

POLICY BRIEF:

Shocking Lack of Details on Cost of Electric Car Mandate

Colin Craig & Dom Lucyk | November 2023



Executive Summary

Electric vehicles (EVs) are a welcome addition to Canada's automobile market. More companies competing to produce products and services for consumers is a good thing. Competition helps drive innovation and can save consumers money.

However, the federal government's push for a mass adoption of electric vehicles does pose significant implications for electricity grids across the nation – systems which are run by provincial governments. Careful analysis is required as electric vehicles require significant amounts of electricity, upgrades to distribution systems, and major investments in residential and commercial charging infrastructure.

SecondStreet.org decided to investigate how much this will cost Canadian households through their power bills. Generally speaking, governments are counting on Canadians to charge their vehicles at night rather than during peak demand periods.

To examine this issue further, SecondStreet.org filed freedom of information requests (FOIs) with provincial governments and electricity utilities prior to, and following, the federal government's 2021 announcement that all new vehicle sales would need to be "net zero" by 2035. Specifically, analysis was sought on how the federal policy would affect provincial electricity grids and, most importantly, the electricity bills that Canadians pay.

Highlights from that research include:

- There was general consensus that the federal government's policy would pose a significant challenge to provincial power grids. However, no province provided estimates as to how this policy will affect a typical household's electricity bill.



- Several provincial government departments had no analysis on how the federal government's zero emission mandate will affect their electricity grid. Provincial utilities tended to have at least some analysis on the implications of the federal policy.
- Manitoba Hydro flagged that lower-income households will be affected the most.
- Overall, it's not clear where the additional power will come from. While some provinces can reduce hydro exports, others face the added challenge of navigating pending federal policies aimed to restrict natural gas generation. "Renewables" were sometimes identified as a solution, but such power sources are less reliable.
- Materials provided by Newfoundland and Labrador indicated they do not expect to meet Ottawa's target.
- Policymakers will want to consider other pressures caused by EVs: the impact on road infrastructure (as the vehicles are heavier), the cost to low-income ratepayers for system upgrades, and feasibility in remote communities to name a few.

While the federal government decided that all new vehicle sales would need to have zero emissions by 2035, it appears that provincial governments – the level of government responsible for electrical grids – are generally not prepared for the transition and do not know what it will cost ratepayers.

Suspending the 2035 deadline or cancelling it until such research is conducted, and communicated with the public, is a prudent policy option for legislators to consider. At the same time, the government could consider how to encourage consumers to use cleaner burning natural gas vehicles, hybrids and hybrid electric vehicles.

Introduction

In June 2021, the Government of Canada announced “a mandatory target for all new light-duty cars and passenger trucks sales to be zero-emission by 2035.”¹

This announcement accelerated a previous goal for 100% of new car sales to be zero-emission vehicles by 2040.

While the government did not dictate that new vehicle sales must be electric – they must merely be “zero-emission” – the announcement, and the government’s actions, lean heavily towards electric vehicles as the technology of choice going forward. Further, the government also did not explain critical details such as how a transition will occur – where will the additional power come from? What is the financial impact to ratepayers? Etc.

Seamus O’Regan, Canada’s Natural Resources Minister at the time, is quoted in the federal government’s news release as saying, “achieving this target will require all Canadians, and businesses big and small, to embrace the change and go electric.”

The news release also notes:

“As the common service provider for the Government of Canada, Public Services and Procurement Canada (PSPC) leads and enables greening government operations, and will lead the procurement of electrical fleet vehicles as well as the procurement and installation of Electric Vehicle Charging Stations infrastructure in federal buildings.”

The government also indicated that it is helping to fund “10 hydrogen stations,” but this pales in comparison with the “16,500 new electric vehicle chargers” it is funding.

These favourable comments towards electric vehicles were later reinforced by Ottawa’s decision to agree to nearly \$30 billion in production subsidies for Volkswagen and Stellantis-LGES to build electric car batteries in Ontario.^{2,3}

Overall, the government’s planned shift to electric vehicles represents a significant change for Canada’s auto sector. In 2021, just 5.3% of new vehicle registrations were electric.⁴

The federal announcement comes with significant policy implications for provincial governments as the latter regulate electrical grids nation-wide, and often own crown corporations that produce and distribute electricity to residential, commercial and industrial customers.

Beginning at the household level, it should be noted that many older homes do not have the capacity to charge electric cars with “Level 2 chargers” – equipment that can recharge an electric car in a more timely manner. According to Panel Upgrade Experts, a Calgary-based electrical company, renovating a 100-amp panel can cost homeowners anywhere from \$3,000 to \$3,500, while a 200-amp panel can cost from \$4,000 to \$6,000.⁵

Regardless of the age of the home, and its current amperage, electric car owners will also need to purchase chargers and install them. The cost of a Level 2 charger, along with installation, varies based on multiple factors. According to the Ottawa Citizen, the device and installation can cost anywhere from \$500 to \$3,000.⁶ TCA Electric, an electrical company in Vancouver, reports that the device and installation will likely cost between \$1,000 and \$3,000.⁷ ElectricianInToronto.ca notes the cost is around \$800 to \$2,500 on average.⁸ If electric car owners own cottages, they may have to purchase and install a second charging station.

A 2021 Maclean's magazine article discusses another important consideration related to the mass adoption of electric cars – the capacity of local distribution systems in older communities.⁹ In short, the article notes that in many older communities, if “three or four houses” on the same block upgraded their electrical systems to accommodate Level 2 chargers, local transformers would “blow.” Thus, in order to avoid localized power outages, upgrades are required.

A wave of electric cars will not only need new generation sources to create power for these vehicles, but new transmission lines will also be required to transport power to local communities. Transmission lines tend to cover great distances and are used for high-voltage transportation. They differ from power lines in cities and towns that cover short distances and carry lower voltages. Depending on the location of new generation sources, new transmission lines may need to cross great distances to reach customers.

For instance, Manitoba Hydro's new Keeyask generating station in the northern part of the province required a major new Bipole III transmission line to transport power to customers in the southern part of the province. However, due to environmental concerns and other factors, the shorter 800 km route was abandoned in favour of a longer 1,400 km route.^{10 11} Both routes were controversial and involved considerable deliberation. In fact, 17 years passed between

Manitoba Hydro's first inclusion of the Bipole III project in its “capital project justification” (CPJ) list in 2001 and completion in 2018. The transmission lines and converter stations ultimately cost \$4.7 billion to build.

