

# As e-mobility accelerates, can utilities move EVs into the fast lane?

June 2022

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# About this report



Electricity networks across the US and Canada face a new and significant test: the oncoming mass adoption of 85 million electric vehicles (EVs) by 2035. The grid, already under pressure from changes in climate and energy use, must become more resilient than ever before. This report examines the imminent challenges and opportunities for power and utility companies and identifies what they can do to accelerate e-mobility.

The pace of EV adoption in the US and Canada is ramping up. But three major pain points could delay the switch from internal combustion engine (ICE) vehicles to EVs and upset the transition to e-mobility. The first two hurdles: supply of EVs and the often-cited range anxiety, will be addressed by market forces. The third: the ability to charge quickly and easily, hinges on both charge point operators (CPOs) being able to secure permission to install infrastructure and on grid operators being able to provide the connections. The whole premise of e-mobility depends on a safe and resilient grid, supported by digital capabilities to mitigate the impact of EVs on local networks. In the evolution of transport, distribution utilities are the lynchpins.

This study focuses on the anticipated surge in EV sales across the US and Canada and the charging infrastructure required to support it. We consider different charging needs across six distinct charging environments: residential (single-home units and multi-dwelling units), workplace, fleet hubs, overnight stay hubs and highway corridors. And we examine the potential impact on electricity load.

We lay out the scale of the challenge and technology solutions that are either available or in development to manage peak load and capture value from flexibility in EV batteries. We also acknowledge the pivotal role of the customer in driving the e-mobility transition and the need for the emerging industry to coalesce around customer demands.

This report is informed by the experiences and insights of industry leaders operating in the e-mobility ecosystem of supporting businesses. Representatives from automotive, utilities, fleet management and charging infrastructure shared their experiences and opinions openly and honestly with us, and we thank them for their invaluable contributions.

## Report authors

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# Foreword



- ▶ EV adoption is gaining momentum. By 2035, 85 million EVs will hit the roads in the US and Canada.<sup>1</sup>
- ▶ Though the US and Canada lag Europe and China on EV adoption, there are opportunities to seize an advantage. Innovators are thinking beyond cars, to the electrification of trains, buses, light rail and taxis, and will aim to secure a share in the emerging multibillion-dollar market.
- ▶ The future of e-mobility and associated wins for customers and the environment will be found in collaborative partnerships within an extended ecosystem.
- ▶ Success will hinge on compelling customer incentives and the electrification of vehicles that appeal to the everyday needs of consumers in the US and Canada.
- ▶ Home is where most charging takes place. And it's likely to remain that way for the foreseeable future. Charging solutions (currently patchy) must be designed with the destination and the user in mind.
- ▶ As EV adoption increases, the risk to the electricity grid comes from concurrent charging. The more vehicles that connect to the grid, the greater the burden on the adequacy, security and quality of power supply.
- ▶ To minimize disruption to the distribution grid, managed charging solutions – both active and passive – are the answer. They help with understanding congestion hotspots, tracking energy variances and deferring EV charging until there is adequate electricity supply, including renewables, at the lowest rate.
- ▶ Utilities will seek to occupy the customer space in the evolving e-mobility ecosystem. Already in customers' homes and armed with insights about energy usage, utilities can turn data into a valuable commodity and deepen the customer relationship with more sophisticated and tailored EV charging solutions.
- ▶ Customers will be front and center of the e-mobility transition. Utilities will compete with nontraditional players for the right to serve. Proactive partnership models and an innovative ecosystem will widen customer choice and promote the design of e-mobility concepts for the present and the future.

<sup>1</sup> This report focuses on battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), i.e., EVs that are powered from the grid. *EY Mobility Lens Forecaster*, May 2022

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A close-up, side-profile photograph of a woman with dark hair and a small stud earring. She is wearing a light grey ribbed turtleneck sweater. Her hands are visible as she holds a black charging cable, which is connected to a dark grey charging station. The station has three ports labeled 'DC 1', 'DC 2', and 'DC 3'. The background is blurred, showing what appears to be a parking lot at dusk or night.

# Chapter 1:

EV adoption enters  
the mainstream in  
the US and Canada

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Conditions align for the  
acceleration of e-mobility

Momentum for e-mobility is accelerating in the US and Canada. The tipping point into mass adoption coincides with enhanced regulation and government-led initiatives to encourage EV acceptance. It comes alongside rising costs for the consumer at the pump and growing awareness of the climate agenda. Investment capital is flowing to the corporations that take a proactive stance on the environment and decarbonization.

At the consumer level, barriers to adoption are easing as e-mobility technology evolves. Public confidence is building, and familiarity with the logistics of charging at home, at work or at the store is working its way into everyday consciousness. Parking lots are dotted with EV chargers, a sure sign that new modes of transport will overtake the old. And automotive companies are embracing the challenge by investing in electric power trains that exceed policy targets. They are also reshaping their factories, production lines and manufacturing processes to increase EV choice for consumers.

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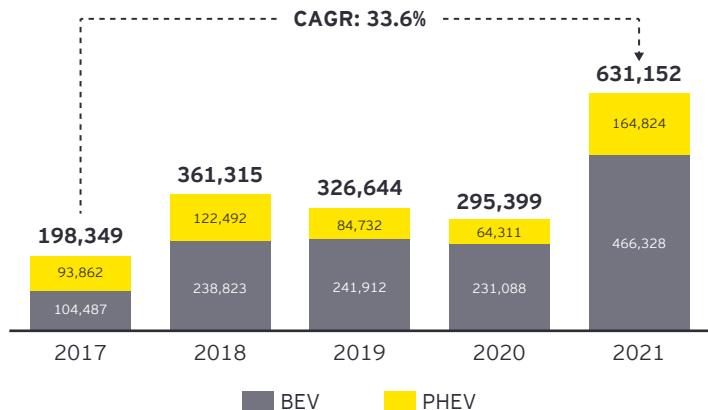
The speed of the EV transition will be quick. It's the 2006 solar boom, only five times faster.

Colin Murchie

Senior Business Director, EVgo, America's largest public fast-charging network

Technology is evolving quickly too. At Lion Electric, which builds heavy- and medium-duty trucks and school buses, Patrick Gervais says, "Four years ago, we were able to do about 100 to 125 kilometers on a single charge. Now, we can do up to 250 kilometers in school buses and up to 400 kilometers in trucks."

Figure 2: Total US light-duty EV registrations by type (units)

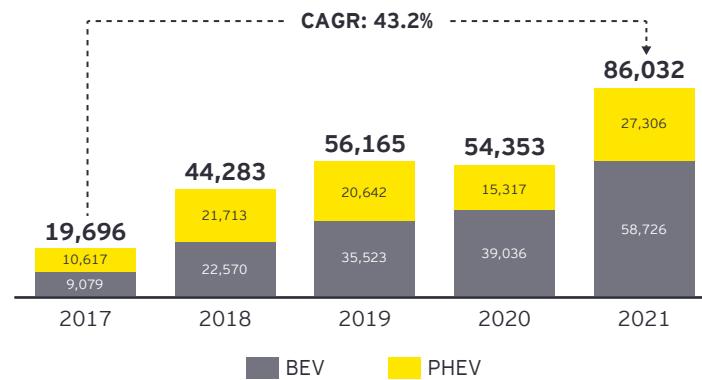


Source: "Global EV Outlook 2022," IEA.org, IEA EV Data Explorer, May 2022.

