Accelerating the Deployment of Zero Emission Vehicles: Atlantic Canada and the Prairies

March, 2018

Prepared for Natural Resources Canada

Pollution Probe
Clean Air. Clean Water.

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Executive Summary

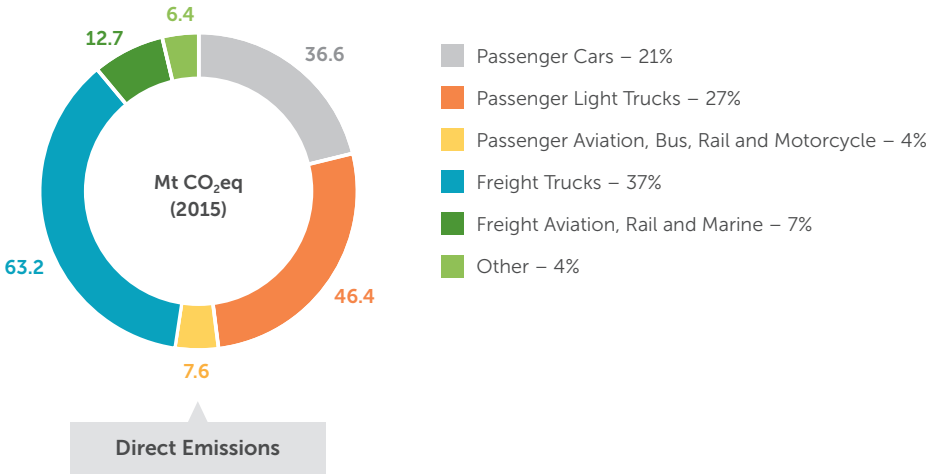
The main objectives of this study were centered around understanding perspectives on zero-emissions vehicles (ZEVs) and their deployment in the Atlantic and Prairie regions of Canada, two regions that have seen minimal uptake of ZEVs. This report serves to communicate the current state of play of ZEVs in these two regions and is particularly focused on regional and inter-regional challenges and opportunities, which were confirmed and discussed via stakeholder consultations carried out in each region.

In addition to serious detrimental impacts to the natural environment, climate change represents one of the largest threats to social, economic, and political systems worldwide. A 2011 study by the National Round Table on the Environment and the Economy estimated that climate change could cost Canada $21-43 billion per year by 2050.

International concern has been demonstrated by the near-unanimous ratification of the Paris Agreement, which aims to limit global warming to "well below 2°C above pre-industrial levels". A low carbon economy will ultimately be required to achieve the significant greenhouse gas (GHG) emission reductions required to meet the objectives of the Paris Agreement.

Canada has set a 30% GHG emissions reduction target below 2005 levels by 2030 (equivalent to 523 Mt CO_2e). Canada's long-term goal is to reduce emissions by 80% from 2005 levels by 2050. Federal and provincial governments have introduced climate policies to help achieve these ambitions.

GHG emissions from the transportation sector are the second largest source of emissions in Canada, representing 24% of total GHG emissions in 2015, of which 12% originate from light duty vehicles. Canada recognizes that reducing transport emissions will be required for meeting its targets and has identified expanding the number of ZEVs on Canadian roads in its approach for doing so. The federal government is working with provincial and territorial governments, industry and other stakeholders to develop a Canada-wide ZEV strategy in 2018.



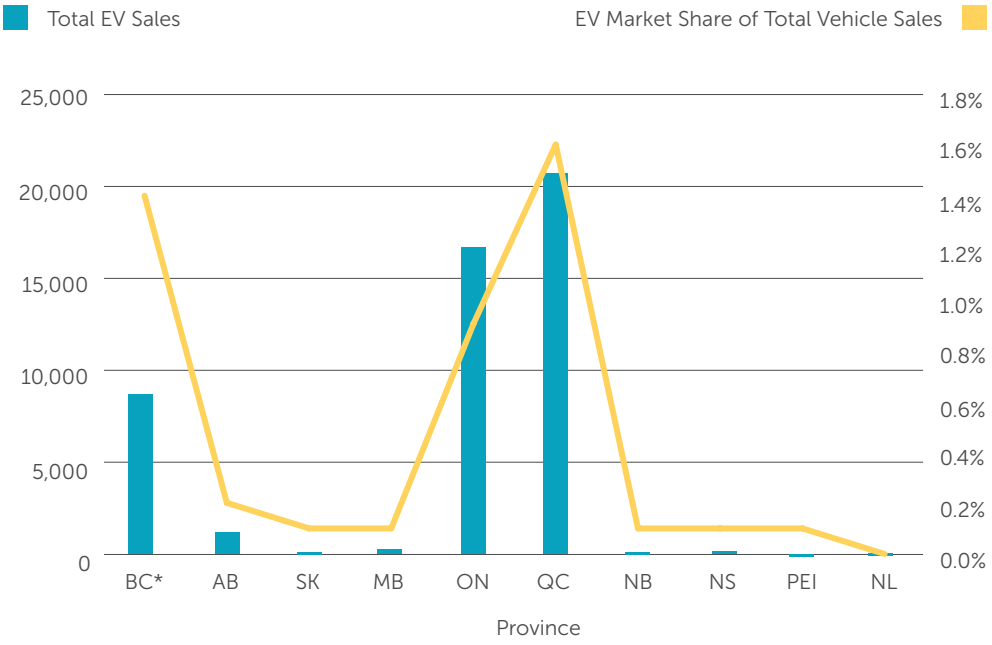
Canada's 2015 transportation GHG emissions by source

Source: Environment and Climate Change Canada[5]

ZEVs include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and hydrogen fuel cell electric vehicles (FCEVs). Canada has seen impressive growth in ZEV sales over the past few years. In fact, ZEV sales in Canada increased 68% between 2016 and 2017. As of the end of 2017, the total number of ZEVs on Canadian roads was 47,800.

Total ZEV Sales and Market Share (through year-end, 2017). *BC sales include territories.

Source: FleetCarma, Electric Vehicle Sales in Canada, 2017



General key barriers to ZEV adoption in Canada include the upfront purchase cost, technology uncertainty, vehicle availability, lack of charging infrastructure and lack of public awareness and education. Quebec, Ontario and British Columbia have implemented policies and programs to help overcome a number of these barriers and have seen significant growth in ZEV sales over the 2013 to 2017 time period.

Provinces in the Prairie and Atlantic regions have seen much lower ZEV adoption rates. While some municipalities in Alberta (namely Calgary and Edmonton) are developing their own ZEV strategies, accelerating ZEV deployment does not feature prominently in provincial climate strategies. Several provinces in the Atlantic region have included ZEVs as part of their plans to reduce GHG emissions from the transportation sector, however policies have not yet been defined and implemented, and uptake remains low.

REGIONAL BARRIERS AND OPPORTUNITIES

Subject matter expert interviews, regional workshops in Fredericton and Calgary, and an Atlantic Canada webinar were conducted to explore regional and provincial barriers and opportunities with respect to accelerating ZEV deployment.

In Atlantic Canada, barriers to ZEV adoption were identified including:

- Lack of incentives and high purchase costs
- Lack of consumer and policy-maker awareness and education about ZEVs and their benefits
- Lack of public charging infrastructure
- Lack of ZEV availability in dealerships
- Lack of available models (e.g., pickup trucks) to meet required vehicle performance specifications for large consumer demographics
- Lack of access to maintenance and repair
- Higher future ZEV deployment would displace revenue from gasoline sales taxes used for road infrastructure
- Displaced revenue for dealerships from service and repairs for ZEVs

Priority opportunities for action identified by Atlantic Canada region stakeholders included:

- Incentives for vehicle purchase and charging infrastructure
- Increase charging infrastructure
- Education and awareness campaigns by multiple groups (Government, NGOs, OEMs, etc.)

In the Prairies region, barriers to ZEV adoption were identified including:

- Lack of provincial government interest/engagement
- Lack of coordination of stakeholders/activities
- The higher cost of ZEVs and lack of equivalent models (e.g., pickup trucks and SUVs)
- Lack of public charging infrastructure
- Lack of consumer awareness (economic and environmental benefits, total cost of ownership, infrastructure, safety)
- Lack of ZEVs and service capabilities at dealerships
- Technology barriers (battery performance and perceived cold weather performance)
- Lack of standardization of charging infrastructure

Prairie region stakeholders identified several priority opportunities for action including:

- The need for governments to make ZEVs a priority
- Funding for vehicle incentives, charging infrastructure incentives and education/awareness
- Exploring future/smart mobility systems

PROVINCIAL PERSPECTIVES ON GRID READINESS

While utility stakeholders from across Canada agree that ZEVs do not pose an immediate challenge from an electricity generation capacity and transmission perspective, the primary challenge that ZEVs pose is to local electricity distribution systems. This is especially true considering that ZEV adoption tends to be concentrated in certain, mostly urban, neighbourhoods. Regional perspectives on grid readiness are highlighted below.

NEWFOUNDLAND AND LABRADOR	PRINCE EDWARD ISLAND	NOVA SCOTIA	NEW BRUNSWICK
98% of Newfoundland and Labrador's electricity will be from renewable resources when the Muskrat Falls hydroelectric project comes into service. Completion of construction and operation of the Muskrat Falls generating station and transmission lines will mean a link to North America's electricity grid for exports to allow for the sale of excess power to markets, helping to enable regional GHG reductions. Current levels of ZEV market penetration do not threaten local electricity grids. However as ZEV uptake increases, the effects of ZEVs on electricity infrastructure will require examination. NL Hydro has the exclusive right to sell electrical power to retailers. It is expected that grid impacts could be minimized by encouraging ZEV owners to charge during off-peak periods. Measures, such as time of use pricing, would require significant metering technology changes in Newfoundland and Labrador.	Approx. 25% of the province's electrical needs are met by wind, the highest percentage of any jurisdiction in North America. Further increasing electrical production from wind is a priority. The use of smart grid technology will enable wind integration. An increase in the peak load identified as possible adverse impact of ZEV adoption and associated electricity use, if users charge their vehicles when they get home from work in the early evening in winter. Provincial Energy Strategy (2016/17) identifies options for mitigating potential impacts, in cooperation with electric utilities. These include linking the introduction of ZEVs to smart grid measures and harnessing vehicle batteries to manage electric loads.	NS Power is keen to examine the potential impacts of ZEV adoption on the provincial electrical system. The short-term impacts of L3 fast charging on the electrical system are expected to be greater than L2 charging. NS Power's recent proposal to install 12 L3 chargers as part of pilot project to study the impact and usage of the charging network on the electrical system, was rejected by the Nova Scotia Utility Review Board. The majority of existing L2 charging stations in Nova Scotia are not network-enabled, which means the opportunity for data collection on usage patterns is limited.	NB Power targets 40% of electricity sales being provided from renewable energy, and a total of 90% of electricity generation from non-emitting sources by 2020. Large GHG emissions reductions could thus be achieved from ZEV adoption. NB distribution is robust —no foreseeable grid concerns—might be local community challenges in future when adoption numbers increase. NB Power is keen on smart grids as strategy and ZEVs can play a big role (i.e. storage, vehicle-to-grid, etc.).

MANITOBA	SASKATCHEWAN	ALBERTA
Provincial grid is >98% emissions-free and generation capacity is well in excess of demand, which means switching from internal combustion engine (ICE) vehicles to ZEVs offers large-scale GHG reduction benefits. Transportation is leading source of emissions in the province, yet ZEVs are not a focus of Manitoba's proposed Climate and Green Plan. Over 500,000 plug points at home and at work already exist in the province. Manitobans are accustomed to plugging in. Conversion of all gasoline-powered vehicles to electricity would require 1,200 GWh to 2,500 GWh a year. The large-scale integration of ZEV charging into the electrical grid identified as one area of focus for Manitoba's ZEV advisory committee.	Electricity generation is the leading source of emissions in the province followed by the oil and gas sector; current priority is for government to reduce emissions in these areas rather than transportation. Currently low demand for and uptake of ZEVs in province, so ZEVs currently pose little-to-no threat to provincial grids. Province has no plans to become engaged on public ZEV charging. Government will reassess actions if and/or when ZEV adoption increases. SaskPower has the exclusive right under the Power Corporation Act to supply, transmit and distribute electricity, and to provide retail services to consumers in the province, except for the Cities of Saskatoon and Swift Current. Both purchase electrical power in bulk from SaskPower.	Not an issue on transmission systems. Utility capacity to incent ZEV users to charge off-peak or monitor ZEV impacts on the grid is limited because necessary advanced metering infrastructure does not exist. No legislative provisions enabling utilities to rate base the cost of charging infrastructure. Future challenge on local transformer levels with larger ZEV adoption, but there are technologies and incentives for time of day charging that could help address this. A number of Alberta utilities are being proactive in planning for increased ZEV adoption and recognize emerging opportunities with respect to ZEVs and advanced energy management solutions.

