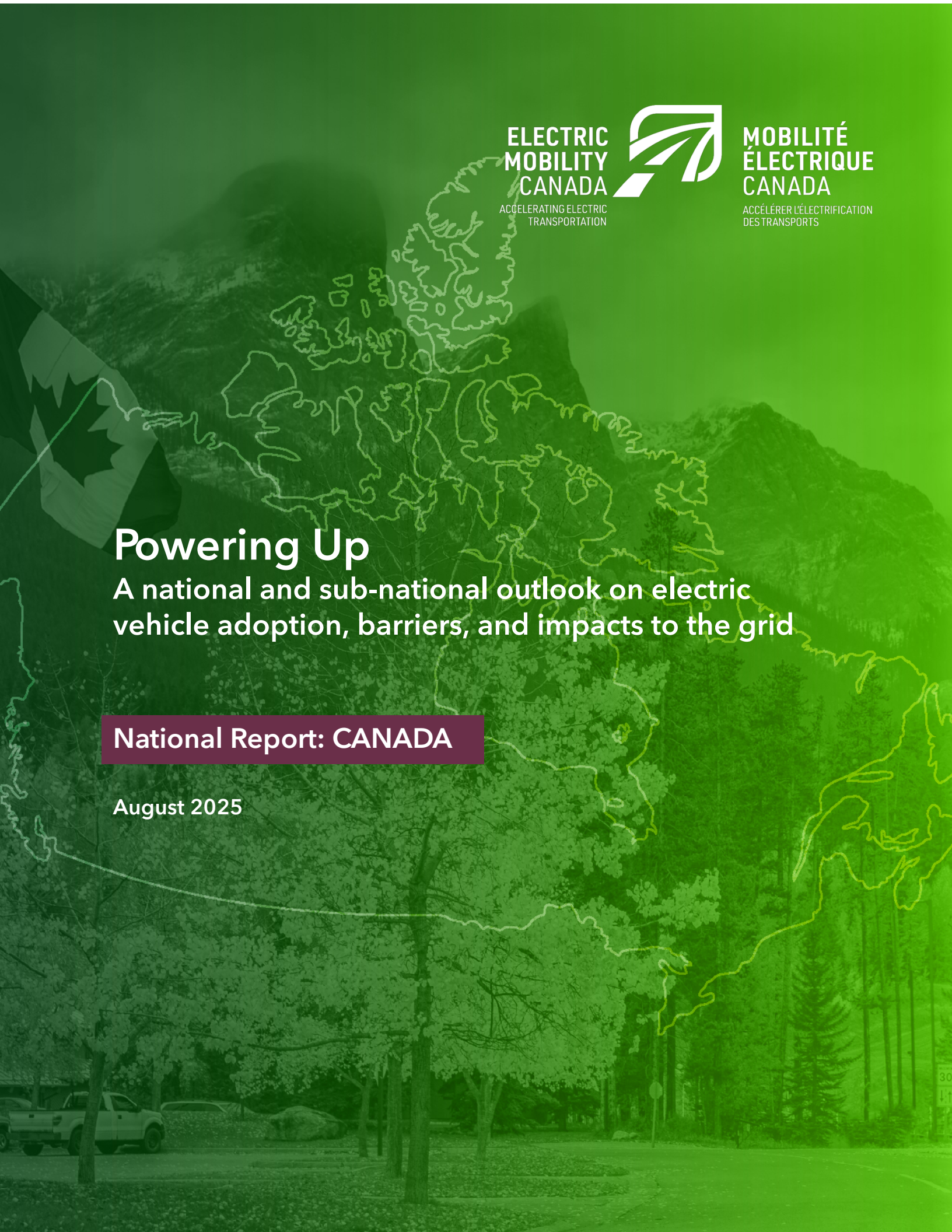
ELECTRIC MOBILITY CANADA
ACCELERATING ELECTRIC TRANSPORTATION

MOBILITÉ ÉLECTRIQUE CANADA
ACCÉLÉRER L'ÉLECTRIFICATION DES TRANSPORTS



Powering Up

A national and sub-national outlook on electric vehicle adoption, barriers, and impacts to the grid

National Report: CANADA

August 2025

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This report was prepared by Dunsky Energy + Climate Advisors, an independent firm focused on the clean energy transition and committed to quality, integrity and unbiased analysis and counsel. Our findings and recommendations are based on the best information available at the time the work was conducted as well as our experts' professional judgment. **Dunsky is proud to stand by our work.**

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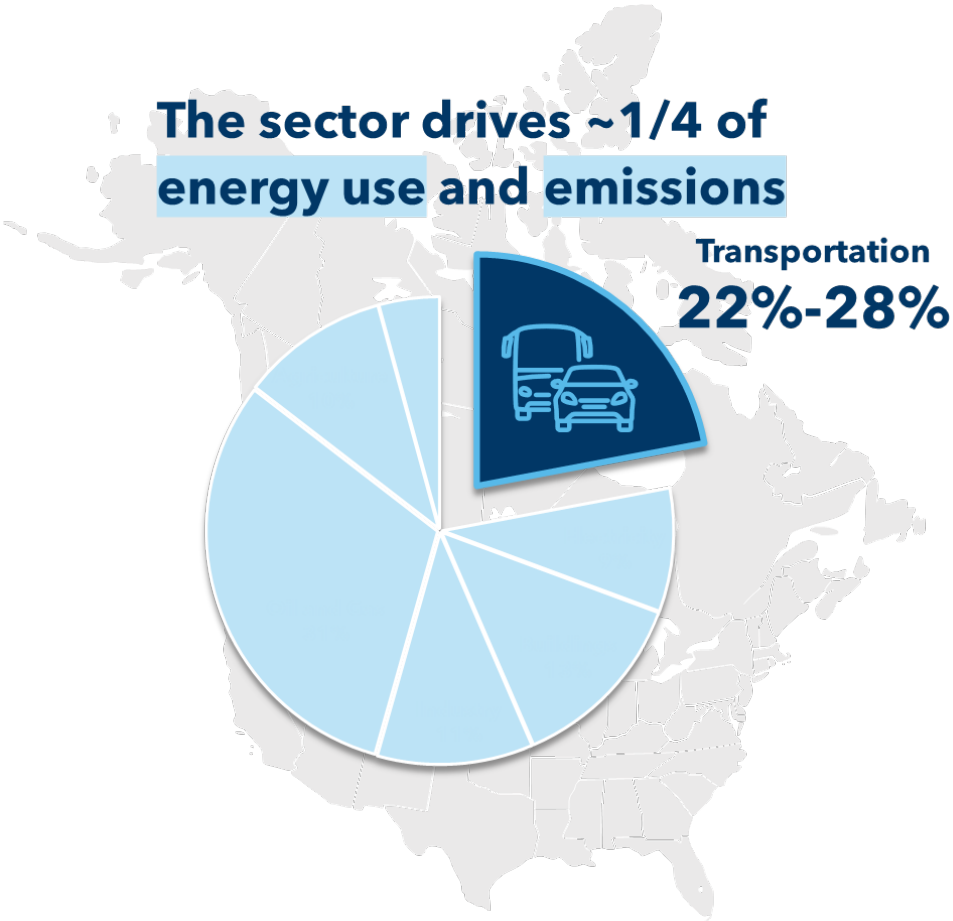
1. Background

1.1 Introduction

Powering Up: *A national and sub-national outlook on electric vehicle adoption, barriers, and impacts to the grid*, is a collaboration between Electric Mobility Canada and Dunsky Energy + Climate Advisors. Its goal is to provide robust data points for national and sub-national decision-making regarding the electrification of transportation. Light-duty vehicles (LDVs) were chosen as a focus because of their significant impact on total transportation greenhouse gas emissions (GHGs) in Canada.

Figure 1. Contribution of transportation to overall emissions in Canada



Addressing barriers to electric vehicle deployment is crucial to ensuring that Canada can meet its near-term climate targets (for 2030 and 2035) and maintain a realistic chance of achieving greater transportation decarbonization by 2050. By thoroughly examining key

barriers to Zero-emission Vehicle[1] (ZEV) adoption—including regionally tailored assessments of consumer affordability, customer economics, and electricity system impacts—our reports aim to identify policies and interventions that would enable the transition to electric mobility.

In this National Report and the accompanying Provincial and Territorial Reports, we outline the policy landscape and historical trajectory surrounding the adoption of light-duty ZEVs in Canada and provide a forecast of ZEV adoption under multiple scenarios between 2025 and 2040. We then analyze the implications of this adoption on electricity demand across the country and how utilities, policymakers, and private actors can support a transition to ZEVs that is reliable, affordable, and predictable.

The key will be to transition to electric transportation in a way that is reliable, affordable and predictable

Primary benefits of ZEV adoption for Canadians:

- **Cleaner air** due to reduced emissions as the transportation energy source shifts from fossil fuel to electricity, which is becoming greener, and from reduced tailpipe emissions, improves air quality and helps to reduce the effects of climate change.
- **Improved affordability** due to savings on a total-cost-of-ownership basis – electricity is much cheaper than gasoline across Canada, offering operational savings from fuel as well as from maintenance, which has lower costs for ZEVs than for internal combustion engine vehicles (ICEVs).
- **Downward pressure on electricity rates** due to beneficial electrification, which creates opportunities for utilities to increase revenues, invest in infrastructure, and manage peaks and valleys in demand across their systems to reduce costs over time.

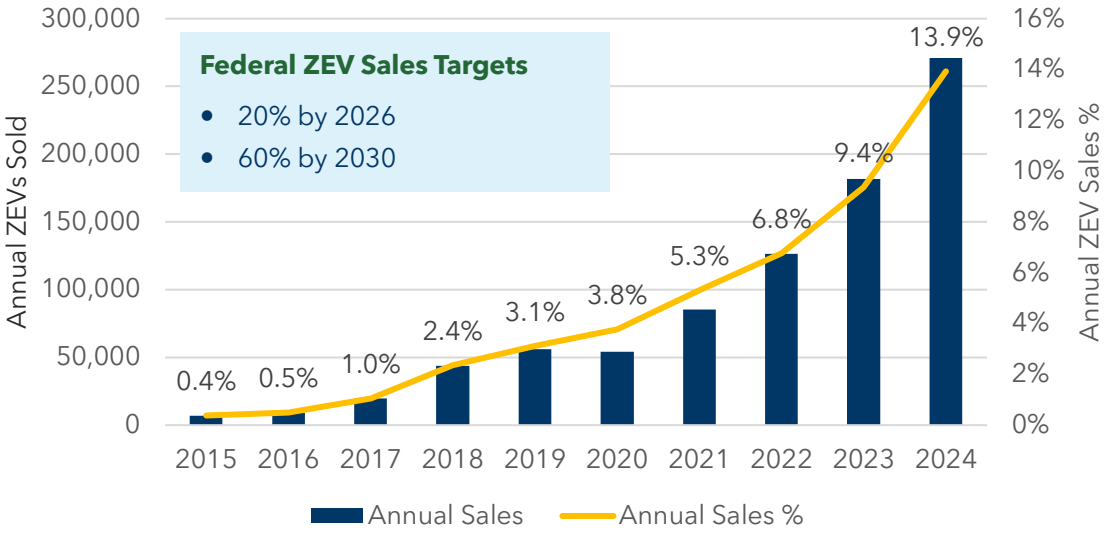
[1] Includes fully-electric or battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

1.2 Historical ZEV Adoption

ZEV adoption in Canada has varied across provinces and territories over time, with different policies and incentives affecting barriers to adoption for residents in varying ways.

Figure 2. Historical ZEV registrations, Canada[2]

Over 270,000 ZEVs have been sold in Canada in 2024.



Light-duty ZEV adoption in Canada has reached 14%, approaching its interim target of 20% of new sales by 2026.

Overall, adoption has been steadily increasing since 2018. Sales stagnated in 2020, likely due in part to the effects of the COVID-19 pandemic, as well as the broader decline in vehicle sales. However, they have since been increasing, with larger increases in year-over-year sales in the years since.

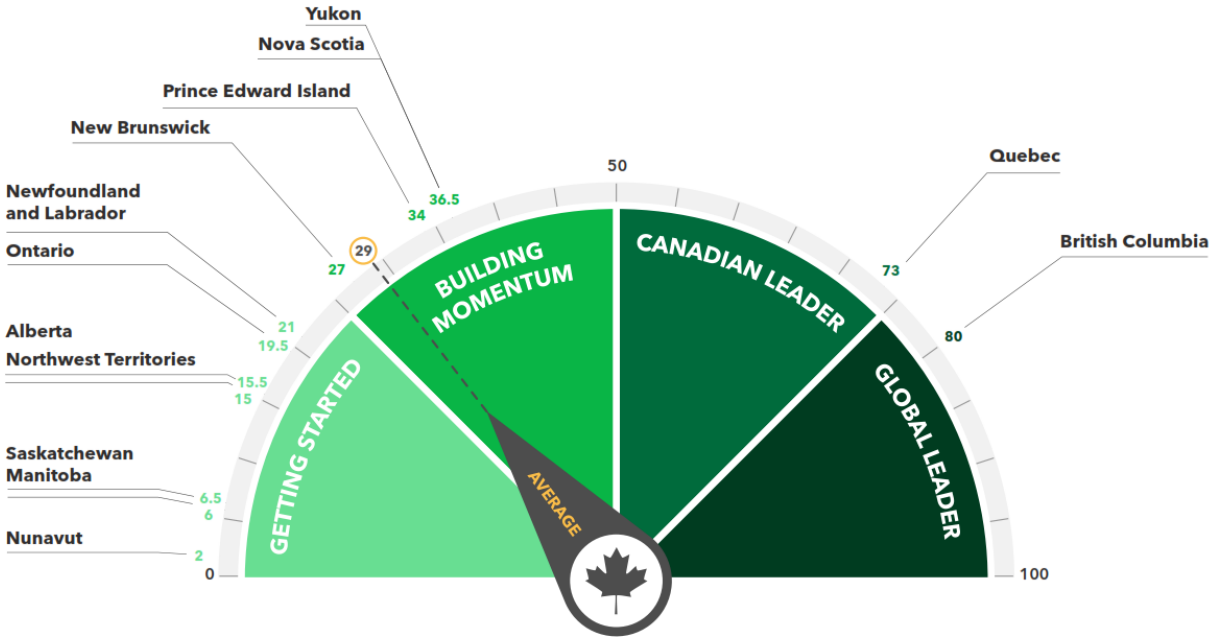
[2] Sources include Statistics Canada. New motor vehicle registrations, quarterly, by geographic level. Accessed January 2025 and Statistics Canada. Vehicle registrations, by vehicle type and fuel type. Accessed January 2025.

1.3 Policy Landscape

In 2022, Dunsky developed a Provincial and Territorial Zero-Emission Vehicle Scorecard for Electric Mobility Canada. In that scorecard, the average score across all provinces and territories was 29 out of a possible 100. The scores were attributed based on the presence and level of ambition of actions – that is, programs and policies – by provincial and territorial governments to support ZEV adoption. There was a strong correlation between provinces and territories that had high rates of ZEV adoption and those with high scores (e.g. Québec and British Columbia), with some notable exceptions including Prince Edward Island and Yukon, which have since 2022 increased their annual ZEV sales, possibly due to some of the key policy action opportunities that were highlighted in this report.

Figure 3. Overall results, ZEV Scorecard (2022)[3]

The average score across all provinces and territories was 29 out of a possible 100.



[3] Electric Mobility Canada. 2021-22. *Provincial and Territorial Zero-Emission Vehicle Scorecard.*

At the time, certain anticipated actions from the Canadian federal government were expected to continue to bolster the ability of provinces and territories to secure supply of ZEVs and adopt regionally sensitive incentives, programs and regulations. Major updates against some of these anticipated actions from 2022 are outlined in Table 1.