Conversely, power sources which are more flexible in terms of where they can be built – natural gas power plants and nuclear power plants being two such sources – would likely require shorter transmission lines as they can be situated more closely to customers in major urban centres. However, current federal policy calls for a “net zero” power grid by 2035, so this does pose challenges for natural gas power in the future.

One final implication for electricity grids, and arguably the most important, concerns generation. Simply put, where will the electricity come from to power a wave of electric cars hitting the market?

It should be noted that even “green” energy sources such as hydro dams and wind power sites can face significant obstacles. For example, British Columbia's “Site C Dam” faced considerable backlash from environmentalists.¹² The public has even raised concerns about nearby wind power sites – whether it be their impact on insects, bats and birds, or the health effects caused by the noise and vibration from the turbines spinning.¹³

Combined, these factors represent a considerable challenge for electricity systems across Canada. This challenge is exacerbated by Ottawa's push to decarbonize electricity systems themselves – simply put, shutting down coal power generation and requiring natural gas power plants to also reach zero emissions. Replacing these sources with renewables, such as wind and solar, is challenging. Many readers will know, that a major shortcoming of these energy sources is that they do not generate power when the wind isn't blowing and the sun isn't shining.

The question is – how much will the EV transition cost ratepayers in each province?

At the federal level, the government has some estimates on electric vehicles and what the costs will be for mass adoption. Their December 2022 analysis projects that consumers will spend an additional \$55.8 billion in electricity costs, but will save \$89.7 billion in fuel costs.¹⁴ However, these estimates do not appear to tell the whole story. An August 2023 news release by the federal government notes that “regardless of the implementation of these regulations [which require a net zero electricity grid by 2035], it will cost more than \$400 billion nationally through 2050 to undertake routine replacements of aging facilities and to expand generation capacity to meet the expected increase in demand.”¹⁵ For perspective, that’s approximately \$10,000 per Canadian.

However, Ottawa expects increased demand on the electricity grid as a result of EV adoption to be less significant. In the government’s 2022 Regulatory Impact Analysis Statement for their zero emission vehicle policy, they note:

“A significant increase in demand for electricity, particularly at peak time, could lead to an increase in electricity prices. This is not expected to be a significant issue, however, as the proposed Amendments are only projected to increase ZEV electricity demand as a percentage of overall electricity demand from 1.2% in the baseline to 2.5% in the regulatory scenario in 2035.”

As we will discuss momentarily, not all provincial governments share this optimistic view.

A report by the Canadian Chamber of Commerce helps put the magnitude of the government’s zero emission vehicle requirement into perspective:¹⁶

“As it stands today, the Canadian electricity grid is not ready to support full electrification, and reliability must be included in expanded capacity. A 2022 report released by the Canadian Climate Institute states that “A range of studies conclude that

achieving net zero will require an increase in overall electricity generation to become 1.6 to 2.1 times greater by 2050 compared to 2020 levels. Total electricity capacity will need to rise even more, reaching 2.2 to 3.4 times current capacity”. The federal government has also set 2035 as the target to achieve net-zero electricity grid. While wind and solar power are commendable sources of clean energy, gas remains vital for stable base load for some regions where cold temperature challenges exist. In Alberta, a cold streak from December 15, 2021, to January 9, 2022, held the average temperature at –22C. During this time Alberta’s wind assets achieved only 29.5 percent of its average maximum capacity, while Alberta’s solar assets reached only 2.6 per cent of its average maximum capacity. Gas was the stable base load operating on 71.2 per cent of average maximum capacity and producing 69.7 per cent of Alberta’s total power share for those three weeks. Had Albertans been more reliant on wind and solar during that period, rolling brownouts or blackouts may have been necessary.”

Driving.ca wrote the following about the increase in demand for electricity from widespread EV adoption and other pressures on Canada’s electricity grid:¹⁷

“...an SNC-Lavalin report — Engineering Net Zero: Our Net Zero Blueprint for the Future — says that our 2050 net-zero-carbon promise will require an additional 1,500 terrawatt-hours of energy per year ... the authors calculated that we’ll need to build no less than 115 hydro reservoirs the size of BC Hydro’s Site C (each producing 1,100 MW of power) to meet our future electricity demand. Or, if damming up a whole slew of our vibrant rivers isn’t your cup of tea, it would require the equivalent, say SNC’s engineers, of 19 Bruce nuclear plants (6,232 MW combined, from Bruce A and B) here in Ontario.”

Considering the potential ramifications that could come from the mass adoption of electric vehicles, provincial energy ministries, utilities, regulators and system operators owe it to ratepayers to conduct proper due diligence – and communicate the findings with the public – before the implementation of system-wide change.

Methodology

The Canada Energy Regulator notes the following about jurisdiction when it comes to electricity policy in Canada:

“Each province has jurisdiction over electricity generation, intra-provincial transmission, and distribution while the federal government has authority over some aspects of the nuclear generation sector, electricity exports, and designated international and inter-provincial transmission lines.”¹⁸

In short, provincial governments are responsible for most aspects related to regulating and supplying the electricity that Canadians use on a daily basis.

With this in mind, SecondStreet.org filed Freedom of Information (FOI) requests with provincial governments and crown corporations in October 2021 and January 2023.

In October 2021, SecondStreet.org filed the following Freedom of Information request:

Please provide any analysis or reports that examine what would need to happen with the province’s electricity system if:

– consumers in the province switched to electric vehicles instead of diesel/gas-powered; and/or

– if natural gas was phased out in the province as a fuel for heating and consumers used electric heat instead. (Changes would include: new generation capacity required, transmission/distribution system upgrades, other requirements, the cost for the changes, etc.)

In 2023, SecondStreet.org asked for the following records:

Please provide documentation on the impact to the province’s electricity system and ratepayers due to the federal government’s decision to require 100% of all passenger cars and trucks sold by 2035 to be zero emission. Please be sure to include any estimates or analysis on changes necessary to power generation needs, transmission requirements, local distribution infrastructure, household upgrades and the cost to consumers. Please also provide copies of any materials provided to the federal government related to this topic and their announcement. The time frame for this request is March 1, 2021 to present.

