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DRIVING THE CLIMATE CRISIS:

The Role of EVs in Canada's Green Revolution

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INTRODUCTION

Canadians drive the dirtiest vehicles on the planet (5). Transportation in general accounts for 28% of our nation's carbon emissions, and road transport in particular accounts for just under 19% – numbers significantly above the global averages of 20% and 15%, respectively (1, 2).

Transportation accounts for **28%**

Road transport accounts for **19%**

Our growing love of SUVs and trucks is a key factor here; these vehicles emit **30% more** greenhouse gases than smaller vehicles per kilometer (6), and are the second-largest contributor to global increases in the last decade, after power generation (3, 4). In addition to impacts on the planet, internal combustion (ICE) vehicles have also been shown to negatively affect our health and wellbeing, with both particulate matter in exhaust and noise pollution being linked to long term risks such as dementia (7, 8), heart disease, obesity, and depression (9).

As people try to reconcile their desire to move around our often quite car-dependent cities with their growing desire to address the climate crisis (10, 11), interest in electric vehicles (EVs) has been growing both domestically and internationally. In 2018, EV sales surpassed two million for the first time (12), and while adoption is growing the fastest in China and Europe (14), even in North America growth has been faster than expected. EV Adoption, for example, estimates an increase in the USA market for EVs from just 3.4% of car sales in 2021 to 29.5% in 2030 (13). Domestically, a 2019 poll found that a great majority of Canadians thought we would shift to EVs within fifteen years, with half expecting the transition to take place in under ten (15). In fact, Canada has already reached one crucial tipping point, with one in eight (12.5%) new vehicles registered in the country in 2023 being electric (29). 5% market share is considered an important inflection point in emerging technology markets, as beyond this number products quickly go from niche to mainstream; in Europe, once 10% of vehicles were electric, the market share quickly tripled (30).

EVs offer an appealing avenue of action for governments looking to reduce carbon emissions by nudging consumers in the right direction with a combination of legislation, investment, and consumer incentives. Norway was very much an early adopter of this sort of policy, beginning the push towards EVs in the 1990s, and aiming to make EVs 100% of new vehicle sales as of 2025 (16, 17). The European Union and the United Kingdom have set 2035 as the target year for 100% electrification, as have fifteen states, including California (19). Federally, the USA is planning for EVs to account for half of new vehicle sales by 2030 (20), showing marginally more ambition than China, which aims for 40% of new vehicles to be electric by the same year (21). Here in Canada, Quebec and British Columbia have already created legislation aimed at reaching 100% electrification by 2035 and 2040, respectively (23, 22).

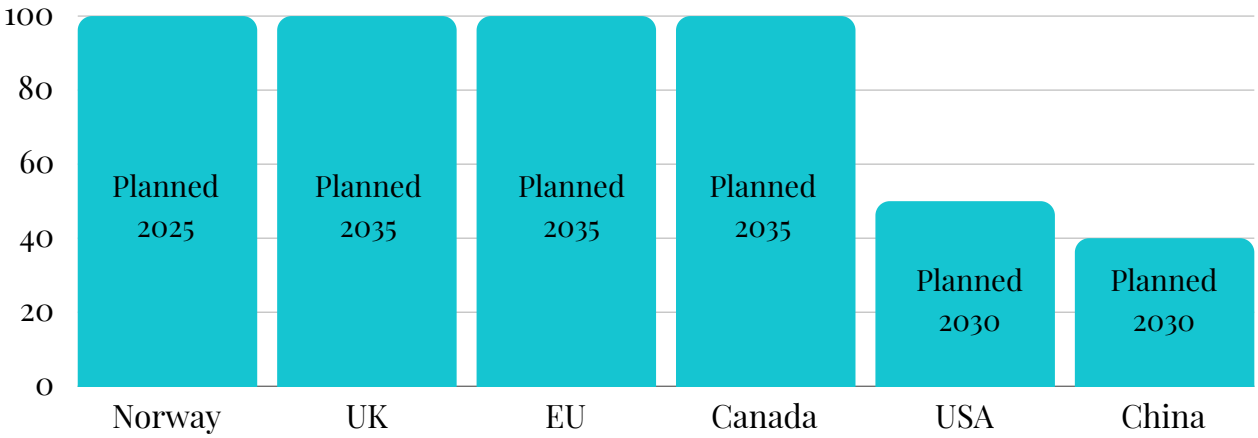


Figure 1. *Percentage of EVs to be Sold as New Cars*

Given this momentum, it is not surprising that the Government of Canada has decided to join the growing list of countries committing to an EV future (24). As of December 19, 2023, the federal government has announced gradually escalating targets for EV sales, starting at 20% of all new vehicles sold in 2026, and culminating at 100% of new vehicles in 2035.

