment in Electric Vehicles*, Union of Concerned Scientists, https://www.ucsusa.org/sites/default/files/images/2018/06/cv-ev-infrastructure.pdf.
- *Executive Summary of the Texas River Cities Plug-In Electric Vehicle Infrastructure Plan*, Texas River Cities Plug-In Electric Vehicle Initiative, https://austinenergy.com/wcm/connect/ac56bb9b-8c50-4358-b774-655d08e38dc8/executiveSummaryOfTRCPlan.pdf?MOD=AJPERES&CVID=mO61Nnd
- *Net Zero Energy Roadmap for the City of Burlington, Vermont*, Burlington Electric Department, https://www.burlingtonelectric.com/sites/default/files/inline-files/NetZeroEnergy-Roadmap.pdf
- *Electric Transportation Rate Design Principles for Regulated Utilities*, Alliance for Transportation Electrification, https://img1.wsimg.com/blobby/go/2398067f-0bc3-41a7-84e3-4f90ff64c63d/downloads/ATE%20Rate%20Design%20Principles.pdf?ver=1626634532123
- *Power Your Drive Research Report*: *April 2021*, San Diego Gas & Electric, https://www.sdge.com/sites/default/files/regulatory/SDG%26E%20FINAL%20Power%20Your%20Drive%20Research%20Report%20April%202021.pdf
- *Residential Electric Vehicle Time-Varying Rates That Work: Attributes That Increase Enrollment*, Smart Electric Power Alliance, https://sepapower.org/resource/residential-electric-vehicle-time-varying-rates-that-work-attributes-that-increase-enrollment/
- Electric Vehicle Charging Stations, Entergy New Orleans, https://www.entergy-neworleans.com/evcs/
- Entergy Electric Technology Programs and Incentives, Entergy, https://www.entergyetech.com
- In-Home Level 2 EV Charger, Green Mountain Power, https://greenmountainpower.com/rebates-programs/electric-vehicles/in-home-ev-charger/
- Electric Vehicle Pricing Plans, San Diego Gas & Electric, https://www.sdge.com/residential/pricing-plans/about-our-pricing-plans/electric-vehicle-plans
- *Electric Service Tariffs, Rules And Regulations*, Electric Rate Tariff Adjustments Distribution Flexibility Program – Optional, Holy Cross Energy, p. 38-39, https://www.holycross.com/wp-content/uploads/2019/06/Electric-Service-Tariffs-Rules-and-Regulations-amended-14May2019-CLEAN_a.pdf#page=38

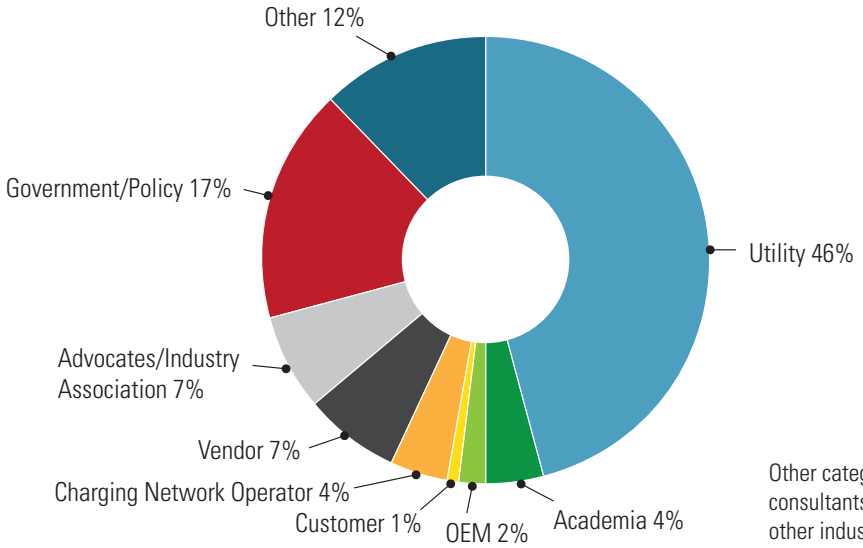
Appendix A: Participation Representation

The initiative had widespread participation. The following list includes the companies represented by participants on call registrations or that participated in individual interviews. The DOE team would like to thank everyone who contributed to this document and shared their experience and insights. Special thanks go to the many presenters, our industry steering committee who provided valuable feedback and assistance, and our facilitators that keep the conversations dynamic and productive.

