EV GROWTH: WITH THE RIGHT SUPPORT, CANADA'S ELECTRICITY GRID CAN HANDLE IT.

Grid Readiness Statement

Electric Mobility Canada | Mobilité Électrique Canada

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INTRODUCTION

Electric mobility represents a historic transformation of Canada's automotive industry and is generating significant new economic opportunities for companies, workers, and consumers involved in Canada's growing electric vehicle (EV) economy. A new player in the mobility ecosystem is electric utilities, who traditionally have had very little direct involvement with the road transportation sector, powered as it is by fossil fuels. With the advent of electric powertrains, electric utilities have now become a central player in this crucial transition. However, questions remain in the public mind about the readiness of electricity systems to accommodate new loads from electric vehicles.[i]

Utilities in Canada have regulated responsibilities for affordable, reliable power generation and distribution, and the industry has over a century of experience in serving customers in every province and territory. Utilities are key to unlocking the potential of EVs to lower drivers' energy costs, reduce transportation emissions, and improve air quality for all Canadians. At the same time, while Canadians have expressed support for the goal of net-zero emissions by 2050, there is low public literacy with respect to the impact of this change on the energy system, along with a persistent, underlying expectation of stable costs and reliability.[ii] With these factors in mind, this statement is intended to provide a high-level overview of utilities' ability to accommodate the increase in electricity required for the transition to a highly electrified transportation system.

Across the country, Canada's electric utility sector is at the forefront of technology, policy, and programming to accommodate the increasing share of EVs on the road, while simultaneously managing other important considerations, such as maintaining affordability, providing responsive customer service, planning the evolution of the workforce, and shifting generation away from fossil fuels and towards greater use of distributed and non-emitting resources. While utilities are all facing these developments, they present differently in each jurisdiction due to a number of factors such as geography, customer base, regulatory regimes, and past investments. While we focus here on key trends and commonalities, it should be understood that the specific experience of, and response by, each utility towards these concurrent issues will be unique.

Although this statement skirts deeper discussion of the technical underpinnings and workings of the electricity system, it is important to recognize some of the system's primary components: generation, which produces the electricity; transmission, which carries the electricity over larger distances at high voltage; and distribution, where the electricity is brought to customers' homes and businesses. All these components are necessary to bring the electricity services and amenities upon which customers depend energy, measured in kilowatt-hours (kWh), and capacity, the ability to deliver different levels of electric power, measured in kilowatts (kW). References to these concepts will be made as needed to highlight important points, but new conceptions are also emerging around what counts as a primary component of the grid; for example, EV batteries, demand management tools, and other 'distributed energy resources' (DERs) are increasingly recognized as energy regulatory assets that can provide grid services.