In the US, the federal government aims for 50% EV sales and 500,000 public chargers by 2030. The targets are underpinned by existing incentives and new funding packages of USD7.5b to build charging infrastructure and USD3b for advanced battery supply chains, as set out in the Infrastructure Investment and Jobs Act (IIJA).

The story in Canada is much the same. Just 86,000 battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) were sold in 2021, accounting for 5.2% of all new vehicle registrations.<sup>2</sup> Compare that with Europe, where 20% of vehicles sold were electric.

Figure 1: Total EV registrations by type (units)



Total vehicle type excludes buses, trailers, recreational vehicles, motorcycles, golf carts, etc.

Source: Statistics Canada, Table 20-10-0024-01, "New motor vehicle registrations, quarterly," <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002401>.

As change agents align for EV adoption in the US and Canada, progress is not as fast as in Europe and China. In 2021, electric car sales represented 9% of the global car market, with around 16.5 million electric cars on the roads worldwide, consuming roughly 55 terawatt-hours (TWh) of electricity per year. Of the 6.6 million EVs sold worldwide that year, 3.3 million were sold in China and 2.3 million in Europe. Meanwhile, the US lagged with 630,000 EVs, the equivalent of 4% of new car sales.<sup>3</sup>

Among the factors holding back EV sales in the US is the lack of compelling consumer incentives as compared to Europe. Though the US administration set aggressive EV deployment targets, a key policy goal (huge expansion in buyer subsidies) has stalled in Congress. On top of that the pickup truck, the vehicle of choice for many Americans, has been slow to electrify, putting the brakes on adoption. Meanwhile the sheer scale of US terrains and the patchwork nature of state-led legislation further stand in the way of rollout.

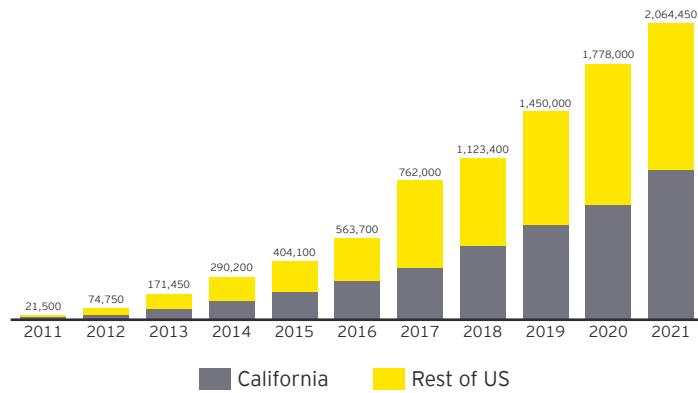
<sup>2</sup> "New motor vehicle registrations: Quarterly data visualization tool," Statistics Canada, date accessed 1 June 2022.

<sup>3</sup> "Global EV Outlook 2022," IEA.org, May 2022.

The first quarter of 2022 offered new promise. Global electric car sales reached 2 million in the first three months of the year, up 75% from the same stretch in 2021.<sup>4</sup> In the US, total electric car sales jumped from 2.5% of sales in the first quarter of 2021 to 5.2% in the same period in 2022. At around 200,000 units,<sup>5</sup> the increase is likely due in part to new EV models hitting the market and historically high gasoline prices.

Leading the US in EV adoption is California. The state accounts for 39% of all EVs sold in the US in the first quarter of 2022, despite making up just 12% of the US population.<sup>6</sup> This is in large part thanks to the state's enhanced purchase incentives, which persuade automakers to prioritize EV distribution to Californian dealers, giving consumers greater vehicle choice. In March 2022, California announced it would aim for 68% of all sales to be EVs by 2030 and 100% by 2035. Other progressive states are likely to follow California's lead, creating regional differences.<sup>7</sup> California also leads in the medium- and heavy-duty (MHD) truck sector. Its 2020 Advanced Clean Trucks Act requires that at least 30% of all MHD truck sales are zero-emissions vehicles (ZEVs) by 2030, rising to 100% by 2050. Fourteen other states, plus Washington, DC, have pledged to follow California's lead.<sup>8</sup>

**Figure 3: EV cumulative sales in California and the US**



Source: "Global EV Outlook 2022," IEA.org, IEA EV Data Explorer, May 2022.

Canada suffers from being the world's largest emitter of greenhouse gases (GHGs) from light-duty vehicles (LDVs) per kilometer driven.<sup>9</sup> Passenger vehicles and trucks made up more than 50% of road transport GHG emissions in 2020. To remedy that, Canada is getting firmly behind e-mobility. The new Emissions Reduction Plan (ERP), published in March 2022, mandates that EVs must make up 20% of new passenger vehicles sold by 2026, quadrupling current sales. That rises to 60% by 2030. By 2035, all new vehicles sold must run on batteries.<sup>10</sup>

But EV adoption in Canada is patchy. Quebec and British Columbia (BC) account for 75% of EVs sold, due to existing provincial sales mandates and purchase-price rebates. While EV sales made up 13% of new registrations in BC in 2021,<sup>11</sup> it is a different story in Ontario, where a provincial rebate was dropped in 2018. EV sales plummeted to just 3% of new vehicle sales in 2021.<sup>12</sup> To alter the narrative and accelerate EV adoption, the Canadian government's 2022 federal budget committed an extra CAD1.7b on EV rebates for consumers by 2025, triple the levels on offer since 2019. This comes on top of existing sales mandates.

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You need a strong zero-emissions vehicle mandate to bring the cars into Ontario. That's not happening. The cars go to Quebec, BC and California because that's where the ZEV-mandates are. A balance must be found between EV demand and supply.

**Neetika Sathe**

Vice President of the Green Energy & Technology Centre (GRE&T Centre), Alectra

Canada's **Emissions Reduction Plan** for 2030 contains key milestones to help it meet its legally binding target of net zero by 2050. The ERP accelerates the federal government's 2040 target for 100% zero emissions LDV sales by 2035, with interim targets of 20% ZEV sales by 2026 and 60% by 2030. Provinces such as British Columbia and Quebec have scaled up their policy ambitions in response.

<sup>4</sup> "Global EV Outlook 2022," IEA.org, May 2022.

<sup>5</sup> "10 Takeaways from U.S. Auto Sales: Q1 2022," Cox Automotive, 20 April 2022.

<sup>6</sup> Fred Lambert, "US electric car sales jumped to an impressive record high last quarter," electrek.co, 28 April 2022.