Registrations per Call Topic



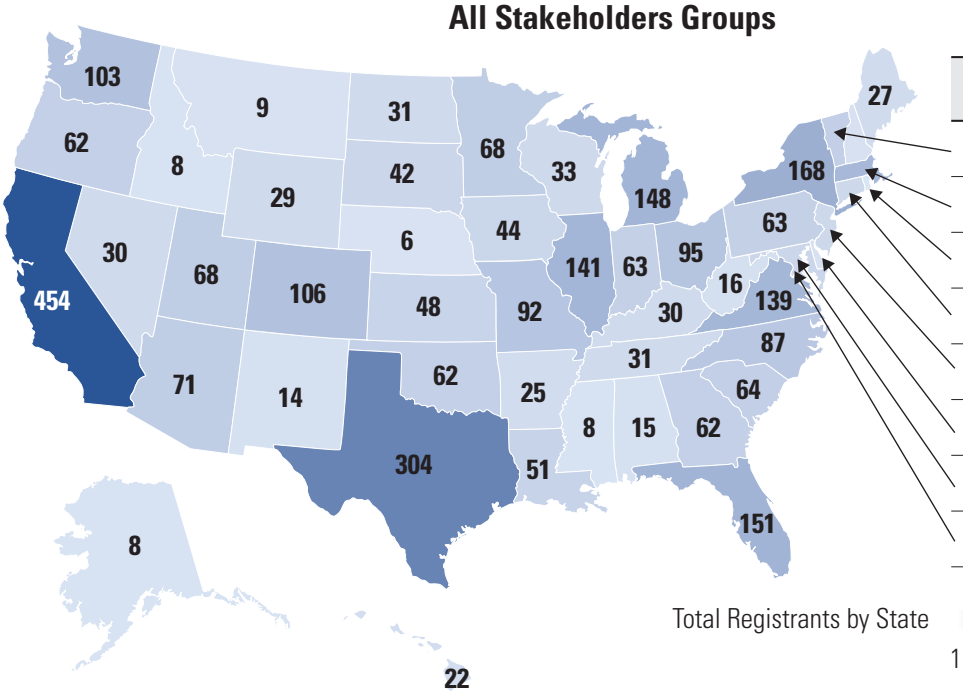
Participation by Stakeholder Category



Other category includes fuel retailers, consultants, and representatives from other industries like solar.

Geographic Representation of Registrations

All Stakeholders Groups

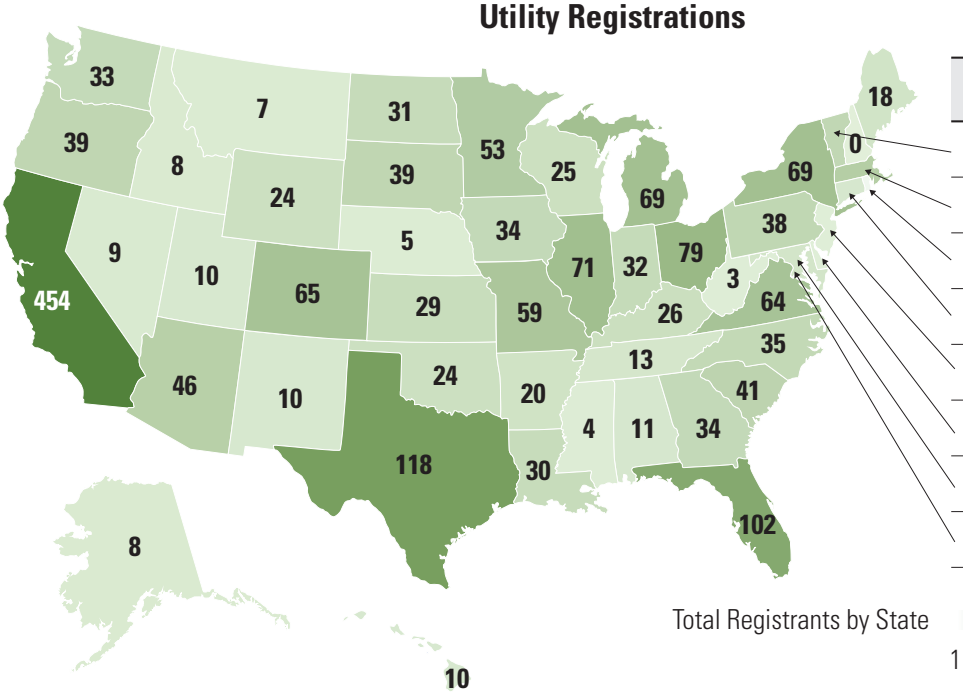


State	All	Util
VT	54	37
MA	134	50
RI	1	0
CT	35	11
NJ	35	2
DE	9	2
MD	42	16
DC	115	14