Cover photo: Matt Wiebe, 2016
Electricity pylons at sunrise in Manitoba

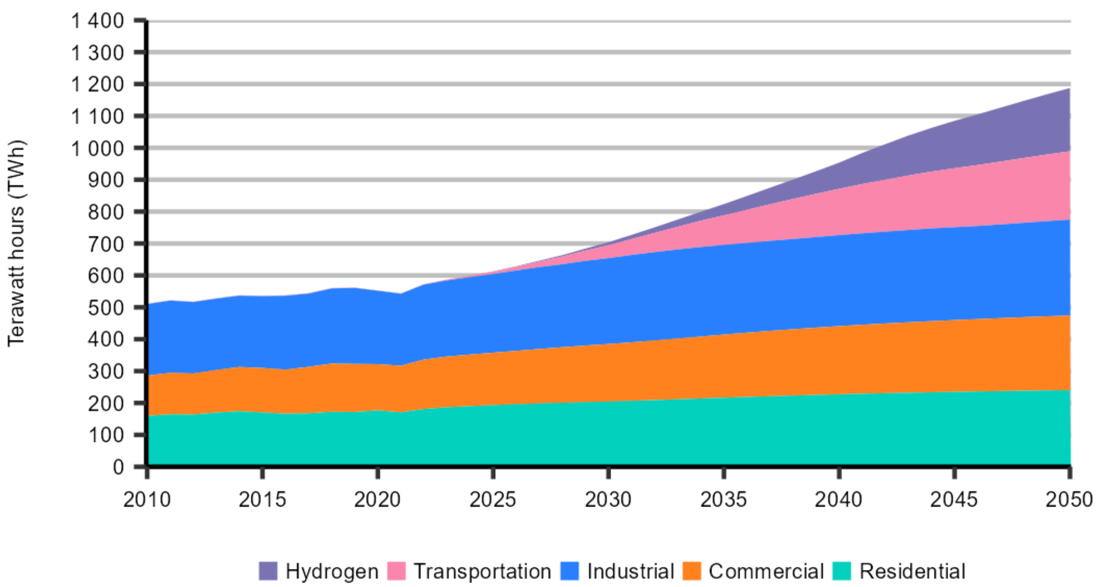
CANADA'S CURRENT AND FUTURE ELECTRICITY NEEDS

From an electricity system planning perspective, in the near term of 5–10 years, Canadian electric utilities are generally prepared to meet the increasing consumption brought about by the electrification of transportation, though some incremental investment is likely to be required in areas of higher demand (e.g., early-adopter neighbourhoods) or of lower existing capacity. Systems are planned with a degree of margin, and while vehicle electrification is rapidly accelerating, it presently represents a small share of overall system requirements. Systems are starting to be built to support higher levels of demand, especially where there are clear expectations that the electrification of building heat will be a significant component of load growth. However, the process of replacing the current stock of equipment, through turnover, is a decades-long affair.

Recent data show that electric transportation consumes much less than 1% of total national electricity consumption as BEVs and PHEVs represent only 2% of the Canadian light-duty vehicle fleet. However, over the next three decades, depending on different factors and scenario assumptions, the share of electricity demand from transport is expected to grow to approximately 15% to 20% percent of total electricity consumption.[iii,iv,v] For instance, in recent national modelling, Navius Research finds that the transportation sector requires 152 terawatt-hours (TWh) of electricity (16% of total Canadian demand) by 2050 under a business-as-usual case (that is, including only policies currently in force and legislated). Under a net-zero scenario featuring additional policy commitments, transportation's share of demand rises to 188 TWh (17% of the total) in 2050.[vi] Similarly, the Canada Energy Regulator, in its own modelling of a global net-zero emissions economy by mid-century, finds that transportation electrification requires about 214 TWh in 2050, representing around 18% of overall electricity demand projected for that year.[vii]

Figure 1: Canadian electricity use by sector — *Global Net-zero Scenario*

Source: Canada Energy Regulator (2023), *Canada's Energy Future 2023*, p. 65.



These results supplement earlier findings from 2021, when ICF Canada conducted an assessment for Natural Resources Canada of the readiness of Canada's electricity system for increased uptake of electric vehicles, in line with federal targets then in effect (i.e., 100% Zero-Emission light-duty vehicle sales by 2040). The study entailed a Canada-wide, province-by-province ZEV load forecast over a time horizon of 30 years (2020 through 2050) and developed projections of both the annual load growth from EV charging and hydrogen production to power fuel cell electric vehicles. While cautioning that its forecasts rely on many simplifying assumptions, and should be considered only as "illustrative," ICF found that "the total annual load growth due to EV charging has the potential to be 20.4 TWh in Canada by 2030, 104 TWh by 2040, and 156.5 TWh in 2050. This represents 3.4%, 16.1%, and 22.6% of the electrical power consumption in 2030, 2040, and 2050, respectively."[viii]

The Canada Energy Regulator expects annual electricity production in 2050 to increase from current levels around 645 TWh to between 972 and 1,359 TWh per year, depending on the scenario, which represents a very manageable 1.5% to 2.7% annual growth.[ix] In the CER's analysis, transportation electrification generates approximately one-third of the increase in electricity demand required by 2050 in the scenarios featuring strong electrification. Over the long term, transportation is therefore expected to take up a growing share (up to one-fifth) of total electricity consumption, but the majority of the overall increase in peak load will come from population and economic (GDP) growth, as well as growth in electric heating demand.

By 2050, studies suggest that achieving net zero in Canada means installed capacity will likely need to increase by a factor of 2–3 to support a doubling of electricity consumption.[x] Given that most load growth falls in the 2030–2050 period, there is time to plan and build to accommodate the shift to e-mobility, but substantial investment will be required—in generation, transmission, and distribution—at a higher rate than Canada has invested in the past 30 years. Indeed, as the International Energy Agency (IEA) recently noted, to meet national energy and climate goals, global electricity use must grow at least 20% faster in the next decade than it did in the previous one, and even more rapidly for alignment with a net-zero-by-2050 pathway; similarly, global annual grid investments should double by 2030 and continue growing beyond, "with emphasis on digitalising and modernising distribution grids."[xi] Since lead times for electricity projects tend to be long (5–15 years for most assets of substantial size), it is important that planning work begin now, so that investment decisions can be made and the system can be prepared for the anticipated increase in demand. The utility sector is mandated to serve customers, and it will be falling short of its responsibilities if it impedes customers from accessing the electrical capacity needed to fuel their vehicles.