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Abbreviations and Acronyms

AB	Alberta
AC	Alternating current
ACE	Automotive Centre of Excellence
BC	British Columbia
BEV	Battery electric vehicle
CEV Program	Clean Energy Vehicle Program. A BC program
CO_2e	Carbon dioxide equivalent
CVMA	Canadian Vehicle Manufacturers' Association
DC	Direct current
EHVAP	Electric and Hydrogen Vehicle Advancement Partnership. An ON program.
EVAA	Electric Vehicle Association of Alberta
EV	Electric vehicle
EVCIP	Electric Vehicle Charging Incentive Program. An ON program.
EVCO	Electric Vehicle Chargers Ontario program. An ON program.
EVIP	Electric Vehicle Incentive Program. An ON program.
EVSE	Electric vehicle supply equipment
FCEV	Fuel cell electric vehicle
GAC	Global Automakers of Canada
GHG	Greenhouse gas
GWh	Giga-watt hours
HDEV	Heavy duty electric vehicle
HDV	Heavy duty vehicle
HOV	High occupancy vehicle
ICE	Internal combustion engine
IEA	International Energy Agency
kW	Kilowatt
kVA	Kilovolt-amperes
L1	Level 1 charging

L2	Level 2 charging
L3	Level 3 charging
LDV	Light duty vehicle
LEV	Low-emission vehicles
MB	Manitoba
MEVA	Manitoba EV Association
MSRP	Manufacturer's suggested retail price
Mt	Megatonne
MW	Megawatt
NB	New Brunswick
NDC	Nationally determined contributions
NFLD & LAB	Newfoundland and Labrador
NGO	Non-governmental organization
NO_x	Nitrogen oxide
NRC	National Research Council
NRCan	Natural Resources Canada
NS	Nova Scotia
OEM	Original equipment manufacturer
ON	Ontario
PEI	Prince Edward Island
PHEV	Plug-in hybrid electric vehicle
QC	Quebec
RFP	Request for Proposals
SK	Saskatchewan
SUV	Sport Utility Vehicle
SUVI	Specialty-Use Vehicle Incentive. A BC program
TCO	Total cost of ownership
V	Volt
ZEV	Zero emission vehicle

About

POLLUTION PROBE

Pollution Probe is a national, not-for-profit, charitable organization which is improving the health and well-being of Canadians by advancing policy that achieves positive, tangible environmental change. It is a leader in building successful partnerships with industry and government to develop practical solutions for shared environmental challenges. Pollution Probe is leading the delivery of the Electric and Hydrogen Vehicle Advancement Partnership on behalf of the Government of Ontario, to accelerate the adoption of low emission passenger vehicles.

THE DELPHI GROUP

The Delphi Group is a Canadian strategic consultancy providing innovative solutions in the areas of climate change and corporate sustainability. As a pioneer in sustainability and environmental risk management, The Delphi Group has more than 25 years of experience helping some of Canada's best-known companies improve the sustainability of their organizations —as well as the local and global communities in which they operate.

This study was made possible by support from:

NATURAL RESOURCES CANADA

Natural Resources Canada (NRCan) seeks to enhance the responsible development and use of Canada's natural resources and the competitiveness of Canada's natural resources products. We are an established leader in science and technology in the fields of energy, forests, and minerals and metals and use our expertise in earth sciences to build and maintain an up-to-date knowledge base of our landmass. NRCan develops policies and programs that enhance the contribution of the natural resources sector to the economy and improve the quality of life for all Canadians. We conduct innovative science in facilities across Canada to generate ideas and transfer technologies. We also represent Canada at the international level to meet the country's global commitments related to the sustainable development of natural resources.

In order to fulfil NRCan's Transportation and Alternative Fuels Division's mandate to increase awareness, availability and use of lower carbon transportation options along with its ongoing support of the federal ZEV Strategy, NRCan commissioned Pollution Probe to assess the current state and future opportunities for ZEV deployment in Atlantic Canada and the Prairies. The goal is to be working with relevant stakeholders to assess best-practices from Ontario, B.C., and Quebec in terms of EV deployment; identify issues related to grid readiness and grid impact of ZEVs; as well as to undertake a deep dive on regionally specific barriers to and opportunities for accelerated penetration of ZEVs.

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BRUCE POWER

Bruce Power is Canada's first private nuclear generator, providing 30 per cent of Ontario's power. The company is committed to providing clean energy to the province beyond 2060, to help the province continue to achieve reduction in Greenhouse Gas Emissions (GHG). Since 2013, Bruce Power has been involved in the promotion of electric vehicles bringing focus to the extensive opportunity Ontario has to leverage the clean supply mix in helping to reduce Greenhouse Gas contributions from its transportation sector.

CANADIAN VEHICLE MANUFACTURERS' ASSOCIATION

The Canadian Vehicle Manufacturers' Association is the industry association that has represented Canada's leading manufacturers of light and heavy duty motor vehicles for more than 90 years. Its membership includes Fiat Chrysler Automobiles (FCA) Canada, Inc.; Ford Motor Company of Canada, Limited and General Motors of Canada Company. Collectively its members account for approximately 60% of vehicles produced in Canada, operate 5 vehicle assembly plants as well as engine and components plants, and have over 1,300 dealerships

The CVMA creates a framework within which member companies work together to achieve shared industry objectives on a range of important issues such as trade, consumer protection, the environment and vehicle safety. The CVMA provides research, information, industry-government advocacy and other services aimed at building a better understanding of the importance of a healthy automotive industry to Canada's economic well-being and prosperity.

GLOBAL AUTOMAKERS OF CANADA

Global Automakers (GAC) is the national industry association representing the Canadian interests of 15 of the world's most respected automakers. The GAC advocates for sound public policy to support a competitive and sustainable automotive market in Canada. Our members are committed to meeting the mobility needs of Canadians by providing greater consumer choice, offering leading edge safety and environmental technologies, while eliminating unnecessary regulatory and trade barriers.

In 2017 GAC's member companies represented 57% of the Canadian automotive market and supported over 60% of Canada's new vehicle dealerships. Moreover, in 2018 Natural Resources Canada recognized GAC members with class leading fuel efficiency in 9 of 13 categories and in energy efficiency in 5 of 9 categories for electric vehicles.

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Global Automakers of Canada

Purpose of the Report

Climate change is an issue that has garnered attention over recent years and policies aimed at greenhouse gas (GHG) mitigation are being developed across the country as Canada positions itself as a global leader in decarbonizing its economy.

The transportation sector represents one of the largest GHG emission sources in Canada, or conversely it could be viewed as a sector with one of the largest mitigation opportunities. In recognition of this contribution both the light and heavy duty vehicle segments are subject to increasingly stringent GHG vehicle regulations through 2025, which are harmonized with those that have been established in the U.S. While no one strategy or technology alone will reduce all transportation-related GHG emissions in the short to medium term, zero emission vehicles (ZEVs) represent a promising opportunity to make meaningful progress in achieving federal and provincial GHG reduction targets.

The main objectives of this study were centered around understanding regional perspectives on ZEVs and their deployment in the Atlantic and Prairie regions of Canada, two regions that have seen minimal uptake of ZEVs compared to Ontario, Quebec and B.C. This report serves to communicate the current state of play of ZEVs in these two regions and is particularly focused on regional and inter-regional challenges and opportunities, which were confirmed and discussed via stakeholder consultations carried out in each region.

Section 4 provides background information on GHGs in Canada, government reduction targets and introduces ZEVs including a discussion of the benefits associated with ZEVs.

Section 5 explores the current state of ZEV deployment across Canada and includes a list of current ZEV models available in Canada.

Section 6 discusses common barriers associated with ZEV deployment in Canada.

Section 7 outlines policies, programs and other initiatives related to ZEVs in leading jurisdictions: Ontario, Quebec and British Columbia.

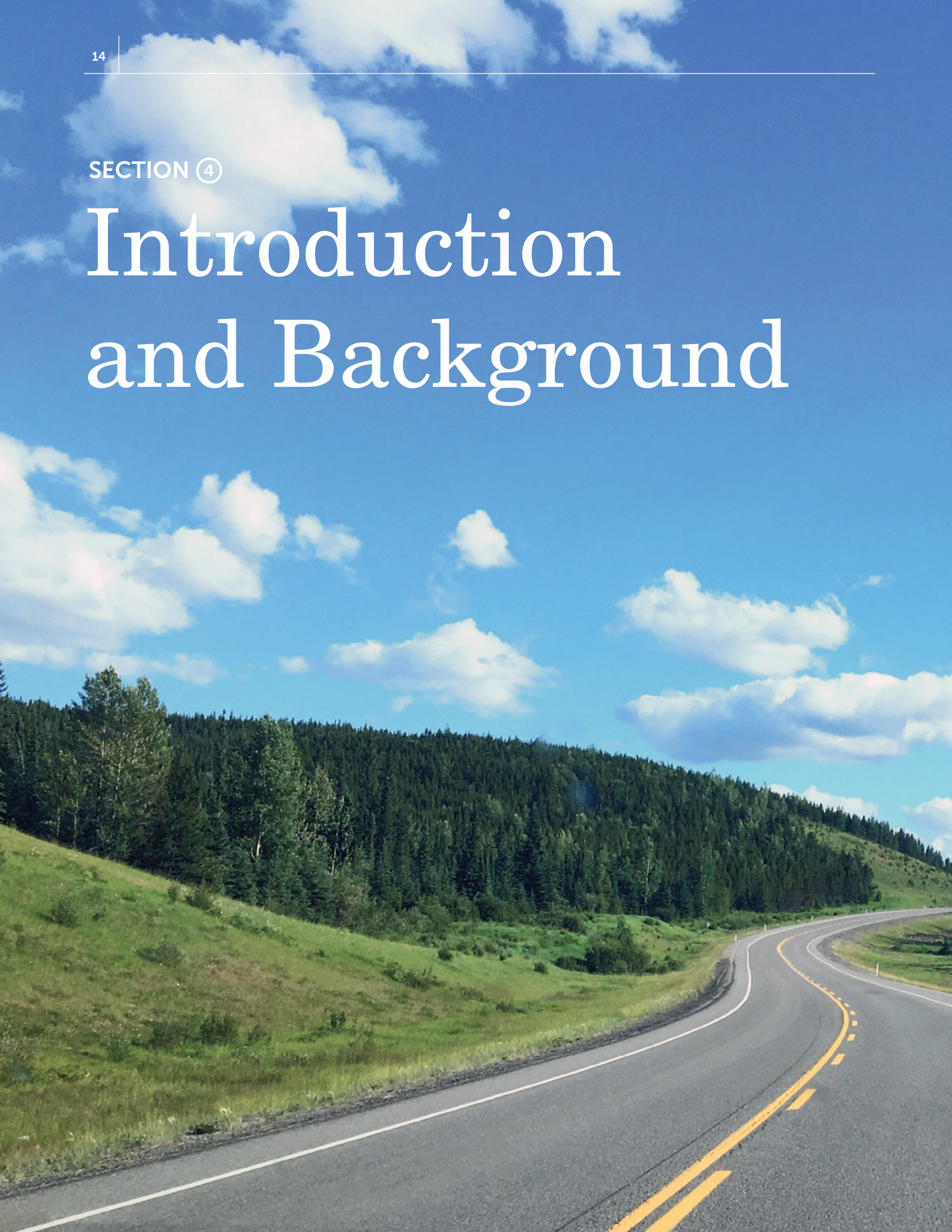
Section 8 explores the current state of ZEV deployment in the regions of interest of this study: Atlantic Canada and the Prairies. Current uptake of ZEVs and associated policies and/or programs are discussed.

Section 9 presents regional and provincial perspectives on barriers and opportunities to increased ZEV adoption in the Atlantic and Prairie regions, as well as information on provincial grid readiness.

Section 10 provides a concise summary of the report.