Total Registrants by State

1 454

Utility Registrations



State	Registrants
VT	37
MA	50
RI	0
CT	11
NJ	2
DE	2
MD	16
DC	14

Total Registrants by State

1 158

Companies Represented in Initiative Registrations

- 19Y Advisors
- 24-7 Travel Stores by Triplett
- 33 North Energy
- 350Dallas
- A & N Electric Cooperative
- ABB
- ACI Worldwide
- Adopt a Charger
- AES Technology Holdings
- AGI
- AICO EDV-Beratung GmbH
- Alabama Municipal Electric Authority
- Alabama Power Company
- Alaska Power Authority - ARECA Insurance Exchange
- Alliance for Automotive Innovation
- Alliance for Transportation Electrification
- Alliant Energy
- All-Pro Electric
- Alpha Power Advisers
- Ameren
- American Electric Power
- American Municipal Power
- American Public Power Association
- AMPLY Power
- Appalachian Power
- Arizona Public Service
- Ark Valley Electric
- Arkansas Energy Office
- Aspen Development Corporation
- ASPIRE Engineering Research Center
- Associated Electric Cooperative
- Association of Central Oklahoma Governments
- AT&T
- Attorney General of Arkansas
- Austin Energy
- Avangrid
- Avista Utilities
- Axiom Power
- Baltimore Gas and Electric
- Basin Electric Power Cooperative
- Baton Rouge Capital Area Transit System
- BBBS
- Braintree Electric Light Department
- Beam
- Belmont Municipal Light Department
- Berkeley Electric Cooperative
- Berkshire Hathaway Energy
- BFPL
- Bidgely
- Blue Ridge Energy
- Bluestem Electric Cooperative
- BlueWave Solar
- Bon Homme Yankton Electric Association
- Booth & Associates
- BorgWarner Inc
- Boulder County, CO
- Brendle Group
- Bridgeport Port Authority
- Brinshore
- Burlington Electric Department
- Burns and McDonnell
- Butler Electric Cooperative
- Butler Rural Electric Cooperative
- C2 Group of Texas
- Cadence Development
- Cadmus Group
- California Energy Commission
- California Public Utilities Commission
- Callaway Electric Cooperative
- CALSTART
- Capital Area Transit System
- Capital Electric Cooperative
- Capitol Access Partners
- Capitol Clean Cities of Connecticut
- Cardinal Infrastructure
- Carroll Electric Cooperative
- Cass County Electric Cooperative
- CEC Corporation
- Center for Sustainable Energy
- CenterPoint Energy
- Central Electric Cooperative
- Central Electric Power Cooperative
- Central Florida Clean Cities
- Central Jersey Electric Auto Association
- Central Kansas Clean Cities
- Central Maine Power Company
- Central Rural Electric Cooperative
- Cervais
- ChargePoint
- Cherryland Electric Cooperative
- Choctawhatchee Electric Cooperative
- Chugach Electric Association
- Cigna
- Citizens Electric Corporation
- City of Anaheim, CA
- City of Banning Electric Utility
- City of Banning, CA
- City of Chicago, IL
- City of Dallas, TX
- City of Denton, TX
- City of Edmond, OK
- City of Fort Collins, CO
- City of Hillsboro, OR
- City of Houston, TX
- City of Lindsborg, KS
- City of Loveland, CO
- City of Naperville, IL
- City of New Orleans, LA
- City of New York, NY
- City of Ottawa, KS
- City of Overland Park, KS
- City of Palo Alto Utilities
- City of Palo Alto, CA
- City of Phoenix, AZ
- City of Plano, TX

- City of Richland, WA
- City of Sacramento, CA
- City of San Francisco, CA
- City of Santa Clara, CA
- City of St George, UT
- City of Tallahassee, FL
- Clark County, NV
- Clean Cities Coachella Valley Region
- Clean Communities of Central New York
- Clean Crossing
- Clean Energy Business Council
- Clean Fuels Ohio
- Clean Power Research
- Clean Transportation
- CleanPower
- Climate Finance Advisors
- Clinton County Electric Cooperative
- ClipperCreek
- CoBank
- Cobb Electric Membership Corporation
- Coffman Engineers
- Collaborative Efficiency
- Columbia Rural Electric Association
- Commonwealth Edison
- Connect CA
- Connecticut Department of Energy and Environmental Protection
- Connecticut Public Utilities Regulatory Authority
- Consolidated Edison
- Consumers Energy
- Consumers Power
- Continental
- Corn Belt Energy
- Corn Belt Power Cooperative
- CoServ Electric
- Coventry and Associates
- Cox
- CPFL Energia
- CPower
- CPS Energy
- Craighead Electric Cooperative Corporation
- Critical Consumer Issues Forum
- CW Real Estate Services
- Daimler Trucks North America
- Dairyland Power Cooperative
- Dallas City Hall
- Dallas-Fort Worth Clean Cities
- Darcy Partners
- Dayton Power and Light
- Declaration Energy
- Delaware Municipal Electric Corporation
- Delek US Holdings
- Dell
- Denver Metro Clean Cities Coalition
- Dhofar power company
- District of Columbia Department of Energy and Environment
- District of Columbia Public Service Commission
- District of Columbia's Office of the People's Counsel
- DNV GL
- Dominion Energy
- Dover Fueling Solutions
- Drive Electric Colorado
- DTE Energy
- Duke Energy
- Duke University
- Dunsky Energy Consulting
- Duquesne Light Company
- E4 The Future
- East Central Energy
- East Kentucky Power Cooperative
- East River Electric Power Cooperative
- East Tennessee Clean Fuels Coalition
- Eastern Illini Electric Cooperative
- Eaton
- ECCO International
- Edison Electric Institute
- EE Capital
- eIQ Mobility
- El Camino Real Consulting
- Electric Applications Incorporated
- Electric Auto Association
- Electric Cooperatives of South Carolina
- Electric Power Research Institute
- Electric Power Systems
- Electric Reliability Council of Texas
- Electric Vehicle Institute
- Electricity Company of Ghana
- Electrification Coalition
- Electrify America
- Electriphi
- ElectroTempo
- Emerging Futures
- Empire Clean Cities
- endeavor
- Energy and Resources Solutions
- Energy Conservation Works
- Energy Innovation
- Energy New England
- Energy Northwest
- EnergyCenter
- EnerNex
- Entergy
- Environment Texas
- Electric Power Board of Chattanooga
- Equnival Partners
- Ernst & Young
- ETTMA
- EV Diaries Podcast
- Evergreen Consulting Group
- Evergy
- EVgo
- EVNoire
- Evoke Systems
- EVolve Houston
- EWGCS
- Exelon
- Facebook
- FCG Germany GmbH
- Federal Aviation Administration