The Government anticipates that the purchase price of ICE and electric vehicles will be comparable by the end of the decade, and that maintenance of EVs will cost owners up to **50% less than for ICE vehicles**, leading to overall savings for drivers of EVs. To further incentivize consumers to make the switch, the f**ederal government will offer incentives up to $5000**, which can be stacked with provincial incentives where available. The government has also committed to funding 430,000 charging stations across the country, and will credit auto manufacturers for investing in similar infrastructure.

This legislation applies to all passenger cars, SUVs, and pickup trucks, and is intended to end all use of "polluting" light duty vehicles by 2050, to keep Canada's auto manufacturing sector competitive, and to ensure that the supply of both EVs and charging infrastructure keeps pace with already-growing demand.

Consumer Preference

The idea that government policy is intended to keep pace with natural consumer demand may surprise some of the more strident news outlets, but it's not without a basis in reality. EVs have decent, but fickle, support among Canadians nationwide. According to a 2022 Abacus poll, among Canadians looking to buy a new car, 58% see EVs as a desirable option (25). Data from the Canadian Automobile Association similarly shows that all concerns about EVs were significantly reduced after purchase (32). A 2023 Ernst & Young poll, meanwhile, found that over half of respondents in the market for a new vehicle were looking for an EV (26), and the majority were willing to pay a substantial (30%) premium for the privilege, citing high fuel prices and environmental concerns as key motivators. EVs were expected to make up 30% of new car sales as of 2030 prior to this new Federal legislation; even in Alberta, EV sales outpaced the national growth rate in 2022 (31). Certainly, auto manufacturers believe that the growth of the EV market is a safe bet, with the number of zero-emission models available in the country growing from approximately 28 in 2019 to an anticipated 91 by the end of 2024 (24).

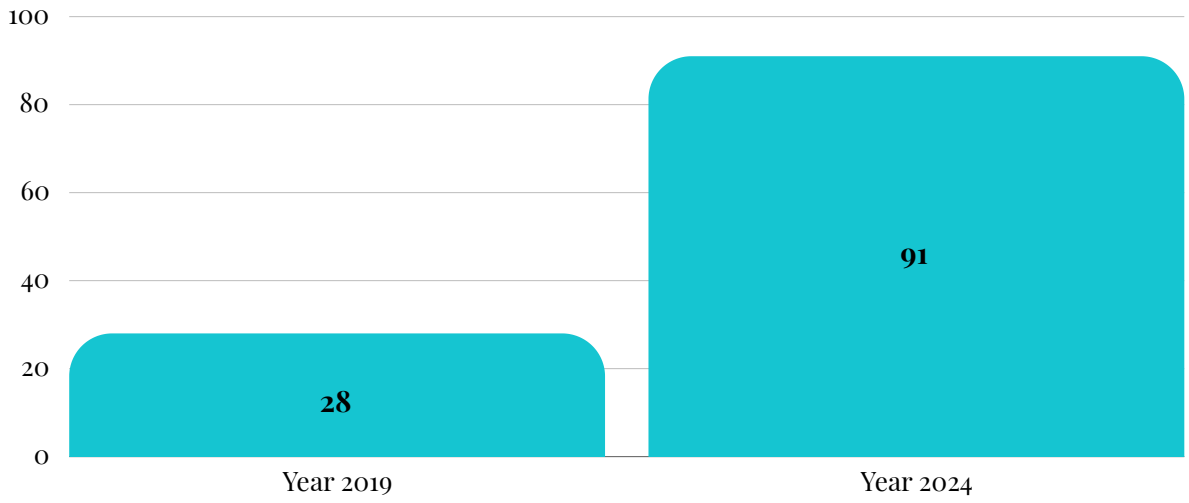


Figure 2. *Growth in Number of EV Models (2019 - 2024)*

On the other hand, a JD Power poll conducted in the summer of 2023 found that 66% of respondents were reluctant to consider an EV, citing concerns about range, purchase price, and lack of charging infrastructure (35). While it was not mentioned in this poll, it is also possible that the decline in gas prices between 2022 and 2023 contributed to reducing the appeal of EVs (33). Environmentalist organizations have also grown weary of policymaker focus on EVs at the expense of much more impactful actions, such as investing in mass and active transport, and are concerned that EVs do little to reduce raw material consumption or negative impacts on infrastructure, public safety, or particulate pollution (34). These concerns will be discussed in the sections below.