Table 1. Key anticipated federal actions on the horizon and updates since 2022

Key anticipated federal actions on the horizon (2022)[4]		Major updates in 2023-2024
MHD ZEV Incentives	In July 2022, the Minister of Transport announced the Incentives for Medium- and Heavy-Duty Zero Emission Vehicles (iMHZEV) program. Over the next four years, the government will provide $550 million in the form of purchase incentives to support businesses and communities in the transition to MHZEVs.	Since 2022, this program for MHDVs has been launched, and over 6,000 vehicle incentives have been administered.[5,6]
Federal ZEV Availability Standard	In Canada's 2030 Emissions Reduction Plan: Clean Air, Strong Economy, the Federal government announced its plan to develop a light-duty ZEV sales mandate for new vehicle purchases of 100% ZEV sales by 2035. The market share of light-duty ZEV sales has grown steadily over the past few years from 2.3% in 2018 to 5.6% in 2021. Under the proposed ZEV standard, sales would grow to minimum targets of 20% by 2026 and 60% by 2030.	The interim and 2035 targets for light-duty ZEV sales were incorporated into Canada's Electric Vehicle Availability Standard, which was finalized at the end of 2023.[7]
Low Carbon Fuel Regulations	In June 2022, the federal government published the Clean Fuel Regulations, which will require producers and importers to drive down the emissions intensity of liquid fuels over time. It will also create a credit market in which operators of ZEV charging could generate credits.	Since 2022, credits have been actively exchanged on the market at an average price of $127.30 as of June 2023.[8]
Clean Electricity Regulations	The federal government is currently developing the Clean Electricity Regulations which will aim for a net zero emissions electricity grid by 2035.	These regulations were published in the Canada Gazette at the end of 2024.[9]

[4] Electric Mobility Canada. 2021-22. *Provincial and Territorial Zero-Emission Vehicle Scorecard.*
[5] Government of Canada. *Statistics on the Incentives for Medium-and Heavy-Duty Zero-Emission Vehicles (iMHZEV).* Accessed March 2025.
[6] As of the writing of this report, the iZEV program for light-duty vehicles has been paused due to funding being exhausted. It is unclear whether this program will be re-funded in the future. This does not affect the iMHZEV program for medium- and heavy-duty vehicles.
[7] Government of Canada. *Canada's Zero-Emission vehicle sales targets.* Accessed March 2025.
[8] Government of Canada. May 31, 2023. *Clean Fuel Regulations credit market report, June 2024.*
[9] Government of Canada. December 31, 2024. *Clean Electricity Regulations: SOR/2024-263.*

1.4 Vehicle and Housing Market Overview

After a slight dip in the overall LDV fleet in 2020, sales in Canada have been steadily increasing again, reaching over 16 million LDVs on the road in 2024. This market change has implications not only for the potential total ZEV sales but also for the grid impact of an increasing number of electric vehicles.

Figure 4. Historical light-duty vehicle stock on the road, Canada total[10]

The vehicle market in Canada is growing, reaching a total stock of over 25 million in 2024.

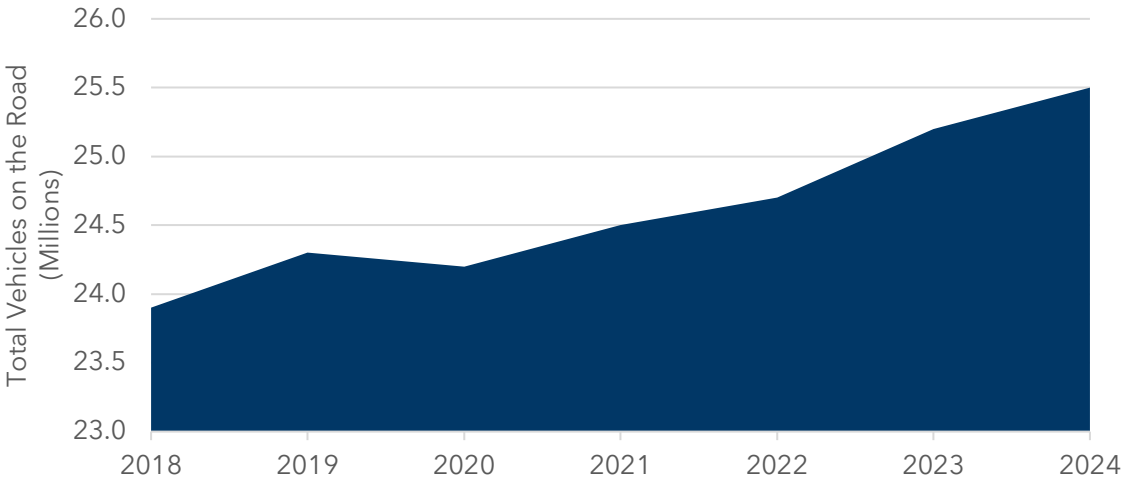
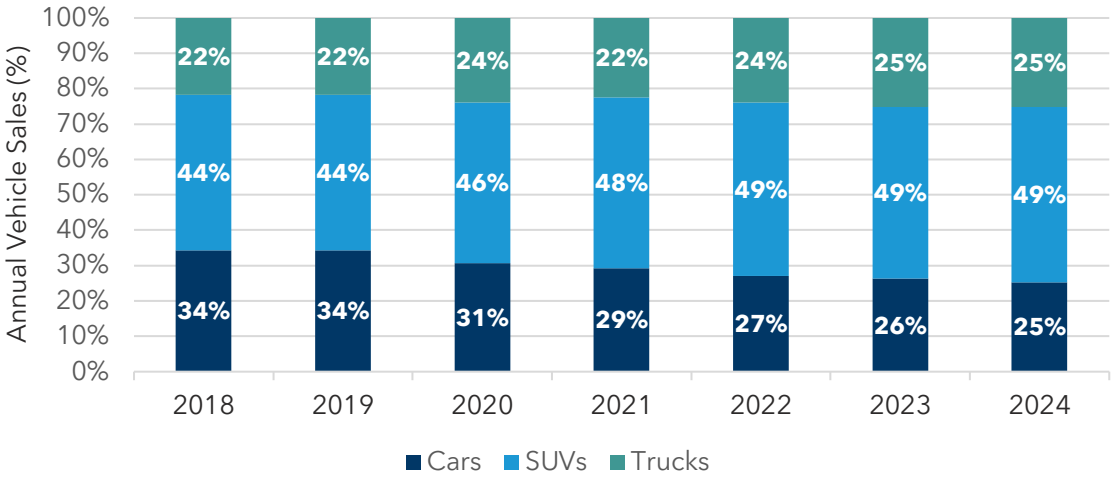


Figure 5. Historical light-duty vehicle segment mix, Canada average[11]

The current segment mix is 49% SUVs and 25% cars, the remaining 25% being light trucks.

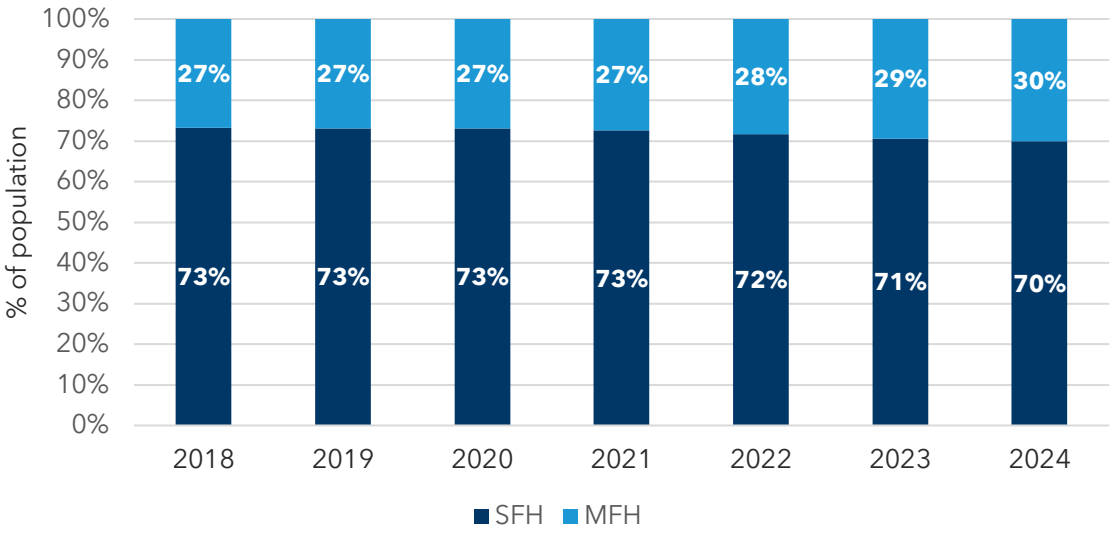


[10] Natural Resources Canada. *Comprehensive Energy Use Database: Transportation Sector, Canada.* Accessed January 2025.
[11] Ibid.

Canada's LDV segment mix has been relatively stable over the last six years, with close to half of new sales being SUVs and the remainder being almost evenly split between cars and light trucks. It is important to understand the vehicle segment mix when these vehicles are transitioned to electric because larger vehicles are heavier and tend to be less energy efficient, therefore requiring more charging energy for the same amount of driving.

Figure 6. Historical percent of population in single-family (SFH) versus multifamily homes (MFH), Canada average[12]

Most Canadians live in SFH, but the proportion living in MFH is increasing over time.



Over two-thirds of Canadians (70% in 2024) reside in single-family homes, a proportion that has remained relatively stable over the past six years.[13] This means that 30% of Canadians live in multifamily homes, which has implications for their access to home charging and barriers to ZEV adoption. It is also worth noting that metropolitan regions have much higher proportions of their residents living in multifamily homes, including Montréal and Vancouver, with about 60% MFH.

This breakdown in housing types has an impact on ZEV adoption because the barriers to home charging for those in single-family homes tend to be much lower than in multifamily homes. Single–family home residents typically have more control over installing a charger where they park, and the costs of doing so are also typically lower. Provinces and municipalities committed to supporting ZEV adoption must either enable home charging in multifamily buildings through supportive policies, such as ZEV-ready requirements, or provide equivalent charging access in public places, which is significantly more expensive.

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[12] Based on population projections from Statistics Canada's M1 scenario (June 24, 2024. *Projected population, by projection scenario.*) and housing market data from the Canada Mortgage and Housing Corporation (June 25, 2023. *Housing market data.*).

[13] We use Statistics Canada definitions of housing types as follows: Multifamily buildings include "Apartments five stories and more", "Apartments 5 stories and less" and "Row houses", while single family homes include "Semi-detached", "Single detached", "Apartment or flat in a duplex" and "Other".

2. Results

In this section, we present highlights from the results of our ZEV adoption forecasts across Canada for the period between 2024 and 2040. The forecasts were developed under multiple scenarios based on different program and policy interventions. We also present highlights from a survey of Canadians that aimed to refine our understanding of some of the key barriers to ZEV adoption, as well as Canadians' knowledge of and attitudes towards ZEVs.

Please refer to the Appendix for details about our ZEV adoption methodology and Dunsky's Electric Vehicle Adoption Model (EVA™). Note that key inputs and scenario assumptions were varied to model each province and territory, and details about those assumptions can be found in each provincial and territorial report completed as a part of *Powering Up*.

Key results highlights that we cover in this section include:

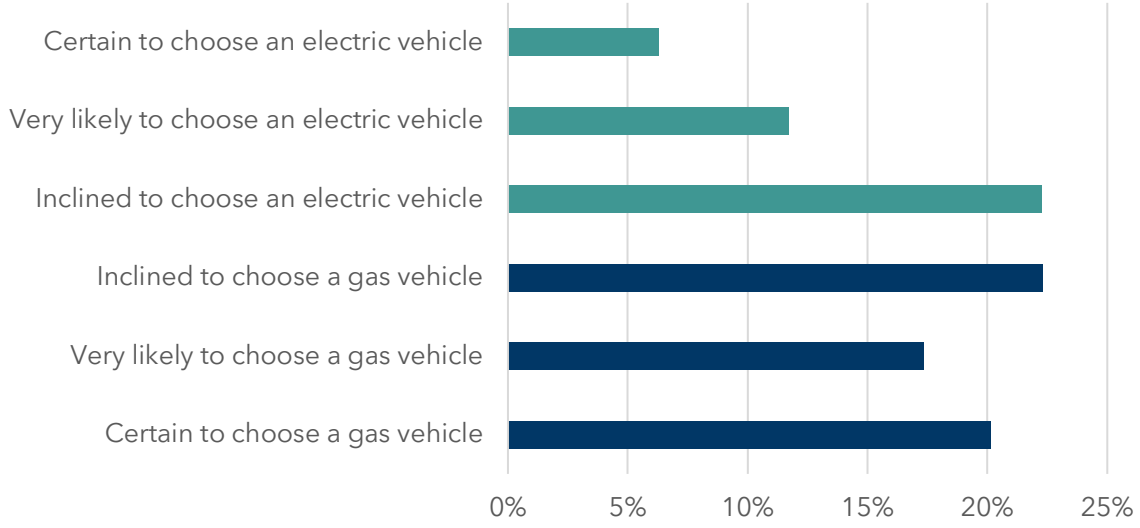
1. The electrification of light-duty vehicles offers benefits to Canadians in the form of cleaner air (due to reduced emissions) and improved affordability (due to cost savings on a total-cost-of-ownership basis).
2. Load growth from the electrification of vehicles in 2040 will also offer net benefits to utilities and could amount to an average of $3,000 per ZEV in additional revenue for utilities across Canada.
3. Without effective programs and policies in place over the next few years, Canada will be on a slower path to electrification, resulting in lost benefits for Canadians in both improved air quality and financial savings from reduced fuel and maintenance costs.

2.1 Results from the Survey of Canadians

As a part of the *Powering Up* project, Electric Mobility Canada surveyed over 6,000 Canadians. A portion of this survey aimed to confirm, update, or determine new assumptions that should be used in the EVA™ model to forecast ZEV adoption in Canada as accurately as possible. This section summarizes some of those key results.

Figure 7. When thinking about your next vehicle purchase, which will you choose? Canada average

Two in five Canadians (40%) plan to buy a ZEV as their next vehicle. This preference is lower than Canadian urban residents (49%) and individuals aged 30-44 (51%).



Although Canadians are willing to pay a premium for a ZEV over an ICEV (see **Figure 8**), the EVA™ model assumes that the comparatively higher upfront costs will pose a barrier to the majority of potential ZEV buyers until ZEV prices reach parity with ICEVs across most segments.

Figure 8. When considering the upfront cost of an electric vehicle vs a traditional gas vehicle, how much more do you consider acceptable today? Canada average

67% of Canadians would be willing to pay a premium for a ZEV versus an ICEV.

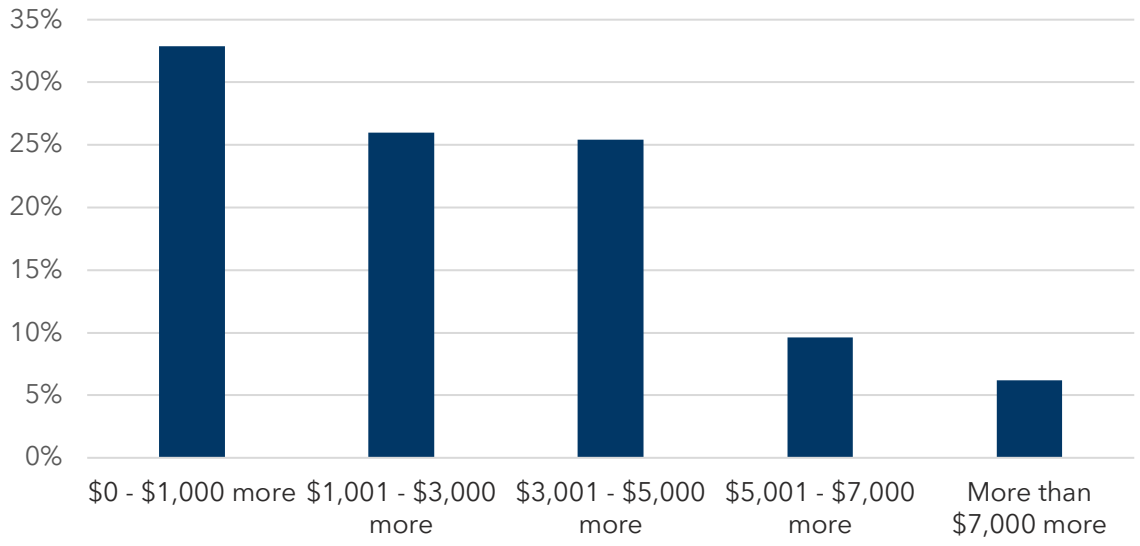


Figure 9. How many long distance (500 km or more) trips do you make in one year? Canada average

Nearly half of Canadians take 1-2 long distance trips annually.