- Federated Energy Services Cooperative
- FedEx Corporation
- Fenimore Energy Advisors
- FirstEnergy
- Flathead Electric Cooperative
- FlexCharging
- Flint Energies
- Florida Clean Cities Coalition
- Florida Department of Agriculture and Consumer Services, Office of Energy
- Florida Department of Transportation
- Florida Electric Cooperatives Association
- Florida Keys Electric Cooperative
- Florida Power and Light
- Florida Public Service Commission
- Florida State University
- Ford Motor Company
- Fort Pierce Utility Authority
- Forth
- FreeWire Technologies
- Freight Insights
- Frontier Energy
- Fuels Institute
- Future Fuel Strategies
- Gadgeon Systems
- Gartner Advisory Services
- GDS Associates
- General MicroGrids
- General Motors
- General Services Administration
- Georgetown Climate Center
- Georgia Power Company
- Georgia Public Service Commission
- Georgia Transmission Corporation
- Global Partners
- GNA
- Google
- Great Lakes Energy Electric Cooperative
- Great River Energy
- Greater Lansing/Michigan Clean Cities Coalition
- Greater Portland Council of Governments
- Greater Washington Region Clean Cities Coalition
- Green Business Certification
- Green Mountain Energy
- Green Mountain Power
- Green Power Electric Membership Corporation
- Greener by Design
- Greenlots
- Greenshift
- GTI
- Guardian Fueling Technologies
- Guidehouse
- GulfSlope Energy
- Halo Automotive
- Harney Electric Cooperative
- Harrisonburg Electric Commission
- Hawaii Automobile Dealers Association
- Hawaii Energy
- Hawaii Green Infrastructure Authority
- Hawaii Public Utilities Commission
- Hawaiian Electric Company
- Hawk Utility Consulting
- HDG
- HDR Engineering
- Hendricks Power
- High West Energy
- Highline Electric Association
- Hitachi
- Hitachi ABB Power Grids
- Holy Cross Energy
- Houston-Galveston Area Council
- Houston-Galveston Clean Cities Coalition
- Hubbell Incorporated
- Hubject
- Hunt
- Iberdrola USA
- IBM
- ICF
- Idaho Power Company
- Illinois Commerce Commission
- Imperial Irrigation District
- Indian Nations Council of Governments
- Indiana University
- Indiana Utility Regulatory Commission
- Indigo Engineered
- Innova EV
- Integrated Roadways
- Intermountain Rural Electric Association
- International Brotherhood of Electrical Workers
- Ions
- Iowa Association of Electric Cooperatives
- Isles
- Jackson Energy Cooperative (KY)
- Jackson Energy Membership Corporation
- Jacobs
- Jay County REMC
- JEA
- Jefferson Energy Cooperative
- JF Petroleum Group
- Jo Carroll Energy
- K-Electric
- Kentucky Attorney General's Office
- Kentucky Office of Energy Policy
- KERBspace
- Kevala Analytics
- Kiewit Corporation
- Kimley-Horn
- Kitu Systems
- Koben Systems
- Kongu Engineering College
- Kum & Go