Charging Infrastructure

Concerns about limited charging infrastructure are a key issue pushing consumers away from electric vehicles (35), and remain the top concern even for EV owners (although the concern is reduced significantly after purchase) (32). This anxiety is not unreasonable. Natural Resources Canada estimates that the country needs between 442, 000 and 469, 000 public charging ports; we currently have just 35, 671 (36). Compounding this somewhat is the fact that 87% of existing chargers are in Ontario, Quebec, and British Columbia (37). While these provinces also account for approximately 75% of the population (38), and two of three also have their own EV legislation (23, 22), for a nationwide policy to be effective there will need to be as much availability of charging infrastructure beyond major metropolitan centers as there is in downtown Vancouver.

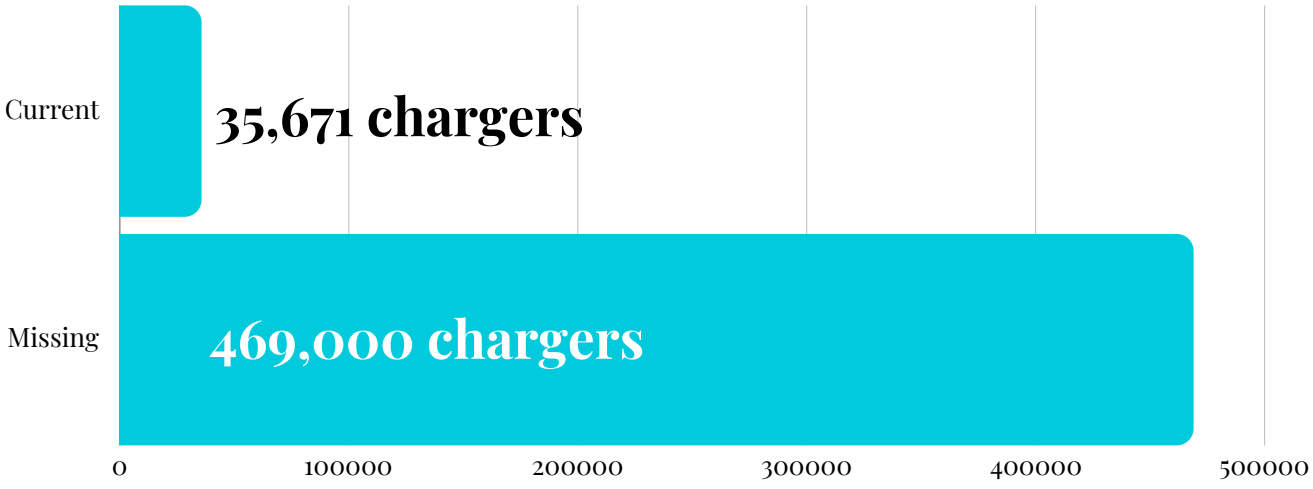


Figure 3. *Public Charging Station Deficit*

Arguably, this is one of the advantages of the new legislation. Knowing that EV dominance is a certainty in the relatively near future will help to motivate governments, non-profits, and businesses to build up the required infrastructure in time. Which sector should bear the bulk of the responsibility for setting up these charging stations is a contentious subject; some see it as a federal responsibility, since it is the federal government creating the mandate, while others believe auto manufacturers will be in the best place to use their data to create an efficient, profitable system (39). Certainly, government support and subsidies will be necessary in less populous, more northern, and more remote communities (39). Grants and incentives can also help to increase the availability of charging infrastructure nationwide. In addition to credit offered to auto manufacturers who build publicly available charging stations over the next decade (24), there are funding programs such as the

Zero Emission Vehicle Infrastructure Program, which provides up to 50% of the cost of new charging projects, or up to 75% for projects in Indigenous communities (40).

Programs like this can help get infrastructure built in areas where it otherwise may not have been by reducing initial cost burdens and minimizing risk (41). However, data suggests that there is a significant lag time between funding and operation (42), which could weaken confidence that such infrastructure will be ready to use when consumers need it.

Anxiety about charging infrastructure brings to mind images of the vast, often quite remote highways that cross the country. Few situations feel as helpless as the thought of being stranded by a roadside, hours away from the nearest charging station, and even if cross-country road trips are a relatively minor use of vehicles in Canada, they are still a familiar enough part of our lives that such worries are not without a source. Both abundance and speed are key factors for soothing this fear. Charging stations need to be available at regular enough intervals, and with enough capacity at each station, that no one need worry about finding one in time, and these charging stations need to have fast charging capacity, which can reduce the amount of time required to fully charge a vehicle from several hours to just fifteen minutes (12). There are lessons to learn here from Norway's initially-messy rollout of charging infrastructure policy, especially given that Norway, though smaller, shares some of Canada's difficult climate and remote terrain. That country now has a national charging strategy to address shortfalls in its existing system, including requirements for user-friendliness, compatibility with all vehicles, minimum charging capacity, and maximum distances between charging stations that fall well below the typical range of an electric vehicle (44).