SECTION 4

Introduction and Background



4. Introduction and Background

4.1 CLIMATE CHANGE AND IMPACTS

Climate change has serious implications for social, economic, and political systems in addition to direct impacts on the natural environment. Anticipated impacts from climate change include rising sea-levels, thawing permafrost and extreme weather events that can include increased precipitation, flooding, heat waves, droughts, and forest fires, all of which have cascading socioeconomic impacts.[1] Canada is expected to experience higher rates of warming than other countries due to its high latitude.

The costs of climate inaction may be great. A 2017 report by the Universal Ecological Fund estimates that economic losses from extreme weather events combined with health costs from burning fossil fuels could amount to $360 billion per year in the United States alone, over the next decade.[2] A 2011 study by the National Round Table on the Environment and the Economy estimated that climate change could cost Canada $21-43 billion per year by 2050.[3]

International concern has been demonstrated by the near unanimous ratification of the Paris Agreement, which aims to limit global warming to "well below 2°C above pre-industrial levels". While much effort has been put into individual actions and local projects to reduce GHG emissions, a low carbon economy will ultimately be required to achieve the significant GHG emission reductions outlined in the objectives of the Paris Agreement.

4.2 GREENHOUSE GAS (GHG) EMISSIONS IN CANADA BY SECTOR

GHG emissions in Canada grew 18% from 1990 to 2015. According to Environment and Climate Change Canada, emissions growth has been driven by increased mining, upstream oil and gas production and transportation.[4]

A breakdown of Canada's GHG emissions in 2015 are provided in Figure 1. Transportation is the second largest source of emissions in Canada, representing 24% of total emissions in 2015, of which 12% originate from light duty vehicles.

FIGURE 1
Canada's 2015 GHG emission breakdown by economic sector
Source: Environment and Climate Change Canada[5]

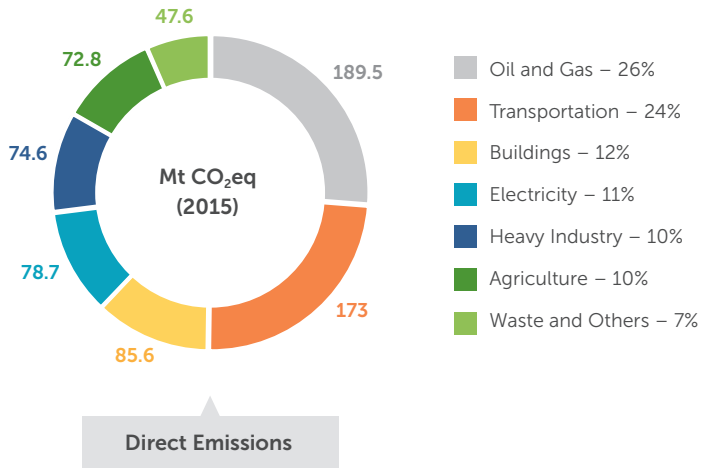


Figure 2 shows Canada's 2015 transportation GHG emissions by source. 48% of all transportation GHGs were emitted from passenger cars and trucks (light duty vehicles), representing approximately 12% of national GHG emissions.

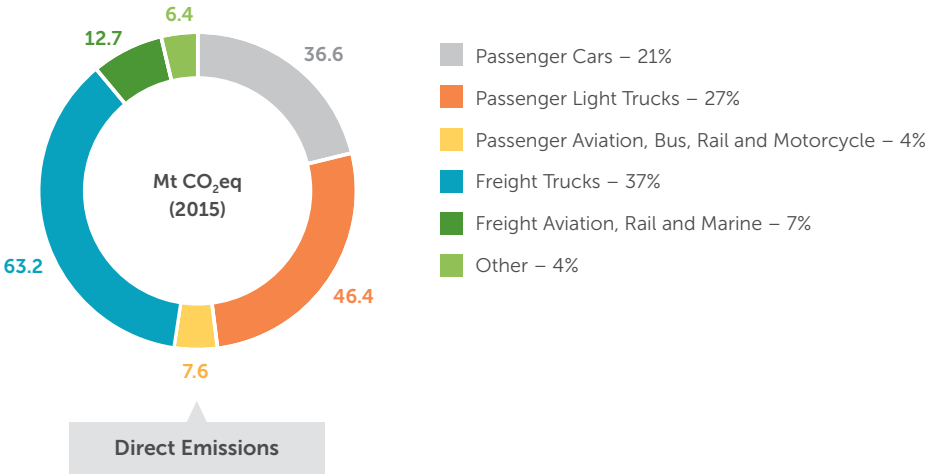


FIGURE 2
Canada's 2015 transportation GHG emissions by source
Source: Environment and Climate Change Canada[5]

Transportation GHG emissions have increased 42% since 1990 – a much higher rate than the sector-wide average for emissions increases. Emissions from passenger light trucks and freight trucks have doubled and tripled respectively due to an increased number of vehicles (especially light trucks and SUVs) and increased on-road freight traffic.[6] Gasoline and diesel fuel are the primary fuels used in transportation, as shown below in Figure 3.

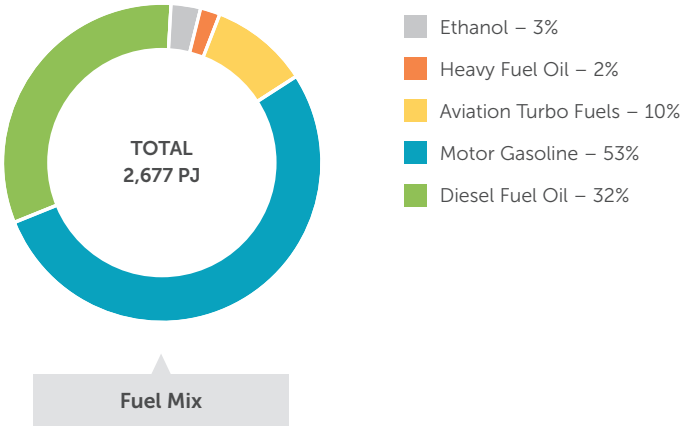


FIGURE 3
Fuel Mix of Transportation Sector, 2014
Source: NRCan[7]

4.3 GOVERNMENT TARGETS FOR GHG REDUCTION

Participating nations in the Paris Agreement are outlining (or have outlined) long-term climate actions post 2020, known as Nationally Determined Contributions (NDCs). Canada's NDC sets a 30% GHG emissions reduction target below 2005 levels by 2030 (equivalent to 523 Mt CO_2e). Canada's long-term goal is to reduce emissions by 80% from 2005 levels by 2050.

Federal and provincial governments have introduced climate policies to help achieve these ambitions. The Pan-Canadian Framework on Clean Growth and Climate Change is Canada's plan – developed with the provinces and territories and in consultation with Indigenous peoples – to meet its emissions reduction targets and build resilience to a changing climate. The Framework, announced in December 2016, outlines initiatives for all sectors of the economy and mandates a national carbon pricing backstop to provinces and territories which do not implement their own carbon pricing policies. At the provincial level, almost all provinces have implemented broad climate change policies with varying levels of GHG reduction commitments and methods for achieving them. British Columbia, Alberta, Ontario and Quebec currently impose carbon pricing through a carbon tax or cap-and-trade program. The remaining provinces and territories are developing or have already proposed carbon pricing policies in response to the Federal commitment to a Canada-wide carbon price. The Federal government will review the proposed policies in the fall of 2018 to determine if they meet the Federal price benchmark.

Canada recognizes that reducing transport emissions will be required for meeting its NDCs and has included expanding the number of ZEVs on Canadian roads in its approach for doing so.[8] In line with this strategy, Canada and China currently co-chair the Electric Vehicle Initiative (EVI) which is a policy forum, under the Clean Energy Ministerial, for multilateral cooperation on the development and deployment of electric vehicles. The goal of the initiative is to facilitate the global deployment of EVs. In June 2017, EVI launched the "EV30@30" campaign, which includes a variety of measures aimed at increasing EV deployment, with a global target of 30% EV sales by 2030.[9] Under the Framework, the federal government is also working with provincial and territorial governments, industry and other stakeholders to develop a Canada-wide ZEV strategy by 2018 to put more ZEVs on Canada's roads.[10]

4.4 WHAT ARE ZERO-EMISSION VEHICLES (ZEVS)?

Zero-Emission Vehicles (ZEVs) which include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and hydrogen fuel cell electric vehicles (FCEVs), offer the potential to significantly reduce greenhouse gas emissions. While there are no emissions from the vehicles themselves during operation, GHGs and other air pollutants may be created when generating electricity or hydrogen. While each vehicle type is outlined below, **this report is primarily focused on BEVs and PHEVs**.

- **Battery Electric Vehicles (BEV)** - BEVs run solely on rechargeable battery packs and electric motors, which are inherently more efficient than internal combustion engines (ICEs) by a large margin. Overall, the average gas-powered ICE vehicle is about 21% efficient[11] while the average BEV is about 80% efficient.[12] In addition to plugging-in, EV batteries can be charged via regenerative braking. The average distance that BEVs can travel on a single charge depends on the model, but commercially available BEVs in 2017 could travel between 150 and 540 km.[13] Batteries are charged regularly by the driver using home or public charging stations which are typically connected to the electric grid. As a result, the quantity and location of GHG emissions and air pollutants released to power a BEV depends on the regional grid's mix of energy sources. BEV charging times depend on the type of charger used, the model of the vehicle (i.e. size of batteries and capacity of on-board chargers) and other factors such as the ambient temperature.

- **Plug-In Hybrid Electric Vehicles (PHEV)** - PHEVs are designed with rechargeable battery packs, an electric motor and an ICE. Some PHEVs can operate using either the electric motor or ICE exclusively while others use both systems complementarily to power the vehicle. In general, the full-electric driving range of PHEVs is much shorter than BEVs, as range is proportional to battery capacity. Commercially available PHEVs in 2016 could travel 22 to 85 km in full-electric mode. For drivers that travel short distances per day, PHEVs can reduce fuel consumption significantly. Like BEVs, PHEVs can reduce GHG emissions by using electricity that is generated for local electricity grids.

- **Fuel Cell Electric Vehicles (FCEV)** - FCEVs are a type of electric vehicle that uses a hydrogen fuel cell instead of a battery pack to power an electric motor. Hydrogen, stored in high pressure tanks, is converted into electricity by the fuel cell to power the vehicle and water is the sole by-product. The use of hydrogen as a transportation fuel is relatively nascent. Hydrogen can be produced from numerous sources such as water (via electrolysis) or methane (via steam methane reforming).

4.5 BENEFITS OF ZEV USE

ZEVs offer many benefits over conventional ICE vehicles. In addition to the potential to reduce GHG emissions, ZEVs also offer potential fuel and maintenance cost savings, are quieter than traditional ICE vehicles and offer a potential co-benefit of improved local air quality (due to the reduction of air pollutants such as NO_x and particulate matter).

GHG Reduction Benefits

Of particular relevance to this report is the benefit associated with GHGs. ZEVs can provide GHG emissions reductions via the use of electricity as opposed to gasoline or diesel. While the amount of GHG emission reductions depends on the carbon intensities of local electric grids, even jurisdictions with more carbon-intensive grids can have a net GHG reduction benefit by shifting to ZEVs.[14,15]

65% of electricity in Canada is generated by renewable sources and 80% in total by non-GHG emitting sources when nuclear generation is taken into account.[16] Each individual province has a unique fuel-mix used to generate electricity. In the Atlantic region, there are large differences in how electricity is generated amongst the provinces. Newfoundland and Labrador and Prince Edward Island generate most of their electricity via non-emitting sources, at 96% and 99%, respectively (although PEI also imports much of its electricity from New Brunswick).[17] New Brunswick generates most (64%) of its electricity via non-emitting sources and Nova Scotia generates about 15% of its electricity via non-emitting sources.

In the Prairies, Manitoba generates all of its electricity via non-emitting sources while Alberta and Saskatchewan generate 13% and 23% of their electricity via non-emitting sources, respectively.

The electricity generation profiles by fuel-type for the Atlantic and Prairie Provinces are shown below in Figure 4 and Figure 5, respectively. "Combustion" includes electricity generation by coal, natural gas and other fuels such as biomass.[18] "Other renewables" include electricity generation by wind, tidal and solar.

