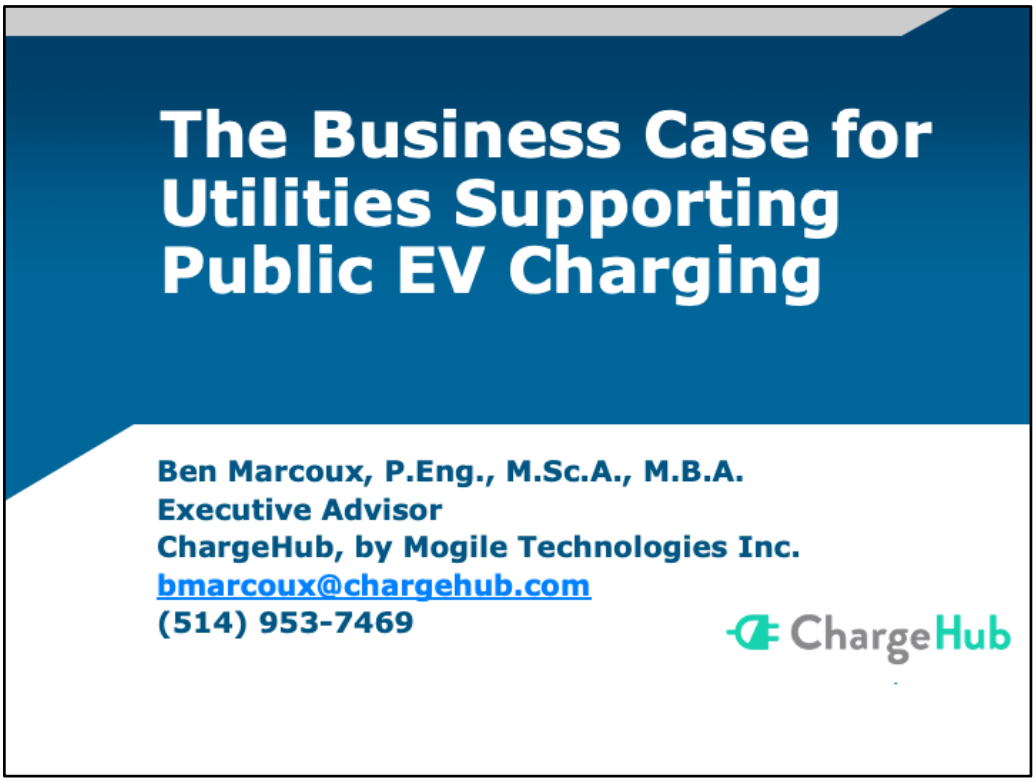
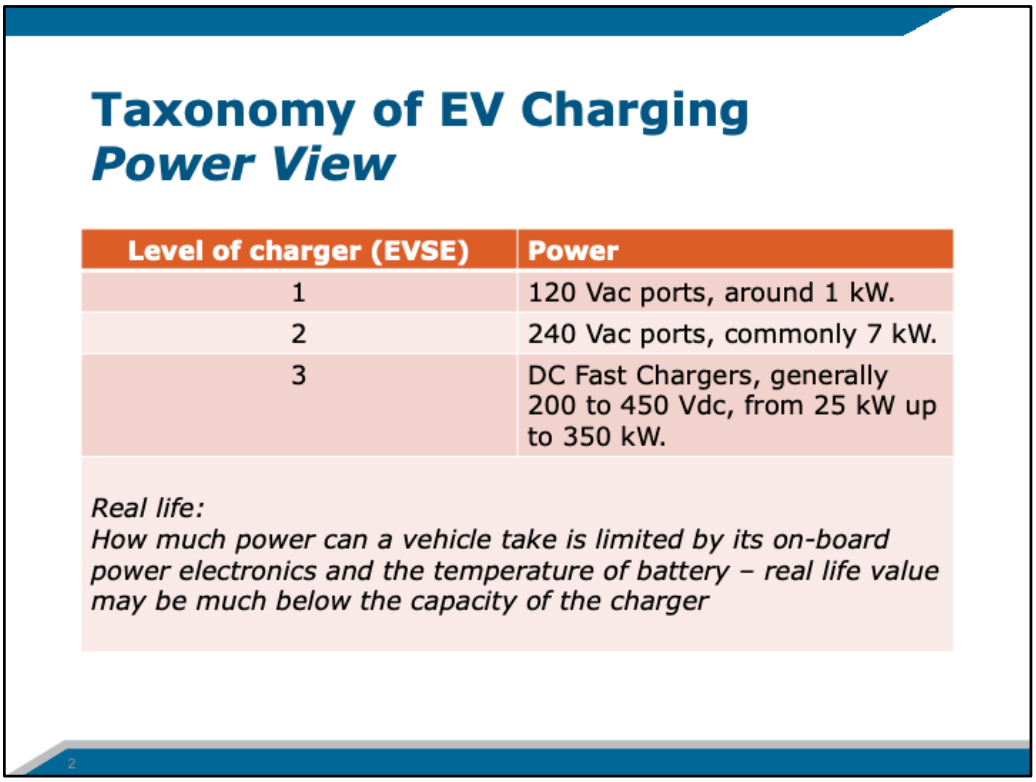


Company info:

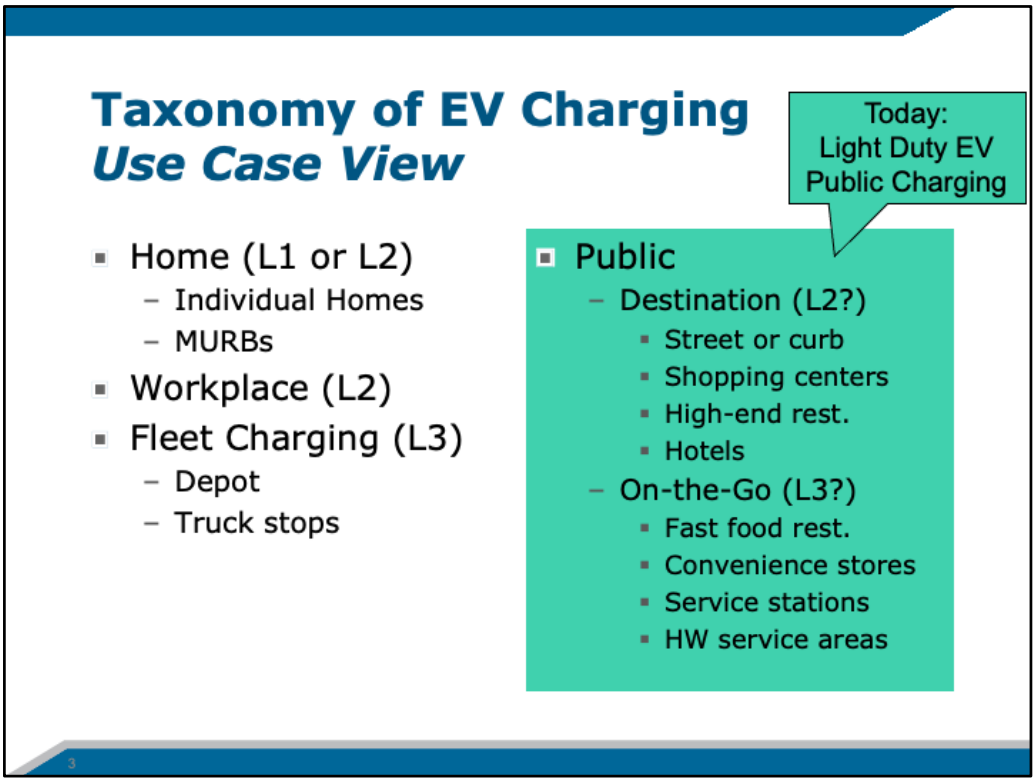
ChargeHub maintains the only independent, curated, user-enriched and commercially available database of public EV charging stations in North America.

This unique perspective on public EV charging serves our commercial and institutional customers—public utilities, governments and automakers—with the necessary driver insights and analytics solutions to apply a data-driven approach to public charging development.



Chargers, or EV Supply Equipment, are defined by their power level:

- Level 1 (L1) chargers refer to 120 Vac ports, at around 1 kW.
- Level 2 (L2) chargers refer to 240 Vac ports, with the vast majority at 7 kW.
- Level 3 (L3) refer to fast chargers at 400 to 800 Vdc, from 25 kW up to 350 kW.
- How much power can a vehicle take is limited by its on-board power electronics and the temperature of battery – real life value may be much below the capacity of the public charger.



Today, we focus on charging of light duty electric vehicles that are publicly accessible.

Destination chargers are intended for drivers parking their cars for sometimes, like on the street, at a library, or at a hotel. Level 2 charging is best used at destination locations, as it is relatively slow.

On-the-go chargers are for quick recharge, like a legacy gas station, either within cities for citizens not having access to home or workplace charging, or along highways. Level 3 charging is best used at on-the-go locations, where drivers are not expecting to stay a long time.

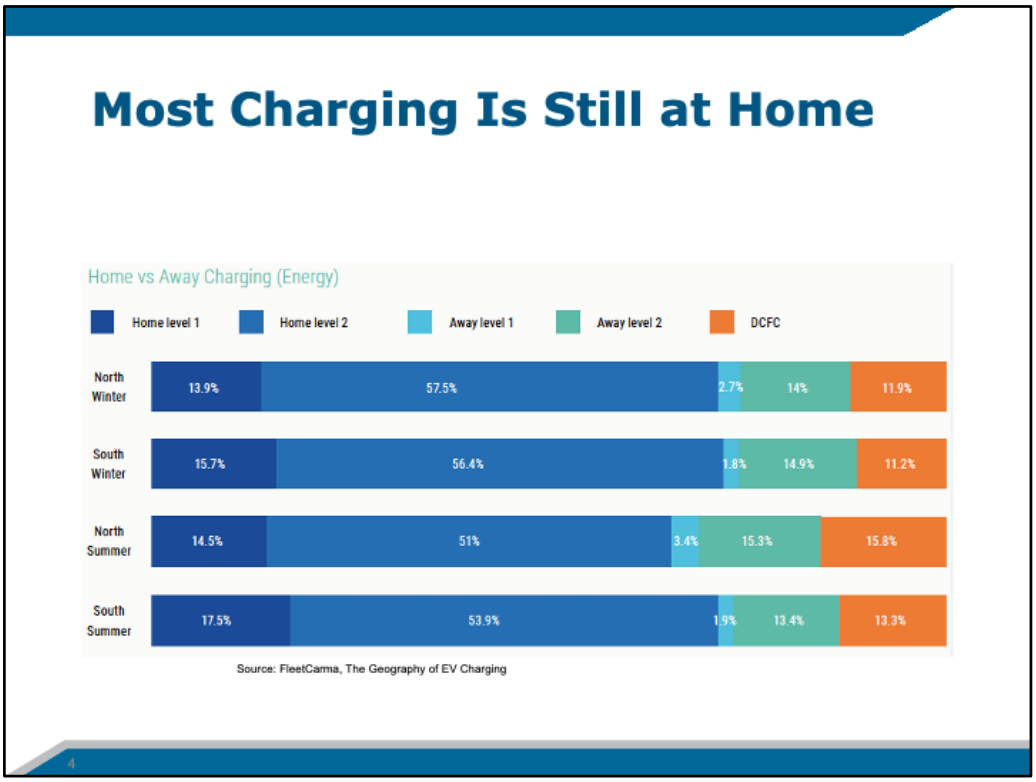
Unfortunately, many charging stations have been installed at unsuitable locations, like level 2 chargers at fast food restaurants – you're not going to want to wait hours at McDonald's.

In addition to today's focus, utilities also need to account for home and workplace charging of light duty vehicles, and for fleet charging.