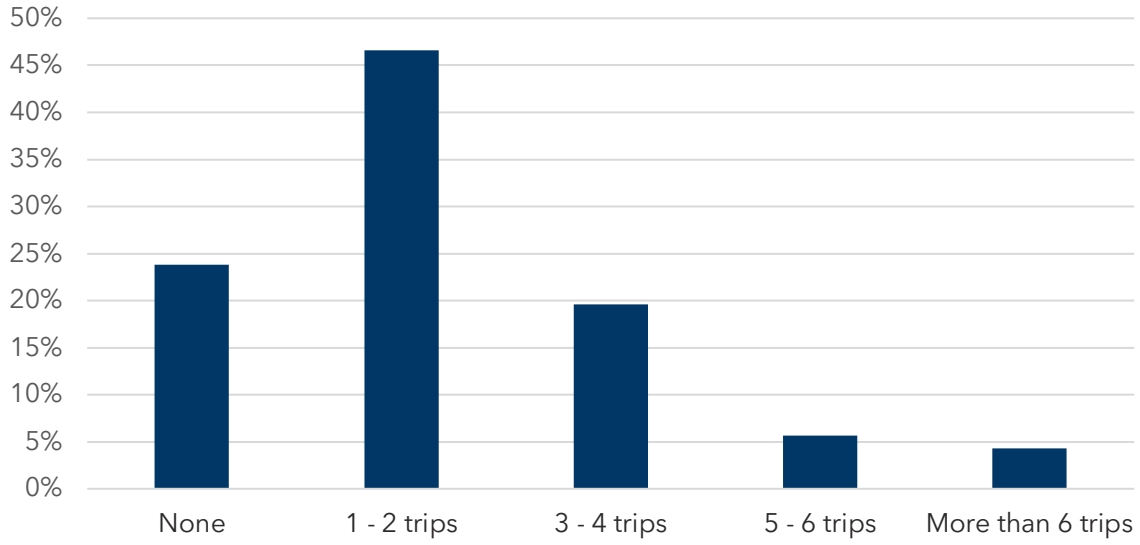
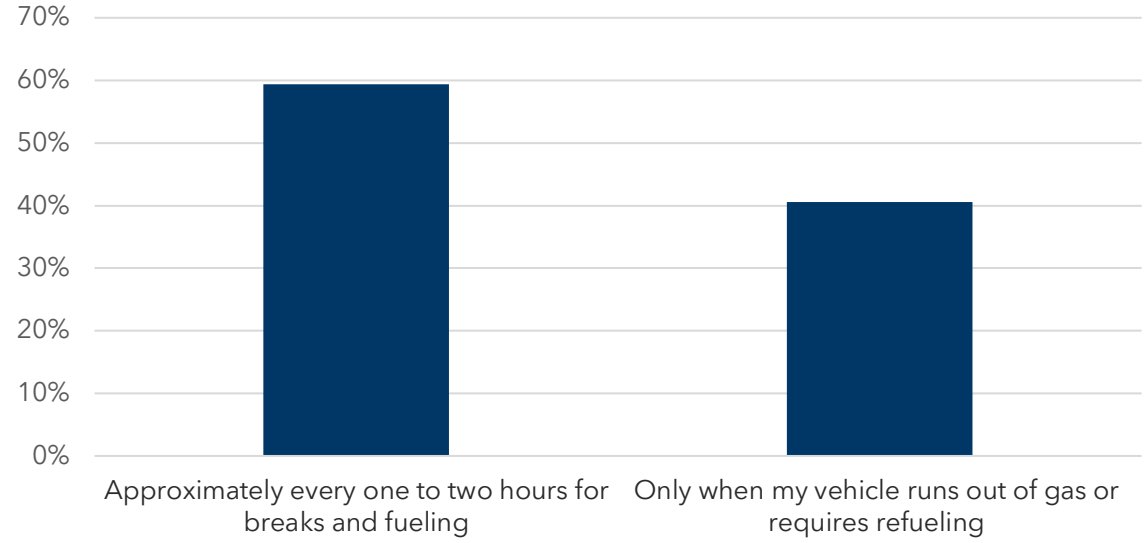


Figure 10. How frequently do you typically make stops during long-distance trips (500 km or more)? Canada average

59% of Canadians stop more frequently on long trips than they would need to refuel, indicating that ZEV range is not a major constraint or inconvenience on their ability to make long-distance trips as long as sufficient public charging is available.



Nearly half of Canadians (47%) drive less than 30 km to get to work (60 km round trip), which means about half of drivers do not need to rely on top-up charging, or do not travel far enough daily for range to be a concern in daily driving.

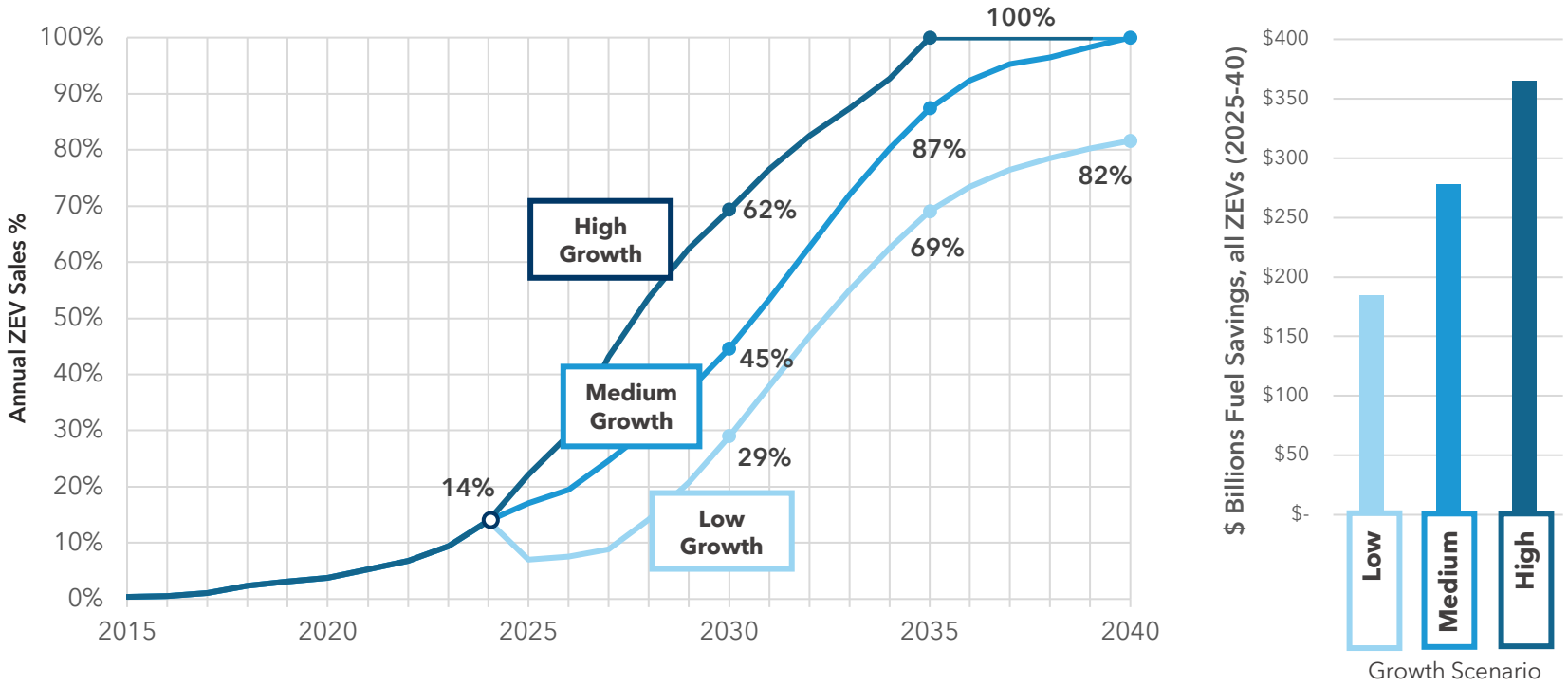
Despite improvements in battery size and access to public charging, there may still be perceived range barriers, also known as "range anxiety", which makes potential ZEV buyers hesitant to switch to electric. Range anxiety could be improved either through education or exposure to EVs and charging as adoption increases.

This survey also included questions pertaining to Canadians' knowledge about EVs, which can be indicative of some common misconceptions that result in perceived barriers to adoption. For instance, the majority of Canadians are unaware of the average range of new EVs, with only 28% knowing that it falls between 400 and 500 kilometres. Additionally, only 47% of Canadians are aware of the federal government rebates for EVs. A sample of additional questions that were asked in this knowledge section is included in the Appendix, Additional Results from Survey of Canadians.

2.2 ZEV Adoption Results

Policies and programs that support ZEV adoption, along with vehicle prices approaching parity with ICEVs in Canada, will be significant drivers of growth in ZEV sales in the LDV category over the next 10-15 years. Financial savings for Canadians from this adoption from fuel alone will be between $1,600 and $1,700 annually per vehicle.[14]

Figure 11. Annual LDV ZEV sales % and total fuel savings by scenario, Canada average[15]



[14] Estimated using total forecasted ZEVs on the road in Canada for each scenario and average fuel efficiencies, fuel costs, electricity costs, and vehicle segment and powertrain breakdowns across all provinces and territories.
[15] National ZEV sales results are based on an average of forecasts for each province and territory. Refer to each provincial and territorial report for assumptions and methodologies used to develop each set of results.

Table 2. Scenario assumptions for ZEV adoption[16]

Parameter	Low Growth	Medium Growth	High Growth
Access to Charging[17]	Limited 58,600 ports by 2030 213,800 ports by 2040	Moderate 116,300 ports by 2030 538,400 ports by 2040	Significant 234,400 ports by 2030 678,600 ports by 2040
Vehicle Purchase Incentives	Current incentives *(Phased out in 2025)*	Extended incentives *(Phased out by 2030)*	Extended incentives *(Phased out by 2035)*
Federal ZEV Availability Standard	None	100% by 2040	100% by 2035

Policy makers have a critical opportunity in the next few years to put Canada on a strong path to vehicle electrification, enabling Canadians to reap the cost and environmental benefits over the following decades.

In the High Growth scenario, we see a strong pathway towards the current Availability Standard of 100% ZEV LDV sales by 2035, which also meets the interim target of 60% by 2030. In the Medium Growth scenario, Canada reaches this target five years later

[16] National ZEV sales results are based on an average of forecasts for each province and territory. Refer to each provincial and territorial report for scenario assumptions used to develop each set of results.
[17] Charging infrastructure inputs in the high growth scenario are aligned with the estimated charging needs developed in the 2024 Dunsky report "*Electric Vehicle Charging Infrastructure for Canada*". In the medium and low growth scenarios, charging inputs are lower to align with lower levels of adoption, and also to reflect reduced charging availability which contributes to constrained ZEV adoption in these scenarios. Note that these inputs are not the result of a detailed charging needs assessment, but rather high-level estimates based on Dunsky's 2024 analysis to reflect alternate adoption scenarios.

due to an assumed delay in the target, as well as reduced support for charging access and vehicle purchase incentives compared to the High Growth scenario.

The Low Growth scenario models the results of removing or significantly reducing these supports for the ZEV transition – ZEV sales stagnate significantly compared to the other two scenarios in the short term, but as light-duty ZEV purchase costs reach parity with ICEVs, the market begins to grow rapidly as we approach 2030. The Low Growth scenario would also result in the lowest number of ZEVs in the overall LDV stock on the road during the period between 2024 and 2040 due to this slower sales transition as compared to the Medium or High Growth scenarios where the LDV stock in Canada would more rapidly transition to electric as ICEVs are replaced with ZEVs. This has impacts on electricity demand from charging during this period as well as benefits of electrification like cleaner air and savings for Canadians outlined in the Introduction.

2.2.1 Leading and Largest Canadian Provinces

As the two leading jurisdictions among Canadian provinces and territories in terms of ZEV adoption, British Columbia and Québec are on a very similar trajectory. Both have strong vehicle purchase incentives in place and matching ZEV sales targets aligned with the federal ZEV Availability Standard. Although BC has long been a leader in ZEV adoption in Canada, Québec has more recently begun to catch up and surpass annual sales rates in BC, thanks to the strong policy support it has put in place.

Depending on the pace at which both BC and Québec phase out their purchase incentives, growth in ZEV sales may be limited until ZEVs reach price parity with ICEVs across the board around 2028, at which point incentives will no longer be needed to remove financial barriers to ZEV purchases.

While Ontario is not a Canadian leader in ZEV adoption rates today, it has the largest vehicle market in the country, making the potential for ZEV adoption significant if the right policy supports are implemented. Ontario had seen higher rates of adoption before its purchase incentives were removed, putting it behind BC and Québec. Although the long-term trajectory of adoption in Ontario is not dissimilar from BC and Québec, it is starting from much lower rates of adoption and will take longer to reach full fleet turnover than the two leading Canadian provinces.

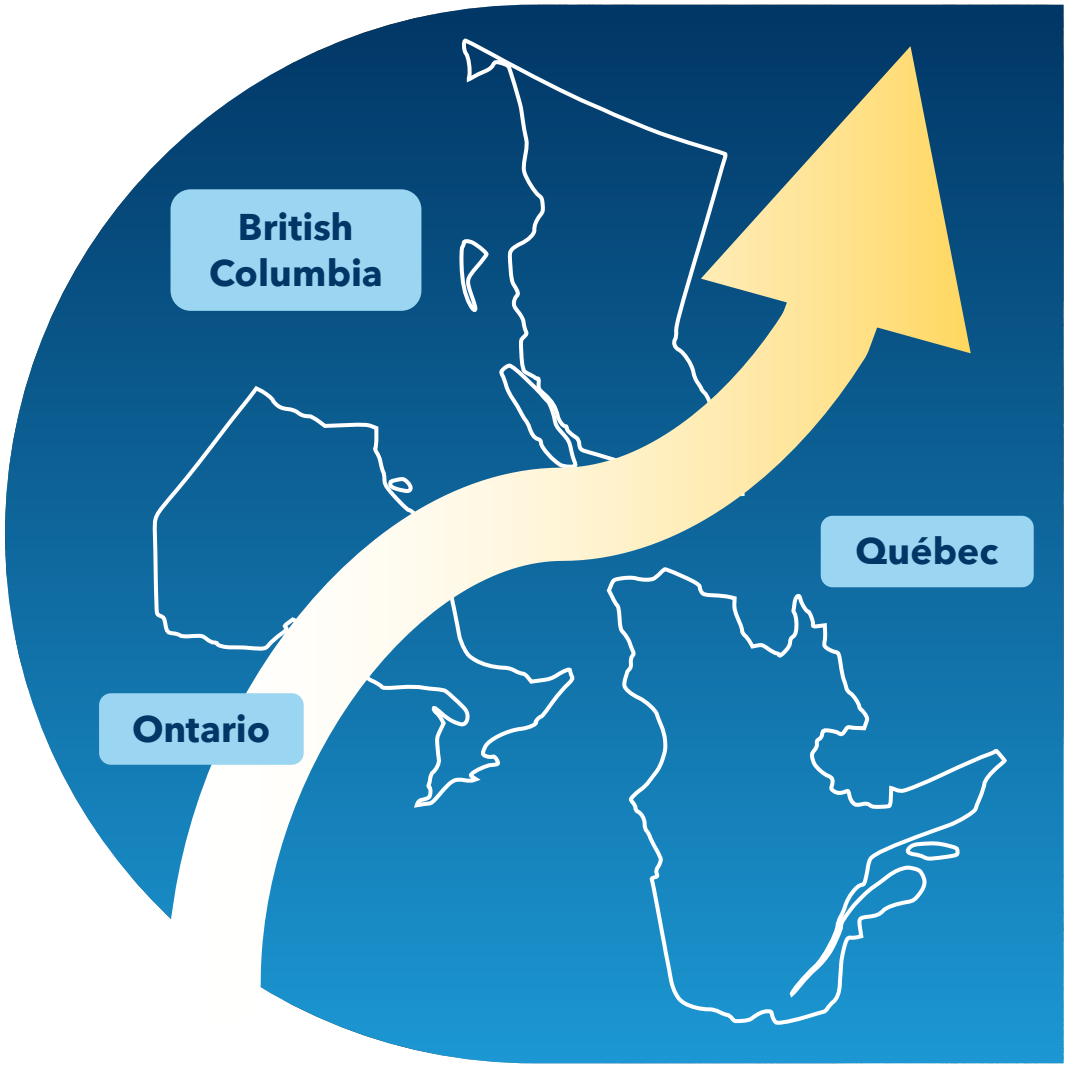


Figure 12. Annual ZEV sales % in British Columbia, Ontario, Québec & Canada

2.2.2 Atlantic Canada

All four Atlantic provinces offer provincial ZEV purchase incentives in addition to the federal rebates. At the time of the development of the Provincial and Territorial Zero-Emission Vehicle Scorecard in 2022, Nova Scotia had the strongest policy and program framework; it achieved the highest score among the Atlantic provinces, at 36.5, closely followed by Prince Edward Island at 34.