One area of uncertainty is the pace of adoption and resulting stock/concentration of medium- and heavy-duty vehicles, which can create larger, discrete areas of higher demand. Because of their nascent deployment in the market, it is more difficult for utilities to predict how quickly and with what degree of materiality they will affect the electricity system, especially at the distribution level. Another important unknown is the extent and pace of electrification of heating, which is potentially a larger end-use of energy by several times (compared to transport), and which must be evaluated and planned for in parallel with electrification of transportation.

It is important to note that, in most cases, utilities require approval from a regulator to make major investments in expanding their system. While necessary to provide oversight, this process creates uncertainty and slows down investments. Utilities and regulators must work together to develop a common understanding of what the electricity system needs, and governments must set the mandates and frame the processes through which they expect these entities to engage and make decisions. A bottlenecked process will hamper investments being made in a timely fashion, leading to higher costs and poorer service to customers. Conversely, as the IEA contends, "action today can secure grids for the future."[xii]

NEW SOURCES OF DEMAND NECESSITATE NEW INVESTMENT

The forecasted long-term growth in both energy and demand from the electrification of transport and other end-uses will necessitate new investments to ensure grid readiness.[xiii] Today's power systems are large and resilient, but they are right-sized for current demand levels and cannot be expected to serve tomorrow's needs. This is not an accident, but rather an intended outcome of system planning, because systems of power production, transmission, and distribution are right-sized to the societies they serve. Well-managed electricity systems like those of North America are built for anticipated load growth and include a margin of redundancy, but it would be irrational (and needlessly costly) for systems to be overbuilt for demand that does not exist. As the IEA has recently observed, "Regulation surrounding the requirements to meet when building new grids has usually focused on avoiding the risk of stranded assets as much as possible and has not managed to capture the risk of insufficient grid development. Adjustments to the regulatory framework can better capture the value that new projects add and open the door to needed anticipatory investments."[xiv] There is no surprise in finding that the current grid is insufficient for the needs of 2050, just as the current number of homes in Canada is insufficient for the needs of the Canadian population of 2050. The grid evolves to meet the needs of society; change is therefore to be expected. Recognizing that the mega-trends of electrification and decarbonization are already actively shaping Canada's future possibilities, it is time for utilities to plan for an extended period of expansion, and to invest in increasing generation, transmission, and distribution infrastructure, including demand-side resources, to meet our energy needs into the future.

Photo: Mike Gifford, 2006 / HQ pylon

KEY ISSUES

Reliability

In planning for system needs, utilities must consider when demand will take place. Total annual electricity production is broken up minute-by-minute, hour-by-hour, and utilities must work to ensure that customers' demand for electricity can always be met. The peak in demand may come only for a few dozen out of the 8,760 hours in a year, but utilities must be ready to serve their customers in all those hours, 365 days a year, and to react quickly when natural disasters and other unpredictable events strike.

The risk to the system is most acute at the distribution level, where increases in demand are applied to individual assets—transformers, feeders, transformer stations—and cannot be easily shared, unlike at the bulk system level, where one generation unit's shortfall can be made up by another. The low-voltage distribution system represents the "last mile" of bringing power to each and every customer, and redundancy at this level is generally not economically feasible.

With many more assets to maintain, distribution utilities will have infrastructure that will need to be upgraded to meet the higher demand before it reaches the end of its planned life. To mitigate against wastefully replacing assets before their end-of-life, and to meet the fast pace of change, distribution utilities must enhance their ability to leverage the flexibility in their systems, and to create local capacity and flexibility through distributed energy resources (DERs) that can meet local needs with local solutions, including generation, storage, and demand management. This requires both deployment of more advanced technologies that enhance sensor and metering capabilities and enable more sophisticated control rooms, as well as regulatory changes that value demand-side resources, like pricing tools and managed charging, on an equal footing with supply resources. In addition, regulatory changes should incentivize the use of lowest-cost resources, enable the deployment of tools that allow these to be dispatched to meet system needs, and allow for recovery of program costs and lost revenues.