Light duty vehicles: cars, SUV and pick-ups

MURB = Multiple Unit Residential Building

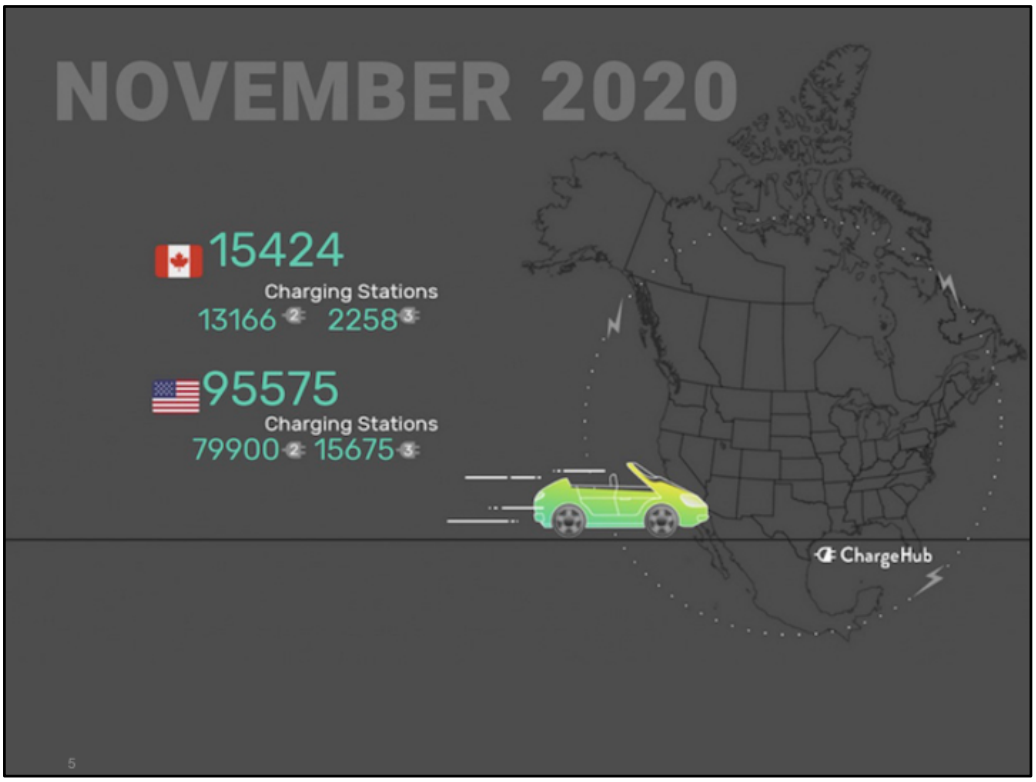
HW – Highway



The vast majority, perhaps 70%, of charging still occurs at home, although this is trending down. The rest is in public or at a workplace. Most DCFC is public.

While most EV drivers do not use public charging regularly, the perceived lack of public charging drives range anxiety. It also slows the expansion of the market and the adoption of EVs by drivers who do not have access to home or workplace charging.

Source: FleetCarma, The Geography of EV Charging



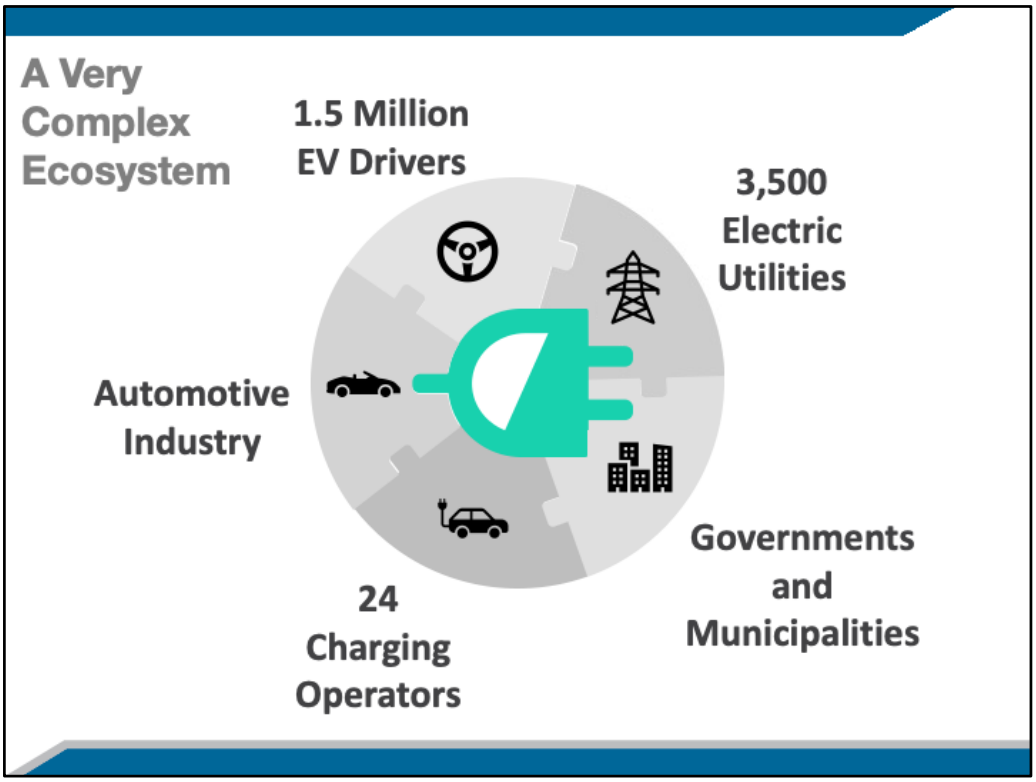
This is a current snapshot of the public charging infrastructure in US and Canada.

Overall, there are about 110,000 charging ports, up from 85,000 in January of this year, a 30% increase in less than a year.

These stations are operated by charging operators. In the USA, the largest operators, measured by port count, are ChargePoint, Tesla, SemaConnect and Blink. In Canada, the largest operators are Tesla, the Electric Circuit (in Québec), Flo and ChargePoint. I will not bury you with statistics, but please contact me if you need something more specific.