Since 2022, however, Nova Scotia's investment in public charging has slowed while PEI has invested significantly in deploying new public chargers and currently offers the most generous provincial purchase incentive of up to $5,750 on top of the federal rebates, establishing itself as a leader in Atlantic Canada. PEI may also benefit from its small geographic area, where the limited number of total public chargers and dealerships offering ZEVs can support a higher proportion of its population.

In the future, our forecasts show that these investments in purchase incentives and public charging will lead to a stronger trajectory towards achieving a 100% ZEV sales target in PEI and New Brunswick. While the adoption of EVs in Newfoundland and Labrador has been the slowest in Atlantic Canada, recent improvements in ZEV availability and investments in a cross-provincial fast-charging network should open the door to steady growth in adoption in the coming years, depending on ongoing policy support.

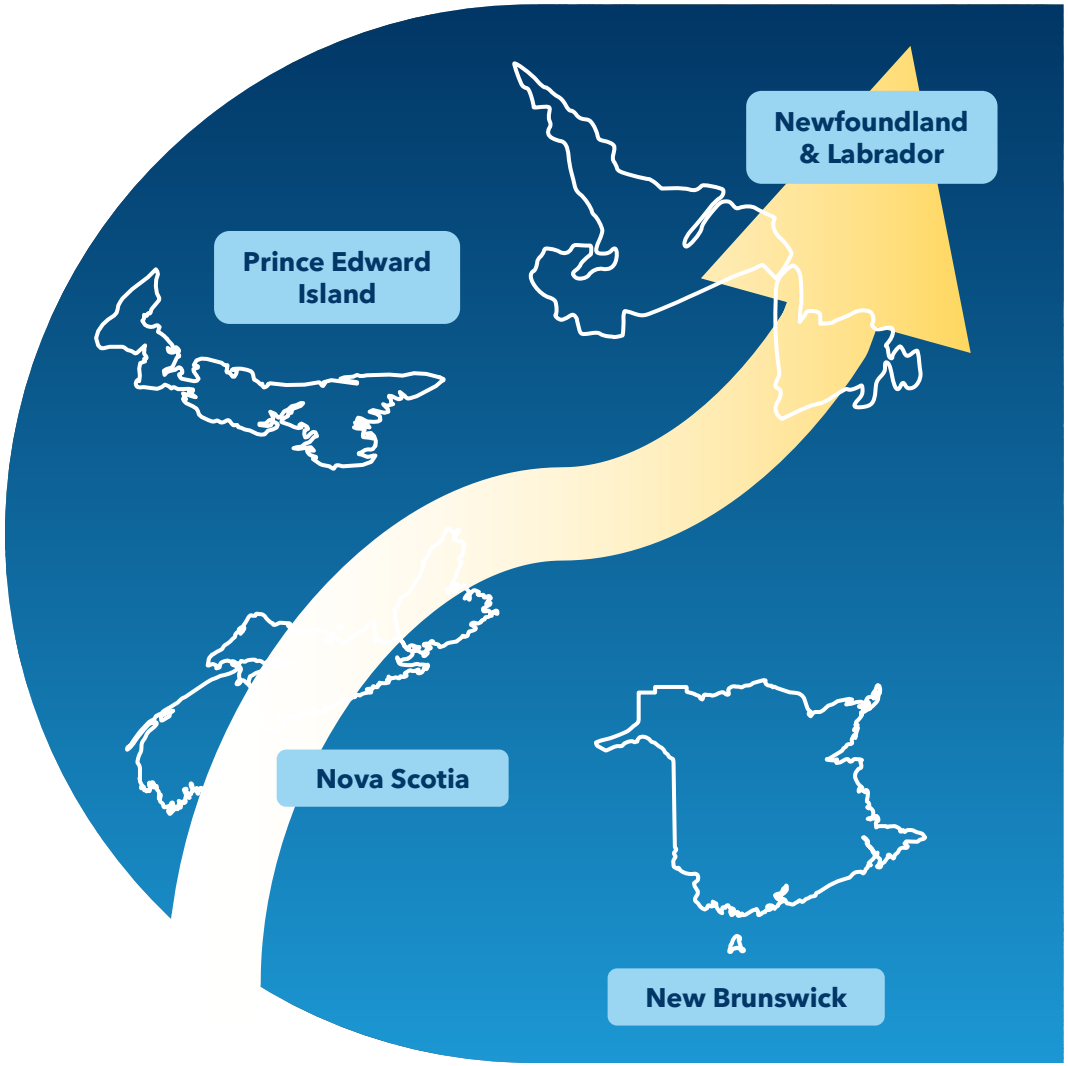
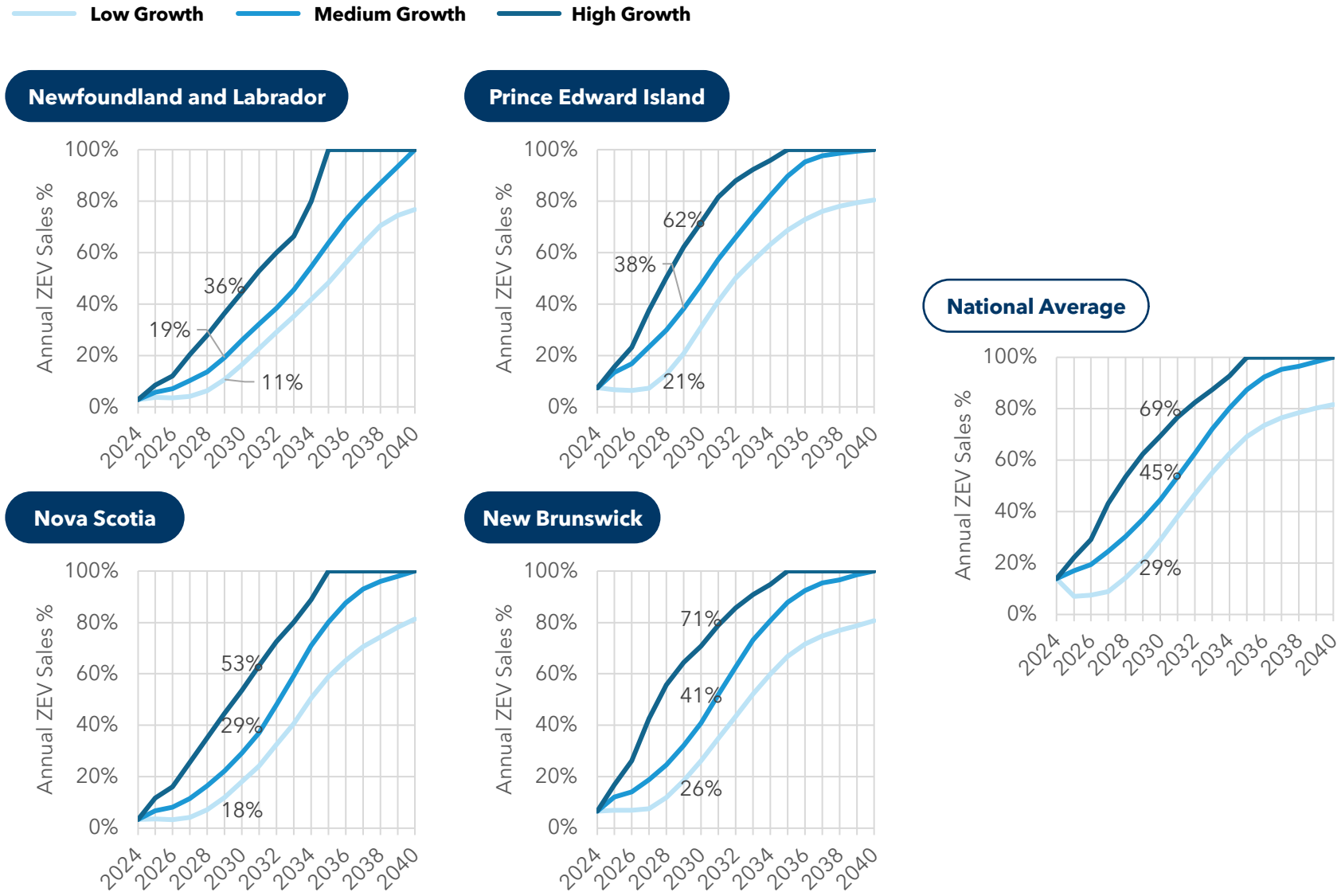


Figure 13. Annual ZEV sales % in Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick & Canada

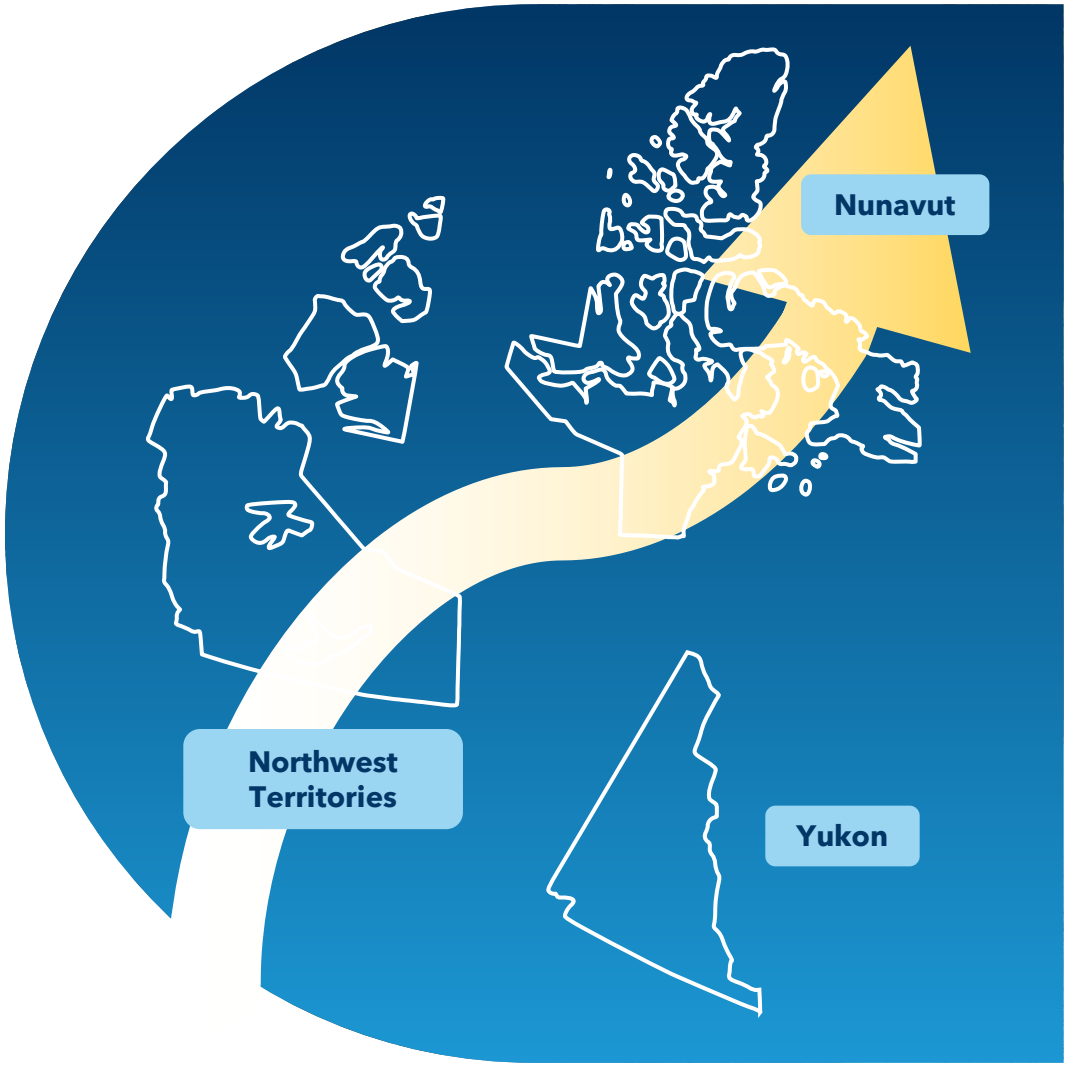


2.2.3 Northern Canada

Canada's three territories face unique barriers to ZEV adoption. These barriers can also affect Canadians in northern areas of other provinces or southern areas during certain seasons. Cold outdoor air temperatures can increase vehicle energy needs by up to a factor of three on the coldest day of the year compared to requirements in warm weather, primarily due to cabin heating needs, which may necessitate additional top-up charging to complete daily driving.[18]

Additionally, access to vehicles for purchase and travel between communities appears quite different in the territories compared to the provinces. There are fewer dealerships to serve these communities, and access to vehicles for purchase sometimes requires transporting them by boat,[19] which only happens at certain times of year.[20] Additionally, many northern communities are not connected by road, and so inter-community travel often requires other forms of transportation. These factors affect Nunavummiut mostly significantly, and to a lesser extent Northwest Territorians and Yukoners.

With access to vehicles, charging, and on-road transportation in Yukon being most similar to that of its southern neighbours, the trajectory of ZEV adoption in Yukon is likely to be strongest on the path to achieving a 100% ZEV sales target. This is also supported by programs and policies which Yukon has put in place to support adoption, including a purchase incentive and significant investments in public charging.



[18] Geotab. November 30, 2023. *To what degree does temperature impact ZEV range?*
[19] Peter Worden. May 2015. *By Air, By Sea, By Land.*
[20] Government of Nunavut. *Transportation: Sealift Services.* Accessed March 2025.

Figure 14. Annual ZEV sales % in Yukon, Northwest Territories, Nunavut & Canada

2.2.4 Prairie Provinces

The prairie provinces of Alberta, Saskatchewan and Manitoba currently fall roughly in the middle of the pack compared to other provinces and territories in terms of ZEV sales proportion. At the time of the development of the Provincial and Territorial Zero-Emission Vehicle Scorecard in 2022, all three ranked in the "Getting Started" category alongside Northwest Territories and Nunavut.