<sup>7</sup> "Transportation Electrification," California Public Utilities Commission, site accessed 2 June 2022.

<sup>8</sup> Emily Porter, "Electric Trucks Can Move Our Stuff Today," RMI.org, 4 May 2022.

<sup>9</sup> Daniel Breton, "The Government of Canada's 2035 Electric Vehicle Mandate Is Absolutely Attainable," Electric Mobility Canada, site accessed 2 June 2022.

<sup>10</sup> "2030 Emissions Reduction Plan - Canada's Next Steps for Clean Air and a Strong Economy," Environment and Climate Change Canada, 29 March 2022.

<sup>11</sup> Darron Kloster, "B.C. electric vehicles sales tops in North America," Times Colonist, 2 June 2022.

<sup>12</sup> Allison Jones, "Sales of electric vehicles plummet in Ontario now that province has cancelled rebate," CBC.ca, 15 December 2019.

## Automakers on board with e-mobility, but supply is falling short

With the backing of both governments, the shift toward e-mobility is progressing. By 2030 EY analysts calculate that Canada's EV market will grow to 6.7 million and will double to more than 14 million by 2035. In the US EV adoption is predicted to grow from around 2.3 million in 2021 (less than 1% of the total 284 million vehicles)<sup>13</sup> to more than 70 million in 2035, when EVs will account for 18% of vehicles on the roads.

Accelerating EV adoption hinges on a ready supply of vehicles. In response automotive companies are bringing new models to market and expanding battery production. Their aim is to capture market share by rolling new EV models quickly off the production line to appeal to a broadening pool of consumers. In the coming year the number of all-electric offerings will quadruple, from 13 to more than 50.<sup>14</sup>

Hyundai has unveiled a USD5.4b plan to build EVs and batteries in Georgia,<sup>15</sup> while Ford is investing USD22b through 2025 to deliver BEVs and plans to be carbon neutral by 2050. In January General Motors (GM) announced a multibillion-dollar plan to build battery cells and electric pickups in Michigan,<sup>16</sup> one of several states where it is boosting capacity. GM also aims to introduce 30 new EV models globally by 2025<sup>17</sup> and has committed to phase out ICE vehicles by 2035.<sup>18</sup> With new electric pickups, such as the Rivian R1T, GMC Hummer EV and Ford F-150 Lightning, the market is seeing exponential growth in EV nameplates.

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EV awareness is rising — the 2022 Super Bowl adverts did a great job at that — but availability is the first, second and third most important factor for EV adoption right now.

Chris George

US EV Director, Octopus Energy

Despite automakers' EV aspirations, short-term supply remains a major hurdle and is failing to keep up with customer demand. According to Ontario's Electric Vehicle Society, some buyers are having to wait a year to take delivery of their vehicles.<sup>19</sup>

Multiple external pressures contribute to the shortfall. Supply chain disruptions and increased battery costs are exacerbated by trade tensions due to the war in Ukraine, which is increasing input costs, especially for EVs. The industry has yet to overcome the semiconductor shortages that constrained a post-pandemic recovery in automotive sales. And a surge in COVID-19 cases in China's key manufacturing hubs of Shenzhen and Changchun has led to factory shutdowns, aggravating supply chain pressures on auto and electronics manufacturers.

## Greener mandates

### Canada

- ▶ Eliminating carbon-dioxide (CO<sub>2</sub>) from passenger cars by 2050 is a major part of Canada's journey to net zero by 2050.
- ▶ In 2019, the transport sector was the second largest source of GHG emissions, accounting for 25% (186 megatons of carbon-dioxide equivalent) of total national emissions.
- ▶ Canada's LDV fleet is No. 1 in the world for GHG emissions per kilometer driven.

### The US

- ▶ The transport sector accounts for 29% of total US GHG emissions, making it the largest contributor to US GHGs.
- ▶ By 2025, US emissions could be 14% to 18% below 2005 levels, far short of what is needed to address climate change.
- ▶ Between 1990 and 2019, GHG emissions from the transport sector grew by 54%. Growth in emissions was mostly driven by increases from freight trucks and passenger light trucks.
- ▶ Little success has been made in reducing GHG emissions from transport. After dropping sharply in 2020 due to the steep decline in transport activity during the COVID-19 pandemic, GHG emissions from road transport rebounded in 2021.

Source: Mia Rabson, "Mandatory EV sales quotas needed by end of next year: Guilbeault," *Canadian Press*, 10 December 2021.

<sup>13</sup> "Number of vehicles in operation in the United States between 4th quarter 2017 and 4th quarter 2021," *statista.com*, March 2022.

<sup>14</sup> Paul A. Eisenstein, "Electric Cars: The Surge Begins," *Forbes*, 6 October 2021.

<sup>15</sup> "Hyundai Motor Group to Establish First dedicated EV Plant and Battery Manufacturing Facility in the U.S.," *Hyundai press release*, 20 May 2022.

<sup>16</sup> Sam Abuelsamid, "GM Pouring \$7 Billion Into New EV Plants In Michigan," *Forbes*, 25 January 2022.

<sup>17</sup> "Factbox: U.S. automakers line up EV models to take on Tesla," *Reuters*, 5 January 2022.

<sup>18</sup> Jim Motavallid, "Every Automaker's EV Plans Through 2035 And Beyond," *Forbes*, 4 October 2021.

<sup>19</sup> Moises Canales-Lavigne, "Wait times growing for Canadians wanting to purchase electric vehicles," *Global News*, 3 May 2022.

## Investors back greener corporates

The other big catalyst for EV adoption is the investment community's backing for cleaner power trains.

To date, the automotive industry has largely targeted tailpipe emissions. But given the increasing focus on lowering emissions associated with material production, there is a growing expectation that automakers should aim to reduce their total Scope 3 emissions too. Investors are putting funds behind those automakers and businesses that publicly demonstrate their commitment to corporate social responsibility via their environmental, social and governance (ESG) practices, policies and activities. In the US, where the Securities and Exchange Commission intends to standardize climate disclosure reporting,<sup>20</sup> EV adoption is becoming a commercial imperative as well as an environmental one.

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A lot of corporates are signing up for net-zero mandates because of their focus on ESG. Investors are asking for ESG initiatives, and EVs are a big tool in the toolkit for combatting climate change.

**Neetika Sathe**

Vice President, Alectra, the largest municipally owned electric utility in Canada



<sup>20</sup> “To the Point – SEC proposes enhancing and standardizing climate-related disclosures,” EY.com, 23 March 2022.



## Chapter 2:

Patchy charging infrastructure rollout creates national division

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Drivers' needs should govern location of public charging stations

EVs must be as easy, or easier, to drive as ICE vehicles if they are to sustain customer enthusiasm. The vehicles and the enabling infrastructure must go hand in hand to accelerate EV adoption. However charging infrastructure rollout is patchy.