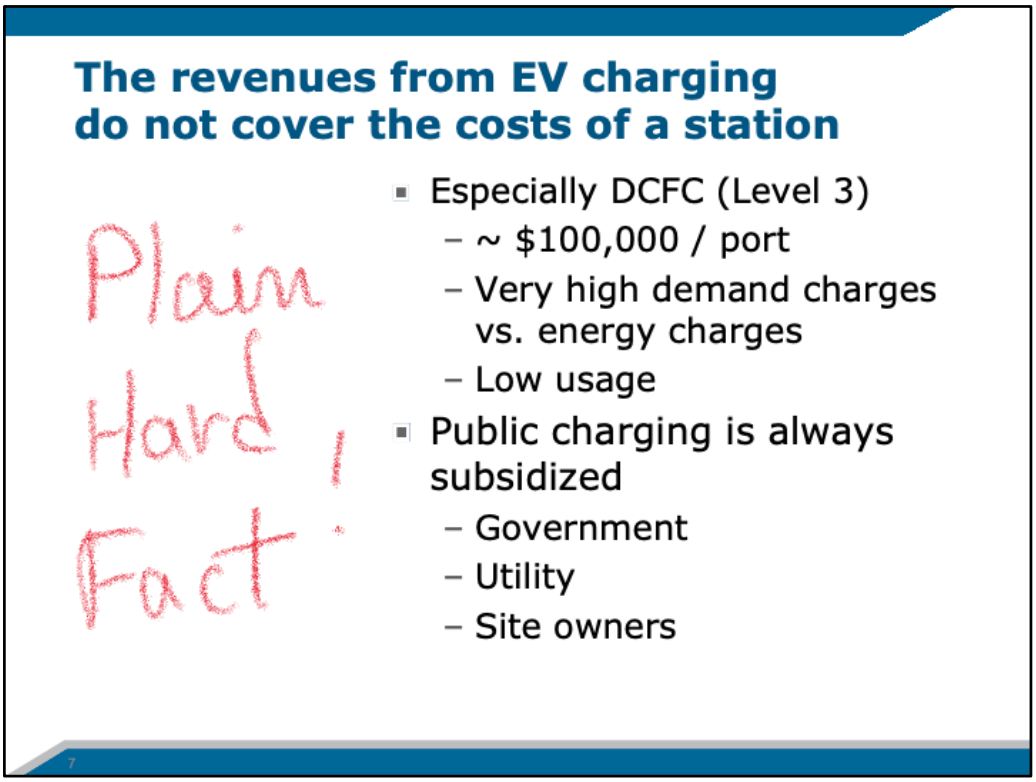
Overall, there are about 24 independent operators in North America, with various business models. Some own the stations, while others just operate them. Some focus on level 2, others on level 3, with multiple connector types. Some are operating across North America, other in just a limited area. Some stations are free to use, while drivers pay for others, with payment schemes varying greatly between operators and between states and provinces. Some operators manufactures their own stations, while others buy them form electrical vendors like ABB. Every state, province and cities, have their own rules and regulations that affect the placement and the costs of public charging stations.

Overall, this is a rapidly growing market, perhaps the fastest growing electrical load segment in North America. However, it is marred by the complexity of the ecosystem.



The public charging ecosystem is very complex, with many players and an array of US-Canada EV Charging Ecosystem (2020)

- 1.5 million EVs
- 3500 electric utilities, including 300 with about 100,000 customers or more
- 50 states and 10 provinces; thousands of municipalities
- 24 public charging network operators with 110,000+ charging ports
- 25 automakers with 39 brands; 100+ global OEM parts suppliers



Even after multiple generations of investments, charging revenue of public stations generally does not cover their costs due to low rates of usage. This holds especially true for the installation of DCFCs, where capital cost can reach over $100,000 per port. Tariffs where utilities apply “demand charges” also result in significant operating costs. Demand charges are tariffs based on the maximum power drawn from the grid on a monthly basis, and often constitutes the larger share of electricity costs for DCFC stations.

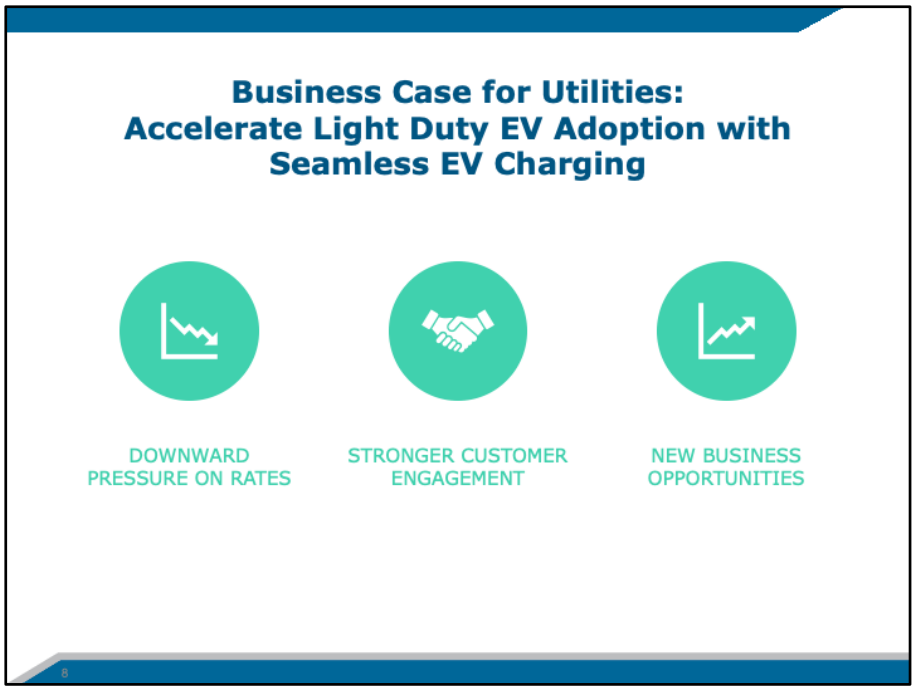
Therefore, the business case of charging operators greatly depends on support from:

Site owners: who deploy chargers to attract new customers or meet current client needs. For example, restaurants, boutiques, apartment buildings and shopping malls are installing Level 2 charging stations. Conversely, DCFC stations follow a more traditional model—paralleling the ease and accessibility gas stations offer—and are often installed at convenience stores located to serve drivers for intercity travel and urban drivers needing a quick charge.

Governments: aiming to meet greenhouse gas emission reduction targets. Many policies and support programs exist—through rebates or utility rates—and vary greatly from one region to another. One of the most significant levers is when a state or province issues a Zero-Emission Vehicle (ZEV) mandate. Under such mandates, automakers are required to supply EVs which creates a direct impact on the amount of ZEV available in North America. Currently, 25 automakers sell 39 brands of light-duty vehicles and prioritize the delivery of EVs to ZEV jurisdictions (12 states and two provinces), with varying progress toward marketing EVs. Where such mandates are nonexistent, drivers may be unable to purchase EV due to supply constraints.

Utility regulators: who understand that EVs exert a downward pressure on rates for all ratepayers. Among the ±3500 utility companies in North America, some offer EV programs and others are considering EV-specific rates to reduce demand charges at public stations. Such practices make sense but are not yet common practice.

As a result, charging operators focus their efforts on where the market is. When analyzing the charging stations in North America, our comprehensive database confirms that many more public charging stations are in ZEV states than in non-ZEV states.