Since then, few major policy or program updates have been made in either Saskatchewan or Alberta to support the adoption of ZEVs. Manitoba has since introduced a vehicle purchase incentive, new investments in public charging infrastructure, and plans to implement new codes and standards to increase home charging availability in multifamily buildings, which will impact its future adoption trajectory and will likely result in a smoother transition towards 100% ZEV sales over the next 15 years.

Figure 15. Annual ZEV sales % in Alberta, Saskatchewan, Manitoba & Canada

2.3 Electric Grid Load Impact Results

A significant consequence of increasing the number of ZEVs on the road is a rise in electricity demand for ZEV charging. Charging needs vary based on vehicle size, driving distances, and temperature. Areas of the country with higher proportions of large vehicles, longer driving distances, and lower temperatures will require more electricity per vehicle than others. In this study, we assume that average vehicle kilometers travelled in each province and territory remain at current levels going forward and that vehicle ownership levels per capita remain constant. However, efforts are being made to reduce Canadians' reliance on personal vehicles, which can reduce driving distances and, therefore, reduce the overall energy demand from ZEVs.

In all modelled scenarios, ZEV impacts on grid peak days[21] will be significant over the long term; however, utilities can offset this by effectively deploying smart charging. The impacts on electrical grids from ZEVs will also depend on the time of day that vehicles are charged, as well as the charging location. Most of the peak load impact from ZEV charging will be from home charging, with the majority of this charging occurring in the evening and overnight when drivers return home and park their vehicles for the night. By contrast, public and workplace charging are more likely to occur during the day, encompassing both Level 2 and Direct Current Fast Charging (DCFC, also known as Level 3). The degree to which this natural ZEV charging peak overlaps with the local electricity demand peak, as well as those utilities' ability to implement smart charging programs that can shift charging load away from peak times, will determine the overall peak load impacts of ZEVs on local grids.

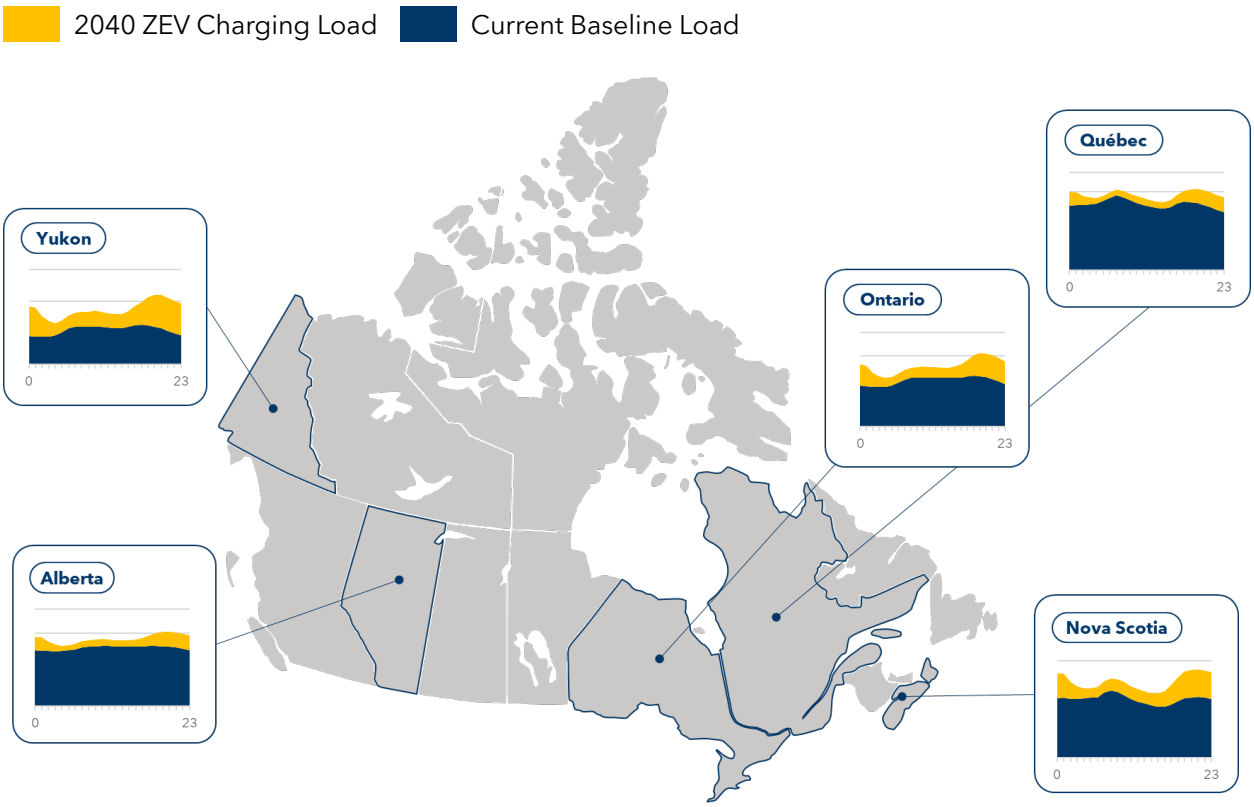
2.3.1 Peak Day ZEV Load in 2040

Energy demand from EVs increases in colder climates because outdoor air temperatures on cold days can double or triple energy needs relative to warm summer days, primarily due to cabin heating requirements.[22] We can therefore expect provinces with colder climates to require more energy per ZEV, particularly in winter, compared to those with warmer climates.

The picture of electrification and grid capacity needs would be incomplete if utilities look at ZEV impacts in isolation. The combination of ZEVs, building heating and other load growth drivers will shift many utilities from summer-peaking to winter-peaking regimes over the next 10-15 years. Solar generation and energy storage are also reshaping load profiles.

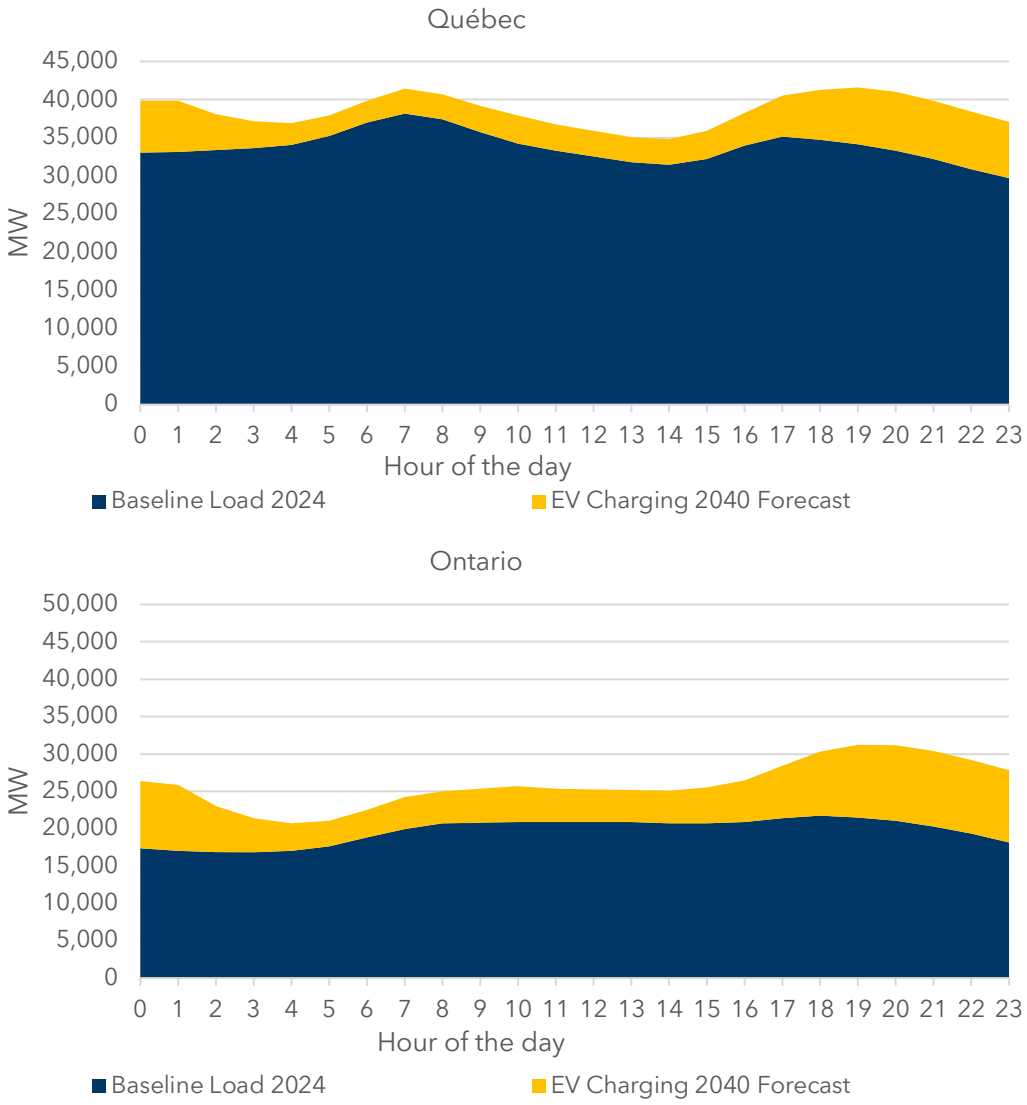
[21] Refers to the day with the highest electricity demand in a single hour, for a given year and season.
[22] Geotab. November 30, 2023. *To what degree does temperature impact ZEV range?*

Figure 16. ZEV Charging Load in Five Jurisdictions, winter, medium growth



Additionally, electrical grids built for electric heating in winter already have greater load capacity per capita, making the additional load from ZEVs a smaller proportional increase in demand compared to grids where heating with fossil fuels is more common. Figure 17 shows a comparison between a province with widespread electric heating, like Québec, with Ontario, which relies primarily on heating from fossil fuels. Québec's existing grid has significantly higher capacity despite having a much smaller population and total vehicle fleet.

Figure 17. Peak Day ZEV Charging Load in QC and ON, 2040, medium growth



Overall, load growth from ZEVs will be significant over the long term, and their impacts can potentially double peak demand in some provinces if left unmitigated. Most of this load will be coming from home charging and fleet depots.

Table 3. Contributions to winter peak load from ZEV charging, medium growth[23]

Province/ Territory	Baseline peak type	Current	2030		2035		2040	
		Baseline peak (MW)	ZEV load (MW)	ZEV % of baseline	ZEV load (MW)	ZEV % of baseline	ZEV load (MW)	ZEV % of baseline
Alberta	Evening	12,201	598	5%	2,386	20%	5,325	44%
British Columbia	Evening	12,126	250	2%	616	5%	1,044	9%
Manitoba	Dual	4,562	294	6%	1,042	23%	2,097	46%
New Brunswick	Morning	2,979	53	2%	182	6%	347	12%
Newfoundland and Labrador	Dual	2,058	58	3%	203	10%	424	21%
Northwest Territories	Evening	38	4	10%	15	38%	35	92%
Nova Scotia	Morning	1,857	39	2%	143	8%	279	15%
Nunavut	N/A	N/A	0.5	N/A	3	N/A	9	N/A
Ontario	Evening	21,070	985	5%	3,540	17%	6,927	33%
Prince Edward Island	Dual	337	32	9%	104	31%	202	60%
Québec	Morning	36,996	1,148	3%	2,816	8%	4,301	12%
Saskatchewan	Evening	3,731	137	4%	769	21%	1,913	51%
Yukon	Dual	118	10	8%	30	25%	56	47%

Investments are needed to ensure Canada's electricity grid has the capacity to supply future ZEVs in Canada. When effectively managed with smart charging, additional loads from ZEV charging could cost approximately $48 billion in infrastructure upgrades across the country between 2025 and 2040 in our Medium Growth scenario.[24] These costs are more than offset by $71 billion in additional revenue that utilities could earn from increased electricity sales to power ZEVs under the same growth scenario. **This revenue represents 150% of the total costs.**[25] Further optimization of vehicle-grid integration could potentially bring grid upgrade costs down even further, putting additional downward pressure on electricity rates for all customers.

[23] Note that the "ZEV % of baseline" is affected not only by the volume of ZEVs that are forecasted, but also the degree to which typical ZEV charging peaks overlap with the existing baseline peak. Evening peaking grids are more likely to have a higher "ZEV % of baseline" than those with a morning peak.
[24] See the Appendix, Grid Upgrade Investments for methodology and assumptions used to calculate this figure.
[25] Based on our charging energy forecasts for each province and territory for Powering Up, and an average assumed price of electricity between 2025 and 2040. See each province and territory report for electricity price assumptions and forecasted charging energy figures.

Revenue from ZEV charging could completely fund grid upgrades for peak load increases from 2025 to 2040 with effective smart charging.

Additionally, three things are working in utilities' favour to prepare the grid for ZEVs and reduce investment costs:

1. Overall fleet turnover (the time it takes for all vehicles on the road to be replaced with electric vehicles) will be gradual, which will allow time for utilities to adapt or increase electrical infrastructure.
2. Many ZEV charging loads are potentially flexible, as ZEV batteries are generally oversized for most drivers' daily needs and vehicles are parked for extended periods. These factors enable a high potential for shifting charging times to off-peak periods, as well as implementing other smart charging strategies.
3. Parallel efforts are being made to reduce Canadians' reliance on cars and total vehicle distances travelled, which will also benefit the grid.

While the additional electrical load from ZEVs is significant, utilities across Canada are actively forecasting this load growth in order to anticipate the necessary capacity upgrades and piloting solutions that can help to take advantage of the inherent flexibility of charging loads.

2.3.2 Potential of Smart Charging

The electrification of vehicles offers a key opportunity: most ZEVs, especially light-duty ones, are overdesigned for daily needs. Many offer 400-500 km of range, while nearly half of Canadians drive less than 60 km round-trip to work each day. This creates a 12-hour window where charging can occur, ensuring a full battery the next day. Drivers can shift charging times or even feed energy back to the grid without affecting their driving. This approach, called load shifting (**Figure 18**), involves delaying charging to take advantage of off-peak rates or utility incentives for peak load reduction.

Load shifting can be achieved through network-connected chargers controlled remotely or via vehicle manufacturer telematics. While network chargers used to be more expensive, prices are falling as ZEV drivers value features such as usage monitoring and remote control. Telematics availability is also expanding as manufacturers are enabling access to their data platforms and APIs. An additional load control method is bi-directional charging, which allows energy to flow back to the home (V2H) or the grid (V2G).