Today most EV charging takes place at residences, where vehicles tend to park for long durations overnight. In the US, 88% of EVs have access to residential charging,<sup>22</sup> but this varies significantly across the country and by property type. According to the National Renewable Energy Laboratory (NREL), 70% of detached single-unit households have access to home charging. It plummets to 10%-20% for rented apartments.<sup>23</sup> By 2035, when 18% of the vehicle stock is expected to be electric, most EV charging is still likely to be done at home.

Soon the EV market will expand beyond early adopters (those that are typically high-income, single-family homes with access to off-street parking). This will create demand for charging solutions that cater to households without regular access to overnight home charging, such as rentals and multi-dwelling units. Destination locations such as shopping malls, community centers, movie halls and restaurants will provide convenient places for EV drivers to charge.

Ultimately growth in EV sales will warrant a network of publicly accessible fast chargers to:

- ▶ Enable longer trips in an EV
- ▶ Encourage buyers who lack access to private charging to consider an EV
- ▶ Tackle range anxiety as a barrier to EV adoption

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At a quick-serve restaurant, you are there for 20 minutes and can get 90 miles of range out of a 75kW charger, which is good for a couple of average driving days. If you put chargers where people are going already, then no one ever needs to go someplace just to charge. It distributes load around the grid, distributes charging more equitably, and it helps to promote local businesses. It's a better model for social, economic and environmental reasons.

**Jeff Wolfe**

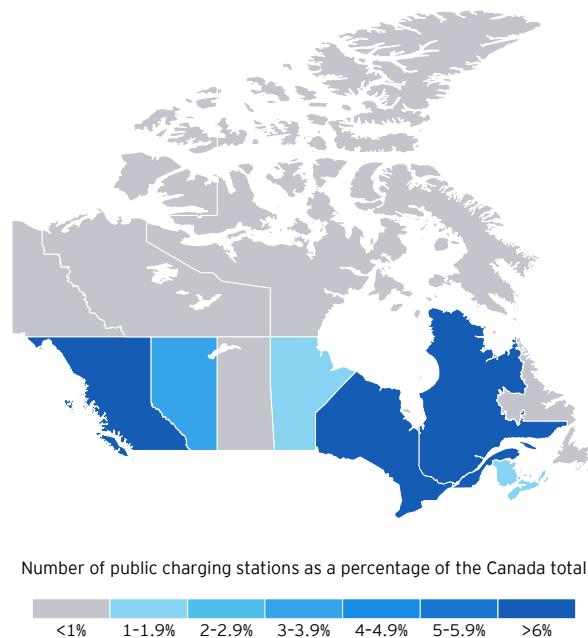
CEO and Co-Founder, Veloce Energy

## Greater equality needed in EV charging rollout

In the US and Canada combined there are around 55,000 level 2 and DC fast-charging public stations.<sup>24</sup> That number falls far short of future anticipated needs.

EY analysts forecast that around 300,000 public charging stations will be needed in Canada by 2030, rising to 600,000 by 2035. Currently, Canadian EV drivers have access to more than 16,000 charge ports at nearly 7,000 public charging stations. This includes 1,300 DC fast-charging stations, capable of 95 to 130 kilometers' range per 20 minutes of charging time.<sup>25</sup> Quebec, BC and Ontario account for 90% of all installations.

**Figure 4: Number of public charging stations as a percentage of the Canada total**



Canada's Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative, which allocated CAD96.6m toward building a coast-to-coast network of fast-charging stations, has come to end.<sup>26</sup> Now the Zero Emission Vehicle Infrastructure Program is offering CAD680m through 2027 to tackle charging shortages at workplaces and multi-unit dwellings.<sup>27</sup> Promises to build 50,000 new chargers, announced in late 2021, are criticized as insufficient. In March 2022, the ERP announced an additional CAD500m for ZEV charging stations. Natural Resources Canada has previously advocated one charging station per every 20 EVs by 2025.<sup>28</sup>

<sup>22</sup> Gordon Bauer and Chih-Wei Hsu, et al, "Charging up America: assessing the growing need for U.S. charging infrastructure through 2030," *theicct.org*, July 2021.

<sup>23</sup> Yanbo Ge and Christina Simeone, et al, "There's No Place Like Home: Residential Parking, Electrical Access, and Implications for the Future of Electric Vehicle Charging Infrastructure," *National Renewable Energy Laboratory*, October 2021.

<sup>24</sup> A station location is a site with one or more EVSE ports at the same address, e.g., a mall parking lot. An EVSE port provides power to charge only one vehicle at a time even though it may have multiple connectors. A connector is what is plugged into a vehicle to charge it.

<sup>25</sup> "Electric Charging and Alternative Fuelling Stations Locator," *Natural Resources Canada*, site accessed 2 June 2022.

<sup>26</sup> "Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative," *Natural Resources Canada*, site accessed 2 June 2022.

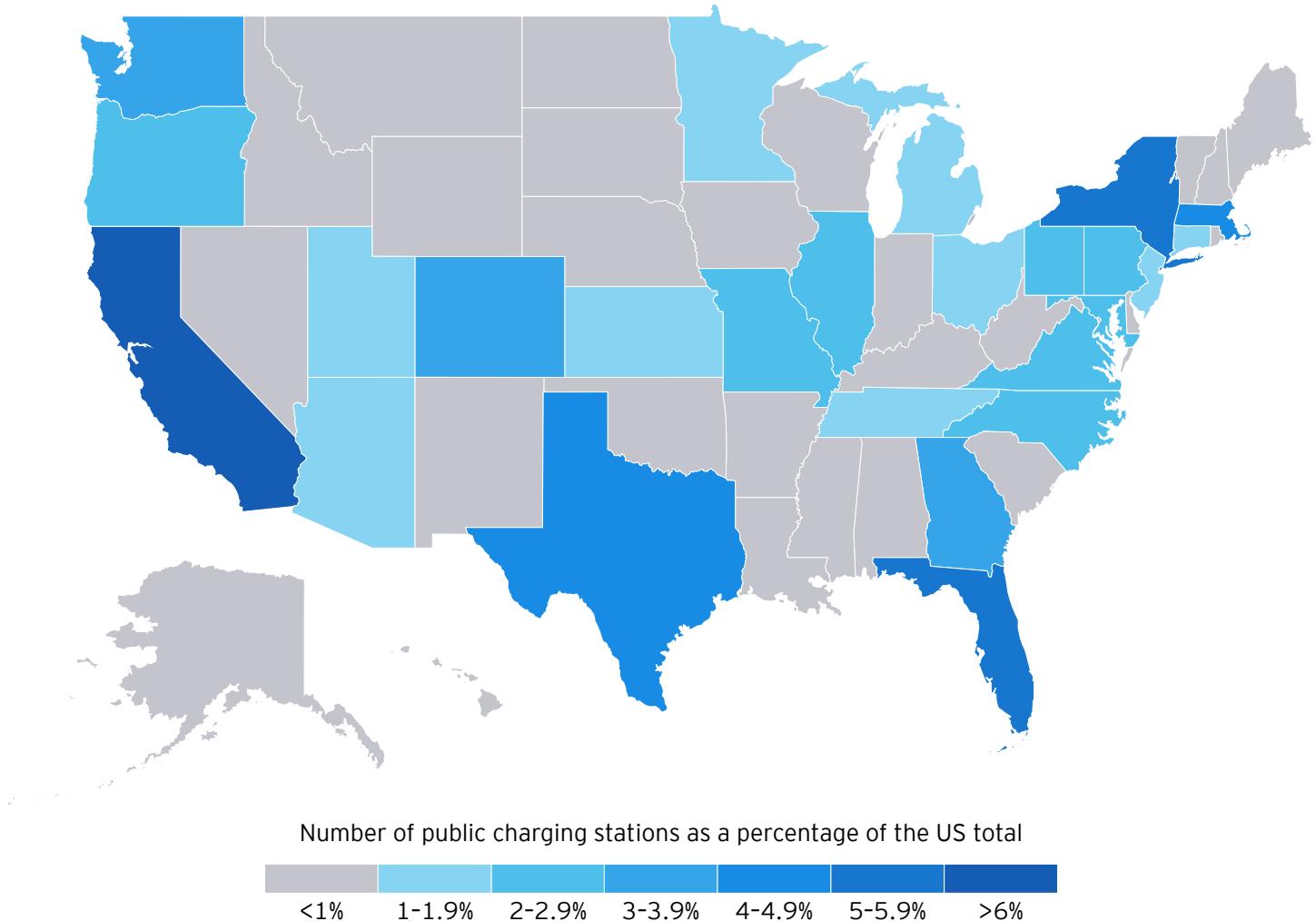
<sup>27</sup> "Zero Emission Vehicle Infrastructure Program," *Natural Resources Canada*, site accessed 2 June 2022.