- La Plata Electric Association
- Lakeland Electric
- Lansing Board of Water and Light
- Las Vegas Power Professionals
- Law Office of Karen Dalglish Seal
- Lea County Electric Cooperative
- Lehi Power Department
- L'Energy Mobility
- Lewis County Rural Electric Cooperative and Macon Electric Cooperative
- LG Electronics
- LG&E and KU
- Liberty Utilities
- Lighthouse Solar
- LineHaul Station
- Lockhart Power Company
- Lone Star Clean Fuels Alliance
- Lorain Medina Rural Electric Cooperative
- Los Angeles Clean Cities Coalition
- Los Angeles Department of Water and Power
- Louisiana Clean Fuels
- Lower Valley Energy
- M Energy
- M.J. Bradley & Associates
- Macon Electric
- Madison Gas and Electric Co.
- Manta Consulting
- Maquoketa Valley Electric Cooperative
- Marshall University
- Maryland Energy Administration
- Maryland Public Service Commission
- Massachusetts Bay Transportation Authority
- Massachusetts Clean Energy Center
- Massachusetts Department of Public Utilities
- McKinsey
- McMinnville Electric System
- Memphis Light, Gas and Water Division
- Mercedes-Benz R&D North America
- Merge
- Metroplex Energy
- Metropolitan Energy Center
- Michigan Public Service Commission
- Michigan Technological University
- Microgrid Systems Laboratory
- Middle Tennessee Electric Membership Corporation
- Middleborough Gas and Electric Department
- Midstate Electric Cooperative
- Midwest Energy
- MiEnergy Cooperative
- Mihelic Vehicle Consulting
- Minnesota Rural Electric Association
- Minnesota Valley Electric Cooperative
- Mississippi State University
- Missoula Electric Cooperative
- Missouri Public Service Commission
- Missouri River Energy Services
- MJM Electric Cooperative
- Modern Energy
- Mohave Electric Cooperative
- Momentum Dynamics
- Montana-Dakota Utilities Company
- Mortenson
- Mountain Parks Electric
- Mountain View Electric Association
- Muscatine Power and Water
- Mustang Prairie Energy
- National Association of Convenience Stores
- National Association of Regulatory Utility Commissioners
- National Association of State Utility Consumer Advocates
- National Electrical Contractors Association
- National Grid
- National Information Solutions Cooperative
- National Rural Electric Cooperative Association
- Nevada Office of Energy
- New Jersey Clean Cities Coalition
- New Jersey Department of Environmental Protection
- New Mexico Public Regulation Commission
- New York City Department of Citywide Administrative Services New York City Fleet
- New York City Department of Transportation
- New York Power Authority
- New York State Department of Public Service
- New York State Department of Transportation
- New York State Electric & Gas
- New York State Energy Research and Development Authority
- NewMo
- Nexant
- Next Generation Infrastructure Consulting
- Nobles Cooperative Electric
- Nolin Rural Electric Cooperative
- North American Council for Freight Efficiency
- North Carolina Electric Cooperatives
- North Carolina Electric Membership Corporation
- North Carolina Utilities Commission
- North Central Texas Council of Governments
- North Texas Electric Auto Association
- Northcentral Electric Cooperative
- Northeast States for Coordinated Air Use Management
- Northern California Power Agency

- Northern Neck Electric Cooperative
- Northern Plains Electric Cooperative
- Northfield Electric Department
- Northwest Rural Public Power District
- Northwestern Rural Electric Co-operative Association
- Nova Scotia Power
- NRG Energy
- Nuvve
- NV Energy
- NXP Semiconductors N.V.
- Ocala Electric Utility
- Ohio Turnpike
- OhmConnect
- Okanogan County Electric Cooperative
- Oklahoma Association of Electric Cooperatives
- Oklahoma Electric Cooperative
- Oklahoma Municipal Power Authority
- Old Dominion Electric Cooperative
- Omaha Public Power District
- Oncor Electric Delivery Company
- Open Access Technology International
- Open Energy Solutions
- OpenADR Alliance
- Oregon Public Utility Commission
- Oregon Trail Electric Cooperative
- Orlando Utilities Commission
- Pacific Gas & Electric
- Paired Power
- Palmetto Clean Fuels
- Panasonic
- PANDO Group
- Panola-Harrison Electric Cooperative
- Paul Smith's College
- Pend Oreille Public Utility District
- Peninsula Light Company
- Pennsylvania Light Company
- Penske
- People's Energy Cooperative
- PepsiCo
- Piedmont Electric Membership Corporation
- Pierce Pepin Cooperative Services
- Pilot Company
- Pioneer Utility Resources
- Pittsburgh Region Clean Cities
- PJM
- Platte River Power Authority
- Plug to Grid Strategies
- Plumas-Sierra Rural Electric Cooperative
- PNM
- Polk-Burnett Electric Cooperative
- Port Harcourt Electricity Distribution Company
- Port of Seattle
- Portland General Electric
- Potomac Electric Power Company
- Powder River Energy Corporation
- Powerflex
- PowerSouth Energy Cooperative
- Price Electric Cooperative
- Project Management Advisors
- Public Service Company of New Mexico
- Public Service Company of Oklahoma
- Public Utilities Commission of Nevada
- Public Utilities Commission of Ohio
- Public Utilities Commission, State of Hawaii
- Puerto Rico Energy Bureau
- Purchase College
- Purdue University
- Qmulus
- Quanta Utility Engineering Services
- Rappahannock Electric Cooperative
- Recargo/PlugShare
- Regional Planning Commission
- Reilly Associates
- Reinhausen
- Renewable and Grid Edge Technology Consulting
- Revel Transit
- Revitalize Charging Solutions
- Roanoke Electric Cooperative
- Rochester Public Utilities
- Rock Energy Cooperative
- Rocky Mountain Institute
- Roseville Electric Utility
- Rowan Energy Integration
- Rush Truck Centers
- Rutgers University
- S Curve Strategies
- Sacramento Municipal Utility District
- SafeAI
- Salem Electric
- Salt River Project
- San Diego Gas and Electric
- San Diego Regional Clean Cities Coalition
- San Francisco Clean Cities Coalition
- San Francisco County, CA
- San Francisco Department of the Environment
- San Francisco Public Utilities Commission
- San Francisco Water
- San Isabel Electric Association
- Santa Clara Valley Transportation Authority
- Santee Cooper
- Sardarkrushinagar Dantiwada Agricultural University in Gujarat
- Sawatch Labs
- ScottMadden
- SemaConnect
- Seminole Electric Cooperative
- Shell
- Shenandoah Valley Electric Cooperative
- Siemens
- Silicon Valley Leadership Group