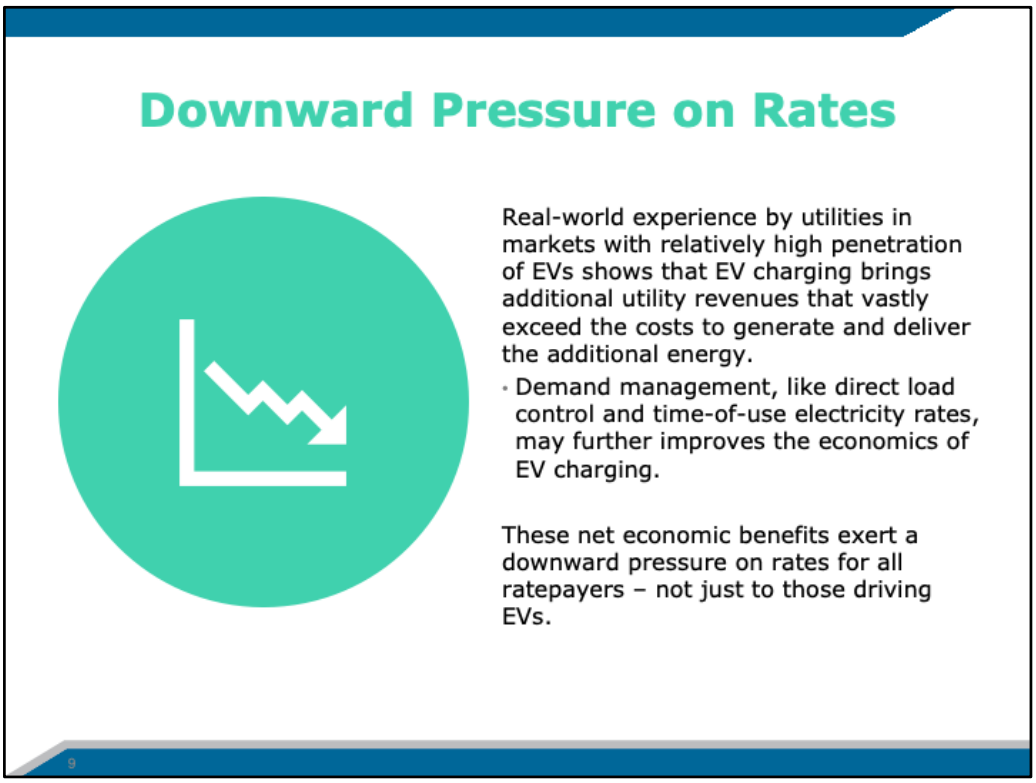


There are 3 main value streams for electric utilities to support light duty EV charging:

Downward Pressure on Electricity Rates

Stronger Customer Engagement

Unlocking Business Opportunities for Electric Utilities



The real-world experience of utilities with noticeable penetration of light-duty EVs shows that EV charging brings additional revenue that vastly exceeds the costs to generate and deliver that energy. In fact, throughout the electric transportation value chain, utilities are, arguably, the businesses with the most to gain from the switch to light-duty electric vehicles.

This optimism may come as a surprise, given concerns expressed in some industry opinion pieces over the ability of the grid to support EVs. However, in California, with high EV penetration, otherwise relatively low average residential load, and high clustering of EVs, a mere 0.15% of EVs required a service line or distribution system upgrade.[1] At a system level, a Hydro-Québec study showed that home charging an EV draws an average of only 600 watts on peak—a small amount.[2] It is worth noting that these two examples do not rely on any strategies for EV load management, which further lower contribution to peak load.

In practice, many factors mitigate the grid impact of unmanaged EV charging. For instance, owners of modern long-range EVs tend to charge at home only every two to three days[3], and often well outside peak demand hours. Also, many EV drivers simply charge from a standard 120 V wall plug—called level 1 charging—which is slow but can add enough range for daily commute in many circumstances. More and more drivers can now charge at their workplace or at public stations, diversifying the load curves.

If anything, the advent of EVs may enable electric utilities to grow again: current year-over-year electricity consumption growth (kWh) is close to 0% in North America, down from about 2.5% as recently in the 1990s.[4] Incredibly, yearly growth was about 8% to 10% in the 1950s and 1960s, as a wave of electrification propelled the economy. Let's not forget the DNA of electric utilities evolved to *grow* the electricity grid, the greatest engineering achievement of the 20th century.[5]

Looking forward, increase in electricity use due to the transition to electric vehicles range from a fraction of a percent to perhaps 2% per year[6]—not negligible, but clearly manageable given past growth rates.

Overall, grid impacts of light-duty EV load profile over at least the next decade should be relatively modest. The net economic benefit from additional demand revenue vastly exceeds the costs of providing it. That benefit can exert downward pressure on rates for all utility customers—not just those driving EVs. For example, Avista estimates that the net present value to ratepayers of a single EV on its system is $1,206, without managed charging.[7] Furthermore, shifting charging to off-peak hours or periods of high renewable generation further improves that benefit—up to $1,603 per vehicle

Sources:

1 Joint IOU Electric Vehicle Load Research - 7th Report, June 19, 2019.

2 Public Fast Charging Service for Electric Vehicles, Hydro-Québec, R-4060-2018, HQD-1, document 1.

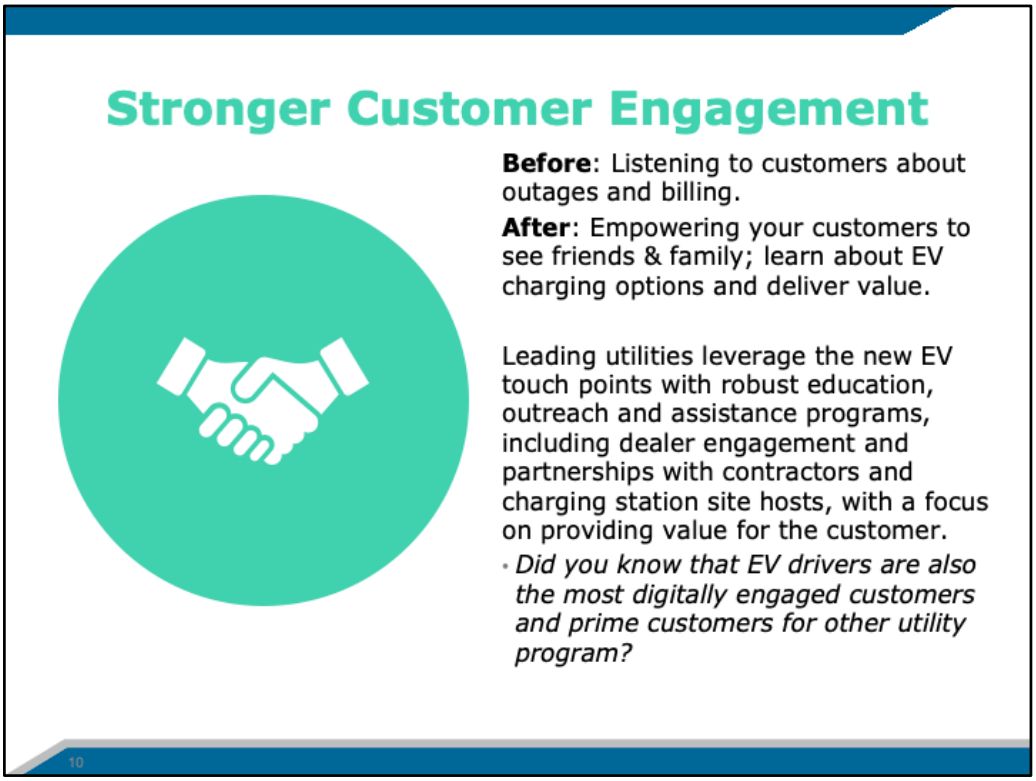
3 Not charging every day is recommended by automakers. See, for instance, the recommendations of Hyundai at https://www.greencarreports.com/news/1127732_hyundai-has-5-reminders-for-making-your-ev-battery-last-longer.