<sup>28</sup> Mia Rabson, "Canada needs to build millions – not thousands – of EV charging stations, industry group says," *Canadian Press*, 21 December 2021.

Meanwhile, in the US there are around 48,000 level 2 and DC fast-charging public stations, with almost 120,000 chargers currently in operation. More than 6,200 are DC fast-charging stations with more than 24,000 chargers. The Alternative Fuels Data Center calculates that California has by far the largest share,

with 29% of all charging stations. New York comes in second with 6%, and Florida is in third place, with just over 5%. By contrast, Mississippi, one of the poorest states in the US, has just 0.2% of the total, which highlights the huge polarization in availability across the US.<sup>29</sup>

**Figure 5: Number of public charging stations as a percentage of the US total**



Source: EY analysis of data from the Alternative Fuels Data Center – as of 19 May 2022

The US has committed USD7.5b over the next five years via the IIJA for a network of half a million publicly accessible EV chargers along highway corridors and in communities.<sup>30,31</sup> USD2.5b is set aside to install EV charging and alternative fuels on public roads, around schools and parks, and in publicly accessible parking facilities. These grants will be prioritized for rural areas, low- and moderate-income neighborhoods, and communities with low ratios of private parking or high ratios of multi-unit dwellings. The remaining USD5b will be allocated to the National Electric Vehicle Infrastructure Program to strategically deploy EV charging infrastructure and to establish a network that enables data collection, access and reliability.

For now charge points are largely centered in more affluent and coastal communities, while central and agricultural states tend to be underserved due to the lack of affordable EV powered heavy industrial vehicles.

At Cox Automotive, Stephanie Valdez Streaty advocates mobility equity. "Plans to make sure that underserved areas get access to grants and funding are paramount," she says. Andrew Horstead, EY Global Power & Utilities Lead Analyst, concurs: "Infrastructure must be sited in locations where it will serve the greatest need so that all communities benefit from EV rollout." For Chris George at Octopus Energy: "EVs should be for everyone."

<sup>29</sup> "Alternative Fueling Station Counts by State," U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, site accessed 2 June 2022.

<sup>30</sup> "President Biden's Bipartisan Infrastructure Law," whitehouse.gov, site accessed 2 June 2022.

<sup>31</sup> "President Biden, U.S. Department of Transportation Releases Toolkit to Help Rural Communities Build Out Electric Vehicle Charging Infrastructure," U.S. Department of Transportation, 2 February 2022.

EY analysts forecast that 3 million public charge points will be needed in the US by 2030, rising to 8 million by 2035, a 9x increase on current levels. To deliver the number of chargers required to support the projected deployment of EVs, public funding must be complemented by private company investment.

At the same time improvements must be made to the permitting and connections process for charge point installations. All too often delays occur where the CPO has to provide detailed plans to the utility, which must then assess the viability of the connection and the potential need for grid upgrades. This can take up to 12 months – sometimes longer.

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We need to get away from ‘gas station thinking’ of a charge point every 50 miles. A more refined approach could focus on installing charge points in major conurbations to satisfy customers’ immediate and relevant needs and building out at 100-mile intervals from population centers until the network organically connects. That should be sufficient for the next two to four years, and the rest will come organically as EV uptake scales.

Just follow the retailers. They do their homework on optimal locations for consumers.

Colin Murchie  
Senior Business Director, EVgo

Thought must also be given to the type of charger that is best suited to the environment in which it is located. For instance, a DC fast charger (DCFC), which can give a full charge within 15 minutes or so, is not as critical at a movie theater complex, where EVs sit idle for a couple of hours, as it is at a fast-food restaurant, where inactive time is limited.

“Every state is unique in terms of driver needs, city locations and the level of existing infrastructure build-out. States should be able to determine where charge points will serve the greatest need, prioritizing charging along highway corridors, as well as convenience and accessibility for both long-distance drivers and local communities,” explains Andrew Horstead.

### Types of chargers

In broad terms, there are three types of EV chargers: Level 1 AC (L1), Level 2 AC (L2) and Level 3 (DC fast charging or DCFC).

**L1 charging** is most widely used in residential locations, offering the smallest range per hour (RPH) and supplying average power output of 1 kW-1.4 kW. Most L1 chargers are found in consumers’ garages and carports and can take eight to 12 hours to produce a full charge.

**L2 charging** is faster, taking four to six hours to fill the battery of an average passenger EV. L2 chargers have a power output of 3.3 kW-19.2 kW. They are mostly found at commercial charging sites, such as restaurants, multi-unit dwellings or hotels. While the EV is charging, drivers can eat, meet, sleep or run errands.

**DCFC** is designed to fill a battery to 80% within 10 to 40 minutes. DCFC charging systems typically cost more and require more involved utility service upgrades. DCFCs are suited to high-volume sites, commercial fleet lots or locations with shorter dwell times.