- Silicon Valley Power
- Sioux Valley Energy
- Slot One Entertainment
- Smart Electric Power Alliance
- Smart Energy Consumer Collaborative
- Smart Grid Solutions
- Smart Taipei City Office
- Snohomish County Public Utility District
- Snohomish County, WA
- Sol Systems
- Solar Hub
- Solar Synergy
- South Carolina Office of Regulatory Staff Energy Office
- South Central Indiana Rural Electric Membership Corporation
- South Central Power Company
- South Dakota Clean Cities Coalition
- South Shore Clean Cities
- Southeast Energy Efficiency Alliance
- Southeast Louisiana Clean Fuel Partnership
- Southeast Michigan Council of Governments
- Southern Alliance for Clean Energy
- Southern California Edison
- Southern Company
- Southern Maryland Electric Cooperative
- Southern Minnesota Municipal Power Agency
- Southern Renewable Energy Association
- Southside Electric Cooperative
- Southwest Arkansas Electric Cooperative
- Southwest Energy Efficiency Project
- Southwestern Electric Cooperative
- Springfield Utility Board
- St. Croix Electric Cooperative
- State Grid Corporation China US Rep Office
- State of Utah
- State University of New York College at Cortland
- Stellantis
- Stem
- Strategy Blue
- Sunflower Electric Power Corporation
- Sunflower Utility Association
- Sunrun
- Sustainable Westchester
- T Kau Solar Solutions
- Talquin Electric Cooperative
- Tampa Bay Clean Cities Coalition
- Tampa Electric Company
- Tennessee Municipal Electric Power Association
- Tennessee Valley Authority
- Territo Electric
- Territo Information Systems
- Texas A&M Transportation Institute
- Texas Department of Transportation
- Texas Electric Cooperatives
- Texas Electric Transportation Resources Alliance
- Texas-New Mexico Power
- The Brattle Group
- The Climate Group
- The George Washington University
- The Mobility House
- The National Center for Energy Control
- The Ray
- The Transtec Group
- The University of Texas at Austin
- The University of Texas at Dallas
- The University of Texas at El Paso
- Thor Hinckley
- Tipmont Rural Electric Membership Corporation
- To the Point
- Today's Power
- Torq EVs
- Town of Apex, NC Electric Utilities
- Toyota
- Transformational Liaisons
- Travel Centers of America
- Traverse City Light and Power
- Trico Electric Cooperative
- Tri-County Electric Cooperative
- Trinity River Community Solar Systems
- Trinity Valley Electric Cooperative
- Tri-State Generation & Transmission
- Tri-State Transportation Campaign
- Tritium
- Tufts University
- Tulsa Clean Cities
- Twin Cities Clean Cities Coalition
- U.S. Department of Transportation
- U.S. Environmental Protection Agency
- Union Power Cooperative
- United Cooperative Services
- United Power
- United States Army Infantry
- United States Council for Automotive Research
- University of California Los Angeles Smart Grid Energy Research Center
- University of Houston
- University of Illinois
- University of Rhode Island
- University of South Alabama
- University of Utah
- University of Vermont
- Utah Associated Municipal Power Systems
- Utah Clean Cities
- Utah Division of Air Quality
- Utah Governor's Office of Energy Development
- Utah Inland Port Authority
- Utah Motorsports Campus

- Utah State University
- Utah Transit Authority
- Vehicle-Grid Integration Council
- Verizon
- Vermont Agency of Transportation
- Vermont Department of Environmental Conservation
- Vermont Department of Public Service
- Vermont Electric Cooperative
- Vermont Electric Power Company
- Vermont Public Utility Commission
- VINCI Energies
- Virginia Clean Cities
- Virginia Department of Mines, Minerals and Energy
- Virginia State Energy Office
- Vitesco Technologies
- Volta Charging
- Volvo Trucks
- Vrinda
- Wabash Valley Power Alliance
- Walmart
- Washington State Department of Commerce
- Washington State Department of Transportation
- Washington State University
- Washington Utilities & Transportation Commission
- Wawa
- Webasto
- West Monroe Partners
- West Virginia Clean Cities
- West Virginia Electric Auto Association
- West Virginia Office of Energy
- West Virginia University Institute of Technology
- Western Farmers Electric Cooperative
- Wheatland Electric Cooperative
- White River Valley Electric Coopeartive
- Wisconsin Clean Cities
- Wisconsin Department of Transportation
- Wisconsin Power and Light Company
- Womanium, MBTA
- World Resources Institute
- Xcel Energy
- Xos Trucks
- Yampa Valley Electric Association
- Yellowstone Teton Clean Cities