4 https://data.nrel.gov/files/90/EFS_71500_figure_data%20(1).xlsx, figure 2.1, for US data.

5 As assessed by the national Academy of Engineering, see http://www.greatachievements.org.

6 For examples of forecast electricity use from EV adoption, see: - Mai et al., Electrification Futures Study, page 82. https://www.nrel.gov/docs/fy18osti/71500.pdf. - Canadian electric vehicle transition—the difference between evolution and revolution, EY Strategy, October 2019, page 9. https://assets.ey.com/content/dam/ey-sites/ey-com/en_ca/topics/oil-and-gas/canadian-electric-vehicle-transition-the-difference-between-revolution-or-evolution.pdf.

7 Electric Vehicle Supply Equipment Pilot Final Report, Avista Corp., October 18, 2019.



Today, ratepayers largely interact with their utility for outages and billing issues. Not exactly positive customer engagement.

Compare this to how engaged drivers of gasoline cars are. They'll drive out of their way to pay less, and fuel up on days when prices are lower. They follow loyalty programs and use coupons. Gas stations have become minimarts. Clearly, motorists are deeply engaged with those providers.

In offering EV charging, utilities become mobility enablers, empowering their customers to visit friends and family, or to go to work and shopping. Those consumers make a conscious decision to interact with the utility every time they plug in their vehicles.

Just as gas stations do, leading utilities can leverage those new touch points, offering robust education, outreach, and assistance programs. Those start right on the dealer lot, move through vetting electrical contractors for home installations to partnering with charging-station site hosts, all along focusing on boosting value to the customer. It can even add an element of fun: the gamification potential of EV charging and driving is high, with some automakers already using games to change behavior.[1]

One major value-creation opportunity is leveraging home EV charging to get customers to opt into time-of-use or dynamic electricity tariffs. Residential EV charging responds well to price signals; even a small rate differential induces a strong tendency for overnight charging.[2] Light-duty EVs can be easily programmed through the car or the charger to begin charging at a preset time, making the burden on the driver low. The impact of time-of-use tariffs on charging is impressive: PG&E customers enrolled in time-of-use tariffs conduct 93% of EV charging off peak; at Southern California Edison, 88% of charging is off-peak.[3]

Today, the big problem with time-of-use tariffs is that utility customers are not opting into them. A few jurisdictions mandate use of smart meters and chosen to impose time-of-use tariffs: Ontario in Canada[4] and, soon, California and other states[5]. However, most regulators are giving customers the choice ("opt-in") rather than imposing tariffs. Unfortunately, opt-in percentages for residential time-of-use tariffs tend to be very low—sometimes less than 1%[6]. For utilities, this is unfortunate, as time-of-use tariffs improve their peak-to-average ratio, reducing system costs for all ratepayers.

Charging an electric vehicle with low-cost off-peak electricity is a powerful argument for utilities when persuading customers to go for whole-house time-of-use rates. Furthermore, the ongoing need for off-peak EV charging makes it uneconomical for drivers to return to flat electricity rates, ensuring customers stay on those plans. Once adopted, time-of-use tariffs also encourage customers to shift other household loads to off-peak—a positive feedback loop. By promoting whole house time-of-use tariffs, the net value of EV charging to ratepayers becomes higher yet.

Benefits extend beyond EV charging and time-of-use opt-in. Utility professionals know how difficult it is to recruit customer participants for energy efficiency and demand-response programs.[7] However, EV drivers are utilities' most digitally engaged customers[8] and hence prime targets for such programs. They are the customers most open to buying Energy Star® appliances and smart thermostats. The day a customer buys an electric vehicle may be the best time to sign them on a utility demand-response program—not only for the home charger, but also for cooling, space heating, water heating, even battery storage. With more touch points, greater trust, and clearly defined savings, recruiting EV customers into energy programs is much easier.

EV charging lets utilities reset and boost their customer engagement—especially as owning and driving a car has more passion behind it than other electricity uses (hot water to clean dishes, say).

Sources:

1 See "Gamification-based framework for engagement of residential customers in energy applications", https://www.sciencedirect.com/science/article/pii/S2214629618304420.

2 Final Evaluation for San Diego Gas & Electric's Plug-in Electric Vehicle TOU Pricing and Technology Study, Nexant, Inc., February 20, 2014