# Chapter 3:

It's not how  
much energy EVs  
consume, but when  
they consume it

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Pressure is mounting to outline  
innovative solutions to energy  
needs



Electric Bus

The US and Canada face an era of rapid change across the entire energy system as they prepare to:

- ▶ Integrate more renewables
- ▶ Update infrastructure that is reaching the end of its useful life
- ▶ Accelerate the electrification and digitalization of the economy
- ▶ Accommodate more sophisticated and interactive energy consumption by consumers
- ▶ Add new communication technologies to improve the understanding of grid conditions

Grid innovation will play a critical role as the EV market mobilizes around e-mobility and as charging infrastructure is installed.

Chief among the challenges for utility companies is to determine whether bulk power systems can meet the expected surge in electricity demand as EVs are deployed in greater number. In Canada, EY analysis estimates that electricity demand for EV charging is expected to account for 2.4% of overall power demand in 2030, increasing to 5.3% in 2035, equivalent to around 35TWh a year. In the US, electricity demand from EVs is expected to add 128TWh by 2030, rising to around 400TWh in 2035. By then EVs will account for 10% of overall US power demand.

Risks of destabilizing the network will come not just from demand growth but from concurrent demand, as millions of EVs attempt to charge simultaneously. This is called an "unmanaged charging" scenario. In this context an EV fleet must become an increasingly important consideration for power systems, given its implications on peak power demand and transmission and distribution. The more vehicles that connect to conventional electrical networks, the greater the risk to the adequacy, security and quality of power supply if they charge concurrently. Unmanaged charging can lead to voltage drops, voltage fluctuations and power losses.<sup>32</sup>

Factoring in predicted EV adoption, the number and types of chargers in use, and the estimated average daily distances traveled by electric vehicles, EY analysts calculated the likely draw on the electricity grid. Across the six use cases, in all instances peak load will increase from 3% to 37% in a low-EV-uptake scenario, equivalent to what we could expect in 2030. It increases from 39% to 84% in a high-EV-uptake scenario, what we may anticipate in 2035.<sup>33</sup> Two further observations stood out:

- ▶ The greater the coincidence in usage patterns, the greater the impact on peak demand. So for residential charging at an MDU, where the height in EV charging coincides with peak daily electricity usage, the impact on demand is greatest.
- ▶ Impact is positively correlated to charging speed. So a single 350 kW charger has a much greater effect on peak demand than multiple 7 kW slow chargers operating in a home or workplace setting.

EV charging will have the greatest impact on the distribution grid, which will need to manage significant additional loads. This could warrant grid upgrades and reinforcement of low- and medium-voltage transformers and lines.

The addition of charging for heavy-duty vehicles (HDVs), with their higher power needs, will lead to even greater stress on local grids. If a bus operator plans to electrify its fleet at a downtown depot where the grid is already constrained, this will add significant load to the network. In this instance peak load could increase between 15% and 56% depending on the number of vehicles charging at any one time. The problem becomes exacerbated where there is limited flexibility in positioning the charging station due to availability of land. If connection capacities at the location are already constrained, then the distribution grid could require upgrades, which can be costly.



EY analysis considered the six most common charging use cases, as identified in our conversations with the industry:

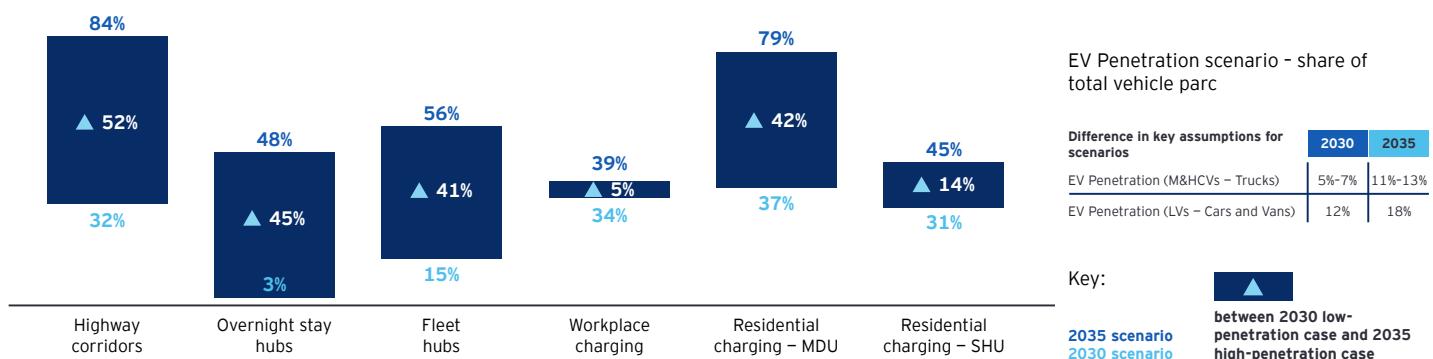
1. Residential – single-home unit (SHU)
2. Residential – multi-dwelling unit (MDU)
3. Workplace
4. Fleet hub
5. Overnight stay hub
6. Highway corridor

<sup>32</sup> Abdollah Ahmadi and Ahmad Tavakoli, et al, "Power quality improvement in smart grids using electric vehicles: a review," *IET Electrical Systems in Transportation*, 11 April 2019.

<sup>33</sup> Serge Colle and Thierry Mortier, et al, "Power sector accelerating e-mobility," *EY.com*, 2022.

**Figure 6: Impact of unmanaged charging across six charging use cases**

Peak load variance (% increase) by EV penetration

Source: EY analysis, May 2022<sup>34</sup>

Highway corridors, particularly in remote locations, can present significant challenges for the rollout of charging infrastructure. According to the International Energy Agency (IEA), a typical roadside charging hub (which includes several chargers for LDVs) is unlikely to demand more than a two-megawatt (MW) connection. It can typically be connected to a low-voltage network. On the other hand, chargers that allow several HDVs to charge simultaneously could require connections of up to 10MWs. And that would mean connecting to a high-voltage grid. Grid upgrades could be an expensive barrier: the IEA estimates a USD8m price tag for an electric truck charging hub in a remote location.<sup>35</sup>

Chris George at Octopus Energy comments, "People are moving to Texas in droves, and when you begin adding vehicles to the grid, as well as electrifying cooker tops, heat pumps and water heaters, there is reason to begin addressing grid reliability now, not later. For the electrification of everything, we need to be prepared to support multiples of today's demand with innovative technologies and increased renewable generation." Alectra, meanwhile, estimates that it will need to modernize the grid to meet the charging capacity needs of EVs. "Our load forecasting and planning folks say there is no immediate concern about the increase in demand. But longer term, there is a concern given forecasted EV adoption rates," says Neetika Sathe.

At AEP, Chief Customer Officer Phil Dion is less concerned: "EVs won't 'break the grid.' That's because they will be adopted in a gradual fashion and will naturally disburse on our system. Further, you cannot look at EVs in a vacuum. Greater adoption of other technologies, like solar panels and batteries, both at utility scale and the individual customer level, will, with proper planning, bolster the grid's ability to serve EV load." He explains, "Just as we accommodated load growth from air conditioning, we will integrate new load from EVs as well as other resources. That said, due to their high-capacity needs in one location, fleets and fast chargers might prove more challenging, but we're working on that. And we'll be ready."