FIGURE 4
Electricity Generation Profile of Atlantic Provinces
Source: Adapted from ECCC NIR[19]

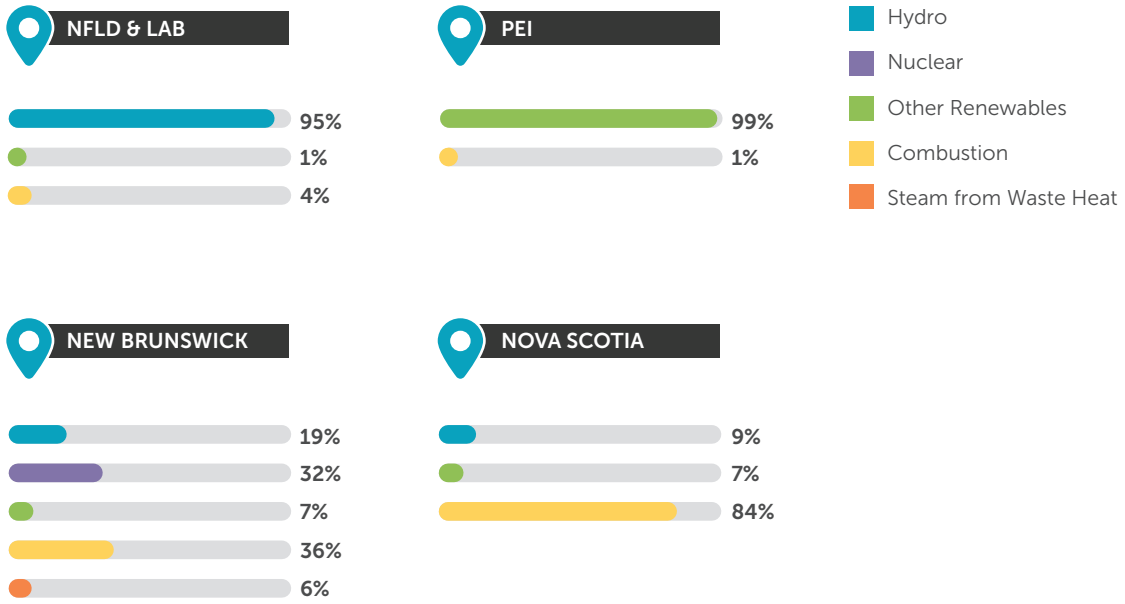
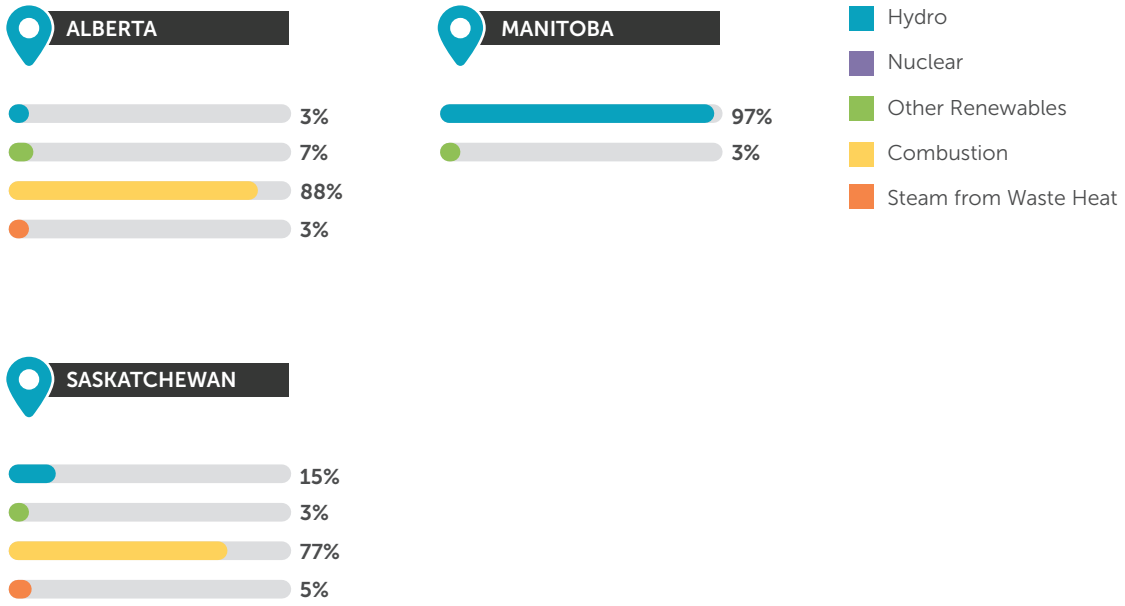


FIGURE 5
Electricity Generation Profile of Prairie Provinces
Source: Adapted from ECCC NIR[20]



GHG reductions from widespread ZEV adoption would be greatest in provinces with lower electricity generation carbon intensities, such as PEI, Newfoundland and Labrador, New Brunswick and Manitoba. However, it is noted that New Brunswick, Nova Scotia, Saskatchewan and Alberta have all set goals to increase renewable energy generation. New Brunswick and Nova Scotia have both set a renewable energy target of 40% by 2020.[21] Alberta's target is 30% of electricity generation via renewables by 2030[22] and Saskatchewan has set a target of 50% of electricity generation via renewables by 2030.[23]

Total Cost of Ownership

ZEVs provide both an opportunity and a challenge in total cost of ownership (TCO) for consumers, encompassing a wide range of cost categories such as:

- Purchase price
- Fuel/energy cost
- Operating and maintenance costs
- Depreciation

The cost differential at the point of sale of a ZEV compared to a conventional ICE vehicle is higher depending on battery size or fuel cell technology. A competitively priced ZEV without subsidies is not expected in the near future, due to a combination of high battery prices, manufacturing scale and low consumer demand. While recent progress has been made in reducing the cost of batteries, the most expensive ZEV component, price parity between a ZEV and a comparable ICE vehicle is not expected until the 2025-2029 timeframe, according to Bloomberg New Energy Finance.[24] Lithium-ion battery packs are currently selling for an average price of $269/kWh[25], which is 24% lower than in 2016 and only about a fifth of the cost seen in 2010.[26] This lower cost is largely attributable to increased global production.

One of the more significant advantages of ZEVs is their reduced "fueling" costs. While there is considerable variability across the country, generally speaking, it is cheaper to "fuel" a ZEV with electricity than a conventional car with gasoline. The weighted average price that ZEV consumers see today for home charging is $0.117 per kWh. The cost to fuel a ZEV can be as little as 12.5% that of a gasoline equivalent vehicle, although fuel cost savings are heavily dependent on regional electricity costs.[27] With significantly lower anticipated operating, maintenance and repair costs owing to a significantly lower number of moving parts, ZEVs typically have a lower TCO in comparison to equivalent ICE vehicles.[28]

Depreciation is typically the greatest cost component of vehicle ownership. In general, ZEV depreciation is significantly worse for the first generation of ZEVs compared to their non-ZEV equivalents. The projected residual values of these vehicles are amongst the lowest in the marketplace, in part explained by the lack of ZEV experience on the part of buyers of used cars.

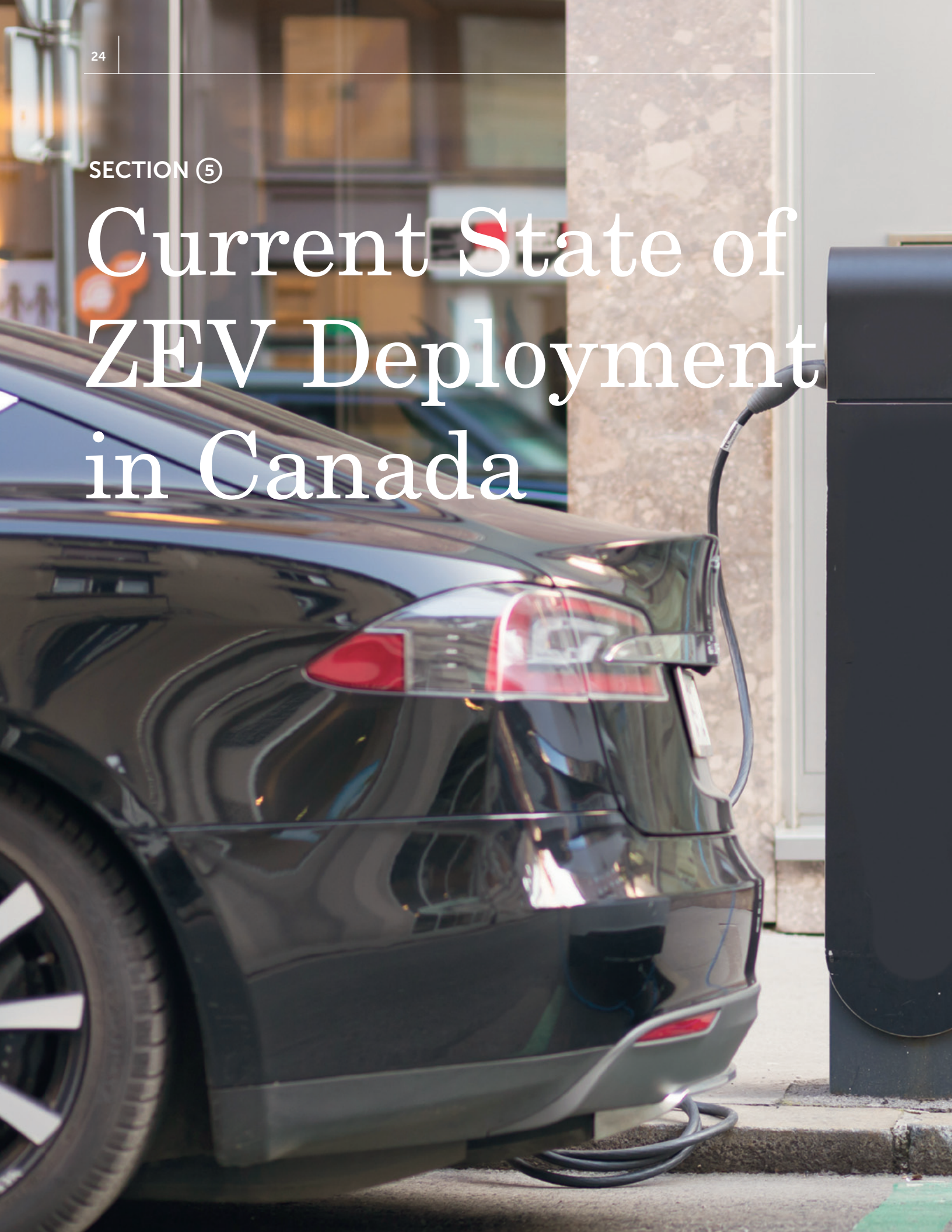
Other Potential Benefits

ZEVs are nearly whisper-quiet and offer the driver and passengers a more pleasurable and healthy experience. A study published by the National Institute of Environmental and Health Sciences states that "nearly 100 million people in the United States had annual exposures to traffic noise that was high enough to be harmful to health".[29]

ZEVs present other potential co-benefits to human health by improving local air quality in densely populated areas. Widespread adoption of ZEVs could result in improved local air quality as emissions of air pollutants (such as NO_x and particulate matter) are shifted from vehicle tailpipes to power plants, which are usually located away from urban centres. In addition, centralized power plants may be better equipped to measure and control air pollutants in comparison to individual vehicles.

SECTION 5

Current State of ZEV Deployment in Canada



5. Current State of ZEV Deployment in Canada

5.1 ZEV MODELS AVAILABLE IN CANADA

There were 26 ZEVs (either PHEV or BEV models) available in Canada in 2017, with many more future model releases already announced by automakers.[30] The make and model of vehicles available in 2017, along with high-level details are listed in Table 1.