It is important to note that this paper does not examine the merits of the government’s decision to embrace electric vehicles, nor does it examine the full life cycle emissions of electric vehicles, hybrids and internal combustion engine vehicles. The high cost of EVs and the ability of consumers to purchase such vehicles is also outside the scope of this research. This paper is focused on examining how the federal government’s policy *could* affect electricity grids across Canada and the bills that residential ratepayers pay.

Results

The table below summarizes materials provided by each Department/Ministry of Energy and appropriate Crown Corporation. To see each government body’s response, please visit [SecondStreet.org](https://www.secondstreet.org).

Respondent	Summary of Responses
<p>BC – BC Hydro</p> <p>2021 Integrated Resource Plan</p>	<p>No analysis provided on the expected cost to a typical household for upgrades to the province’s electricity system.</p> <p>The utility provided a detailed report on power generation needed due to increased demand from EVs. Some observations from the report include:</p> <ul style="list-style-type: none"> • The utility has plans to minimize strain on the electric grid by “education and marketing efforts and customer smart-charging technology incentives to support a residential time-of-use rate intended to shift home charging ... of residential electric vehicle drivers to off-peak demand periods.” This approach will be focused on more depending on the percentage of drivers adopting EVs. • For BC Hydro to meet their load serving obligations, they must “implement EV peak reduction initiatives to achieve 75 per cent EV driver participation and up to 480 MW of capacity savings by fiscal 2030” (page 59). • They plan to increase power generation beginning in 2031. This includes renewing existing agreements with power generation facilities, branching out to new renewable energy resources, and upgrading existing BC Hydro facilities. However, it is worth noting the report states BC Hydro does not expect to renew an agreement with the McMahon natural gas-fired production facility, which is set to expire in 2030. • BC Hydro’s 2020 load forecast projects modest electricity growth averaging about 1.5% per year over the planning horizon, primarily “due to electric vehicles, and oil and gas load growth.”
<p>BC – Ministry of Energy, Mines and Low-Carbon Innovation</p>	<p>No analysis was provided.</p> <p>The Ministry also indicated they did not “receive any analysis from the Federal Government of the information you’re requesting.”</p>
<p>AB – Ministry of Energy</p>	<p>No analysis was provided.</p>

<p>AB – Alberta Electric System</p>	<p>No analysis provided on the expected cost to a typical household for upgrades to the province's electricity system.</p>
<p>Operator (AESO)</p>	<p>The AESO did, however, provide a 2020 report that examines how a shift to electric vehicles will affect Alberta drivers. It's worth noting that this was developed before the federal government's EV mandate was announced. With that caveat, some observations include:</p> <ul style="list-style-type: none"> • The report included an estimate on how expensive gasoline would need to be in order to make purchasing an EV economically viable for Alberta drivers: <ul style="list-style-type: none"> - Sunday Driver (5,200 kms/yr) \$7.67 - Commuter (12,500 kms/yr) \$3.15 - Daily Driver (20,000 kms/yr) \$1.99 - Long Haul Driver (52,000kms/yr) \$1.56 • The report also makes a noteworthy point on page 13 that charging EVs in B.C. is considered a low-emission activity because the grid is powered by hydro, while charging EVs is a high-emission activity (in comparison) in Alberta and Saskatchewan because the grid is largely powered through natural gas. • Contains projections on EV adoption and the resulting demand to the electrical grid. It's worth noting that, even before the federal government's mandate was announced, AESO projected that 67% of light-duty vehicles in the province would be EVs (see page 76 for table) by 2042. The table shows that, on average, charging loads for all EV vehicles (light, medium and heavy-duty) will increase from a peak load of 39 MW in 2023 to a peak load of 2,408 MW in 2040. • On page 140 (summary slide), the report acknowledges that, "from 2022 to 2040, loads resulting from EVs will increase from 3.5 MWhavg to 60MWhavg, and 2 MWhavg to 38 MWhavg in Calgary and Edmonton, respectively." <p>AESO also provided some emails related to SecondStreet.org's inquiry. Peter Huang, AESO's Manager of System Planning, wrote the following:</p> <p><i>"I want to start by saying that the 5,000 MW peak EV load as indicated would be a challenge for the transmission/distribution infrastructure. For your reference, the peak load for the City of Calgary and City of Edmonton is roughly 1,700-1,800 MW for each city; 5,000 MW is practically doubling of existing urban area load. To be prepared for the situation, the solution will likely involve a multi-pronged strategy. For example, before the EV load hits the transmission grid, distribution systems would be impacted first and a strategy to manage the situation would be required. If the strategy involves minimal expansion of the distribution line infrastructure (say with battery storage,</i></p>

	<p><i>DER, and/or market incentives/policy), then the corresponding transmission expansion would be minimal as well. However, there is still a cost associated with these strategies.</i></p> <p><i>Now, IF distribution system is somehow expanded and doubled in size for the urban areas (at significant cost), a corresponding expansion of the transmission system to serve the additional 5,000 MW of load will also incur significant costs. Typically a 240 kV transmission line is capable of serving 500 MW, while a substation is typically capable of serving 100-200 MW. This gives you a sense of the infrastructure expansion that could be required if we simply build to serve 5,000 MW of new load. This does not include other transmission expansions required to accommodate the corresponding 5,000+ MW increase in generation resources and other transmission services. In addition, routing these large 240 kV transmission towers in densely populated areas will be extremely challenging to say the least; finding sites to build 30-40 new substations will also face the same challenge, if it's feasible."</i></p>
<p>SK – Ministry of Energy</p>	<p>No analysis was provided.</p>
<p>SK – SaskPower 2021 FOI</p>	<p>No analysis was provided on the expected cost to a typical household for upgrades to the province's electricity system.</p> <p>They provided a partially redacted report from 2019 with some analysis on potential impact to electrical load from an increase in electric vehicle usage. However, this report was written long before the federal government's EV mandate was announced. As such, it projects low adoption for EVs in the province (only 7% of new vehicle sales by 2030).</p> <ul style="list-style-type: none"> • Page 59: The report makes an interesting comment: "EVs will result in a net-negative business case for the utility, thus any interventions by the utility to increase the uptake of EVs (eg: infrastructure deployment) should be accompanied by a load management strategy to ensure a net-positive business case". Although this doesn't mention it directly, this statement alludes to the fact that greater EV adoption – especially now with the federal mandate – will pose greater costs for SaskPower and therefore higher rates for users. • "The high cost of capacity coupled with high coincidence of EV loads and utility peak will undermine the value EVs bring to the utility if load management is not used." (Page 88) <p>It is important to note that a much higher adoption of EVs is now expected than what SaskPower's analysis assumed. Thus, the utility's concerns about the need for load management and net costs to the utility are even more relevant.</p>