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Just as we accommodated load growth from air conditioning, we will integrate new load from EVs as well as other resources.

**Phil Dion**  
Chief Customer Officer, AEP



<sup>34</sup> EY grid impact analysis is conducted using the World Resources Institute EV simulator tool. This evaluation is illustrative and is conducted for six presumptive transformers located in a utility's service territory. The analysis is not carried out for any specific utility or service territory. The review factors in several assumptions around vehicle attributes, user driving and charger behavior, and charger attributes and is sourced using secondary research, expert input and analysis.

<sup>35</sup> "Global EV Outlook 2022," IEA.org, May 2022.

## Technology solutions promise new flexibility

Though infrastructure reinforcement might seem an obvious answer to managing the impact of EV charging on distribution grids, it may not be the most efficient solution. The unpredictable EV burden is not the only challenge for grid operators. They are also dealing with the introduction of heat pumps and the electrification of buildings and the industry.

Up-front investment is needed to control power flows, limit power losses and manage peak hours so the grid is available on demand. That requires a clear view of anticipated EV adoption, heat pumps, etc. and congestion hotspots on local distribution grids, as well as the ability to track energy variances by geographic location. In turn it will inform decisions relating to energy expansion. EY analysts calculate an increase in grid spending of USD25b by 2035 if the US is to meet its sustainability goals and satisfy the expectations of the industry and users by appropriately rolling out EV charging infrastructure.

EY analysis and interviews with leading industry commentators identified several encouraging digital capabilities at differing stages of maturity that could mitigate the challenges associated with unmanaged charging. Among them is the installation of batteries or distributed generation at charging stations to reduce the impact on the grid and to lower grid infrastructure costs.

Showing significant promise, as they have in Europe, are managed charging programs. These programs shift the charging of EV batteries to non-peak hours, reducing peak demand and softening the grid burden from rapid EV growth. This reduces the need for investment in generation and grid infrastructure and improves resiliency.

Managed charging programs are now available at utilities in 36 states across the US.<sup>36</sup> And there is a growing portfolio of options on offer. Passive programs are the most popular. These are mainly EV fees, such as time-of-use (ToU), that incentivize users to charge during off-peak hours or when there is surplus generation from renewables. The incentives come with additional benefits and gamification elements to enhance user engagement. Utilities such as Ameren, ConEd, National Grid, PG&E, Xcel Energy, PEPCO and Wisconsin Electric Power offer rebates to customers based on how much electricity they use to charge their EVs during non-peak hours. Several utilities also offer nonresidential charging incentives, which create another possible source of demand response.

Active managed charging programs, which give utilities direct control over customers' EV charging via either the charger or the automobile's telematic system, are also gaining in popularity. This is partly due to greater collaboration between utilities, charging and metering manufacturers, and automakers. These programs rely on signals, e.g., "dispatch," sent from a utility or aggregator to a vehicle or charger to optimize EV load by turning charging on and off. This allows utilities or aggregators to start, limit or stop

the rate of EV charge temporarily during times of high demand without materially impacting overall EV charging.

Pilots to compare the effects of active and passive EV managed charging on consumer behaviors and on the grid are underway. For example, Alectra is testing its AlectraDrive@Home and AlectraDrive@Work projects. Utilities such as Xcel Energy, Duke Energy, FP&L and SDG&E offer programs that remotely connect and manage customers' charging devices when demand and price per kilowatt hour are typically at their lowest, using renewable energy if preferred.

Depending on the charging use case, EY analysts estimate that managed charging can lower peak demand by 9% to 45%.<sup>37</sup> Residential charging is particularly well suited to load management programs due to long dwell times. Most personal vehicles are stationary for 22 hours or more every day and are likely within a few hundred feet or less of existing electrical infrastructure.<sup>38</sup> Given that a typical EV requires an average of 22kWh or less per residential charging session, which is delivered over two to three hours via a level 2 charger, the potential for managed residential charging is huge.<sup>39</sup>

At workplaces lengthy dwell times during the day also create opportunities to manage charging. Incentives can be layered to avoid EV charging during high-demand hours in the mornings, while stationary vehicles can be used to store surplus solar generation in the middle of the day. Similarly fleet charging can provide demand-side management opportunities. Predictable charging regimes mean the fleet owner can optimize when and for how long vehicles charge on site, which brings operational and cost efficiencies.

Opportunities for managed charging are restricted along highway corridors and at public charging points where there is limited EV dwell time and little scope for drivers to alter their charging behaviors to align with rate schedules.



<sup>36</sup> "Electric Vehicle Managed Charging," Northeast Group, May 2022.

<sup>37</sup> EY grid impact analysis, May 2022. Evaluation of the impact of managed charging on peak demand is based on assumptions around vehicles participating in managed charging, parking duration and managed to charge power limits. These assumptions are based on secondary research, expert input and analysis.

<sup>38</sup> "How Much Time Do Americans Spend Behind the Wheel?" U.S. Department of Transportation Volpe National Transportation Systems Center, 11 December 2017.

<sup>39</sup> Brittany Blair and Garrett Fitzgerald, et al, "The State of Managed Charging in 2021," Smart Electric Power Alliance, November 2021.

Despite the potential of managed charging, several barriers remain:

- ▶ Many managed charging programs are still small in scale or in the pilot phase and cannot keep pace with EV sales. Technical complexity and the cost to utilities in piloting these programs present a significant barrier to scalability.
- ▶ Some network operators in low- and medium-voltage systems may not be able to forecast or may lack adequate data on real-time loads at a geographically granular level.
- ▶ Lack of customer awareness of ToU fees means inadequate enrollment rates.
- ▶ Regulators do not yet look favorably on EVs as distributed energy resources (DERs) and have not created aggregation markets for contracting flexibility services between distribution network companies and consumers.
- ▶ Active managed charging relies upon a reliable, two-way flow of information via communications technologies (Wi-Fi, cellular, telematics, etc.) from the vehicle and charge point to the utility or aggregator. While there are protocols for transmitting the information and relaying the actions required by either party, there are no industry-wide standards for information exchange and communication across the entire e-mobility ecosystem.
- ▶ Regulators have yet to rate base EV programs and infrastructure deployments in some jurisdictions, forcing utilities to seek funding from alternative sources, including from their innovation ecosystems and other partners.

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Utilities need a more complete toolbox of processes, products and services that allow them to anticipate constraints and respond appropriately. This is especially true for fleet electrification, which can present a significant challenge when capacity and real estate are already limited. Utilities have a historic opportunity to serve the largest new load since air conditioning. To avoid ceding the opportunity to competitors, they will need to adopt new technologies, business models and partnerships, which allow them to deliver a first-rate experience to e-mobility customers.