Figure 18. Load shifting of ZEV charging

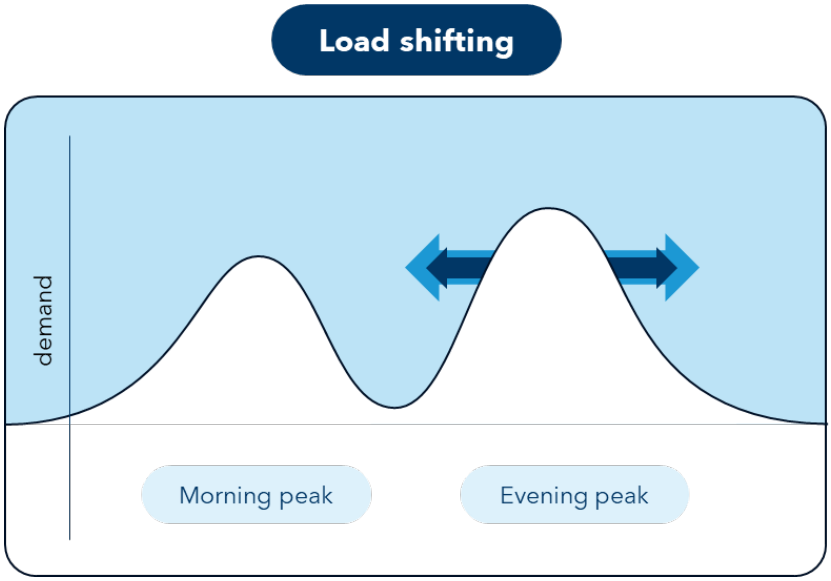
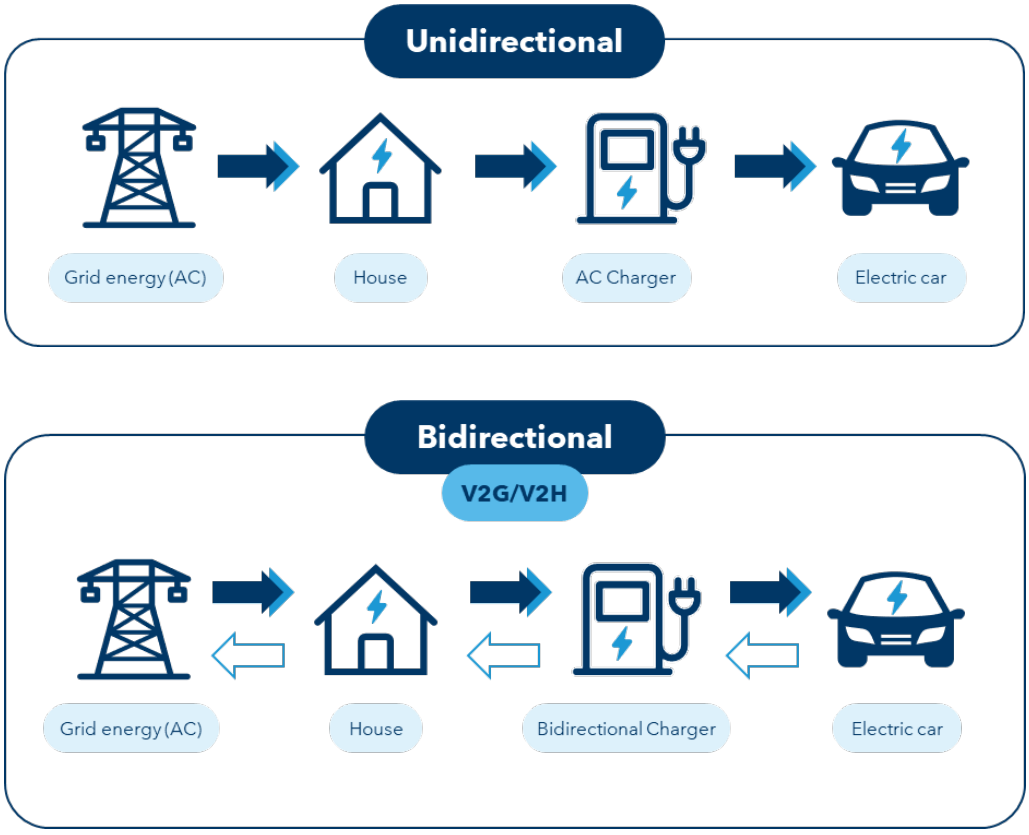


Figure 19. Unidirectional versus Bidirectional Charging

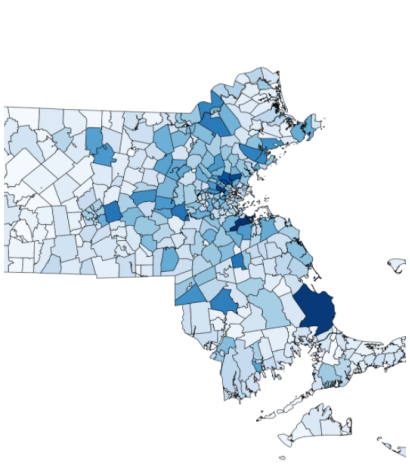


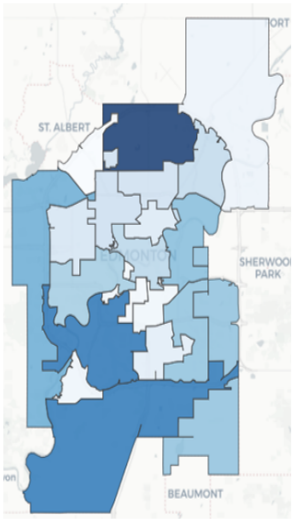
Benefits from reducing peak loads can come at the system level for utilities by reducing system-wide peaks and thereby reducing overall generation capacity needs, or by increasing demand during off-peak times to take advantage of lower-cost and renewable energy sources. They can also come at the distribution level by reducing peaks at the level of substations or even individual feeders, preventing the need for costly infrastructure upgrades. These avoided costs for the utility can put downward pressure on rates, benefiting ratepayers.

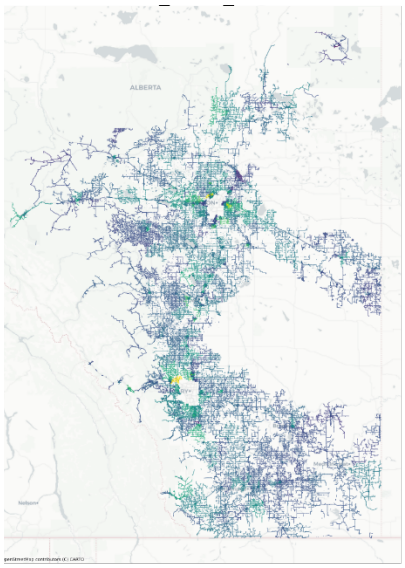
While focusing on province-wide ZEV charging impacts, utilities should analyze their own areas for local effects, such as ZEV clustering and smart charging opportunities. Figure 20 shows examples from other Dunsky analyses to guide infrastructure and smart charging decisions for utilities.

Figure 20. Examples of ZEV load disaggregation analyses by Dunsky

Regional Load Impacts	Substation-level Load Impacts	Feeder-level Load Impacts







Our *Powering Up* analysis indicates that while ZEV adoption will significantly impact the grid, **utilities can effectively manage this load to benefit both themselves and ratepayers**. Utilities should implement smart charging programs by 2030 to test and refine technologies while impacts are low, enabling scale-up later. These programs will provide value over the next 15 years by managing loads and avoiding upgrade costs. After 2040, additional capacity will be required to support ZEVs and other forms of electrification, such as heating.

Continuing with the example of Ontario and Québec from the previous section, we can see in Figure **21** and

Figure 22 that the potential opportunity for smart charging is significant on winter peak days, particularly in jurisdictions where vehicle ownership is high and the existing electrical grid is not already robust due to previous investments made to increase capacity to support electrification of heating. Since our analysis only considers the participation of vehicles charging at home in smart charging programs, expanding program offerings to workplaces and fleets could only increase this potential.

Figure 21. Managed charging potential, winter peak day, medium growth, QC

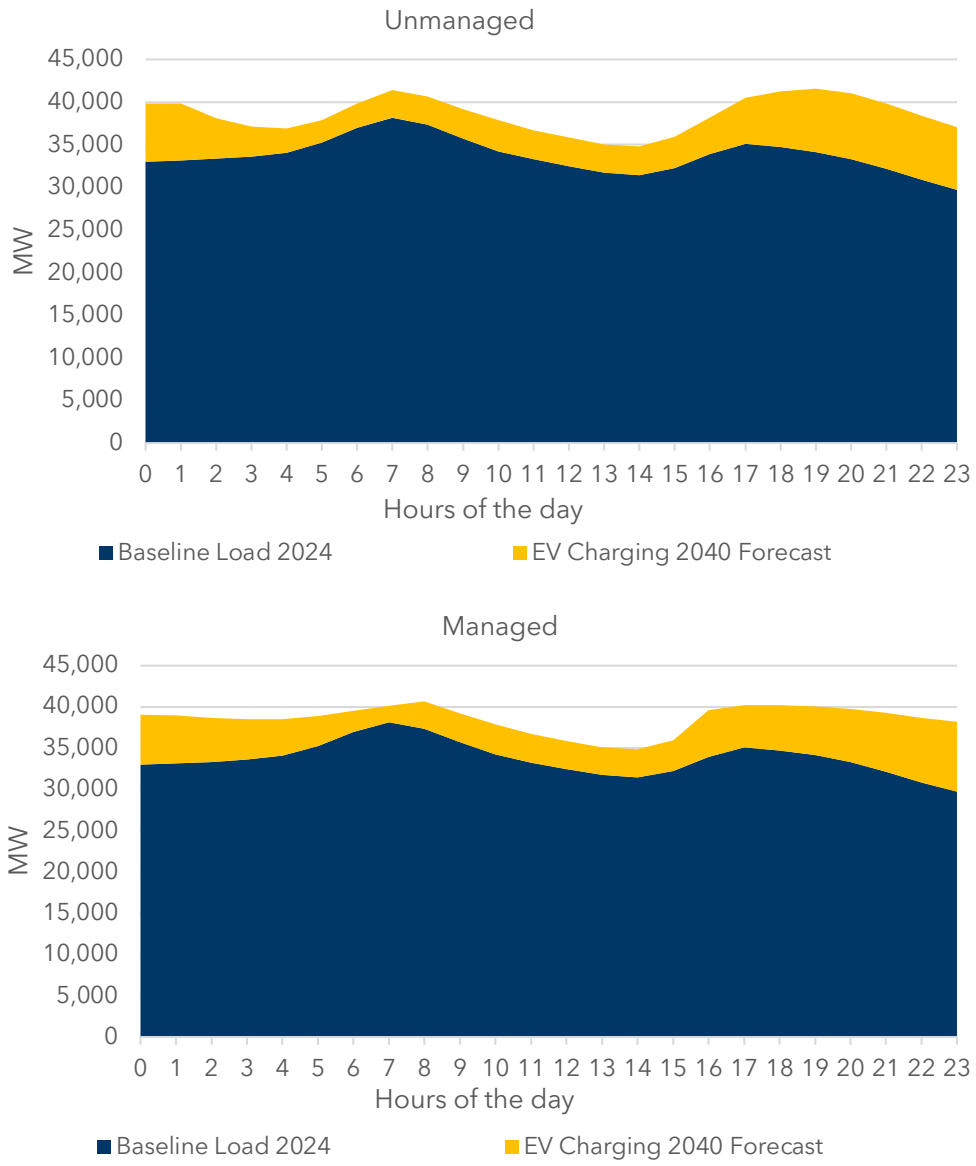
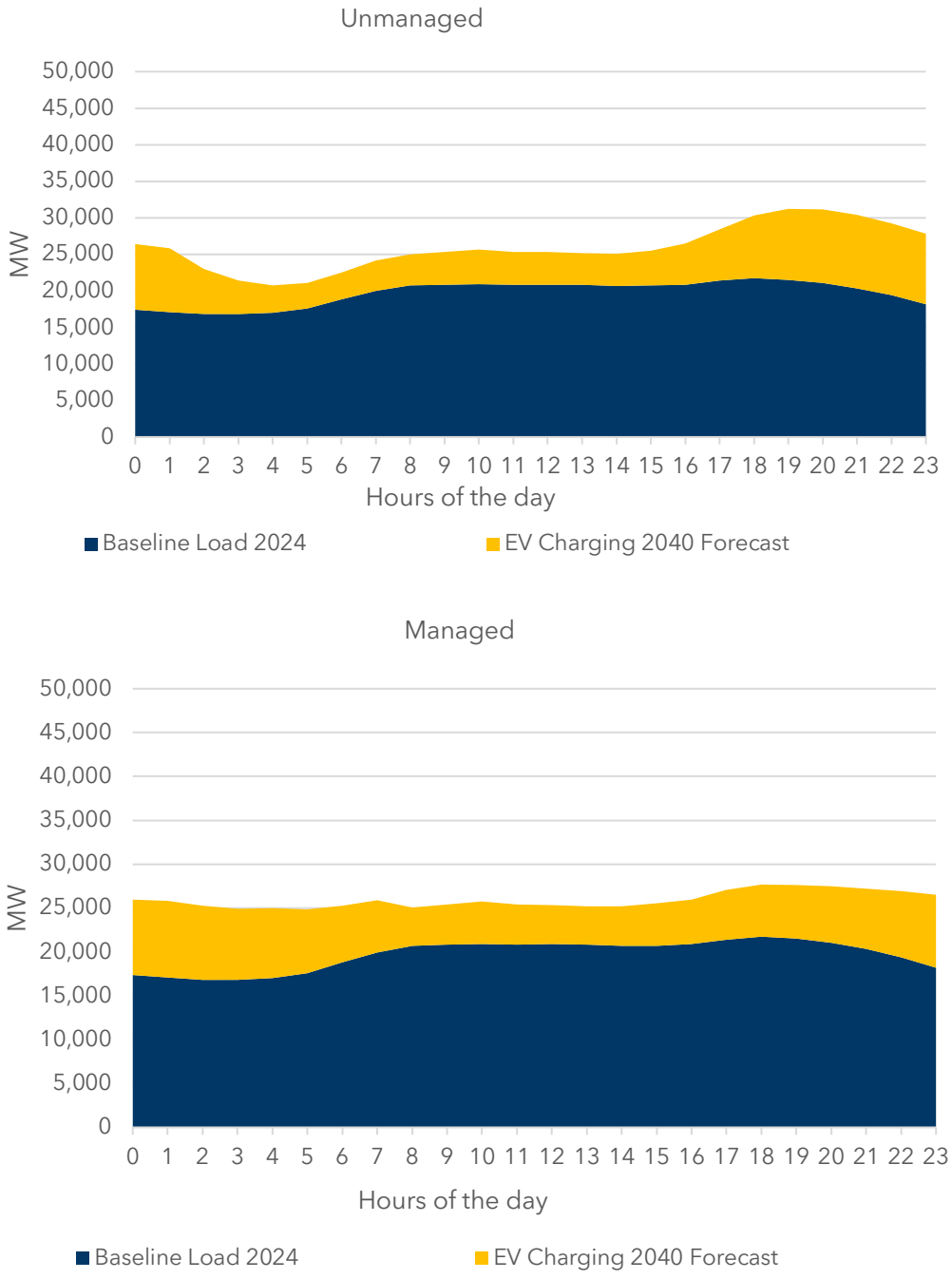


Figure 22. Managed charging potential, winter peak day, medium growth, ON



3. Key Takeaways

1

The electrification of light-duty vehicles offers benefits to Canadians in the form of cleaner air (due to reduced emissions) and improved affordability (due to cost savings on a total-cost-of-ownership basis). These benefits will also increase as utilities work towards moving electricity production away from fossil fuels and as the up-front costs of light-duty ZEVs continue to reach parity or even offer savings against their ICEV counterparts over the next five years.

2

Load growth from the electrification of vehicles in 2040 will also offer net benefits to utilities and could amount to an average of $3,000 per ZEV in additional revenue for utilities across Canada.[26] The net benefits from grid expansion to support additional ZEV load over the long term can be assured through the employment of managed charging. While V2G capabilities are still largely at a pilot stage, several studies have found that even unidirectional charging with load management is sufficient to make EVs a net benefit for the grid, with any incremental capacity costs more than offset by the additional revenue generated from ZEV load growth.[27]

3

Without effective programs and policies in place over the next few years, Canada will be on a slower path to electrification, resulting in lost benefits for Canadians in both improved air quality and financial savings from reduced fuel and maintenance costs.

The **most impactful tools** that local actors have to support the adoption of electric vehicles are **increasing charging access, increasing the local supply of ZEVs, and reducing vehicle purchase costs**. Critical actions to address these barriers include:

- Supportive ZEV-ready policies, standards, and programs to increase home charging availability, and deployment of sufficient public charging to supplement home charging
- Requiring and encouraging a sufficient supply of ZEVs at local dealerships
- Financial support for ZEV purchases as prices approach parity with ICEVs

[26] Based on our charging energy forecasts for each province and territory for Powering Up, and an average assumed price of electricity between 2025 and 2040. See each province and territory report for electricity price assumptions and forecasted charging energy figures.
[27] For a summary of the net benefits of ZEV charging for utility ratepayers see: Nadel, S. January 2024. *Charging Ahead: How ZEVs Could Drive Down Electricity Rates. American Council for an Energy Efficient Economy.*

Appendix

Study Methodology and Modelling Approach

To create a forecast of ZEV charging load in each province, we first leveraged results from our in-house **ZEV Adoption (EVA™) model** to produce a light-duty ZEV adoption forecast based on a market characterization that we produce for each jurisdiction.