<p>SK - SaskPower 2023 FOI</p>	<p>As a follow-up to the 2021 FOI, a similar request about electric vehicle adoption was filed again in 2023.</p> <p>SaskPower responded with a report provided for them by the University of Regina.</p> <p>The response did not include any analysis on the expected cost to consumers to upgrade the province's electricity system. The report did, however, include the following interesting notes:</p> <p><i>"EVs represent an intensive electric load. Their penetration to the power system poses significant challenges to power distribution system operation and control, such as voltage drop and transformer overload." (Page 3)</i></p> <p>Page 125: SaskPower evaluated the impact of EV load growth on the current urban residential power distribution grid based on transformer loading and voltage drop. The report notes, <i>"with current infrastructure, it was found that 22 EVs is the critical number of EVs for a 15-house distribution system while only 11 EVs is the critical number for a 22-house distribution system."</i></p> <p>Considering the average home in Canada has 1.5 vehicles, it is easy to imagine how a cluster of 22 homes might be in a position where they are charging more than 11 EVs at one time and overload the transformer, leading to a localized power outage.</p>
<p>MB – Department of Environment and Climate</p>	<p>No analysis was provided.</p>
<p>MB – MB Hydro</p>	<p>No analysis provided on the expected cost to a typical household for upgrades to the province's electricity system.</p> <p>Manitoba Hydro did, however, provide a number of interesting links to various reports and documents.</p> <p>In a <i>"Special Board Meeting Strategy 2040 Update,"</i> the utility noted:</p> <ul style="list-style-type: none"> • Manitoba's zero emission vehicle (ZEV) sales tripled from 2018 to 2019, largely due to the federal rebate of \$5,000. • Page 97: the report mentions that, <i>"Customers bear the connection costs for extending service to them" and "the time to connect varies according to the construction required, and can be lengthy where system upgrades are required."</i> Although not mentioning it directly,

this page does allude to the fact that customers in northern regions of Manitoba – where load infrastructure will need to be expanded and updated to accommodate increased load demand – could face increased upgrade times and costs.

In July of 2023, Manitoba Hydro released its first *'Integrated Resource Plan'* (IRP). It includes analysis on the impact of ZEVs. Some observations include:

- Manitoba currently generates a surplus of electricity, which it sells on the export market. However, the utility does not expect to renew those export contracts given the coming surge of demand.

"Increasing winter peak demand in all future IRP scenarios – up to two and a half times current demand – signals the need for new generation resources and the associated transmission and distribution infrastructure to deliver electricity to where it is needed. These investments will increase costs." (Page 12)

- The utility projected four different scenarios for the future, each with different assumptions around electric vehicle usage, natural gas usage, economic growth, decarbonization policy and customer self-generation. The report noted:

"...net present values over 20 years for the scenario and sensitivity results range from approximately \$12 billion to nearly \$27 billion, which is in addition to investments needed to maintain existing infrastructure." (Page 13)

- For perspective, a November 2022 news release by the utility noted debt levels are already high: "Manitoba Hydro's debt is \$24 billion and until now, approximately 40 cents of every dollar customers pay to the utility went to cover just the interest cost on that debt."¹⁹ For perspective, SaskPower's financing charges represented just 14% in the 2021-22 fiscal year (Page 116)
- Manitoba's distribution system will also need significant upgrades: "Much of Manitoba's electrical distribution system was built during urban and rural electrical expansion that occurred between 1945 to 1960. In many older areas, the system operates at a much lower voltage than more modern systems, and is at or beyond capacity with limited ability to serve significant increases in electric demand. Additionally, most of the current distribution system is not designed for the two-way flow of electricity that might be desired by customers investing in self-generation and would need more sophisticated protection and control upgrades..." (Page 37).

The FOI included materials referred to as "EV Grid-Readiness consultation". There were a number of interesting points in the report:

- *“As adoption levels increase it is anticipated increased investments in the distribution grid will be necessary in order to supply the peak electricity demand necessary to power EVs. The need for costly distribution upgrades is even greater when considering medium-duty and heavy-duty EV charging.” (Page 1)*
- *“If the utilities/ratepayers are to fund the necessary distribution system upgrades to power EVs then it will result in higher utility charges. Increases in utility costs, due to distribution system upgrades, would be spread across the entire rate base. The resulting higher rates will have a disproportionate financial impact on low-income ratepayers, as their electricity bill consumes a larger portion of their income.” (Page 2)*
- *“Fleet operators are rarely heavy electricity users. The electrification of their fleets could run into challenges/delays as they attempt to add MW’s of charging capacity without consideration to the grid impacts, related demand charges and the reality that large sudden electric utility upgrades can require two years of lead time to implement. This lack of understanding of the electricity sector, inefficient fleet deployment of charging system, and lengthy utility upgrades will slow the pace of EV adoption and increase costs, particularly for fleet operators.” (Page 2)*
- *“Accelerated adoption of EVs will result in increased pressure on the grid and thus costs; especially if EV charging is not shifted off-peak. The ability to shift or manage EV charging would benefit all ratepayers, not just those with EVs. Therefore, electric utilities will need to make this significant investment in order to enable load shifting measures such as time variable rates and utility-controlled charging.” (Page 3)*

Federal Light-Duty Zero Emission Vehicle Consultation

- *“A significant number of remote communities are supplied by long radial distribution circuits that may not have enough capacity to accommodate the substantial increases in electrical demand without prohibitively costly upgrades. The adoption of Heavy-Duty Zero Emission Vehicles and/or significant amount of [direct-current fast charger, or DCFC] infrastructure is anticipated to have a higher impact on distribution system infrastructure in remote communities requiring more upgrades than non-isolated and urban communities.” (Page 6)*
- *“Most DCFC’s require 3-phase electricity...Remote communities and inter-regional roadways are the least likely to currently have 3-phase electricity. To date, a private sector project that was proposed to serve a route leading to a remote community was already terminated due to the millions of dollars that would have been required for upgrading long stretches of powerlines to 3-phase electrical service.” (Page 6)*