Norway's experience offers lessons for urban public charging infrastructure too. Demand for fast, on-the-go charging grew with the increasing prevalence of EVs, which incentivized businesses to implement them – but with no clear guidelines in place, drivers were left with an often-frustrating experience (45). For example, Norwegian EV drivers needed to maintain multiple apps on their phones in order to access charging stations operated by different companies, and needed to keep track of which charging stations were compatible with their vehicle. Charging stations were relatively small and dispersed oddly throughout urban areas, meaning that some could have quite long queues while others in the vicinity sat empty. Better regulations could have made this transition less painful. To its credit, the current Canadian plan does incentivize the building of cross-compatible charging stations, but clearer guidelines about the type, location, and accessibility of charging stations would be helpful for reducing frustration.

That said, for most Canadians, charging is likely to occur primarily at the workplace or at home, where they are already parked for the majority of the day, rather than at public charging stations. Single family homes will likely have no significant issues, as the charge required is similar to that of an air conditioner or water heater and most EVs can be charged with a regular electrical socket (36). Those who wish to upgrade their homes to allow for fast charging will need to spend up to $6500 to do so, and may require permits (43) – but for the majority of households, slow overnight charging will be equally as practical at a much lower cost. Multi-family residences will have more trouble, as shared parking spaces are less likely to have sufficient infrastructure in place, and in many cases buildings will seek ways to track use in order to recoup costs (43). Funding building upgrades and mandating sufficient charging capacity in new multi-family residences are necessary steps that the Government will take to make sure these drivers don't get left behind (39).

Range

For Canadians, concern about charging infrastructure is exacerbated by the knowledge that EVs lose range – that is, the maximum distance a vehicle can travel on a single charge – in extremely cold weather. The extent of the impact is disputed, with different sources estimating as little as an 8% loss of range, and as much as 50% in the coldest conditions (46). Unless the design of EV batteries changes radically, this problem may be insurmountable to an extent due to the nature of the chemical reactions involved, although smart design can help to keep range loss on the lower end of the spectrum (47). Batteries can also take up to twice as long to recharge in cold weather – an intentional engineering choice that is meant to reduce stress on the battery, but that could compound frustration due to extended waits at charging stations in the bitter cold (47).