Michael Conklin  
Ernst & Young LLP Energy eMobility Senior Manager





# Chapter 4:

## Where will utilities choose to play?

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Utilities can maneuver into more customer-centric roles within the EV space

With a growing charging load that is both flexible and intelligent, EVs are integral to the wider discussion around the evolution of the grid and the future of the electric utility industry. EVs are a way to increase load in an era of flat or declining electricity demand, while managed charging, with its flexible demand, can help to balance a power supply that is increasingly diverse, decentralized, renewable and intermittent.

For utilities, rising EV uptake may be something of a double-edged sword. Too many EV drivers plugging in just as energy needs peak will heighten demand and intensify the negative impact on the grid. While the addition of electricity load from EVs is a good thing from the utility's perspective, it comes with an obligation to mitigate the problems that accompany it.

Electric utilities have a significant role to play in accelerating EV adoption and streamlining their integration into the grid. Already utilities:

- ▶ Promote EV charging infrastructure deployment through direct procurement, providing rebates or other incentives to encourage customer and third-party investment and requiring open protocols as a component of a utility-managed program
- ▶ Contribute to the development of standards for managed charging equipment
- ▶ Support the evolution of software and other means to modulate charging rates or shift charging events to activate grid services and balance the network.

The utility is the command center: there to deliver a robust and reliable grid, to keep the lights on, and to provide timely and efficient grid connections to service demand. The energy transition has also brought new responsibilities, including the need to manage flexibility as conventional energy sources give way to renewables and as flexible new loads, including EVs, come on board. E-mobility has changed the traditional dynamic. Utilities are already in customers' homes and have insights into their electricity usage, and communication channels are long established. But now e-mobility will expand the utility's connection with customers from domestic or commercial settings and into the realm of transportation. It has opened up opportunities to harness data to deliver targeted retail solutions and incentives relating to EV ownership and charging.

## How to own the customer

With extensive infrastructure already in place, utilities have a head start on new players that are entering the field: automakers, third-party aggregators, charge point operators, distributed energy resource providers and major retail brands. Each will compete to provide central and ancillary services to deliver or enhance e-mobility. The newcomers, potentially more customer centric than utilities have ever been, will seek to own the relationship with the end user. And this is where utilities, if they are serious about customer service and retention, need to catch up.

At Alectra, customer centricity is the way to future-proof the utility. "I won't leave a work meeting to go and take my car off charge in the garage. But if I put it on a scheduler, it's a set-and-forget technology. It does all the work, it's automated, it's

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Some utilities see themselves providing bundled services, including EV charging, particularly at the residential end of the market. Utilities consider their role as connectors or integrators, sitting between the customer, the vehicle and the charger. That presents huge scope and opportunity for utilities to develop partnerships across the platform and to enhance the whole customer experience.

**Marc Coltelli**  
EY Americas eMobility Energy Leader

algorithm-based and optimized for me and my requirements. That's the kind of customer engagement that will stick in the future. If it doesn't come from the utility, other energy services companies will take away our business," says Neetika Sathe.

"Some utilities see themselves providing bundled services, including EV charging, particularly at the residential end of the market," explains Marc Coltelli, EY Americas eMobility Energy Leader. "Utilities consider their role as connectors or integrators, sitting between the customer, the vehicle and the charger. That presents huge scope and opportunity for utilities to develop partnerships across the platform and to enhance the whole customer experience."

Acknowledging the changes in behaviors that the transition to e-mobility will demand, utilities are starting to position themselves as "energy allies," with the purpose of walking customers through the process and remaining relevant to them. "We want to be there to help our customers, our communities, our people and our cities go from climate ambition to climate action," says Neetika Sathe.



## Utilities' journey to e-mobility maturity

Utilities are at different stages of maturity in supporting the e-mobility transition. While some have yet to make a start, others are strategizing and implementing plans. The most advanced have started to make their mark and are engaging with customers.

Dominion Energy, for instance, which provides electricity to Virginia and the Carolinas, is working with school districts to promote electric school buses.<sup>40</sup> Duke Energy has already electrified over 600 vehicles in its fleet, pledging to convert 100% of nearly 4,000 LDVs to electric and half of its combined fleet of around 6,000 medium-duty, heavy-duty and off-road vehicles to EVs, plug-in hybrids or other zero-carbon alternatives.<sup>41</sup>

EY analysts could envision some utilities venture into charging infrastructure acquisition via their unregulated businesses, as they have in Europe. Canadian utilities are certainly considering this option, given the regulatory constraints on rate basing EV infrastructure. US utilities view the delivery of infrastructure and charging services to fleets as a viable business opportunity. More than 60 utilities, primarily investor-owned power companies, have banded together to install EV fast-charging infrastructure along major US highway corridors by the end of 2023. The aim is for utilities companies to work together beyond their service territories to fill the gaps and support EV drivers on major travel corridors.<sup>42</sup>

It is likely that most utilities will continue to focus exclusively on the flow of electricity across their networks. They will anticipate and spread energy load from all sources, including EVs, and deploy the most sophisticated solutions, such as managed charging and vehicle-to-grid (V2G) applications to enable flexibility. Their knowledge, market position, infrastructure and an almost captive market mean utilities are uniquely placed to leverage the opportunities that arise. And with the right smart energy management solutions, investments, regulation and technologies, they have the potential to build and retain a dominant position.

Marc Coltelli summarizes, "The US and Canada might not yet front the e-mobility pack – we estimate that we are around 18 months behind Europe – but our utilities now have an amazing opportunity to seize the moment and lead the transition. Though we can look to more advanced EV markets and profit from lessons learned, we are equally ready to conceive innovative solutions of our own to some of the emerging e-mobility challenges."

He believes the e-mobility ecosystem will design transport solutions for the future that are geared around customers, their geography, lifestyles and needs. EV customers will operate in a market that EY analysts predict will be worth USD72b by the end of this decade, excluding sales of ancillary products. "Whether you're in utility power generation or automotive design and manufacture, find ways to start conversations now around accelerated collaboration initiatives, for your future customer and bigger environmental gain."<sup>43</sup>

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Whether you're in utility power generation or automotive design and manufacture, find ways to start conversations now around accelerated collaboration initiatives, for your future customer and bigger environmental gain.

Marc Coltelli

EY Americas eMobility Energy Leader



<sup>40</sup> Robert Walton, "Dominion launches electric school bus initiative, aims for 100% electric fleet in Virginia territory by 2030," *Utility Dive*, 30 August 2019.

<sup>41</sup> "Duke Energy advances climate strategy with aggressive pledge to electrify vehicle fleet by 2030," *Duke Energy press release*, 8 September 2020.

<sup>42</sup> "Electric Companies Join Together to Form National Electric Highway Coalition," *Edison Electric Institute*, December 2021.

<sup>43</sup> Felipe Smolka and Marc Coltelli, et al, "Why design thinking is the real engine for electric vehicle adoption," *EY.com*, June 2022.

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