	<ul style="list-style-type: none"> • <i>“Another issue is deployment of EVs in the four northern off-grid diesel communities. Deployment of EVs in these regions would have minimal GHG benefits given the current source of electricity generation and the diminished performance of EVs in extreme cold weather climates. Furthermore, some isolated First Nations in Manitoba are serviced by long seasonal winter roads. The range of HDZEV and ZEV vehicles will need to be sufficient to enable these vehicles to service the needs of the communities in the depths of winter (when the winter roads are open) as there are no charging services along many of those routes nor would it be easy to supply them with existing distribution infrastructure.” (Page 6)</i> • <i>Page 7 notes that a consulting firm known as ICF “conducted research ... which estimates that EV charging could add over 600 MW to Manitoba’s current system peak. The need for costly sub transmission upgrades may be greatest when considering adding heavy-duty ZEV charging, in addition to light-duty ZEV charging. The clustering of this level of charging can easily add several megawatts (MW) of load and will likely need dedicated circuits.”</i> • <i>“Depending on the extent of overall adoption of EV’s in an area, additional system capacity may be required to meet peak electricity demand. These upgrades will be treated as system improvements and the cost will be applied to the general rate base. This will have an inflationary impact on electricity rates, as the cost is borne by all customers, even those who don’t own vehicles.” (Page 8)</i> • <i>“EVs present an opportunity for new electricity revenue for electric utilities; however, analysis conducted by Manitoba Hydro suggests that grid upgrade costs will exceed the benefit of this additional revenue.” (Page 8)</i>
<p>ON – Ontario Ministry of Transportation</p>	<p>No analysis provided on the expected cost to a typical household for upgrades to the province’s electricity system. (Note: Information request was originally filed with the Department of Energy.)</p> <p>The Ministry provided a heavily redacted 697 page response to the federal government’s EV mandate. Some takeaways from the analysis that was not redacted include:</p> <ul style="list-style-type: none"> • Like Manitoba, Ontario requested additional funding from the federal government to build EV charging infrastructure and to “reduce upfront HDZEV (heavy-duty zero emission vehicles) costs.” • Ontario interestingly noted that electric vehicles are heavier than their gas-powered counterparts, which “causes exponential damage to pavement/bridges, leading to exponential costs associated with repair/replacement. This leads to increased emissions related to the repair/replacement of infrastructure, and premature asset depreciation.”

- The response expressed concerns for northern and remote communities, which “lack access to an efficient and connected ZEV charging network. This gap in charging infrastructure availability is contributing to lower uptake of ZEVs and long-distance “range anxiety”. This is especially a concern during winter months when EV range can fall by nearly 50%, limiting EV driver’s ability to plan trips and travel longer distances.”
- The response acknowledged that increased EV adoption will lead to a surge in electricity demand, and that *“the electricity system needs sufficient generation capacity as well the ability to maintain system stability when distributing electricity. Lower-carbon electricity grids will increase emissions reductions from ZEVs. The federal government should continue to consider how to best support provincial low-carbon electricity grids, considering the federal commitment to transition to net-zero emitting electricity grid by 2035.”*
- *“Ontario’s local distribution companies will need to ensure their systems can support new EV loads while maintaining reliable service for all their customers. New technologies such as [vehicle to grid charging] (V2G) and controlled charging may be able to help address this challenge. Federal funding should consider the system-wide costs of facilitating EV adoption, particularly those costs associated with connecting to and reinforcing electricity distribution networks.” (Page 6)*
- *“Heavy-duty hybrid models are growing in availability and offer some important advantages, including low cost of ownership, enhanced range, fuel cycle and charging flexibility, technology readiness and product availability. These vehicles are eligible for government funding programs throughout Canada (e.g., Quebec’s Écocomionnage) and the US (e.g., California’s HVIP).” (Page 23)*
- Page 171 acknowledges that there will be a need to monitor EV growth in the province and manage charging demand “to ensure system reliability”.
- *“Potential for unserved energy begins in 2026 and increases in 2029 if resources coming off contract exit the market. However, if existing resources continue to be available, Ontario is expected to experience minimal unserved energy. This drives the need to focus on capacity in future resource acquisitions. In the long term, higher demand leads to increased natural gas dispatch. If natural gas were to become unavailable or constrained, energy needs grow substantially.” (Page 514)*

<p>QC – Ministry of the Environment, the Fight against Climate Change, Wildlife and Parks</p>	<p>The ministry indicated that Quebec has its own zero-emission vehicle mandate and did not provide the federal government with any materials prior to the development of Ottawa’s dictate.</p>
<p>QC – Hydro Quebec</p>	<p>Reported that they did not have any information pertaining to our FOI requests. Instead, they simply referred attention to publicly accessible documents with Hydro Quebec and Natural Resources Canada.</p>
<p>NB – Natural Resources and Energy Development</p>	<p>No analysis was provided.</p>
<p>NS – Ministry of Natural Resources and Renewables</p>	<p>No analysis provided on the expected cost to a typical household for upgrades to the province’s electricity system.</p> <p>The Ministry provided a letter from Minister Tory Rushton to the federal government in response to the EV mandate. This letter expressed support for the federal government’s EV mandate, but also asked for “considerable federal support and funding to meet these ambitious goals.” This letter touched on Nova Scotia’s EV charging station network and efforts to educate the public on EVs. However, it mentioned nothing about power generation and transmission infrastructure.</p> <p>Also provided was a “stakeholder engagement discussion document.” This document appears to be a slideshow meant to accompany a group discussion. The electricity grid is mentioned only once, as an “other consideration.”</p> <p>Nova Scotia’s response to Transport Canada seeking feedback on the 2035 EV mandate was included. One interesting takeaway is that, while detailing any challenges and opportunities to the electricity grid, the Nova Scotia government noted that “vehicle charging impact is dependent on policy. Appropriately timed vehicle charging, and use of additional available capacity (of) vehicle batteries, can have a positive impact on grid cost and stability. Conversely, unmitigated charging will exacerbate existing peak-management problems, and lead to unnecessary distribution upgrades.”</p>