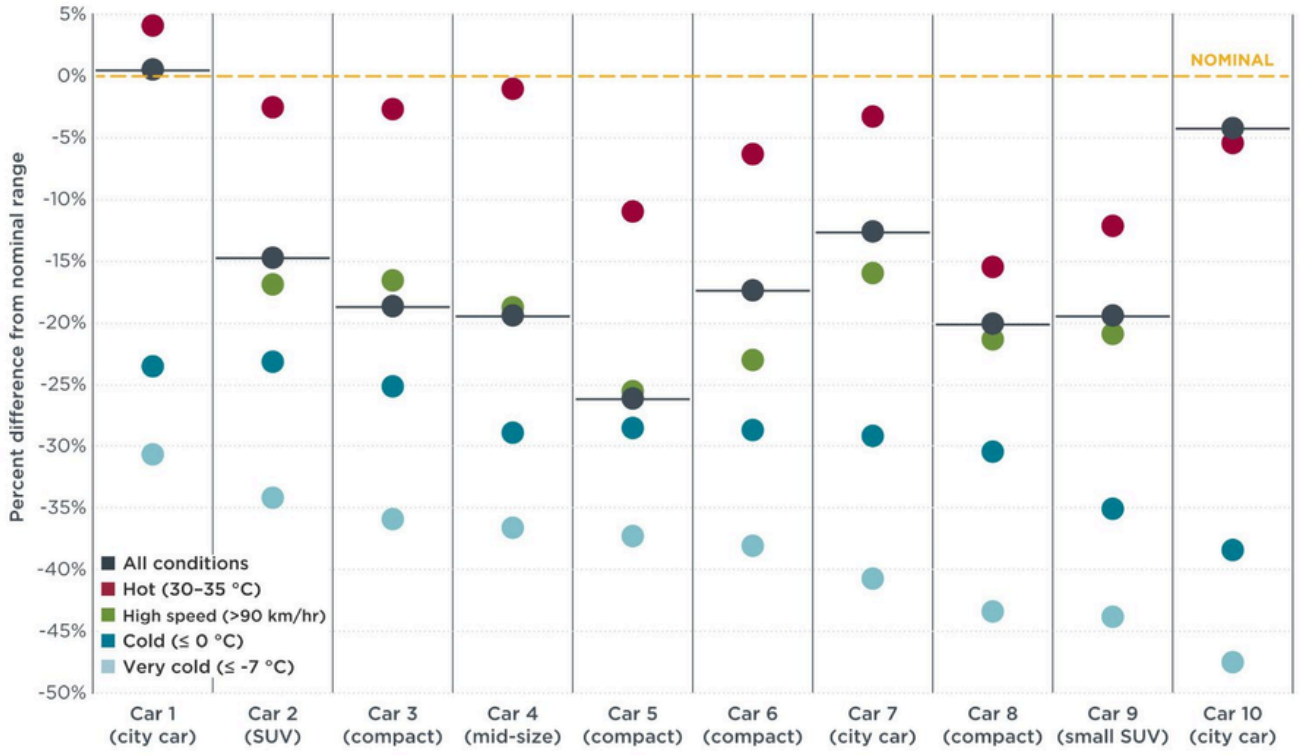


Figure 4. *The International Council on Clean Transportation, "Getting Real: Your EV's Real-World Range"*

Notably, cold weather also reduces the range and fuel efficiency of ICE vehicles significantly, although the overall greater range of ICE vehicles makes this less noticeable for drivers, even as their wallets take a greater hit (46, 48).

What is discussed less often – potentially due to our shared conception of "typical" Canadian weather, heat domes notwithstanding – is that EV battery life is shortened in extreme heat, and lengthened by cold (12). Because both extremes have impacts on EV batteries, solving the issue (to the extent possible) is likely to involve thermal management to keep the batteries in an optimal temperature range (12). For most Canadians, preheating a vehicle before a trip is already a normal, routine part of winter, both to help ICE vehicles start in the cold (a thing that EVs do not struggle with (46)) and for reasons of personal comfort. Doing this to help extend range will not, therefore, require a significant behavioural change (46, 47).

Interestingly, data from the Canadian Automobile Association shows that, of all concerns that drivers had prior to and following the purchase of an EV, worries about range showed the second-steepest decline, after only battery degradation (32). In other words, consumer's anxiety about range loss may not map that well onto their actual, day-to-day driving experiences.

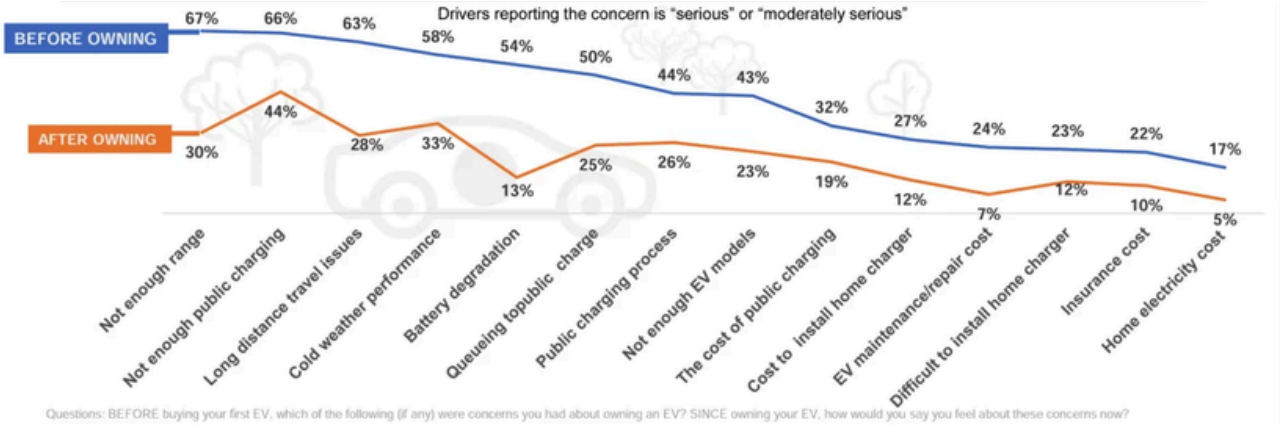
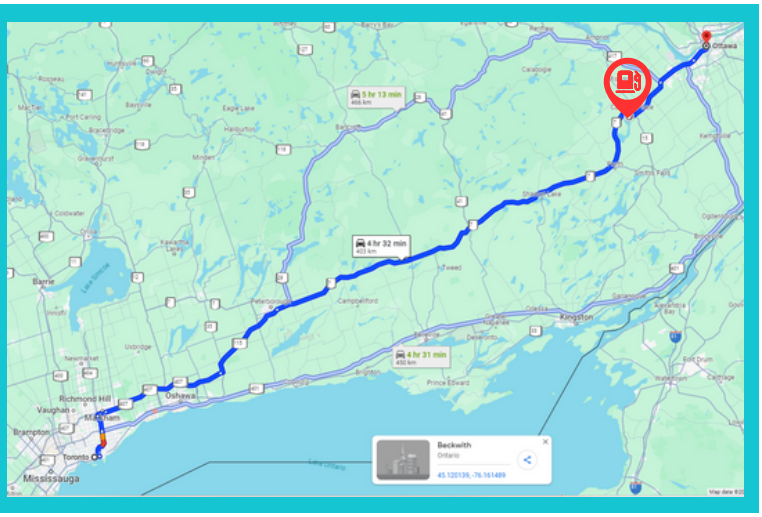