Simply relying on traditional approaches of building more wires and larger assets will be more costly and less reliable than incorporating new methods of optimizing the system. This is why, for example, the International Energy Agency recommends consideration of several options to help mitigate power and energy demanded by vehicle charging, including especially strategies to influence the timing of EV charging connections. These 'connected', 'smart', 'managed', or 'optimised' charging strategies may include passive measures, such as the load-shifting signal provided by time-of-use tariffs, as well as active control measures, such as remote stop-start control and power modulation of charging sessions.[xv]

Ultimately, utilities recognize that although EVs can present challenges for existing electric power systems when charging is unmanaged, "management of EV charging offers unique opportunities to support power system operation and planning."[xvi] As recent research from the University of Calgary and University of Alberta has demonstrated,

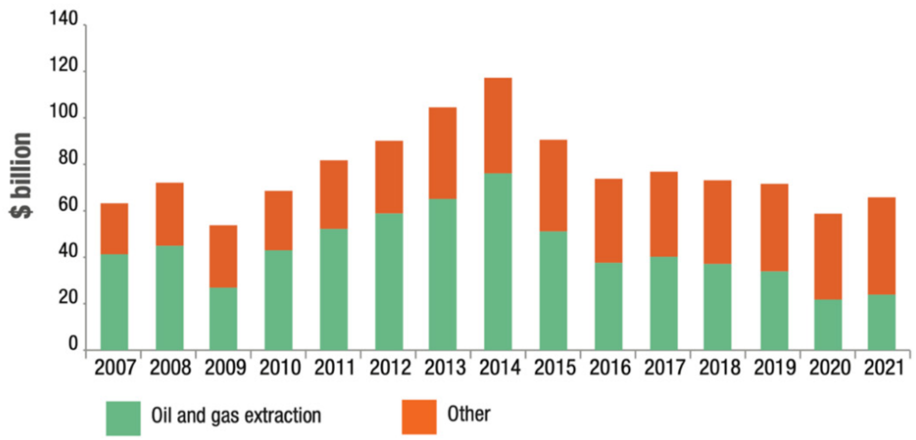
> ***"The magnitude of EV charging price responsiveness is noteworthy in its own right… The ability to shift charging times without sacrificing driving capability in most situations stands in contrast to most residential appliances, for which the service and electric draw must occur simultaneously. Harnessing this considerable flexibility will be imperative as EV sales expand. Studies predicated on the assumption of inelastic EV demand are likely to overstate the cost of integrating EVs into the electric system."***[xvii]

Increasing capacity

At the generation level, utilities will need to build a variety of forms of generation to meet the different needs of their system: baseload, intermediate and peaking resources. Efforts to streamline the regulatory permitting processes will also help reduce the lead time for planning and deploying new resources, allowing them to come online sooner and reducing the overall cost of these projects.

It is important to recognize the scale of the investments needed to expand the electricity system over the coming decades. According to Natural Resources Canada, in 2022, there were 320 planned (announced, under review, or approved) energy projects worth $427 billion, and sixty-one energy projects under construction worth $46.5 billion (see figure 2). Data show that electric power generation and distribution together represented the largest area of energy-sector capital expenditure at $25.3 billion in 2021, surpassing oil and gas extraction ($23.9 billion) for the first time.[xviii] Meanwhile, the Royal Bank of Canada estimates that decarbonizing the existing grid—not accounting for expansion—could cost $5.4 billion annually.[xix]

Figure 2. Capital expenditures[1] in the Canadian energy industry, 2007–2021[xx]



In short, there is a substantial increase in the rate of investment needed, but this is spending that is incremental to work already being done. Providing appropriate signals about the need for new capacity to be brought online will help project developers and the associated ecosystem to scale up for this challenge. As the IEA suggests, "planning for transmission and distribution grids needs to be further aligned and integrated with broad long-term planning processes by governments… Grid plans need to integrate inputs from long-term energy transition plans across sectors."[xxi] Similarly, ICF Canada urges Canadian utilities to thoroughly review their distribution system design practices and consider "chang[ing] the standard design rules in preparation for a higher load per customer due to EV charging."[xxii]

Modelling by Environment Canada suggests cumulative investments into the electricity sector of more than $400 billion will be needed over the coming decades: first and foremost, as part of routine replacement of aging facilities and the expansion of generation capacity to meet increased demands from population and economic growth, but also to enable the switch to EVs and electrified public transit, the adoption of electric heating in buildings, and the electrification of industrial processes.[xxiii] In the midst of this broader system evolution, and in comparison to present spending, the incremental cost of transportation electrification will be only a fraction.

[1] *Excludes residential expenditures and intellectual property investments such as exploration expenses. Includes investments in renewable electricity but does not capture other forms of renewable energy.

EV uptake and affordability

Affordability is an important consideration as utilities, regulators, and policymakers undertake the expansion of the power system. Electricity is an essential service, so rising rates not only hurt those customers who have the least ability to reduce their consumption, but also act as a disincentive for business investment by raising operating costs, which reduces economic growth.