Roundtable Facilitators

- Scott Barrios, Entergy
- Lee Krevat, Krevat Energy Innovations
- Kellen Schefter, Edison Electric Institute
- Regan Zane, USU/ASPIRE
- Fred Crowson, Energetics Incorporated
- Mark Duval, EPRI

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- Garrett Fitzgerald, SEPA
- Phil Jones, Alliance for Transportation Electrification
- Dorothy Kellogg, NRECA
- Rustam Kocher, Daimler Trucks North America and Char.IN (now with Portland General Electric)
- Jeffrey Lehman, AEP
- Erika Myers, World Resources Institute
- Matt Nelson, Electrify America
- Scott Phillippi, UPS
- Michael Rowand, Duke Energy
- Jordan Smith, Southern California Edison
- Patricia Taylor, APPA
- Lincoln Wood, Southern Company
- Steve Zimmer, USDRIVE

Call Presenters

Forecasting

- David Treichler, Oncor
- Keshav Sondhi, Frito Lay
- Mike Rowand, Duke Energy
- Dave Schaller, NACFE (North American Council for Freight Efficiency)
- Muhammad Dayhim, Southern California Edison
- Rustam Kocher, Daimler Truck North America

New Technology Implications

- Alex Rojas, Ameren
- Matt Nelson, Electrify America
- Darren Springer, Burlington Electric Department
- Erika Myers, SEPA
- Bill Boyce, SMUD
- Rich Scholer, FCA

Economic Feasibility

- Lindsey McDougall, Austin Energy
- Maria Bocanegra, Illinois Commerce Commission
- Chris Budzynski, Exelon
- Chris Nelder, Rocky Mountain Institute
- Dean Kinports, San Diego Gas & Electric
- Sara Rafalson, EVgo

Understanding Future Requirements

- Peter Westlake, Orlando Utilities Commission
- Chris Michelbacher, Audi
- Kristy Fleischmann, Baltimore Gas & Electric
- Jos Roling, IBM
- Desiree Villalobos, Southern California Edison
- Sila Kilccote, eIQ Mobility

Managing Load

- Richard Mueller, DTE Energy
- Brian Grunkemeyer, Flex Charging
- Jeff Lehman, AEP
- Apoorv Bhargava, Weave Grid
- Alex Brissette, ABB
- James Campbell, Pacificorp

Designing the Infrastructure

- David Eckels, EVIA
- James Campbell, PacifiCorp/Rocky Mountain Power
- Karen Zelmar, Volta Charging
- Pete Westlake, Orlando Utilities Commission
- Kristy Fleischmann-Groncki, Baltimore Gas & Electric
- Danny Ilioiu, King County Metro

Service Requests

- Scott Phillipi, UPS
- Jeff Lehman, AEP
- Bill Boyce, SMUD
- Matt Nelson, Electrify America
- Eric Smith, SemaConnect
- Jordan Smith, Southern California Edison

Deploying the Infrastructure

- Ed Hedges, Evergy
- Chris King, Siemens
- Russ Musgrove, FedEx Express
- Lincoln Wood, Southern Company
- Chris Bilby, Holy Cross Energy
- Chris Nelder, Rocky Mountain Institute

Reliability and Resilience

- Karl Popham, Austin Energy
- Erick Karlen, Green Lots
- Rajiv Diwan, New York Power Authority
- Jennifer Fortunas, Florida Department of Transportation
- Josh Huneycutt, California Public Utilities Commission
- Maria Sanz, Pacific Gas & Electric Company

MultiFamily and Underserved Communities

- Kristy Fleischmann-Groncki, Baltimore Gas & Electric
- Terry Travis, EV Noire
- Long Haul Fleets and Travel Centers
- Dave Schaler, NACFE
- John Thomas, TA Petro

Regional and Local Trucking

- Bill Combs, Penske Transportation Solutions
- Eric Daniels, Oncor

Conventional Retail Fueling

- Tobias Lescht, Revel
- Paul Nichols, Shell

Pilots and Programs

- Bill Boyce, SMUD
- Rustam Kocher, Portland General Electric

Processes and Programs

- Karl Popham, Austin Energy
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- Jared Largen, BCS LLC
- Peter Tolchinsky, BCS LLC

Appendix B: Vehicle Chargers

Charger Type	Power Rating	Equivalent Load	
Level 1 120 VAC	1.4 kW		Hairdryer
Level 2 240 VAC	3 – 19 kW		Dryer, Water heater
DCFC	50 – 350 kW		Small Office Bldg
High Power Charging	1 MW+	TBD	High Rise/Retail mega-center