Figure 5. *Concerns about Owning an EV Pre- and Post-purchase*

This may be partly because, while the average range of a new EV is 468 kilometres, most Canadians drive less than 60 km per day (46), meaning that they could go almost four days without plugging in their vehicle again even at a 50% range loss. A road trip from Toronto to Ottawa in these conditions would only require a single extra charge – something that can easily be planned around in advance (47). Still, a maximum distance regulation for fast charging stations along highways (akin to Norway's policy) would help to ease anxiety about those long distance road trips in bitter minus fifty freezes that we all imagine we embark on constantly (44).

Figure 6. *One Charge Required from Toronto to Ottawa (average range of 349km)*



Sustainability of the Power Grid

As well as anxiety about the day-to-day practicality of EVs, many Canadians have expressed concern that our power grid is not ready to fuel a nation's worth of electric vehicles. Of course, as with the prevalence of charging stations, it isn't as if we need to have the grid ready to go immediately; instead, demand will climb gradually as the share of EVs in the total transport fleet grows between this year and 2050, giving us twenty-five years to build the capacity needed (36).

Still, it is important to understand what exactly that demand will be, what changes are needed, and whether there will be any negative effects on consumers. On the face of it, it is intuitive that we will need more energy – much more – if we are all going to keep driving as much as we currently do. A 2020 report by Natural Resources Canada estimated that demand on the power grid could increase by approximately 22% over the next two decades due to the increasing prevalence of EVs (36). The federal government estimates that getting the grid ready will cost $400 billion in replaced facilities and expanded capacity (36), including battery storage to help adapt to new peaks in energy use (49) and to stabilize supply at the furthest reaches of the grid, where demand is likely to increase the most (53). The new EV policy will help to make this growing demand more predictable, allowing energy providers to build capacity appropriately in the allotted time, which may have been difficult if EV adoption was left to the whims of the market (49).

Generally, electricity providers consider this kind of scaling viable, albeit not without work and careful planning.

The CEO of Electricity Canada notes that we have been able to keep pace with growing demand so far, and believes that the 3% year-over-year growth in capacity required is achievable, but only if that target is met every year consistently between now and 2035 (49).

The director of the Norwegian power system, meanwhile, states that people tend to overestimate the amount of power EVs will require. In fact, three million electric cars on Norway's roads will require about 5% of the country's current electrical consumption, and half of this is already made up for by declines in household energy use due to increased efficiency of other products such as light bulbs (51). This may help to explain why that country has never experienced grid-related issues due to EV charging, despite beginning the move to EVs much earlier, and with much less efficient technology in place (46).

Some critics worry that increasing demand and infrastructure upgrade costs will drive up utilities prices (36). For many households, these costs will be offset by reduced need to pay for fossil fuels (49), and by the relatively low cost of producing renewable energy once systems are in place (50). As well, some electrical planners view EV charging as a good opportunity to even-out demand on the grid, as EVs can be charged during off-peak hours, such as the middle of the night (49). Dynamic pricing at fast-charging stations, including lower prices at lower-traffic stations, and incentives for off peak charging could further help to stabilize the grid (52).

However, if demand does cause the per-unit cost of electricity to rise, even in the short term, this could create a financial burden for non-drivers, or for those who drive very little, as incentives and cost-offsets primarily affect people who currently drive ICE vehicles.

Cost Effectiveness

Financial burden is another key sticking point for Canadians who express skepticism towards the new EV policy. EVs are more expensive than ICE vehicles at the point of purchase, although this gap is shrinking rapidly as EVs become more common and mass production of parts more efficient (56, 59). While EV owners spend about 60% less in fuel and 50% less in maintenance than ICE vehicle owners (58), the promise of long-term savings does not always suffice to justify higher immediate costs, or greater personal debt. To help bridge the gap in prices, incentives of up to $5000 from the federal government (54) are available, and can be stacked with provincial incentives (up to $7000 for residents of Quebec, $4000 for residents of British Columbia, $3000 for residents of Nova Scotia, and $5000 for residents of Prince Edward Island, Newfoundland and Labrador, and New Brunswick (55, 57). These incentives are generally dependent on income and on the type of vehicle (hybrid vs fully electric) purchased, but for some Quebeckers especially, could easily make the price difference between electric and conventional vehicles negligible even at purchase. As price parity between the two vehicle types draws nearer, incentivized EVs could quickly overtake gas vehicles as the budget-sensible option (59).