<p>NL Department of Industry, Energy and Technology</p>	<p>No analysis was provided.</p>
<p>NL – NL Hydro</p>	<p>No analysis provided on the expected cost to a typical household for upgrades to the province’s electricity system.</p> <p>Provided an in-depth 2022 report titled “<i>Reliability and Resource Adequacy Study.</i>” It goes into much detail on power generation and demand. It also contains a section on EVs and the extra demand they will bring to the power grid. Some takeaways from that section include:</p> <ul style="list-style-type: none"> • While the report acknowledges the federal government’s goal of forcing all new vehicle sales to be EVs by 2035, it anticipates that this figure will only reach 65% at most in Newfoundland and Labrador by 2035. • An estimation on the power needed to charge EVs in the years ahead was given: “EVs could generate up to 1,600 GWh in electricity sales in 2040; however, if EV charging loads are left unmanaged they could increase system peak loads by as much as 525 MW in the same year.” • Some options to manage charging during peak times were discussed, such as, “Education and awareness: EV drivers can be encouraged to purchase smart chargers, programming them to charge overnight and reduce evening peaks. There is uncertainty around customer response/degree of peak shifting. In addition, shifts will be ‘blocky’, as all EV owners will be given the same targeted time period to charging. This risks creating a secondary peak.” • “Telematics: Charging can be controlled through direct communication with vehicle telematics using a Demand Response Management System (DRMS). To-date, the communications protocols are not standardized between manufacturers; impact will depend on technological standardization moving forward.” • “Smart Chargers: Utilities can incentivize smart charger purchases with the expectation that participants will be willing to participate in a managed charging program in the future. Smart chargers are typically controlled through a utility DRMS.”

<p>PEI – PEI Ministry of Energy</p> <p>2021 Email exchange, 2023 FOI response</p>	<p>No analysis provided on the expected cost to a typical household for upgrades to the province’s electricity system.</p> <p>The Ministry did, however, provide some short answers via email:</p> <ul style="list-style-type: none"> • “Regarding the first part of the FOI: They have not done a detailed analysis on what would need to happen with the province’s electricity system if consumers in the province switched to electric vehicles. This ultimately would be the responsibility of the Utilities to ensure a reliable grid. With all the electrification we anticipate a doubling of the load by 2050.” <p>Regarding the second part:</p> <ul style="list-style-type: none"> • In PEI, natural gas is not an energy source. Their main source is oil. They have an increase in heat pumps and electrification and an increase in efficiency programming and funding. They anticipate load doubling by 2050 and that it will be a gradual process over the next 5-10 years. • Approximately 25% of their supply comes from renewable sources (wind energy). • Between 2021 and 2050, PEI plans on adding additional renewable energy. The province noted they currently import 75% of their power from New Brunswick Power, and have four subsea cables to New Brunswick. They expect an increase in supply from New Brunswick Power as their load increases. <p>PEI also provided a short Navius Research report titled <i>“Identifying pathways to net zero greenhouse gas emissions in PEI.”</i> The short report briefly mentioned EVs, but only in the context of reducing greenhouse gas emissions.</p> <ul style="list-style-type: none"> • <i>“Between now and 2040, electricity demand increases by 1.9 times under a scenario in which PEI achieves net zero.” (Page 2)</i> • <i>“Though decarbonization imposes real costs on households and businesses, the provincial economy is 1.6-1.9 times larger in 2040 than today under any scenario in which PEI achieves net zero.” (Page 2)</i> • <i>“The electricity sector is unique in that supply must match demand in every hour of the year. The timing of supply and demand, already important in PEI due to its reliance on wind and imports, will only become more so in an electrified future.” (Page 3)</i>
---	--

General Observations

Generally speaking, provincial governments, and their electric utilities, acknowledged that a shift to electric vehicles represented a significant challenge for electricity grids. Some provinces will be impacted more than others.

For instance, British Columbia, Manitoba and Quebec, which currently generate significant amounts of hydroelectric power, and currently export some of that power, can reduce exports and use the surplus to mitigate at least some of the increase in demand that electric vehicles will pose. As the Canadian Chamber of Commerce has pointed out, the shift to electric vehicles is a harder transition for provinces like Alberta, which currently rely on fossil fuels for a significant portion of their power supply. Saskatchewan, Ontario and many eastern Canadian provinces are in the same position. These provinces not only need to increase the supply of electricity to meet the growing demand that EVs present, they are also facing pressure to reduce emissions from the grid itself.

Despite the sea change that a shift to electric vehicles presents to electric utilities, no provincial government, or utility, provided analysis as to what this change will cost a typical residential ratepayer.

Materials provided by Manitoba Hydro raised several important considerations as utilities contemplate the changes they must undertake.

First, Manitoba Hydro noted that low-income households will be impacted more severely as electric costs present a higher portion of household spending. How will governments manage this challenge? Related to this problem is the matter of homes that do not purchase electric vehicles. Will utilities raise rates on all homeowners to pay for upgrades in order to accommodate electric vehicles? Homeowners who do not have electric vehicles may feel this is unfair.

Remote communities are also worth examining. As Manitoba Hydro noted, some communities rely on diesel generators right now as it is uneconomical to run power lines out to their location. People often travel between those communities and the rest of the province during the winter months when travelers depend on temporary winter roads. This could be a challenge to building EV charging stations. How will such areas accommodate electric vehicles? This concern is also relevant in Canada's northern territories where there can be great distances between communities and require drivers to cross inhospitable terrain that is unsuitable for electric charging stations.

In terms of the impact on local distribution systems, some of the increase in demand can be mitigated by encouraging charging during off peak hours. Most provinces identified this option as part of the solution and the federal government's projections also rely on consumers adopting this habit. However, this approach has its limits. Analysis provided for SaskPower noted that a 22-house collection of homes could only handle 11 electric cars before running the risk of power outages. Manitoba Hydro noted, "in many older areas, the system operates at a much lower voltage than more modern systems, and is at or beyond capacity with limited ability to serve significant increases in electric demand." Even if consumers charge at night, upgrades will still likely be required.

Overall, details were generally sparse when it came to explaining where utilities are going to draw the additional power needed for mass adoption of electric vehicles. Part of this challenge lies in the fact that the federal government has also proposed regulations that require utilities to reach zero emission targets by 2035. While coal power is already being phased out, natural gas power will become a more challenging option for utilities.

Finally, it was interesting to see Newfoundland and Labrador believes Ottawa's zero emission vehicle mandate cannot be met. While their report acknowledges the federal government's goal, the province anticipates that only 65% of new vehicle sales will be zero emissions by 2035.

Related Implications

While researching this issue, SecondStreet.org identified many other possible consequences of the federal government's zero emission vehicle mandate not covered (or only lightly mentioned) in the materials provided above.