3 Beneficial Electrification of Transportation, The Regulatory Assistance Project (RAP), January 2019, p. 66.

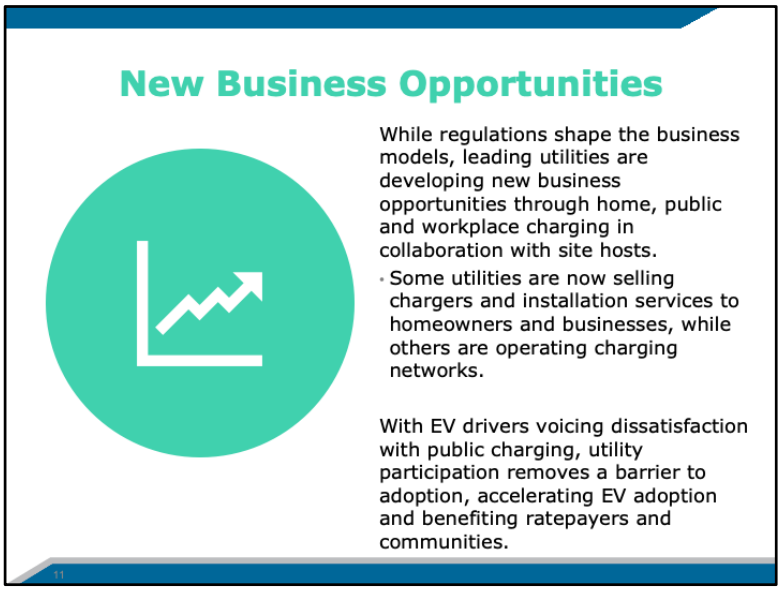
4 Analysis of Ontario's Full-Scale Roll-out of TOU Rates—Final Study, prepared for the Independent Electric System Operator, by The Brattle Group, Inc., Mountain Economic Consulting and Associates, Inc. and eMeter, a Siemens Company, February 03, 2016.

5 2019 Utility Demand Response Market Snapshot, SEPA, September 2019.

6 Driving Transportation Electrification Forward in New York, Considerations for Effective Transportation Electrification Rate Design, Prepared for Natural Resources Defense Council, Synapse Energy Economics, Inc. June 25, 2018.

7 2019 Grid Integration Insights, SEPA, 2019.

8 EV owners tend to fit the demographics of digitally engaged consumers. See https://www.carmax.com/articles/hybrid-electric-2017-survey-results, for EV drivers and The New Energy Consumer: Unleashing Business Value in a Digital World, Accenture, 2015, for smart home owners.



Leading utilities find new business opportunities in home, workplace and public charging of light-duty vehicles, but effective collaboration with other stakeholders is required.

For example, some utilities now sell home charging stations and installation services to both homeowners and businesses. This is a natural extension of outreach and assistance programs aimed at EV dealers. Also, utilities may offer to vet electrical contractors for installation of home chargers, reducing customer anxiety and ensuring safer work.

That installation is a good opportunity to offer time-of-use tariffs, energy-efficiency tips, and demand-response programs to customers. At the same time, utilities can propose other appliances like smart thermostats, perhaps even energy-storage systems. Green Mountain Power is a good example of one utility leveraging the sale and the installation of residential EV chargers in a portfolio of other services and products.[1] A similar opportunity may exist with workplace charging, as well as with multi-dwelling units.

For utilities, public charging of light-duty vehicles may even have more value potential than residential chargers—and DC fast-charging stations (level 3) have more potential than 240 V destination chargers (level 2).[2] Today, EV drivers are deeply dissatisfied with the existing public charging infrastructure, and drivers who do most of their charging at home or work are much happier than those who rely on public fast chargers.[3]

The shortage of public charging stations and lack of awareness of those that do exist fuels range anxiety, and widespread confusion between Level 2 destination and DC fast chargers adds to the uncertainty. EV drivers are baffled by the plethora of pricing plans for public charging, with each operator having its own unique rate structure. Some charge a subscription fee; others sell by units of energy (kWh); still others impose fees by the minute, all with possible surcharges.

All these factors create barriers to EV adoption. For utilities, the opportunities come from supporting the development of a DC fast-charging infrastructure and using their deep reach to promote the existence of that charging, at a scale smaller operators simply can't match. All this will serve to accelerate EV adoption, especially for drivers (a) without access to home or workplace charging; or (b) who regularly take road trips that exceed the range of their EVs.

Note that public DC fast-charging stations are generally not profitable: an analysis of DC fast-charging stations in 8 US states showed them to have negative NPV of $31k to $41k.[4] In other words, the cost of installing and operating a public DC fast-charging station is usually more than the charging revenue it generates. But, DC fast charging is a necessary prerequisite to considering an EV for many buyers. Higher EV adoption brings a corresponding increase in profitable home and workplace charging, creating permanent value for utilities and ratepayers.

For example, a study for NYSERDA showed that the benefits of an expanded DC fast charging infrastructure exceeded additional costs by $235 per EV.[5] With an average of 200 to 300 EVs per DC fast charger, this more than compensated for the lack of profitability. Another example: Hydro-Québec justified including the capital costs of a DC fast charging infrastructure in its rate base because of its "induced effects" on EV adoption and the ensuing benefits for all ratepayers.[6] This is also the rationale that NYPA used to deploy its own DC fast-charging stations.[7]

Furthermore, public DC fast charging offers totally new and valuable business areas for utilities. Like gas stations before them, selling energy at a DC fast-charging site acts as a loss leader for profitable ancillary services (like car washing) and many types of retail convenience sales. Compared to gas stations, DC fast charging sites require less infrastructure and are less constrained by zoning by-laws and public safety concerns. With the lower cost and smaller footprint of DC fast chargers in comparison to fuel pumps and tanks, we may see more and smaller sites, especially adjoining existing or new stores.

Fast charging takes a few minutes more than filling a gas tank. The countervailing benefit is that drivers do not have to remain beside the car, sweating, freezing or being rained on, while squeezing a filthy gas-pump handle.[8] With an electric car, a driver only needs to plug it in—and then adjourn to the adjoining café or convenience store for a snack, a coffee, or some groceries. This increases the shopping potential of each visit. We anticipate convenience stores evolving to cater to drivers who spend 15 or 30 minutes onsite, instead of solely "grab and go" offerings while they pay for fuel.

However, drivers will make fewer visits to fast-charging sites versus gas stations, since most charging will occur at home, at a workplace, or at a destination. For site owners, longer and more profitable stays should compensate for the reduced number of visits. Furthermore, demand for such traditional services as car washing and sales of windshield-washer fluid remains. Also, new concepts—appointments to charge a vehicle, valet services, or hand-washing a car while it is being charged—are likely to emerge.

The additional time spent at a charging site is an opportunity for deeper customer engagement, for both the site owner and the utility. Ideally, charging sites can become, in effect, utility stores. Utilities and site owners will need to partner in new and innovative ways to maximize the benefits from the transition to EVs. Utilities within a state should also consider working together, to reinforce each other's efforts.

Sources:

1 See https://greenmountainpower.com/product/home-level-2-ev-charger/.

2 Level 2 chargers operate at 240 volts and typically take many hours to fully charge a light-duty vehicle. They are commonly found in residences, in workplaces and as destination chargers, often at hotels and restaurants. Level 3 DC fast chargers operate at up to 450 volts and typically take tens of minutes to charge a light duty vehicle. Drivers use DC fast chargers for long distance travel or in cities not when home and workplace charging cannot be used.