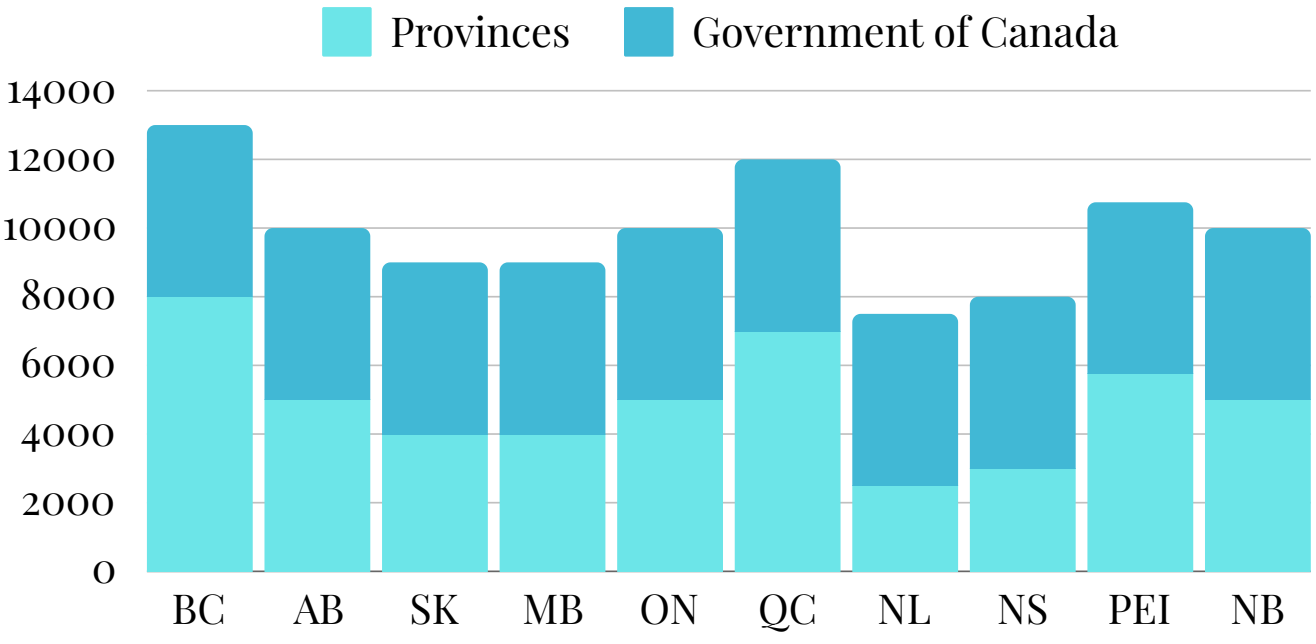


Figure 7. *Sum of Federal and Provincial EV Incentives*

That said, at a societal level incentives may cost more than just mere taxpayer dollars. One problem Norway has encountered is that early adopters tend to be wealthier – the sort of people who are in the market for new cars and who don't mind paying a premium for the most up-to-date option. This has meant that incentives, in practice, have filtered wealth upwards, increasing inequality – but also that phasing them out is difficult, because it is the poorest drivers, who have not yet been able to afford the switch, who would lose out if those funds dried up (63, 64). Incentives in Norway have also disproportionately delivered extra wealth to urbanites, as rural drivers are more reluctant to to make the switch (63). This same phenomenon has created unexpected new difficulties in urban areas like Oslo, where preference given to EVs now makes greener, active (i.e. cycling), and public transport initiatives more difficult to institute (64). In this latter case, complementary funding for public transport and rebates for non-drivers could help to redress the imbalance and discourage overreliance on EVs in cities (65).

There are also indirect costs that may be associated with the transition to EVs. Dealerships and auto mechanics in particular will need to adapt to this new market, although unlike mechanics, dealers have the option to sell primarily online if the cost of upgrading their shops is insurmountable (60). Mechanics will have a harder time, as they will need to upgrade not only their shops and tools, but also their own training (61). Because EV repair requires a substantially different skillset to ICE vehicle repair, it is not always easy to transition from one to the other, and some mechanics may not be interested in retraining (62). Limited options for repair could in turn lead to higher prices for consumers, and although this may be offset by the overall lower maintenance required for EVs than for conventional vehicles, funding for training and shop retrofits could nevertheless help to ensure a smooth transition, both for drivers and for mechanics.