While attention must be paid to limit ratepayer cost increases that fund system investments, we must also be mindful that electricity system investments also take place within the broader context of customers' 'energy wallet.' As customers transition to electric mobility, their costs for fossil fuels will decrease, which can lead to lower overall energy costs. For example, in 2022, the all-in cost of driving an internal combustion engine vehicle in Canada ranged from around $0.42 per kilometre (hatchbacks, sedans, SUVs, and crossovers) to $0.59/km for some premium vehicles; meanwhile, EVs compare favourably across all segments, with a cost between $0.24/km and $0.33/km.[xxiv] Setting aside the total cost of ownership, it is worth noting that electricity costs are historically much more predictable and stable than fossil fuel prices, which are subject to volatile geopolitical forces.

Unit costs are reduced when economies of scale can be achieved with appropriate investments that match consumer demand. A large proportion of the electricity system's costs are fixed, so higher consumption and use of assets actually can lower costs, as fixed costs can be spread out and the (inflation-adjusted) unit price of a kilowatt-hour can be reduced. To improve the effectiveness of planning and project execution, utilities benefit from a predictable investment climate that allows them to focus on long-term value, rather than shifting plans to remain stable on shifting ground. In addition, the soon-to-be-adopted Canadian light-duty ZEV sales regulation will significantly help market predictability, making electricity demand growth easier to predict and plan for.

Finally, in addition to overall household cost savings, investments in electricity systems provide substantial economic benefits to Canadians and the economy as whole. While only a portion of Canada's current fossil fuel consumption needs is provided by Canadian-owned companies, 98% of our electricity consumption is met by domestic producers,[xxv] and the transmission and distribution sectors are served by Canadian workers who contribute to the Canadian economy.

Photo: josullivan.59, Power Lines (2018)

CONCLUSION

The readiness of the grid to support wide-scale EV adoption is not uniform across the country. From coast to coast to coast, electricity providers each have their own financial circumstances, and each operate in their own regulatory contexts. They must also contend with uneven levels of EV uptake across each province and territory. The scale of action necessary to increase preparedness thus differs by jurisdiction. However, broadly speaking, in the near-term utilities are confident that existing infrastructure can serve the growing demand from EVs and other electrical loads. As ICF has noted, while the challenge of building toward and sustaining the next thirty years of transportation electrification is not to be underestimated, grid readiness for ZEVs "is more about developing capabilities surrounding planning and solution deployment within the utilities and with the partnering vendors surrounding the utilities… [N]umerous Canadian utilities… are acting now to improve preparedness through studies and pilots."[xxvi] Utilities are finding that charging behaviour is a unique type of load amenable to many different strategies for managing it, and that peak-avoidance programs can make a significant difference in determining the extent and cost of grid upgrades.

Augmenting electricity resources to power the transportation system over the longer term is both necessary and achievable, but utilities need the funding and regulatory framework to be able to meet these expectations, especially as the pace of change accelerates from the need to mitigate climate risks from fossil fuel consumption. As the IEA notes, "Grid expansion and modernisation needs to happen at speed and scale, and building new grids needs to go hand in hand with improved use of existing infrastructure and new technologies. Policy makers can speed up progress on grids by ensuring regulatory risk assessments allow for anticipatory investments."[xxvii] Old assumptions and practices will need to be updated and collaboration among stakeholders is essential. Utilities will benefit from an operating environment that, as much as possible, provides the stability and predictability that are needed to make favourable decisions about asset investments with long development timelines and assets whose lifespans measures in the decades. One of the keys to ensure market predictability will be through the adoption of the federal ZEV sales regulation that will make EV uptake much easier to plan between now and 2050. Attention will need to be paid to distribution, transmission, and generation, as each will be required to grow in order to provide the electricity system Canada needs in the future.

The majority of the work to build the electricity system of tomorrow will take place at the provincial level, given the overriding provincial authority for electricity sector control in Canadian federalism. Provincial institutions will need to oversee and set the rules for electricity system planning, investment, and remuneration, managing trade-offs and apportioning risk between customers and utilities. However, continued collaboration will be needed nationally, provincially, regionally, and locally to ensure a smooth path forward. Across jurisdictions, regulatory innovation will be needed to enable a shift toward anticipatory investments—"those that," as the IEA writes, "are not immediately needed for current projects, but which can address near-future needs."[xxviii] There is also an important role for the federal government to play in providing leadership, setting the overarching framework for economic and environmental decisions, streamlining permitting, creating programs, developing technology and standards, sharing data, and coordinating efforts.

As we work to meet the generational challenge before us, utilities look forward to collaborating with stakeholders, Indigenous Peoples, and the communities in which we operate, and to serving Canadians with the energy that will power our sustainable prosperity in the 21st century and beyond.

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