3 Based on a survey of Tesla Model 3 drivers. See https://www.bloomberg.com/graphics/2019-tesla-model-3-survey.

4 Energy and Environmental Economics, January 2018, quoted in R-4060-2018.

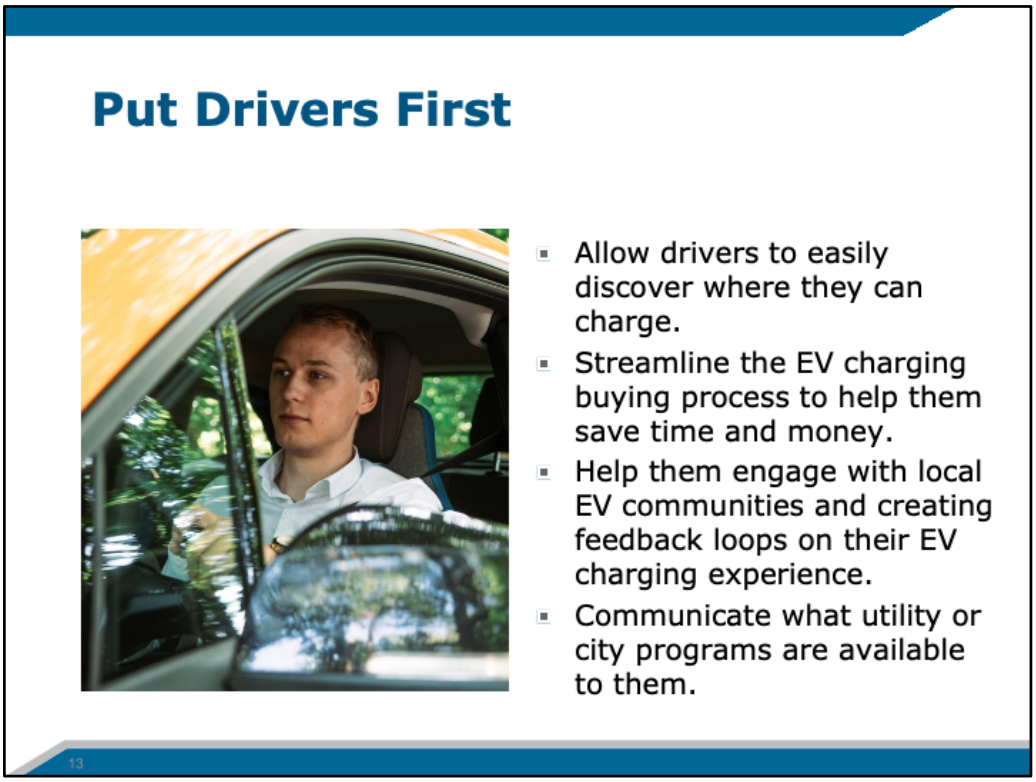
5 Benefit-Cost Analysis of Electric Vehicle Deployment in New York State, February 2019.

6 See, for example, Public Fast Charging Service for Electric Vehicles, Hydro-Québec, R-4060-2018, HQD-1, document 1.

7 See https://www.utilitydive.com/spons/podcast-wheres-the-energy-cloud-going/521431/#ep-six, "Electrified Transportation" podcast, As expressed by New York Power Authority's (NYPA) Doug McMahon.

8 Gas pump handles top study of filthy surfaces, according to Kimberley-Clark. See https://www.prnewswire.com/news-releases/testing-reveals-high-contamination-levels-of-everyday-objects-in-major-us-cities-gas-pump-and-mailbox-handles-are-among-the-dirtiest-132523688.html.

The efforts to expand the public charging infrastructure is getting snagged on technological and regulatory issues. To progress towards electrification, the public EV charging infrastructure needs reorganization; starting with a data-driven and customer-focused approach to public charging.



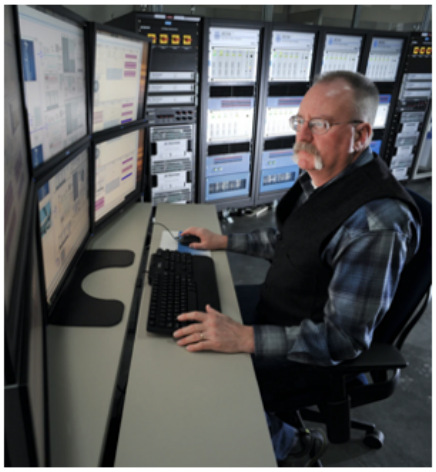
Utilities, like governments, are foremost, in the people's business. When getting into electromobility, the "product" that people buy isn't a luxury, but rather an essential tool to complete daily activities: getting to work, going grocery shopping, visiting friends and traveling to go see family. All of these are potential touch points for utilities and governments to connect with EV drivers and engage with them in new ways that have yet to be leveraged.

Due to the low level of satisfaction regarding the current public charging infrastructure, we recommend putting EV drivers first by simplifying their lives and bringing value, such as:

- Allowing them to easily discover where they can charge.
- Streamlining the EV charging buying process to help them save time and money.
- Helping them engage with local EV communities and creating feedback loops on their EV charging experience.
- Communicating what utility or city programs are available to them.

Get Session-Level Data From Charging Operators

- Prioritize getting access to session-level charging data from charging operators in return for access to city-owned properties or support from the utility.
- Cities and utilities may also require operators to meet certain performance metrics in order to continue benefiting from access or support.



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Session-level charging data is valuable to utilities and cities for planning the infrastructure and for managing services to drivers. Therefore, as a best practice, prioritize getting access to session-level charging data from charging operators in return for access to city-owned properties or support from the utility. Cities and utilities may also require operators to meet certain performance metrics in order to continue benefiting from access or support.

Shield Yourself From Complexity and Changes

- Leave the technology and business complexities of the public charging infrastructure to the many network operators!
- All you need is to stay informed on key trends and forecasts within the market in order to better plan and care for customers, to streamline the EV charging buying and paying process, and to promote their EV (and non-EV) programs.

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Utilities and cities can leave the technology and business complexities of the public charging infrastructure to the many network operators. All they need is to stay informed on key trends and forecasts within the market in order to better care for their citizens who are EV drivers, to streamline the EV charging buying and paying process, and to promote their EV (and non-EV) programs.


Questions?
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