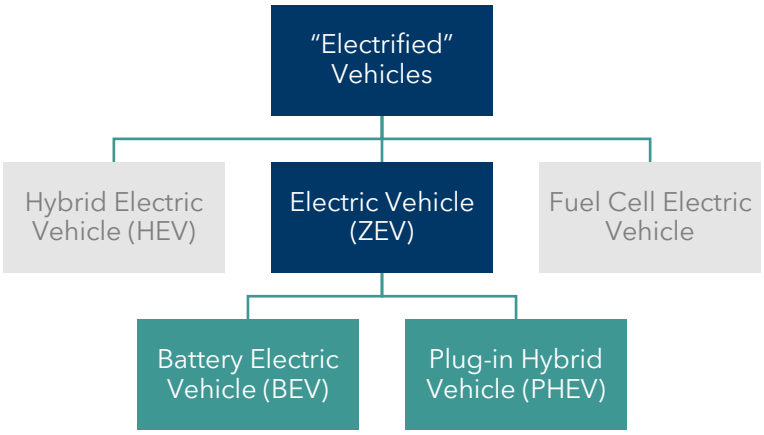
Figure 23. Overview of the EVA™ Model

Technical	Economic	Constraints	Market
Assess the maximum theoretical potential for deployment	**Calculate unconstrained economic potential uptake**	**Account for jurisdiction-specific barriers and constraints, which vary by vehicle class, including:**	**Incorporate market dynamics and non-quantifiable market constraints**
• Market size and composition by vehicle class (e.g. cars, SUVs, pickups) • Forecasted availability of vehicle models in each class	• Forecasted incremental purchase cost of ZEVs over ICEVs • Total Cost of Ownership (TCO) based on operational and fuel costs	• Range anxiety or range requirements • Public charging coverage, capacity, and charging time • Home charging access	• Use of technology diffusion theory to determine rate of adoption • Market competition between vehicle powertrain types

Our ZEV analysis includes the following vehicle powertrain types:

- **Battery electric vehicles (BEV)** – "pure" electric vehicles that only have an electric powertrain and that must be plugged into an electric source to charge (e.g. Tesla Model 3, Volkswagen ID.4, Hyundai Kona Electric)
- **Plug-in hybrid electric vehicles (PHEV)** – vehicles that can plug in to charge and operate in electric mode for short distances (e.g. 30 to 80 km), but that also include a combustion powertrain for longer trips. (e.g. Mitsubishi Outlander PHEV, Toyota Prius Prime, Ford Escape PHEV)

Figure 24. Vehicle types in scope



The following vehicle types are **excluded** from the analysis:

- Hybrid electric vehicles that do not plug in are considered ICEVs.
- Fuel cell electric vehicles such as hydrogen vehicles where the market is assumed to be minimal in the timeframe of the study.

Scenario Analysis

The adoption rate of electric vehicles was assessed under three scenarios that vary policy and program interventions, which can significantly impact ZEV adoption. These include the following key policy and program levers:

1. **Public Charging Access**: Existing infrastructure deployed to date has jumped-started the ZEV market, however significant investments are required to alleviate range anxiety.
2. **Home Charging Access**: With most ZEV charging expected to take place at home, lack of access to home charging for some segments of the population could limit their ability to adopt EVs.
3. **Vehicle Incentives**: Government rebates can help to bridge the gap to cost-parity with ICEVs in the short-term as the up-front purchase costs of ZEVs decline over time.
4. **Federal Zero Emission Vehicle (ZEV) Availability Standard**: Under the current ZEV Availability Standard, auto manufacturers and importers must meet a 100% ZEV sales target by 2035. Our scenario analysis varies whether the standard is present as well as its enforcement year to show its potential impact on ZEV adoption.
5. **Provincial ZEV Mandate**: While some provinces have implemented their own ZEV sales requirements, those that have not may potentially experience lower availability in the next few years as manufacturers and importers focus supply on regions with the highest demand or requirements for ZEV sales, even if there are targets at the federal level.

In addition to the modelled policy and program interventions, the forecasted ZEV adoption is also sensitive to uncertainties around key market and technology factors such as electricity rates, fuel prices, battery costs, total vehicle sales and ZEV model availability.

Our Low Growth scenario represents minimal efforts to support ZEV adoption, and in some cases the removal of existing supportive policies. The Moderate Growth scenario represents

some support to enable ZEV adoption and generally aligns with current commitments and policies, while the High Growth scenario represents a strong policy pathway to reach the Federal ZEV sales target. The specific parameters for each scenario are outlined in Table 4.

Table 4. Scenario assumptions for ZEV adoption[28]

Parameter	Low Growth	Medium Growth	High Growth
Public Charging Infrastructure[29]	Limited 59,000 ports by 2030 210,000 ports by 2040	Moderate 120,000 ports by 2030 540,000 ports by 2040	Significant 230,000 ports by 2030 680,000 ports by 2040
Vehicle Purchase Incentives	Current incentives *(Phased out in 2025)*	Extended incentives *(Phased out by 2030)*	Extended incentives *(Phased out by 2035)*
Federal ZEV Availability Standard	None	100% by 2040	100% by 2035

We refer to specific vehicle purchase incentive levels for simplicity, but what matters for our modelling is the ZEV price relative to an ICE vehicle. The same impact can come from a $5,000 rebate, a $5,000 penalty on ICEs, or a combination that is revenue neutral, like a "feebate" system. This approach would become important for the High Growth scenario to sustain ZEV incentives into the 2030s without high costs.

Electric Grid Load Impacts

To determine the impacts of ZEV adoption on the electrical grid, we used typical 24-hour diversified charging distribution profiles (Figure 25) established from the literature[30] for each vehicle segment and charging location and the Dunsky EVA™ model results, with regional adjustments for vehicle consumption in Canada (i.e. temperature and proportions of vehicle types). The resulting load curves represent the average charging behaviour of different ZEV segments on the road during summer and winter peak days.

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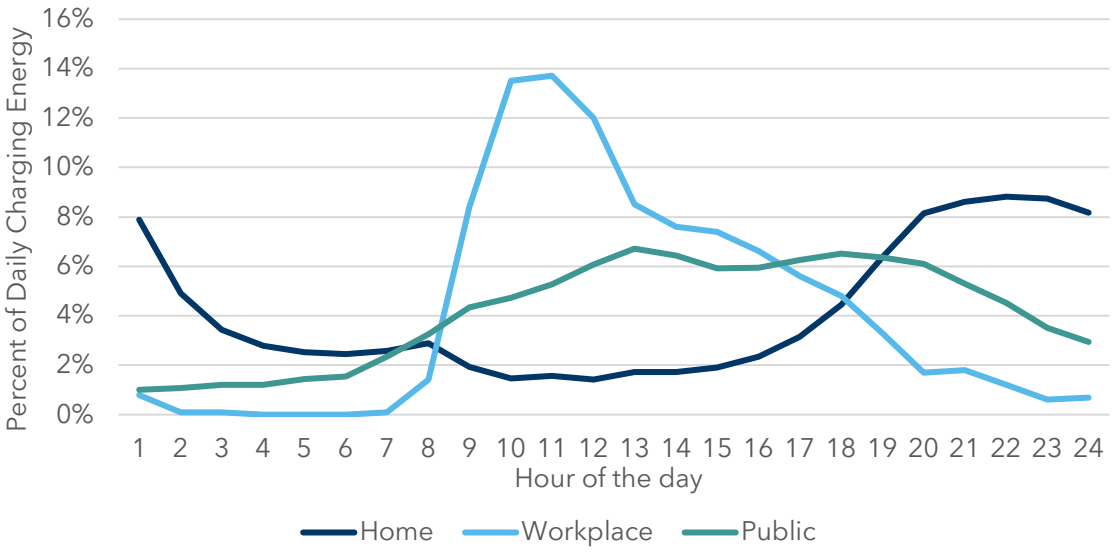
[28] National ZEV sales results are based on an average of forecasts for each province and territory. Refer to each provincial and territorial report for scenario assumptions used to develop each set of results.
[29] Charging infrastructure inputs in the high growth scenario are aligned with the estimated charging needs developed in the 2024 Dunsky report "*Electric Vehicle Charging Infrastructure for Canada*". In the medium and low growth scenarios, charging inputs are lower to align with lower levels of adoption, and also to reflect reduced charging availability which contributes to constrained ZEV adoption in these scenarios. Note that these inputs are not the result of a detailed charging needs assessment, but rather high-level estimates based on Dunsky's 2024 analysis to reflect alternate adoption scenarios.
[30] The charging distribution profiles were developed by leveraging data sets from a range of government and utility-led pilot programs including the California Energy Commission (April 29, 2019. *California Investor-Owned Utility Electricity Load Shapes.*); ISO New England (*2020 Transportation Electrification Forecast.*); and Rocky Mountain Institute. (2019. *DCFC Rate Design Study.*)

The curves in Figure 25 represent the proportion of daily charging energy that the average vehicle would charge in each hour of the day. We calculate average daily energy needs per ZEV based on the average driving distance for vehicles in each jurisdiction and use this in combination with the charging distribution profiles to determine how much charging energy is used every hour for our load impacts analysis.

Figure 25. Diversified charging distribution profiles



Next, these curves are multiplied by the forecasted number of ZEVs on the road in each study year. The results of this load impact analysis produce the hypothetical daily load impact for peak days. The curves consider the use of all charging event types – home, workplace, and public charging. Charging event types refer to the location where charging is taking place, which will change the power level, time of day, and flexibility of the charging load. Each ZEV will get a proportion of its total charging energy from different event types, for example, a personal vehicle is likely to charge at home most of the time, but it will occasionally charge at a public charger while the driver is shopping, or at their workplace. This breakdown of charging event types will vary based on the vehicle's purpose. Our assumptions for charging event type proportions by vehicle segment and origin can be found in Error! Reference source not found.**. Proportion of daily charging energy for each event type and vehicle segment**

Charging Event Type	Personal	Commercial
Home/Depot	80%	100%
Workplace	10%	N/A
Public	10%	N/A

Grid Upgrade Investments

There are three primary components of the grid for which we have estimated future upgrade costs: generation, transmission and distribution. Our approach to calculating grid upgrade costs is summarized in Figure 26.

Figure 26. Grid upgrade cost estimate methodology

Primary Distribution Costs
ZEV Load at Peak (kW) x Marginal Cost of Distribution ($/kW)

+

Secondary Distribution Costs
Primary Distribution Costs ($) x Secondary/Primary Distribution Cost Ratio (%)

+

Transmission Costs
ZEV Load at Peak (kW) x Marginal Cost of Transmission ($/kW)

+

Generation Costs
ZEV Load at Peak (kW) x Marginal Cost of Generation ($/kW)

An overview of our key assumptions in modelling the cost associated with upgrades across each of these three components is outlined in **Table** 5. Each of these assumptions is expected to vary significantly on a regional basis, so we have chosen cost values that fall within the middle of the expected range.

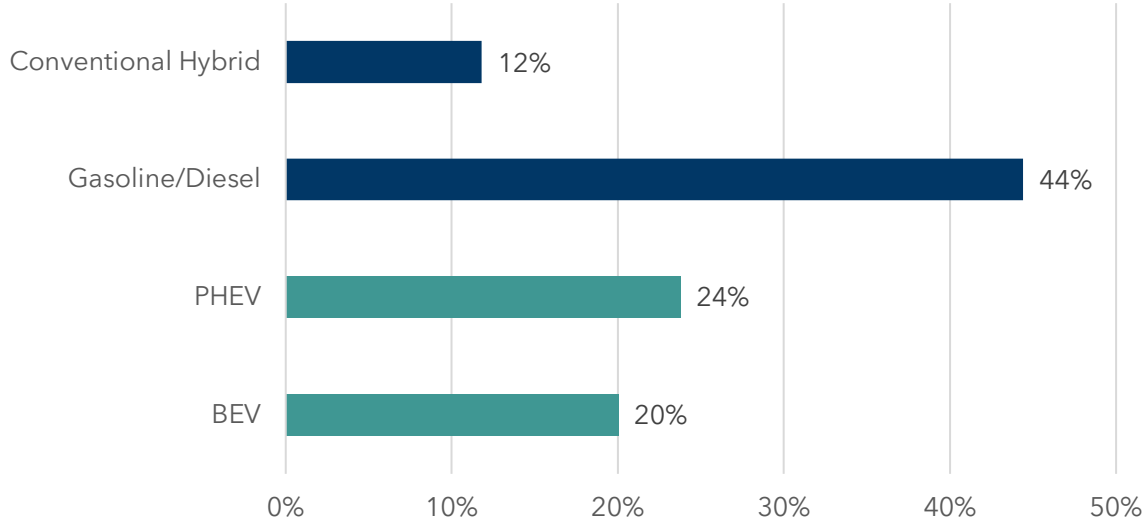
Table 5. Key assumptions included in grid upgrade cost estimate

Variable		Description	Assumption
Dx	**Marginal Cost of Distribution ($/kW)**	The incremental cost to build out distribution capacity in response to peak load growth. *Sources: E3. 2021. Distribution Grid Cost Impacts Driven by Transportation Electrification and Noah Rauschkolb et al. 2021. Estimating Electricity Distribution Costs Using Historical Data*	$250
	Secondary Distribution Costs (% of total Dx costs)	Accounts for end-of-line distribution infrastructure that supplies electrical service to customers. Represented as a share of total distribution costs.[31] *Source: E3. 2021. Distribution Grid Cost Impacts Driven by Transportation Electrification*	37%
Tx	**Marginal Cost of Transmission ($/kW)**	The incremental cost to build out transmission capacity in response to peak load growth. *Source: Dunsky analysis of recent transmission projects*	$950
Gen.	**Marginal Cost of Generation ($/kW)**	The incremental cost to build out generation capacity in response to peak load growth. We have used an assumption of wind + 4 hr battery storage. *Source: Canada Energy Regulator. 2023. Canada's Energy Futures 2023*	$3,700 in 2024 decreasing to $2,900 in 2040

[31] We used the lower end of the secondary cost range from the E3 study in order to account for our expectation that electricity system operators will be motivated to manage load at the grid edge in such a way that minimizes these grid edge investments.

Additional Results from Survey of Canadians

Figure 27. What type of vehicle do you intend to purchase or lease next? (Posed only to current ZEV owners)



After being presented with a series of knowledge testing questions about electric vehicles and their correct answers, survey respondents were asked again to select the type of vehicle they would buy next. The responses to **Figure 28** should be compared to **Figure 7** to assess the potential impact of increased awareness of ZEV benefits on purchasing decisions.

Figure 28. Taking into consideration the information provided to you, when thinking about your next vehicle purchase, which will you choose?

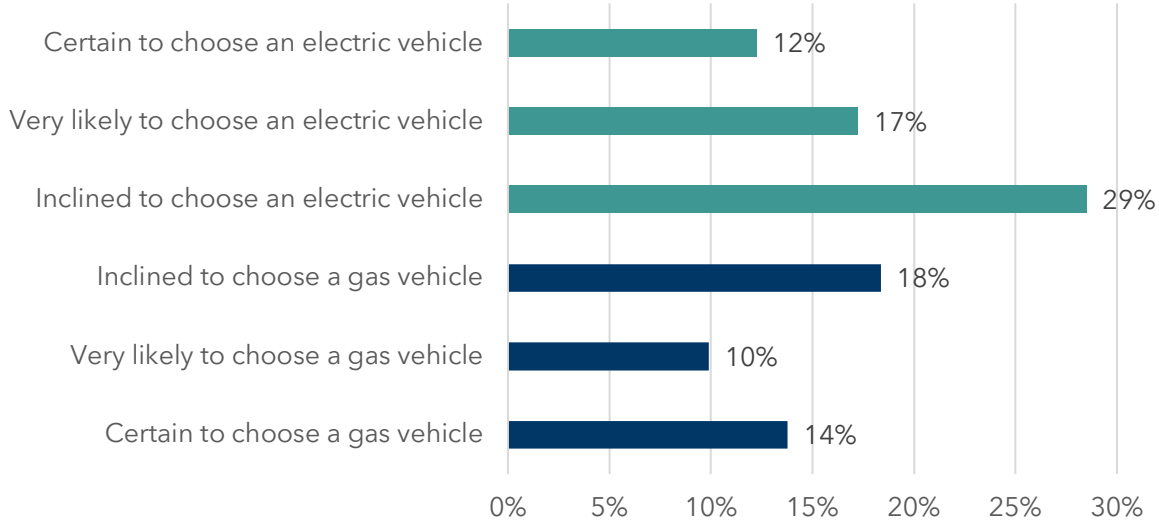


Figure 29. How influential were government incentives in your decision to purchase/lease an ZEV/PHEV?