TABLE 1
ZEVs Available in Canada (2017)
Adapted from Source: FleetCarma[31]

MAKE	MODEL	ZEV TYPE	VEHICLE TYPE	MSRP (CAD)	ELECTRIC RANGE (KM)
Audi	A3 Sportback e-tron	PHEV	Hatchback	$40,900	26
BMW	330e	PHEV	Sedan	$52,100	22
BMW	740 Le xDrive	PHEV	Sedan	$107,900	22
BMW	X5 xDrive40e	PHEV	SUV	$74,000	28
BMW	i3	BEV	Hatchback	$47,300	183
BMW	i8	PHEV	Coupe	$150,000	28
Chevrolet	Volt	PHEV	Hatchback	$39,590	85
Chevrolet	Bolt	BEV	Hatchback	$42,895	383
Chrysler	Pacifica PHEV	PHEV	Minivan	$50,884	53
Ford	C-Max Energi	PHEV	Hatchback	$39,729	32
Ford	Focus Electric	BEV	Sedan/ Hatchback	$31,998	185
Ford	Fusion Energi	PHEV	Sedan	$36,399	34
Hyundai	Sonata PHEV	PHEV	Sedan	$43,999	43
Hyundai	Ioniq Electric	BEV	Hatchback	$35,649	170
Kia	Optima PHEV	PHEV	Sedan	$42,995	47
Kia	Soul EV	BEV	Hatchback	$35,395	149
Mercedes	GLE 550e	PHEV	SUV	$83,000	30
Mercedes	S 550e	PHEV	Sedan	$102,600	22
Nissan	Leaf	BEV	Hatchback	$37,398	172
Porsche	Cayenne S E-Hybrid	PHEV	SUV	$89,400	22
Porsche	Panamera S E-Hybrid	PHEV	Hatchback	$106,600	25
Smart	Fortwo ED	BEV	Hatchback	$28,800	160
Tesla	Model S	BEV	Sedan	$95,300	435
Tesla	Model X	BEV	SUV	$132,000	413
Volkswagen	e-Golf	BEV	Hatchback	$35,995	201
Volvo	XC90 T8 Twin Engine PHEV	PHEV	SUV	$73,400	22

Even the cheapest ZEV currently costs more than the average price paid by Canadians for a new car in 2015 (which was $27,563).[32] The most common ZEV types offered in 2017 were hatchbacks and sedans.

5.2 WHERE ZEVS ARE DRIVEN IN CANADA

Canada has seen impressive growth in ZEV sales over the past few years. In fact, ZEV sales in Canada increased 68% in 2017 alone. As of the beginning of 2018, the total number of ZEVs on Canadian roads is 47,800.[33] The majority of ZEV sales have been in B.C., Ontario and Quebec, all which have seen significant growth in ZEV sales over the 2013 to 2017 time period, as seen below in Figure 6.

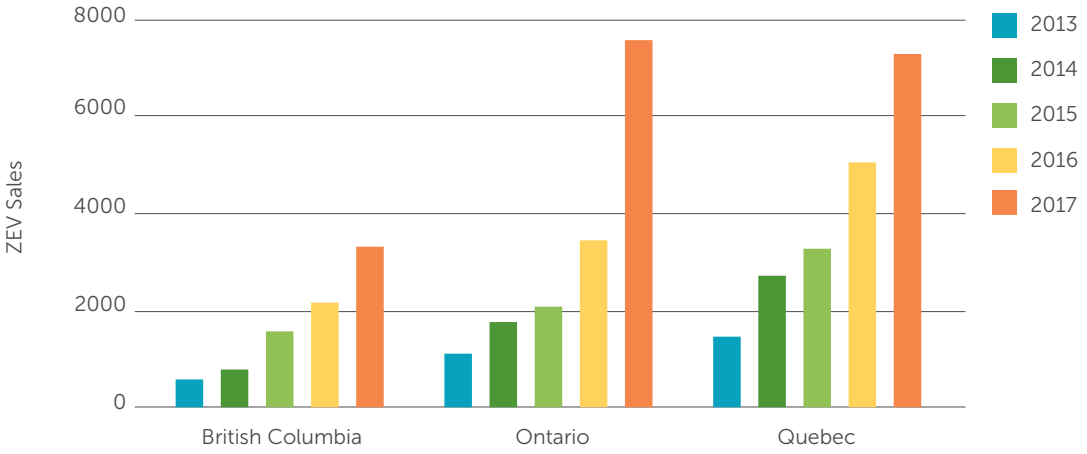


FIGURE 6
Year-Over-Year Comparison of ZEV Sales in British Columbia, Ontario and Quebec (2013-2017).

Source: Canadian Plug-In Electric Vehicle Sales[34]

The year-over-year increases in ZEV sales are reflective of the implementation of comprehensive and relatively more mature ZEV strategies in these three provinces (further discussed in Section 7). While ZEVs offer an array of benefits and are gaining traction in certain marketplaces, barriers remain. These barriers are discussed in the following section.

SECTION 6

Barriers to ZEV Adoption in Canada

6. Barriers to ZEV Adoption in Canada

6.1 UPFRONT CONSUMER PURCHASE COST

Upfront purchase cost is one of the most important factors to Canadian consumers when making a purchasing decision. While the Total Cost of Ownership (TCO) of a ZEV can be lower than that of a comparable internal combustion engine (ICE) vehicle (Section 4.5), the higher capital costs of ZEVs can act as a deterrent.

6.2 TECHNOLOGICAL UNCERTAINTY

Current trends suggest that drivers could be motivated to adopt ZEVs, provided the technology continues to improve in areas such as charging time, and, most importantly, driving range. Critical work is being carried out in Canada to advance energy storage technologies. For example, laboratories at the National Research Council (NRC) are enhancing the safety and reliability of lithium-ion batteries in the Canadian context by focusing on the development and validation of new materials, technologies and test protocols. Research groups out of Dalhousie University and IREQ (Hydro-Quebec's research institute) are also working on advancing the energy storage capacity of lithium-ion batteries. Recent technological developments in lithium-ion batteries, along with increasing consumer demand for these batteries for a wide variety of applications (e.g., cellphones, laptops, portable and stationary power packs), are lowering prices considerably. Industry analysts have reported that costs are falling at a faster pace than originally expected, decreasing by 80% in the last six years.[35] ZEV cold weather performance is being tested by several vehicle manufacturers. General Motors, Ford and Toyota Canada, for example, have cold weather test facilities in Canada. Further, the Automotive Centre of Excellence (ACE) at the University of Ontario's Institute of Technology has a unique climatic wind tunnel for extreme weather testing.

6.3 CHARGING INFRASTRUCTURE

There are several types of charging infrastructure that can be used to charge ZEVs at varying levels of power. The three main types of charging infrastructure for ZEVs are commonly referred to as Level 1 (L1), Level 2 (L2) and Level 3 (L3) chargers which are described in Table 2.

TABLE 2
Charging Station Types

Source: Adapted from Accelerating the Deployment of Plug-in Electric Vehicles in Canada and Ontario [36]

DESCRIPTOR	LEVEL 1	LEVEL 2	LEVEL 3
ZEVs Supported	All PHEVs and EVs	All PHEVs and EVs	BEVs (not all)
Typical Voltage	120	240	480
Current Type	AC	AC	DC
Requirements	Requires standard electrical outlet	Requires 240 volt electrical outlet (for portable chargers) or circuit (stationary chargers)	Charging facility in a fixed location
Charging Time Range	8–30 hours	4–10 hours	25–30 min (to 80% of full charge)
Hardware and Installation Cost	$0	$1,000—$5,000	$50,000—$100,000
Applications	Long term parking (home, work, etc.)	Long and short-term parking (home, office, retail storefronts, etc.)	Long-distance travel (highways)

Barriers to Future ZEV Charging Infrastructure

The type, location and availability of charging infrastructure greatly influences the deployment of ZEVs. Home and workplace charging is deemed the most important form of ZEV charging infrastructure because cars spend the most time parked at these locations and accessibility is convenient. A 2014 ZEV study found that up to 85% of charging events occurred at home.[37] Further, most home charging occurs overnight, when electricity demand is typically the lowest, and this serves to reduce the risk of local grid infrastructure being stressed or overloaded as a result of ZEV charging. L3 charging on interprovincial highways is also an important component of a ZEV charging network, as it facilitates long-distance travel via ZEVs that would otherwise be very time-consuming.

Most ZEVs currently available have ranges that are best-suited for commuting and urban use. Therefore, consumer 'range anxiety' is a major barrier to adoption until more L3 charging infrastructure is installed to accommodate long-distance intercity travel.

Equipment Barriers

Charging infrastructure equipment requirements can be a barrier for ZEV ownership. For example, some homes, whether they be single dwellings or multi-units, do not have the appropriate power capacity and/or available space (e.g., limited to curbside or shared parking) to permit the installation of charging stations and therefore cannot offer at-home charging. Additionally, the upfront cost of installing L2 or L3 charging infrastructure at workplaces and retail outlets may be cost prohibitive for business owners.

Utilities are able to increase power demand charges on commercial facilities that do not manage their peak electricity demand. Provisions for mitigating demand charges, such as installing separate load management systems to help manage a site's energy consumption or developing electricity rates specifically for faster L3 charging load profiles, will be required to remove this infrastructure barrier.

Customer Experience Barriers

Longer refueling (i.e. charging) times, decreased reliability of finding vacant public charging stations and potential frustration caused by interfacing with apps and memberships required to use public charging stations are all potential customer experience barriers.

Electricity Distribution Barriers

Policies and regulations related to charging stations can also be a barrier to ZEV adoption. Outside of electrical utilities, other entities may be restricted from reselling electricity to customers in some jurisdictions. Permitting these hosts to sell electricity to customers would enhance the business case for providing ZEV charging, which in turn could accelerate ZEV deployment. Further, utilities are often unable to invest in charging infrastructure due to the lack of regulatory clarity around their ability to rate base charging infrastructure technologies and programs.

In the near term, the additional electricity demand required to power ZEVs is not expected to exceed generation capacity on Canadian grids. However, concentrated load demands could stress local distribution, particularly in areas with high concentrations of ZEV adopters. Utilities and distribution planners should anticipate changes to load demands as ZEV uptake increases and take steps to ensure that transmission and distribution networks are not over-extended. Tools and standards that allow utilities to control the rate and timing of ZEV charging, especially at residences, must be developed and implemented to avoid stress to street-level transformers and other local distribution infrastructure.

6.4 LACK OF PUBLIC AWARENESS AND EDUCATION

Public awareness and education is paramount to increasing ZEV adoption. There are a broad range of barriers that can prevent consumer progression through initial awareness (where a lack of basic knowledge and various fundamental misconceptions prevent the consumer from being open to considering a ZEV), to purchase, to replication (i.e. repeat purchase). Although certain vehicle buying demographics appreciate and seek out new technologies and innovations, the majority of car buyers are change-averse and generally skeptical towards technologies that are radically different than what they are accustomed to. Public awareness and education efforts should thus focus on clear and simple messaging around ZEV use and ownership, focussing on a handful of key points that people need to know and omitting extraneous details that may convey that owning a ZEV requires a degree of in-depth technical understanding.

One of the biggest hurdles for consumers to overcome is range anxiety. Individuals are concerned they will run out of battery power and be left 'stranded'. Some of these concerns are borne from a lack of awareness and education on existing infrastructure and charging requirements. As an example, a 2014 survey found that 91% of Canadian consumers believed that it was "definitely true" or it "might be true" that there are few public charging stations available[38]. However, at that time there were many public charging stations already in place across Canada.

6.5 ZEV AVAILABILITY AND PURCHASING EXPERIENCE

A barrier to higher ZEV adoption in Canada is the purchasing experience. When deciding on large purchases such as a vehicle, Canadians tend to be pragmatic about conducting their research prior to making a decision. Research often includes online reviews, discussions with colleagues and dealership representatives and importantly a test drive of the vehicle of interest. In some cases, a would-be ZEV purchaser cannot discuss the pros and cons of a ZEV and how it might fit their lifestyle with sales representatives at dealerships, and often there are no ZEV models available to be test driven. Not all dealerships in Canada are certified to sell ZEVs. A dealership's decision to become certified to sell ZEVs requires a financial commitment for certification, staff training and specialty tools, charging infrastructure, and an understanding that there will be low market demand in the near term. While the purchasing experience has improved in leading jurisdictions in Canada, it remains a challenge in emerging markets such as the Prairie and Atlantic regions.