Finally, there are societal costs associated with vehicles that do not disappear just because those vehicles are electric. Like conventional vehicles, EVs require ever-increasing encroachment into the wilderness to accommodate traffic; a road full of Teslas decimates caribou habitats just as much as one full of Model-Ts (67, 69). Similar to gas powered cars, EVs require substantial resources to produce, and are associated with pollution and social justice issues related to mining and manufacturing (70, 71). Like vehicles with internal combustion engines, the weight of EVs causes infrastructural damage, and extra pollution from tire particulate matter (68), a fact not helped by the likelihood that many of these new EVs will be bulky SUVs and trucks rather than station wagons, city cars, and sedans (74).

Like conventional vehicles, EVs entrench car dependence, keeping us building out to economically and environmentally unsustainable exurbs at greater and greater distances from each other, making public and active transport less and less viable, and exacerbating poverty for those who cannot afford cars (71, 73, 75, 76, 77, 81). And, like non-electric SUVs and trucks in particular, the higher weight and power of EVs puts human lives at greater risk (72) than small conventional vehicles, making active transport an increasingly risky choice even in the few places in Canada that it is currently common.

There's the rub. Electric vehicles are undoubtedly better than ICE vehicles in terms of carbon emissions and many forms of physical and noise pollution, but they are certainly not a cure for all that ails us. Far from being the "radical leftist policy" that some sources have painted it as, for our governments and institutions,

EV legislation is about "making the smallest possible change (71)"; it asks very little of our governments, except that they spend a bit differently, and it asks very little of us, except that we buy.

But, as little effort as this alluring option requires, it also gives us comparatively little opportunity for meaningful change in our modes of transportation and in the design of our cities – change that could allow us to live healthier, happier, more sociable, and more economically productive lives (85, 86, 87)

By some measures, the move to EVs was inevitable anyway, and federal policy is just ensuring that we are ready for a future we know is coming. By other measures, EVs will never make enough of a difference to save us (79). By any measure, there is no EV in all of space and time that can compete in carbon emission reduction with a person on a bicycle (82), but incentives to get people moving – or even moving out of their Ford F150s and into trains – are much fewer and further between, and are oftentimes hindered by our ever-growing reliance on our cars (64, 83, 84).

It will take decades to convert enough of our working vehicle fleet to significantly reduce transport emissions – decades we may not have to spare (78). We should still make every necessary vehicle electric (78), but we should also reduce the number of vehicles, and vehicle trips, that are necessary to begin with. We should laugh the electric Hummer out of existence (80). We should, in general, ensure that the policies we *do* institute do the following:

1. Charging Infrastructure

1.1 Guarantee the timely implementation of a nationwide network of cross-compatible EV charging infrastructure, with mandated maximum distances between stations across Canada to ensure that no driver is ever stranded.

1.2 Build sufficient charging stations in Indigenous, rural, and remote communities, using Federal funding to compensate for low profit margins that would disincentivize private enterprise.

1.3 Create accessible, reliable charging network maps that redirect customers to less-busy stations, integrated with a dynamic pricing system that encourages charging at non-peak times and non-peak locations.

1.4 Prioritize upgrading parking facilities in multi-family dwellings to allow for EV charging, and mandate that new builds with pre-planned parking lots have charging capacity.

2. EV Incentives and Funding

2.1 Incentivize smarter consumer choices by linking EV purchase rebates to the climate efficiency and safety of vehicles, such that smaller, safer, and more efficient vehicles receive the largest rebates, and vehicles that are not notably more efficient than their ICE counterparts do not qualify for rebates.

2.2 Ensure that the long term viability and fairness of incentive programs is accounted for, with a plan to phase out incentives that ensures they remain in place the longest for those consumers who are least able to take advantage early on.

2.3 Provide funding to help mechanics retrain and retrofit their shops to prepare for the market shift.

3. Climate and Transport Policy

3.1 Incentivize carpooling and car shares as well as private EV ownership, as these can significantly reduce carbon emissions (88, 89).

3.2 Invest in public transport and in infrastructure for active transport, especially in the dense urban areas where most Canadians live, and incentivize households to use these forms of transportation regularly.

3.3 Provide national rebates for electric bicycles, following those that exist in Nova Scotia (90) and British Columbia (91).

3.4 Monitor fluctuations in the price of electricity as the share of EVs grows and ensure that households that do not have EVs registered - and consume less than the average difference of a household that charges EVs at home - are rebated the difference in cost.

3.5 View EVs as a blunt tool in the climate toolkit; one that is necessary due to the way we have built our country, but not necessarily the best solution in every case, and not a panacea for all our carbon woes.

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