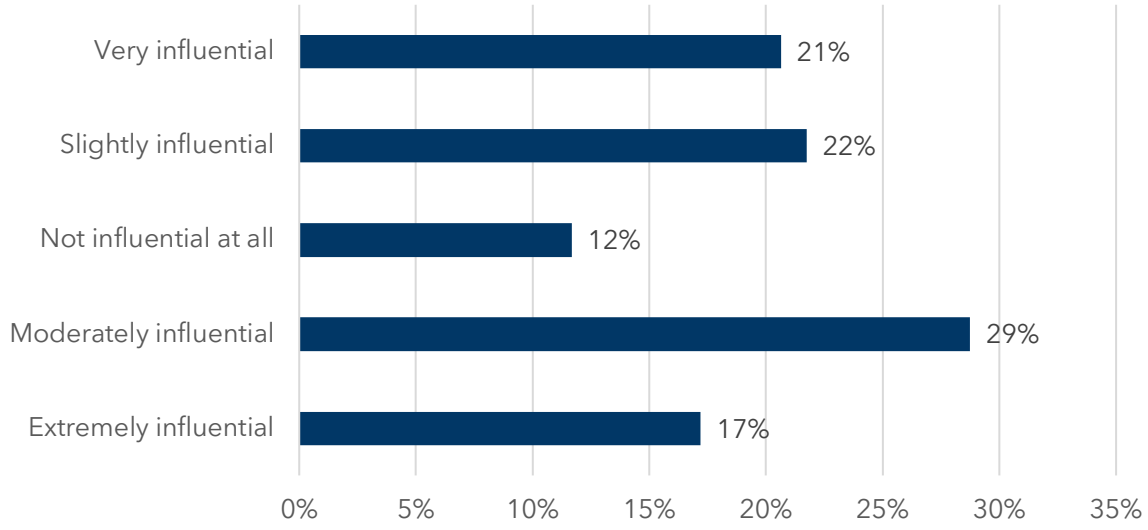


Figure 30. When you are selecting your next vehicle, do you expect you will buy/lease a fully electric vehicle (BEV) or a plug-in hybrid electric vehicle (PHEV)?

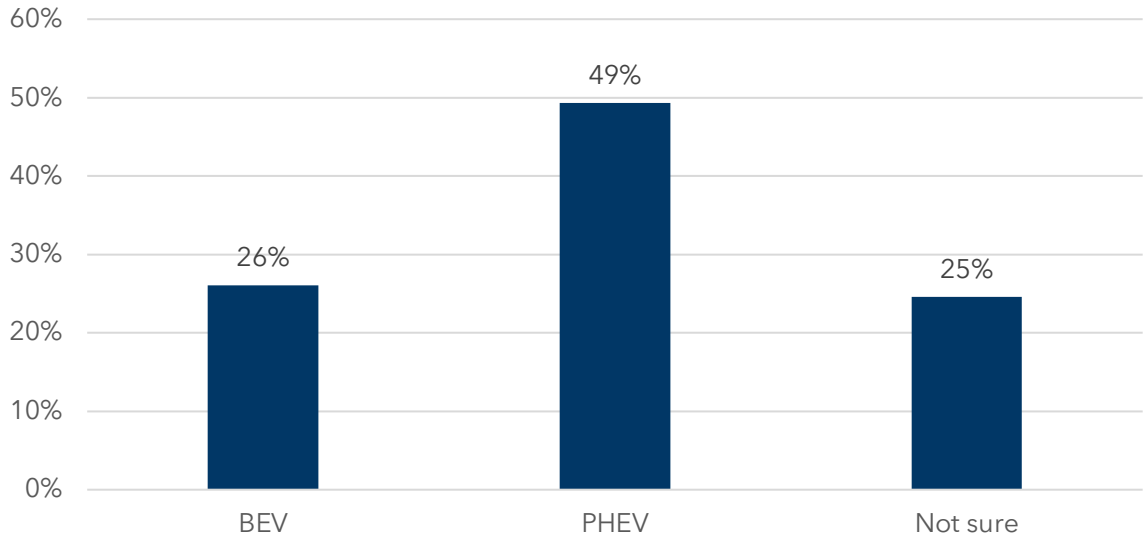


Figure 31. Are you aware of the federal government rebate of up to $5,000 for purchasing an electric vehicle?

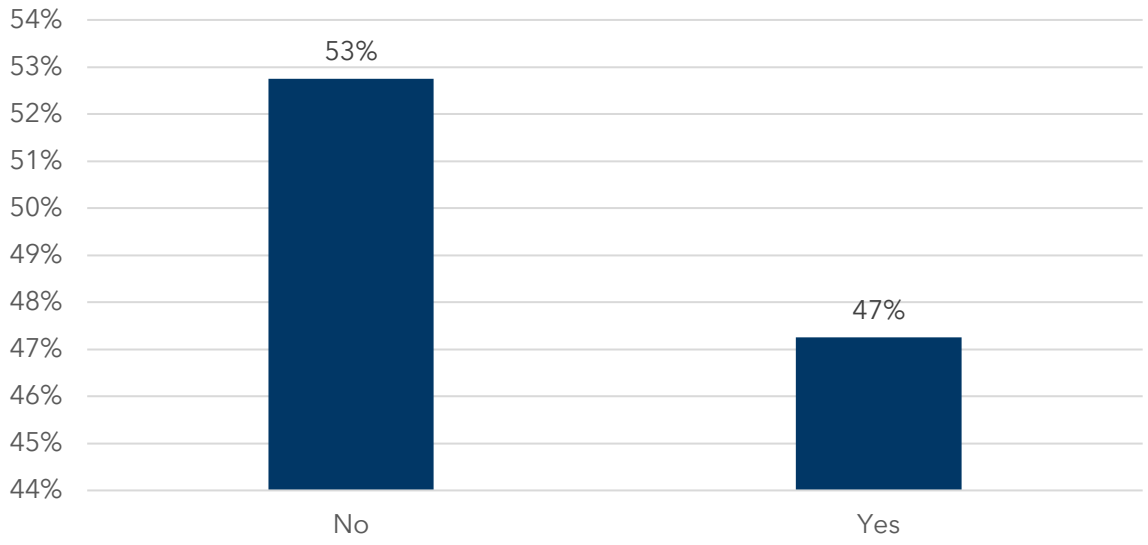


Figure 32. Are you aware that you may be eligible for a federal tax deduction specifically for the purchase of an electric vehicle if you are self-employed or own a company?

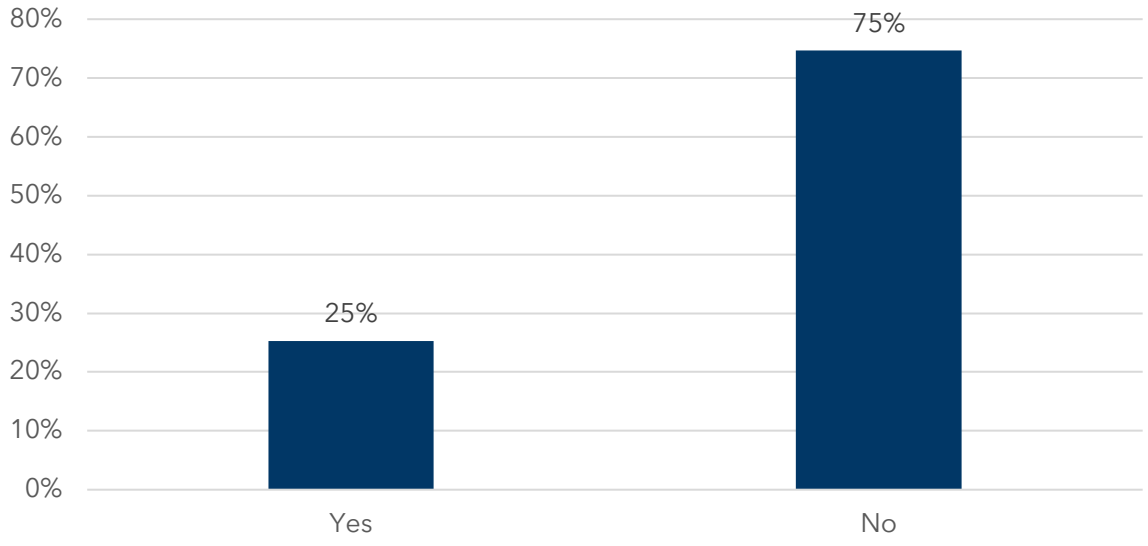


Figure 33. Are you familiar with other incentives available to EVs (e.g., ferries, dedicated lanes on highways, dedicated parking spots closer to the entrance, etc.)?

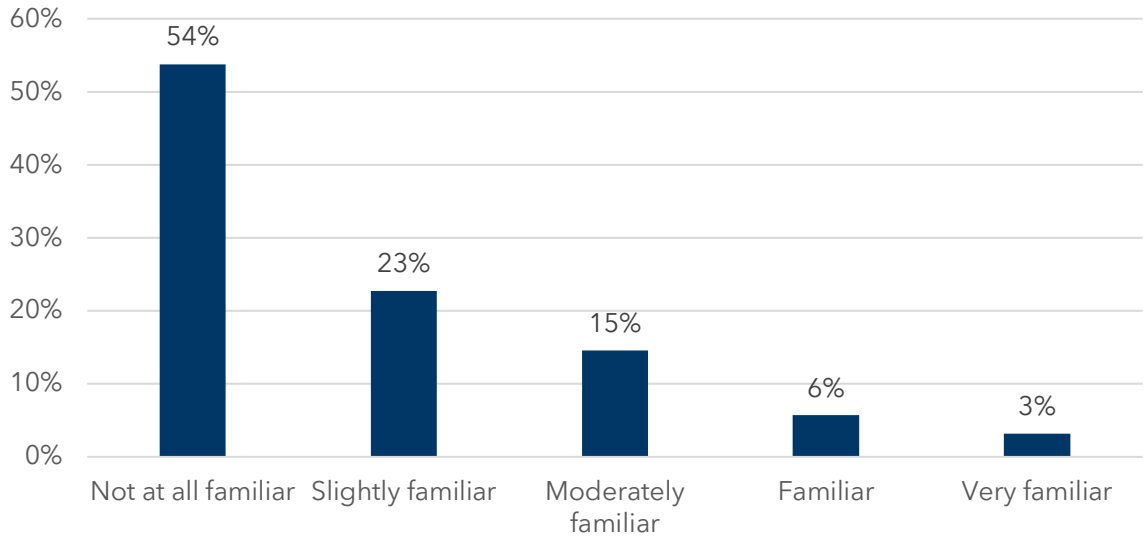


Figure 34. What is the average price of a new light duty vehicle (car, SUV, pickup truck) in Canada?

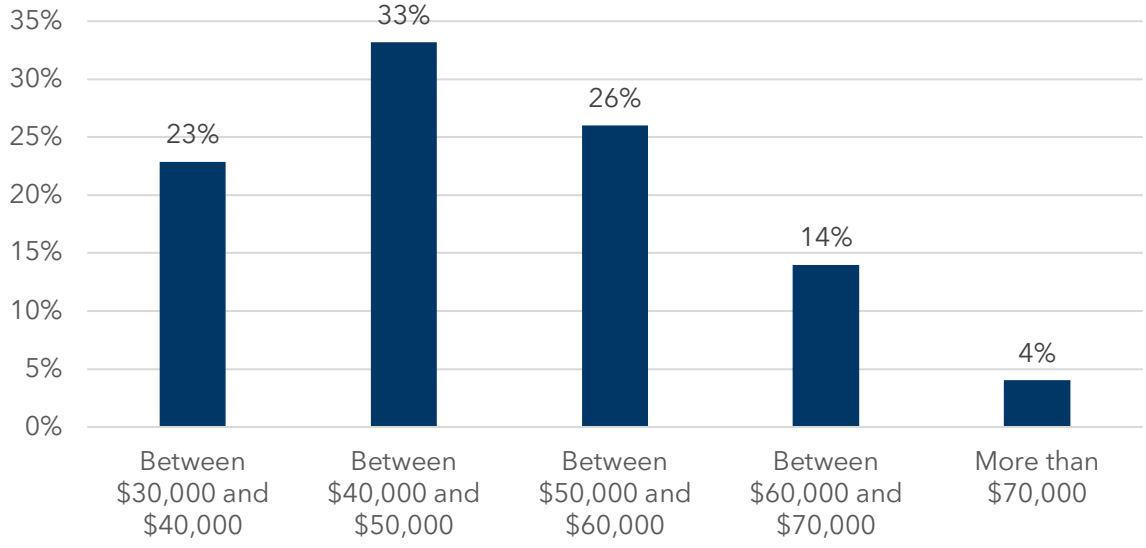
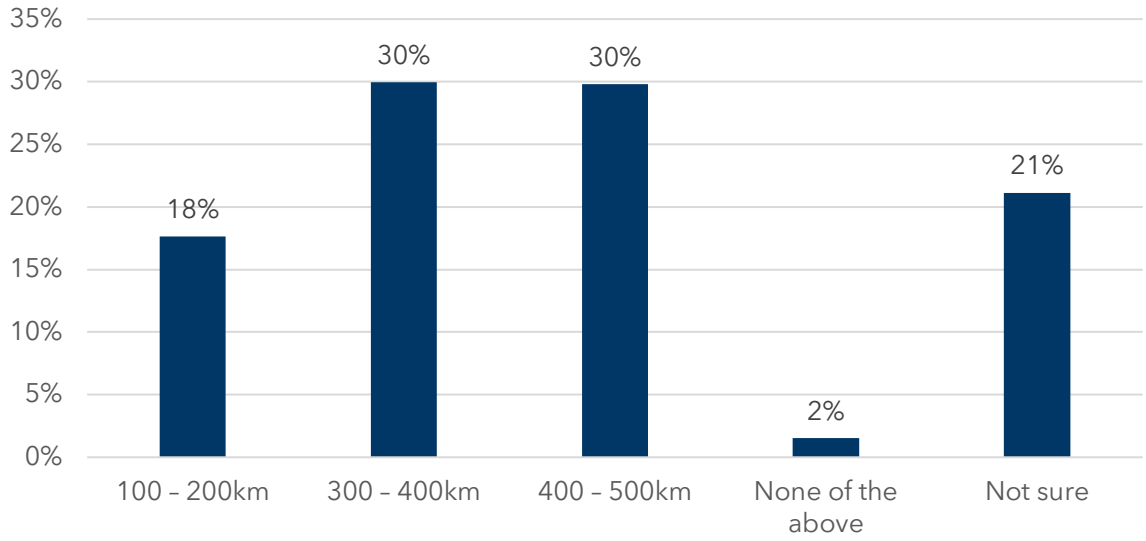


Figure 35. What is the average range of most new electric vehicles?



About Dunsky

Dunsky supports leading governments, utilities, corporations and others across North America in their efforts to accelerate the clean energy transition, effectively and responsibly.

With deep expertise across the Buildings, Mobility, Industry and Energy sectors, we support our clients in two ways: through rigorous Analysis (of technical, economic and market opportunities) and by designing or assessing Strategies (plans, programs and policies) to achieve success.

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