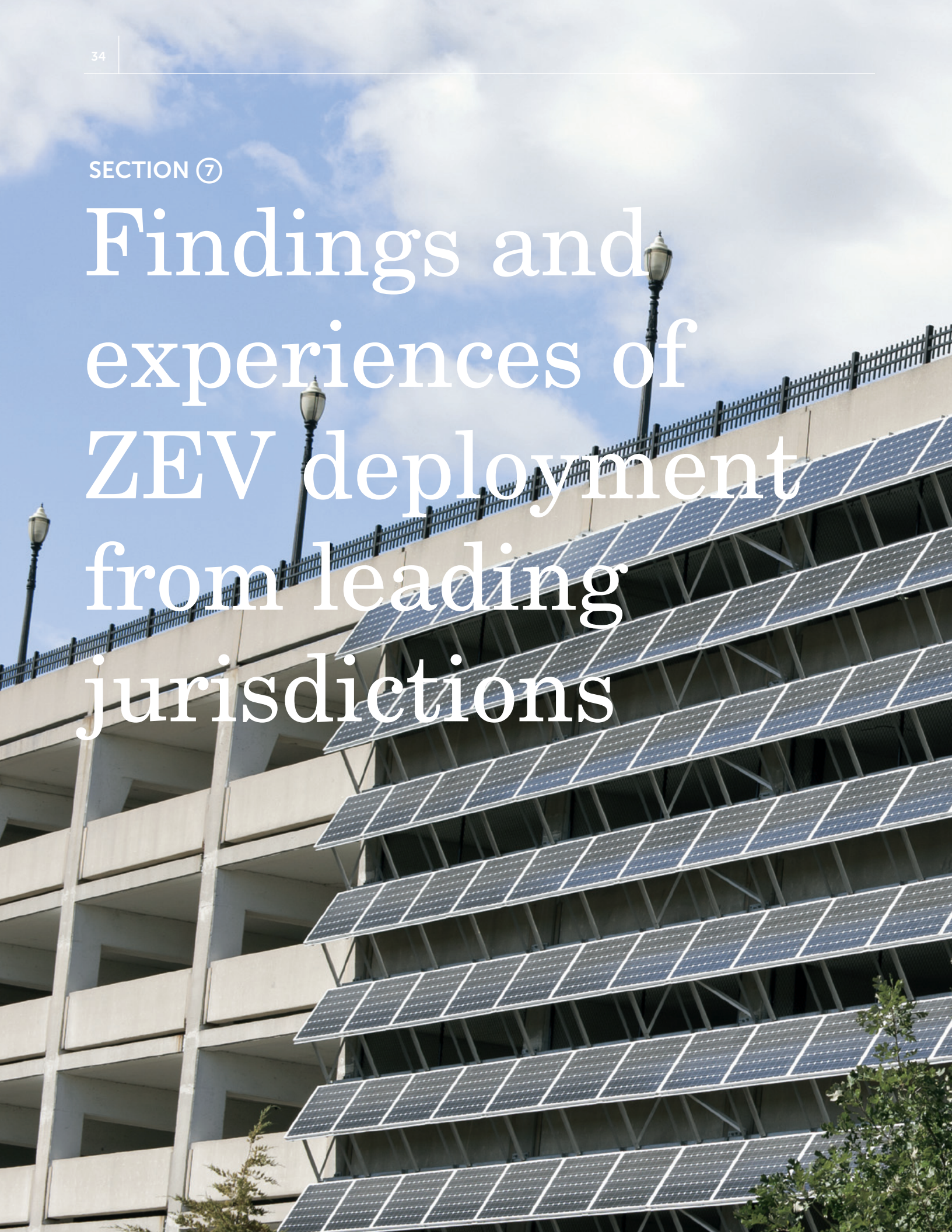
6.6 GRID READINESS

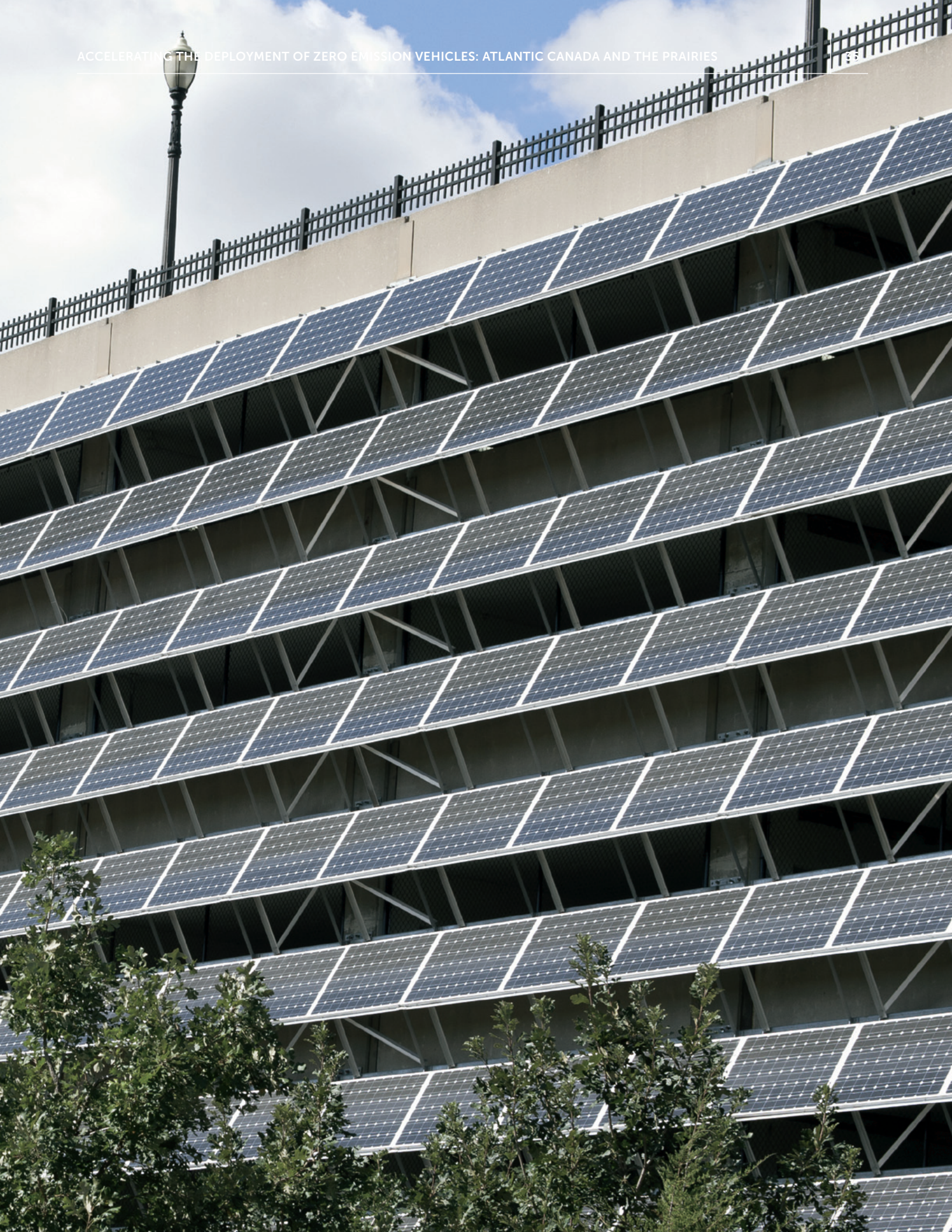
Electrical utility companies vary with respect to their level of ZEV preparedness and awareness. While they are generally aware of ZEVs and associated potential increases in demand, they are not under immediate pressure to accommodate private or public ZEV loads. This is mainly due to the current low level of ZEV uptake and in many cases, an excess of electricity generation capacity. There are some utilities however that are taking a more proactive approach to the increased loads associated with ZEVs and have carried out actions such as conducting assessments of local grid capacity, participating in ZEV-related working groups, conducting pilot and/or demonstration projects (such as integrating EVs into their fleets, installing public charging infrastructure to test its interoperability and monitor usage patterns, and testing various vehicle-to-grid technologies), providing educational materials on websites and expanding the range of products and services they offer.[39]

Most utilities have the excess capacity to accommodate ZEV charging, especially if the charging is managed in a way that defers it from on-peak hours. However, a major barrier facing utilities across the country is the lack of accessible data on ZEV ownership, specifically, the addresses of ZEV owners and the types of chargers being used. This makes it difficult for utilities to predict and monitor changes to the grid stemming from ZEV use. Most utilities are further challenged by ZEVs as they have no current way to pass on costs associated with ZEV charging and general ZEV support to their rate base and are currently forced to do so via affiliates, if they choose to become engaged in this area at all.

SECTION 7

Findings and experiences of ZEV deployment from leading jurisdictions





7. Findings and Experiences of ZEV Deployment from Leading Jurisdictions

This section highlights programs, practices and/or policies in each of the three provinces that have seen significant ZEV adoption rates: British Columbia, Ontario and Quebec. These increased adoption rates can likely be attributed to the fact that each of these provinces have implemented or are in the process of implementing a suite of actions to support ZEVs, which are discussed in this section.

7.1 INTRODUCING THE MATRIX OF ACTIONS

During the development of its approach to ZEVs, the Government of Ontario leveraged international best practices and conducted consultations to create a matrix of actions addressing the uptake of electric and hydrogen vehicles. The purpose of the matrix of actions was to create a framework of the various activities that should be considered by transportation stakeholders within the province to promote ZEV adoption. Figure 7 below shows the matrix of actions developed for Ontario, which was leveraged during the regional workshops conducted as part of this study (see Section 8.1 for further discussion).

British Columbia, Ontario and Quebec are all taking actions in different ways to encourage ZEV deployment, which are further described in the sections below.

FIGURE 7
Adapted from Matrix of Actions developed by Government of Ontario in consultation with various stakeholders for the Electric and Hydrogen Vehicle Advancement Partnership (EHVAP)

FUELING & CHARGING INFRASTRUCTURE

- Provincial public EVSE support program
- Municipalities require EV charging in parking lots
- Build out network of low-emission fueling stations
- EV-ready homes, workplaces
- Charging at government locations
- Promote the expansion of ZEV* charging/fueling infrastructure
- Partner with federal & municial governments for additional charging & fueling infrastructure funding

EDUCATION & MARKETING

- EV showcase facility
- Specialized plates including free HOV/ HOT lane access for ZEVs
- Education/Awareness campaign for business and public/consumers
- College ZEV curriculum
- ZEV campaigns and promotions
- Provide free leases to EV showcase facilities
- Improve & expand dealer/sales training
- ZEV specs, benefits and rebate information provided on websites

CONSUMER SUPPORT PROGRAMS

- ZEV purchase rebate program
- Eliminate HST at point-of-sale
- Free overnight charging
- Low-to moderate-income household vehicle scrappage program
- Finance incentives for consumers
- Partner with federal government for support & incentives
- ZEV promotion on website
- Provide info on locating chargers to customers (apps)
- Draft purchase rebate forms in advance for customers
- Help enrol buyers in charging station networks

DEALERSHIP PROGRAMS

- Establish recognition awards for excellence
- Provide detailed info on ZEV incentives, tax credits utility rebates
- Dealer incentives
- Sales staff training, including how to calculate savings, different cars and benefits of ZEVs
- Expand the network of ZEV certified dealerships
- Sales people have experience driving ZEVs
- Ensure ZEV availability
- ZEV promotional material on display in dealership
- Install charging/fuelling at dealership
- Participate in test-ride events
- Provide sales staff with ZEV training
- Recognize/reward high-performing dealerships
- Schedule customer visits at dealerships for ZEVs
- Dealer training and how-to sell ZEVs

FLEETS

- Green government fleets & vehicles
- Private fleet awareness campaign
- Zero emission school bus pilot program
- Fleet owner/manager training
- How-to guide, introducing ZEVs into your fleet

COMPLIMENTARY ACTIONS

- Co-Investments in R&D
- Low carbon commercial vehicle technology
- Municipal planning for ZEVs
- Promote innovation in ZEV technologies
- Undertake and publish research in ZEVs
- Dissemination of best practices in R&D
- Work with LDCs to send info to customers about rebates, charging stations, savings

- Government actions
- OEM actions
- Dealers & dealership actions
- Advocacy & NGO actions

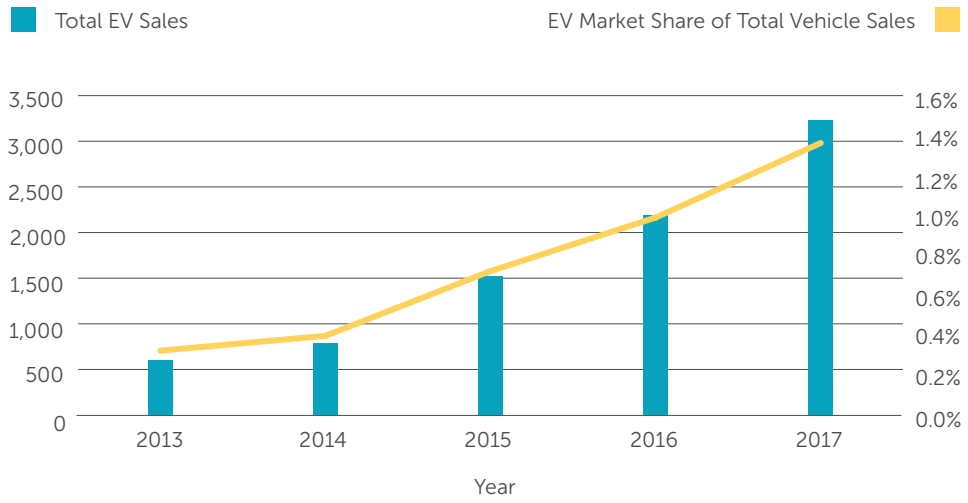
** For the purposes of this document, ZEV refers to zero emission vehicles which includes battery electric, plug-in hybrid, hydrogen and fuel cell electric vehicles.*

7.2 BRITISH COLUMBIA

From 2013 to 2017, annual ZEV sales in British Columbia have increased from an estimated 598 to 3,225, as shown in Figure 8.