For one, an influx of EVs could cause a number of different safety concerns. Northern and remote communities were discussed above for their challenges in building EV infrastructure and power generation. A lack of fossil fuel powered vehicles in those areas could also present a significant safety concern in the winter: in areas with routine extreme cold, EV batteries are less reliable than gas-powered vehicles. A study by Recurrent Auto shows that EVs can lose up to 35% of their range in cold weather.²⁰ The Ontario government puts the figure as high as 50%. EV users must recharge at a dedicated charging station, whereas drivers of gas-powered vehicles can simply bring a fuel container with gasoline if need be. Drivers who are stuck on an isolated ice road with no EV charging station nearby could face a life-threatening situation.

These same concerns can be applied to emergency vehicles. Some cities are taking steps to begin replacing their fleets of fire trucks, ambulances and police cars with EVs.^{21 22 23} The same issues with range reduction in cold weather could be a problem. In emergency situations, a few minutes of time can be crucial – a police officer on the way to an active shooting or a paramedic on the way to the scene of a car crash doesn't have time to wait for a vehicle to charge.

Related to car crashes, there are also concerns about general road safety for EVs. EVs tend to be much heavier than their gas-powered counterparts; a selection of models from Ford, Volvo and Toyota were found to be about 33 per cent heavier.²⁴ This could lead to more fatalities on the road as consumers purchase more EVs. The Massachusetts-based National Bureau of Economic Research (NBER) studied data

from nearly 5 million automobile crashes. It found a 47% increase in the fatality rate with vehicles that weighed 1,000 pounds more than lighter models.²⁵ The cost to life alone is a serious enough consideration, but a higher incidence of severe road crashes would also impact the health care system.

There is also a potential risk to pedestrians and cyclists. A study from the Virginia-based Insurance Institute for Highway Safety said that "it's not clear that all EVs have braking performance that matches their additional mass. If the extra weight leads to longer stopping distances, that will likely lead to an increase in pedestrian and cyclist deaths, which already have been on the rise in recent years."²⁶

Another significant cost due to the extra weight from EVs could be wear and tear on Canadian roads. The British newspaper The Telegraph reported that EVs "could expose roads to 2.24 times more damage than gas cars."²⁷ As noted in the table above, the Ontario government acknowledged that EVs are significantly heavier than gas cars and may cause "exponential damage to pavement/bridges, leading to exponential costs associated with repair/replacement. This leads to increased emissions related to the repair/replacement of infrastructure, and premature asset depreciation." If the EV mandate goes ahead as planned, cities may need to increase their budgets for road and bridge repairs, and drivers will need to plan for longer commutes due to more construction delays.

Finally, many provinces endorsed a strategy called load management to reduce strain on the power grid. This would attempt to shift when people charge their EVs to off-peak times – usually overnight, when there's less demand for electricity. However, it's important to note that not all Canadians work 9-5 jobs. According to CAREX Canada, approximately 12% of working Canadians (around 1.8 million people) work a night shift or rotating schedule.²⁸ Those people may need to charge their vehicles during the day. This could cause a strain to the power grid that is not possible to shift. It is also not a certainty that consumers will heed the government's preference for nighttime charging.

Policy Option

Canadians have not been presented with clear estimates as to how the mass adoption of electric vehicles will affect their power bills.

It appears that most provincial governments have not completed this important research, nor has it been communicated to the public.

One option would be for the federal government to cancel or delay its 2035 requirement for zero emission vehicle sales. This would allow provincial governments, and their utilities, to properly study the implications of the zero-emission vehicle policy, along with related, proposed zero emission requirements for the grid itself. Following such research, the public could be presented with the costs of such a transition, and consulted with for input and approval.

In the meantime, the federal government and provincial governments could examine how they might encourage consumers to purchase lower emission vehicles, including cleaner burning natural gas vehicles, hybrids and hybrid electric vehicles.

Conclusion

Electric vehicles are a welcome addition to the automobile market. They give consumers more choice and greater competition drives innovation.

However, as this paper shows, the federal government's decision to mandate zero emission vehicle sales by 2035, along with the government's push for EVs, present an enormous host of challenges for electricity grids. Overall, it appears the level of government that must implement the changes – provincial governments – are not aware of what this transition will cost typical Canadian households. This is

especially concerning as Canada is approximately 11 years away from full implementation of Ottawa's zero-emission vehicle mandate. While this sounds like a long period of time, large infrastructure projects in the electricity sector often take many years to plan and build.

Considering the public will end up paying the bill for this policy, proper research and transparency are needed. Putting a pause on the mandate, until the details of its implications are fully known and communicated to the public, would be a wise decision.

About the Authors

Colin Craig is President of SecondStreet.org. He has an MBA and a BA (Economics) from the University of Manitoba and is the author of *The Government Wears Prada*, a book that examines how governments could be more cost-effective and prepare for the nation's aging population. Most recently, Colin authored several chapters for the eBook, *Life After COVID: What's next for Canada?* He has contributed to public policy changes at the federal, provincial and municipal levels in Canada and was awarded the Queen Elizabeth II's Platinum Jubilee medal in 2022 for his public policy work.

Dom Lucyk is the Communications Director of SecondStreet.org. He graduated with honours from the Western Academy Broadcasting College in Saskatoon. He's passionate about holding government accountable and public policy that brings greater freedom and prosperity for Canadians.