Source: Mike Rowand (Duke Energy), SAE Government Industry Meeting 2020

Appendix C: Fee and Tax Comparison

Analysis of State-level EV Fees Compared to Gas Taxes							
State	BEV Fee	PHEV Fee	HEV Fee	Gas Tax (cpg)	Est. Annual Gas Tax (10k mi)	Est. Annual Gas Tax (12k mi)	Est. Annual Gas Tax (15k mi)
Alabama	$200	$100	$0	29.21	$74.14	$88.96	$111.21
Alaska	$0	$0	$0	14.98	$38.02	$45.62	$57.03
Arizona	$0	$0	$0	19.00	$48.22	$57.87	$72.34
Arkansas	$200	$100	$50	24.80	$62.94	$75.53	$94.42
California	$100	$0	$0	66.98	$170.00	$204.00	$255.00
Colorado	$50	$50	$0	22.00	$55.84	$67.01	$83.76
Connecticut	$19	$19	$0	35.75	$90.74	$108.88	$136.10
Delaware	$0	$0	$0	23.00	$58.38	$70.05	$87.56
DC	$0	$0	$0	28.80	$73.10	$87.72	$109.64
Florida	$0	$0	$0	42.26	$107.26	$128.71	$160.89
Georgia	$200	$0	$0	36.09	$91.60	$109.92	$137.40
Hawaii	$50	$0	$0	50.17	$127.34	$152.80	$191.00
Idaho	$140	$75	$75	33.00	$83.76	$100.51	$125.63
Illinois	$100	$0	$0	59.56	$151.17	$181.40	$226.75
Indiana	$150	$50	$50	49.79	$126.37	$151.64	$189.56
Iowa	$98	$49	$0	30.00	$76.14	$91.37	$114.21
Kansas	$100	$50	$50	24.03	$60.99	$73.19	$91.48
Kentucky	$0	$0	$0	26.00	$65.99	$79.19	$98.98
Louisiana	$0	$0	$0	20.01	$50.79	$60.94	$76.18
Maine	$0	$0	$0	30.01	$76.17	$91.40	$114.25
Maryland	$0	$0	$0	36.10	$91.62	$109.95	$137.44
Massachusetts	$0	$0	$0	26.54	$67.36	$80.83	$101.04
Michigan	$135	$48	$48	45.12	$114.52	$137.42	$171.78
Minnesota	$75	$0	$0	30.60	$77.66	$93.20	$116.50
Mississippi	$150	$75	$75	18.79	$47.69	$57.23	$71.54
Missouri	$75	$38	$0	17.42	$44.21	$53.06	$66.32
Montana	$0	$0	$0	32.75	$83.12	$99.75	$124.68
Nebraska	$75	$0	$0	28.60	$72.59	$87.11	$108.88

Analysis of State-level EV Fees Compared to Gas Taxes							
State	BEV Fee	PHEV Fee	HEV Fee	Gas Tax (cpg)	Est. Annual Gas Tax (10k mi)	Est. Annual Gas Tax (12k mi)	Est. Annual Gas Tax (15k mi)
Nevada	$0	$0	$0	50.48	$128.12	$153.75	$192.18
New Hampshire	$0	$0	$0	23.83	$60.48	$72.58	$90.72
New Jersey	$0	$0	$0	50.70	$128.68	$154.42	$193.02
New Mexico	$0	$0	$0	18.88	$47.92	$57.50	$71.88
New York	$0	$0	$0	46.19	$117.23	$140.68	$175.85
North Carolina	$130	$0	$0	36.35	$92.26	$110.71	$138.39
North Dakota	$120	$50	$0	23.00	$58.38	$70.05	$87.56
Ohio	$200	$200	$100	38.51	$97.74	$117.29	$146.61
Oklahoma	$110	$82	$0	20.00	$50.76	$60.91	$76.14
Oregon	$110	$0	$0	38.83	$98.55	$118.26	$147.83
Pennsylvania	$0	$0	$0	58.70	$148.98	$178.78	$223.48
Rhode Island	$0	$0	$0	35.00	$88.83	$106.60	$133.25
South Carolina	$60	$30	$30	26.75	$67.89	$81.47	$101.84
South Dakota	$50	$50	$0	30.00	$76.14	$91.37	$114.21
Tennessee	$100	$0	$0	27.40	$69.54	$83.45	$104.31
Texas	$0	$0	$0	20.00	$50.76	$60.91	$76.14
Utah	$120	$52	$20	31.41	$79.72	$95.66	$119.58
Vermont	$0	$0	$0	31.28	$79.39	$95.27	$119.09
Virginia	$64	$0	$0	34.40	$87.31	$104.77	$130.96
Washington	$225	$75	$0	49.40	$125.38	$150.46	$188.07
West Virginia	$200	$100	$100	35.70	$90.61	$108.73	$135.91
Wisconsin	$100	$75	$75	32.90	$83.50	$100.20	$125.25
Wyoming	$200	$200	$0	24.00	$60.91	$73.10	$91.37

Source: Electric Drive Transportation Association (https://electricdrive.org/)

Note:

- Gas tax data is from American Petroleum Institute, July 2021 update - https://www.api.org/oil-and-natural-gas/consumer-information/motor-fuel-taxes.
- MPG calculation uses the most-recent BTS data (https://www.bts.gov/content/average-fuel-efficiency-us-light-duty-vehicles) for a new light-duty passenger vehicle (cell AE-8 in the BTS chart).