FIGURE 8
Historical ZEV sales and market share for British Columbia[40]

Source: Matthew Klippenstein's Canadian EV sales[41]



British Columbia has strong ZEV policy frameworks with well-established financial and non-financial incentive programs and public charging networks.[42] These initiatives helped ZEVs capture 1.4% of total annual vehicle sales in 2017, making British Columbia the province with the second largest ZEV market share in that year.

The Government of British Columbia has introduced purchase incentives for ZEVs through its Clean Energy Vehicle Program (CEVforBC). Residents of BC can also receive incentives towards the purchase of a ZEV through the SCRAP-IT Program. These initiatives are outlined in the following sections.

SCRAP-IT Program

The SCRAP-IT Program, originally introduced in 1996 and expanded in 2015 to offer incentives for ZEVs, is a voluntary early vehicle retirement program that offers financial incentives to recycle older ICE vehicles. Initially only vehicles built before 2000 were eligible for the program but eligibility has since been changed to any model year. The program is run by a not-for-profit independent society which obtains funding from governments, private organizations, and program partners for incentives. Offered incentives include: electric bikes, cash, mobility scooters, BC Transit passes, car share credits, and new and used ZEV rebates.

In 2017, the SCRAP-IT program provided up to 500 $6,000 incentives for the purchase or lease of new ZEVs and 400 $3,000 incentives for the purchase of used ZEVs. These incentives can be combined with other ZEV incentives including those offered by the CEV Program, but the ZEVs must be on the program's list of qualifying vehicles.[43]

From 2008 to 2016, the program had received nearly $26 million in provincial and federal grants for incentives and reduced total carbon emissions by approximately 1 megatonne.[44] By November 30, 2017, the SCRAP-IT Program had processed 43,032 older, more polluting vehicles in British Columbia.

Clean Energy Vehicle (CEV) Program

The provincial government introduced the CEV Program in 2011 which is designed to encourage and accelerate the adoption of ZEVs through incentives, educating the public about clean energy vehicles, investing in infrastructure, and supporting research and training in the CEV sector.

The program offers point-of-sale incentives for applicable ZEVs of up to:[45]

- $5,000 for the purchase or lease of a BEV
- $2,500 or $5,000 for the purchase or lease of a PHEV
- $6,000 for the purchase or lease of an FCEV

The CEV Program has helped British Columbia install one of the most extensive public charging networks in Canada with 64 DC fast charge stations installed along major highways.[46] It has also funded the Emotive public outreach campaign that raises awareness about ZEVs.[47] A 2014 survey by the World Wildlife Fund found that British Columbians exhibited the highest public awareness of ZEVs in Canada and had the highest number of people who had driven a ZEV.[48]

British Columbia has committed over $71 million to the program since its inception, delivering over 4,700 new CEVs, 1,300 residential and public charging stations, 10 research and academic curriculum projects, funding for electrician training, Emotive outreach programming and a new hydrogen fueling station.[49]

Other Practices/Programs of Interest

In British Columbia, ZEVs are able to access high occupancy vehicle (HOV) lanes regardless of the number of passengers in the vehicle.

The Fleet Champions Program can provide ZEV business case analysis, site assessments and infrastructure incentives for charging stations (up to $2,000 per station) to eligible organizations that own fleets in British Columbia.[50]

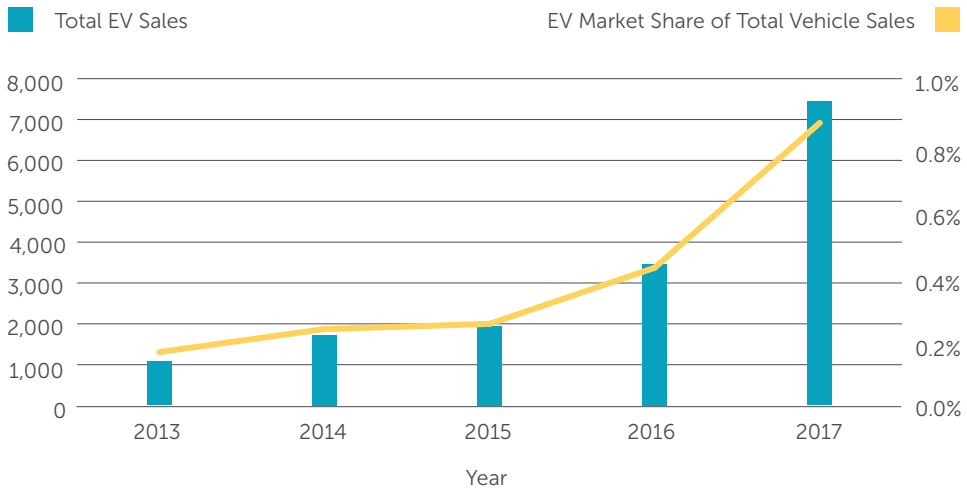
West Coast Electric Fleets recognizes fleet partners from British Columbia, California, Oregon, and Washington State. Partners pledge to contribute to the goal of expanding the use of ZEVs by sharing challenges, needs, lessons, and resources.[51]

7.3 ONTARIO

From 2013 to 2017, Ontario saw an increase in annual ZEV sales from 1,078 to 7,442 per year, as seen in Figure 9.

FIGURE 9
Historical ZEV sales and market share for Ontario

Source: Matthew Klippenstein's Canadian EV sales[52]



The Government of Ontario has developed several programs to remove known ZEV deployment barriers including purchase prices (EVIP) and charging infrastructure costs and availability (EVCIP and EVCO), as well as barriers related educational awareness, OEM challenges, and total ZEV sales (EHVAP). These programs are described in the following sections.

Electric Vehicle Incentive Program (EVIP)

In 2010, the Ontario government introduced the Electric Vehicle Incentive Program (EVIP) to support the adoption of ZEVs. The total financial incentives for a ZEV under the EVIP program are based on several factors including:

- Battery capacity (5 to 16 kWh; eligible incentive = $6,000 to $10,000)
- Number of seats (5 or more seats eligible for additional $1,000)
- The type of ZEV (ZEVs with MSRPs between $75,000 and $150,000 receive maximum incentive of $3,000)
- Lease term (12 month lease = 33% of incentive, 24 month lease = 66% of incentive, 36 month lease (or greater) = full incentive)

To qualify for the EVIP the vehicle must be on the Eligible Vehicles List which is published by the Ontario Ministry of Transportation.[53]

Electric Vehicle Charging Incentive Program (EVCIP)

The Ontario Government is further incentivizing ZEV adoption by providing financial support for the installation of L2 charging infrastructure at homes and businesses. The total maximum incentive provided by the EVCIP is $1,000, of which $500 can be used to cover up to 50% of the purchase/hardware costs and $500 can be used to cover up to 50% of the installation costs.

Electric Vehicle Chargers Ontario (EVCO)

To expand public ZEV charging infrastructure the Government of Ontario created the Electric Vehicle Chargers Ontario (EVCO) grant program. Upon completion, the $20M program will support the installation of approximately 500 charging stations (approximately 200 L3 'DC fast-chargers' and approximately 300 L2) across Ontario at approximately 250 locations including restaurants, businesses, airports, municipal properties and highway rest stops.

Electric and Hydrogen Vehicle Advancement Partnership (EHVAP)

In February 2017, the Ontario government introduced the Electric and Hydrogen Vehicle Advancement Partnership (EHVAP). EHVAP is a voluntary low-emission vehicle (LEV) advancement program to work towards achieving the government's objective of 5% of new passenger car sales or leases in Ontario being electric and hydrogen vehicles by 2020. The partnership seeks to engage all types of partners including automakers, dealerships, dealer organizations, utilities, advocacy organizations and government to support the uptake of low emission vehicles.

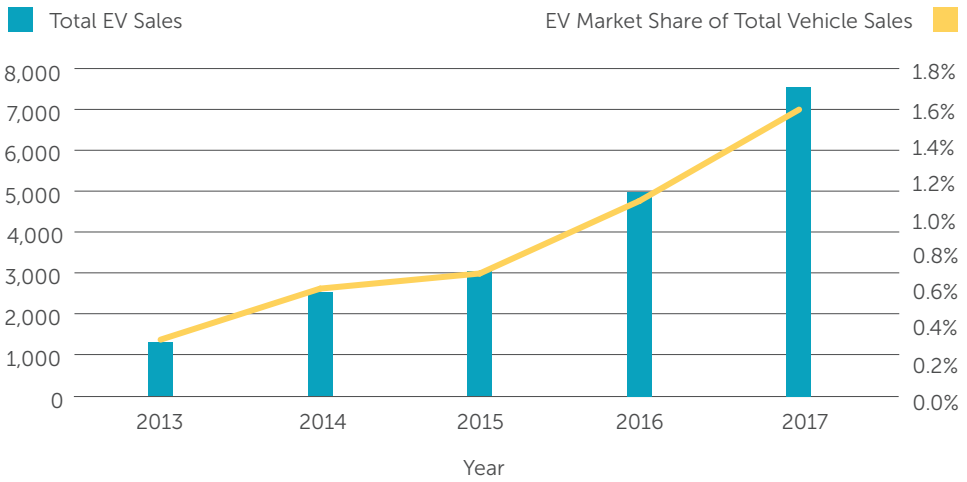
All partners have submitted a four-year ZEV advancement plan, which includes descriptions of their ongoing and intended actions (such as advertising, dealer training, incentives, public education campaigns and marketing) to advance the uptake of LEVs in Ontario and reach the 5% by 2020 target. EHVAP is one of a suite of low-carbon economy programs outlined in Ontario's Climate Change Action Plan (2016) and is supported by proceeds from its carbon cap-and-trade market.

7.4 QUEBEC

Annual ZEV sales in Quebec have grown from 1,311 in 2013 to 7,548 in 2017 as shown in Figure 10.

FIGURE 10
Historical ZEV sales and market share for Quebec

Source: Matthew Klippenstein's Canadian EV sales[54]



It's likely that this increase in sales is largely attributable to the province's commitment to electrifying transportation. The province offers ZEV consumers several purchase incentives, has developed a Transportation Electrification Master Plan and most recently, introduced the ZEV Standard.[55] Further, charging in the province is supported by the Electric Circuit, the first and largest public charging network for electric vehicles in Quebec and Eastern Ontario. These elements are discussed in the following sections.

Transportation Electrification Action Plan

Since 2011, Quebec has been actively moving towards electrifying transportation. In 2015, the Quebec government released its Transportation Electrification Action Plan 2015-2020. The Action Plan states that by 2020, Quebec will be '*a leader in the use of electric-powered means of transportation and a forerunner in the realm of sustainable mobility*'.[56] The Plan outlines 35 initiatives under three major themes: Encourage Electric Transportation, Build an Industrial Base, and Create the Right Environment.

The Plan also has specific objectives and targets, including increasing the number of electric and plug-in hybrid vehicles registered in Quebec to 100,000 by 2020. The plan also states that this interim target is a step towards the even higher target of 300,000 electric vehicles by 2026. Recognizing that these targets are ambitious, the government stated the need for a collaborative approach and structuring of initiatives to increase the number of ZEVs in the province.[57]

Purchase Incentives

The Government of Quebec currently offers three types of incentives to increase the uptake of ZEVs: purchase or lease rebates, a used vehicle pilot project rebate, and a charging station rebate.