References

1. "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada." Transport Canada (Government of Canada) news release, June 29, 2021. Accessed November 13, 2023. <https://www.canada.ca/en/transport-canada/news/2021/06/building-a-green-economy-government-of-canada-to-require-100-of-car-and-passenger-truck-sales-be-zero-emission-by-2035-in-canada.html>
2. Karim, Naimul. "Canada mimics U.S. strategy by offering nearly \$30 billion for Stellantis, Volkswagen battery plants." Financial Post website. July 6, 2023. <https://financialpost.com/commodities/energy/electric-vehicles/canada-us-30-billion-stellantis-volkswagen-battery-plants>
3. Shakil, Ismail. "Canada agrees up to C\$15 billion in incentives for Stellantis-LG-ES battery plant." Reuters, July 6, 2023. <https://www.reuters.com/business/autos-transportation/canada-ontario-give-up-c15-bln-incentives-stellantis-lges-battery-plant-2023-07-06/>
4. "Market Snapshot: Record-high electric vehicle sales in Canada." Canada Energy Regulator website, November 26, 2022. Accessed November 14, 2023. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2022/market-snapshot-record-high-electric-vehicle-sales-canada.html>
5. "2023 Cost to Upgrade an Electrical Panel in Calgary." Panel Upgrade Experts website. Accessed November 14, 2023. <https://panelupgradeexperts.com/blog/2022-cost-to-upgrade-an-electrical-panel-in-calgary/#:~:text=For%20a%20200%20amp%20electrical.to%20get%20a%20precise%20figure>
6. Byrne Paquet, Laura. "Bringing it home: The true cost of EV." Ottawa Citizen, June 6, 2023. <https://ottawacitizen.com/life/bringing-it-home-the-true-cost-of-ev>
7. "Cost to Install EV Charger at Home Canada." TCA Electric website. Accessed November 14, 2023. <https://www.tcaelectric.ca/cost-to-install-ev-charger-at-home-canada/>
8. "How much does it cost to install an EV charger at home?" ElectricianInToronto.ca website. Accessed November 14, 2023. <https://www.electricianintoronto.ca/how-much-does-it-cost-to-install-an-ev-charger-at-home/>
9. McBride, Jason. "No charging spots and a strained electrical grid. Welcome to the electric vehicle boom." Maclean's Magazine. December 13, 2021. <https://macleans.ca/society/technology/no-charging-spots-and-a-strained-electrical-grid-welcome-to-the-electric-vehicle-boom/>
10. Wall, Brad. "Economic Review of Bipole III and Keeyask." Report commissioned by Manitoba Hydro and the Government of Manitoba. November, 2020. https://manitoba.ca/asset_library/en/proactive/2020_2021/ERBK-Report-Volume1.PDF
11. "Bipole Lines." Manitoba Hydro website. Accessed November 14, 2023. https://www.hydro.mb.ca/corporate/facilities/bipole_lines/
12. Gilchrist, Emma. "'They beat us into submission': West Moberly's decades-long fight against Site C dam is over." The Narwhal, June 28, 2022. <https://thenarwhal.ca/site-c-dam-settlement/>
13. Simms, Dave. "NaiKun headaches hold lessons for offshore wind projects." CBC News, March 30, 2011. <https://www.cbc.ca/news/canada/nai-kun-headaches-hold-lessons-for-offshore-wind-projects-1.992837>
14. "Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations." Canada Gazette, Part 1, Volume 156, Number 53, December 31, 2022. Accessed November 14, 2023. <https://www.gazette.gc.ca/rp-pr/p1/2022/2022-12-31/html/reg1-eng.html>
15. "Canada powers toward more clean, affordable, and reliable electricity with draft regulations." Environment and Climate Change Canada (Government of Canada) news release, August 10, 2023. Accessed November 14, 2023. <https://www.canada.ca/en/environment-climate-change/news/2023/08/canada-powers-toward-more-clean-affordable-and-reliable-electricity-with-draft-regulations.html>
16. "2023 Proposed Policy resolutions." Canadian Chamber of Commerce report, accessed November 14, 2023. https://chamber.ca/wp-content/uploads/2023/09/2023_Proposed_Policy_Resolutions.pdf
17. Booth, David. "Driving into the Future: Is charging infrastructure the last roadblock for EV domination?" Driving.ca, December 9, 2022. Accessed November 14, 2023. <https://driving.ca/column/motor-mouth/motor-mouth-is-this-the-last-roadblock-stopping-ev-domination>
18. "Provincial and Territorial Energy Profiles – Canada." Canada Energy Regulator website. Accessed November 14, 2023. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-canada.html>
19. "Manitoba Hydro to update General Rate Application with Public Utilities Board." Manitoba Hydro news release, November 29, 2022. Accessed November 14, 2023. https://www.hydro.mb.ca/articles/2022/11/manitoba_hydro_to_update_general_rate_application_with_public_utilities_board/
20. "Winter & Cold Weather EV Range Loss in 7,000 Cars." Recurrent Auto website, December 12, 2022. Accessed November 14, 2023. <https://www.recurrentauto.com/research/winter-ev-range-loss>
21. "Supply and Delivery of Two (2) Fully Electric Powered Fire Truck – Budget Amendment and Request to Begin Procurement Report." City of Brampton, August 31, 2023. <https://pub-brampton.escrimemeetings.com/filestream.ashx?DocumentId=91400>
22. Lofaro, Joe. "Quebec's first electric ambulances to make their debut in Montreal, Laval in 2023." CTV News, June 22, 2022. Accessed November 14, 2023. <https://montreal.ctvnews.ca/quebec-s-first-electric-ambulances-to-make-their-debut-in-montreal-laval-in-2023-1.5959330>
23. Yakub, Mehanaz. "Police in Quebec and Nova Scotia look to electrify by adding a Ford Mustang Mach-E and Tesla Model 3 into their fleets this summer." Electric Autonomy Canada, February 17, 2022. Accessed November 14, 2023. <https://electricautonomy.ca/2022/02/17/electric-police-vehicles-quebec-nova-scotia/>
24. Proskow, Jackson. "Why the 'significant' weight of electric vehicles is sparking new safety fears." Global News, April 12, 2023. Accessed November 14, 2023. <https://globalnews.ca/news/9587791/electric-vehicle-weight-safety-risk/>
25. "Vehicle Weight and Automotive Fatalities." National Bureau of Economic Research report, November 2011. Accessed November 14, 2023. <https://www.nber.org/digest/nov11/vehicle-weight-and-automotive-fatalities>
26. Arbelaez, Raul. "As heavy EVs proliferate, their weight may be a drag on safety." Insurance Institute for Highway Safety website, March 9, 2023. Accessed November 14, 2023. <https://www.iihs.org/news/detail/as-heavy-evs-proliferate-their-weight-may-be-a-drag-on-safety>
27. Ruffo, Gustavo Henrique. "EVs Could Damage Roads Way More Than ICE Cars Due to Weight." Autoevolution website, June 29, 2023. Accessed November 14, 2023. <https://www.autoevolution.com/news/bevs-could-also-damage-roads-way-more-than-ice-cars-due-to-weight-217255.html>
28. "Night Shift Work Occupational Exposures." CAREX Canada website. Accessed November 14, 2023. <https://www.carexcanada.ca/profile/shiftwork-resources/>