The Quebec government offers individuals, businesses, organizations and municipalities purchase incentives of up to $8,000 for the purchase or lease of a new ZEV. Rebate amounts vary by vehicle type and MSRP. For example, BEVs with an MSRP less than $75,000 are eligible for a rebate of up to $8,000; and BEVs with an MSRP between $75,000 and $125,000 are eligible for a rebate of up to $3,000. Rebates are offered for PHEVs with an MSRP less than $75,000 and are calculated according to a vehicle's electric battery capacity.[58]

To promote the uptake of used ZEVs, the Government of Quebec has established a Used Vehicle Pilot Project which offers up to $4,000 for the purchase or lease of an eligible used BEV. Through this Project, some progressive dealerships have imported used ZEVs from the U.S. and are thus increasing the supply of ZEVs to the province.

The Quebec government also offers a charging station rebate. Financial assistance is provided to individuals for the purchase and installation of a 240-volt (L2) home charging station. Grants of up to $600 are available under this program ($350 for the purchase of an eligible charging station and $250 for the installation of the charging station and associated power supply infrastructure).[59]

ZEV Standard

On October 26, 2016, Quebec adopted *An Act to increase the number of zero-emission motor vehicles in Quebec in order to reduce greenhouse gas and other pollutant emissions* (ZEV Act).[60] Under this Act, Quebec has created the ZEV Standard, which came into effect January 11, 2018.

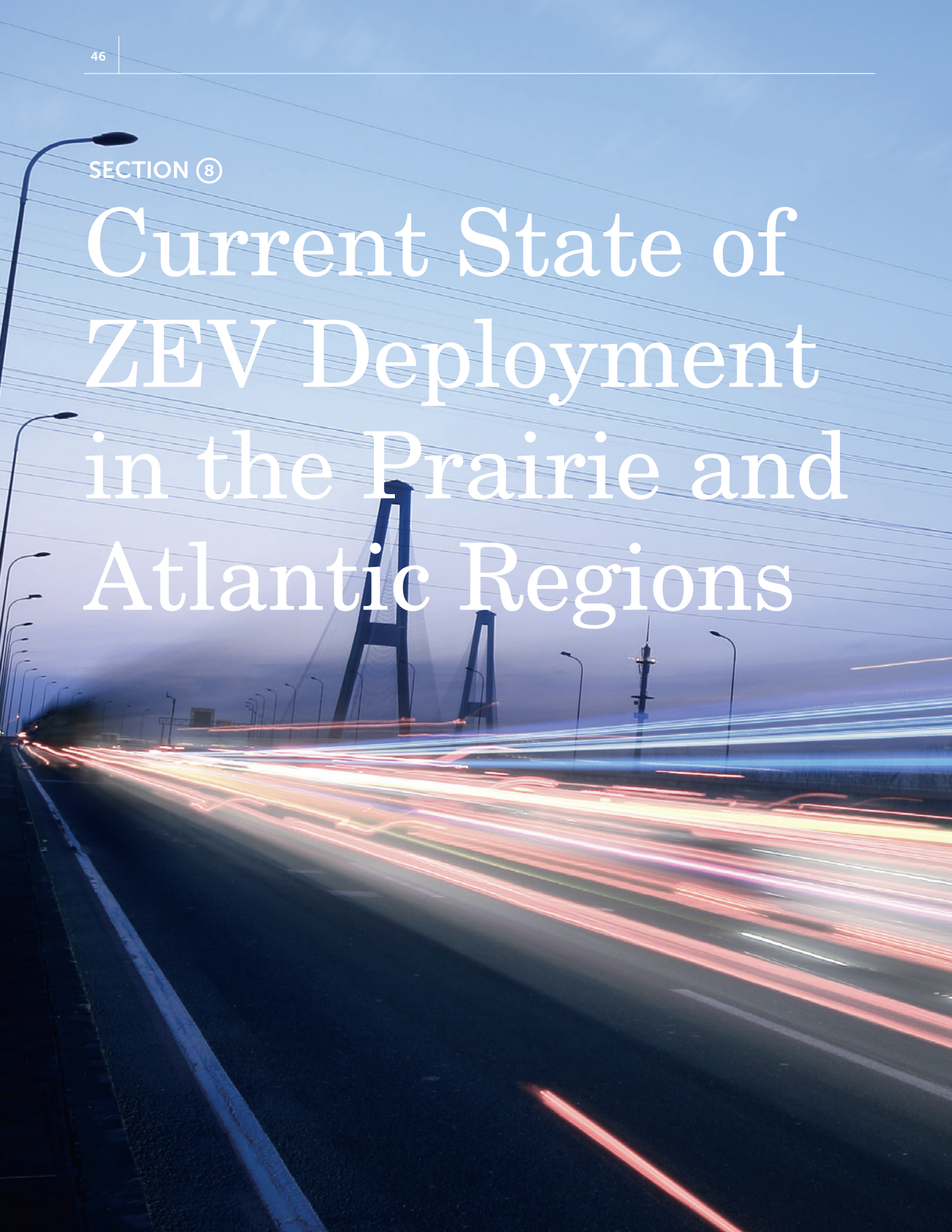
The ZEV standard is intended to increase the supply of zero- and low-emission vehicles so that Quebec consumers have access to a larger number and broader range of low-carbon motor vehicles.[61] The ZEV standard applies to intermediate and large volume motor vehicle manufacturers. Small vehicle manufacturers (< 4,500 vehicle sales annually) may participate voluntarily.

Under the Standard, manufacturers are required to earn credits through the sale and/or lease of ZEVs. Credits required are calculated for each manufacturer based on the total number of new cars sold or leased in Quebec.[62] Credits are related to the electric range of the vehicle: the greater the electric range of the vehicle, the greater the number of credits the automaker earns.

Automakers can also buy and sell credits. Smaller automakers not subject to the Standard, as well as those who are most competitive (i.e. generate more credits than required) can sell their surplus credits to other automakers or bank them for future needs. Automakers that are unable to meet their credit targets can purchase credits to avoid paying the royalties stipulated by the regulation. Income generated will be paid to a Green Fund, which will support the development of climate change projects, specifically those which are aimed at greening the province's vehicle fleet.[63] The amount of credits required from each vehicle manufacturer gradually increases over time.

Other practices/programs of interest

Hydro-Quebec has also invested in advancing ZEV use in the province. Starting in 2012, Hydro-Quebec implemented the Electric Circuit, a network of public charging stations. It's a public/private partnership model wherein Hydro-Quebec '*coordinates the deployment and promotion of 240-volt stations in the network, and partners assume the costs and purchase of installation*.'[64] There is also a business model to advance the deployment of 400-volt stations. Hydro-Quebec will provide 50% of the purchase and installation costs of a station (up to a maximum) and the remainder of the cost is assumed by the partner. Revenue is shared proportionately, based on the investment of each party. The initiative aims to have 2,500 public charging stations in service by December 31, 2020 and provide support for new municipal charging sites.



SECTION 8

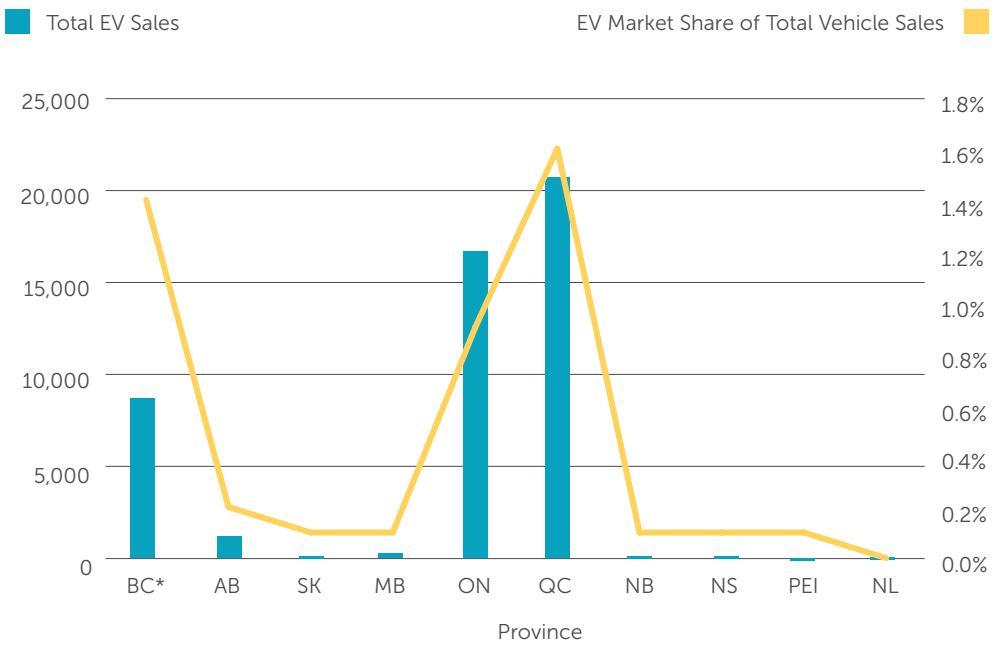
Current State of ZEV Deployment in the Prairie and Atlantic Regions

8. Current State of ZEV deployment in the Prairie and Atlantic Regions

The Prairie and Atlantic Regions of Canada have seen much lower ZEV adoption rates when compared to the leading provinces of Ontario, Quebec and British Columbia (Figure 11). The figure below shows total cumulative ZEV sales and ZEV market share for each province (through October 2017).

FIGURE 11
Total ZEV Sales and Market Share (through year-end, 2017). *BC sales include territories.

Source: FleetCarma, Electric Vehicle Sales in Canada, 2017 [65]



Total ZEV sales in each of the Prairie and Atlantic Provinces was well below those in the leading jurisdictions. Alberta had the highest number of ZEV sales at just over 1,000, representing approximately 0.15% of the market share. All other Prairie and Atlantic Provinces had cumulative ZEV sales well below 1,000 and ZEV sales representing less than 0.1% of the market share. There is a clear difference in ZEV uptake in the 'leading' jurisdictions versus other Canadian jurisdictions. The remainder of this section outlines current policies and other initiatives in the Prairie and Atlantic regions of relevance to ZEV adoption.

8.1 PRAIRIE PROVINCES

Alberta is leading the Prairie provinces in terms of ZEV sales, as seen in the Table 3 below. No Prairie provinces have addressed ZEVs directly in provincial policies and/or plans. Through its Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative (EVAFDI), Natural Resources Canada is funding the installation of three public L3 chargers in Alberta and one in Manitoba, which are being deployed at major retail centres.[66]

TABLE 3
Overview of ZEV uptake in the Prairies

	ALBERTA	SASKATCHEWAN	MANITOBA
Cumulative ZEV Sales (as of year-end, 2017)[67]	1,189	113	234
Are ZEVs Addressed in Provincial Policies/ Plans?	Not directly, however City of Calgary and City of Edmonton are both developing ZEV Strategies.	Not directly.	No direct actions or strategies for ZEVs. However electrification is noted as one of the greatest opportunities for reducing transportation emissions.
Current Charging Infrastructure[68]	City of Calgary: 40 public charging stations (all L2) City is working with regional partnerships across southern Alberta to install a network of 15 to 20 fast charging stations.[69] City of Edmonton: 29 public charging stations (9 are L3; 20 are L2). Total # of communities with public charging infrastructure: 46 ATCO Ltd. and FLO building charging stations in Calgary, Red Deer and east of Edmonton.[70]	City of Saskatoon: 13 public charging stations (all L2). City of Regina: 10 public charging stations (all L2). Total # of communities with public charging infrastructure: 18	City of Winnipeg: 27 public charging stations (25 are L2; 2 are L3). Total # of communities with public charging infrastructure: 10 July 2017 announcement: FAST Charge (L3) stations to be installed at 34 locations along the Trans-Canada Highway roadway connecting ON and MB.[71]

8.1.1 Alberta

Introduced by the Government of Alberta in 2015, the Climate Leadership Plan is a provincial strategy for reducing GHG emissions while diversifying the economy. The Plan does not identify the transportation sector as a key priority area for emissions reduction opportunities, rather it focuses on Alberta's high emitting sectors, namely oil and gas and electricity. The City of Calgary and the City of Edmonton are both developing ZEV strategies on their own.

City of Calgary Strategy

The City of Calgary is developing a ZEV Strategy as part of its Climate Program.[72] Objectives of this strategy are to:

- respond to the growing demand for EV infrastructure and services,
- encourage/support faster adoption of EVs to aid in reducing GHG emissions,
- build partnerships across Alberta to provide an EV charging network within the province that connects to other provinces or states,
- establish what role the City, partner organizations and the private sector should play in providing EV infrastructure and services, and
- increase awareness and create enthusiasm amongst the public and industry about EVs.[73]

City of Edmonton Strategy

The City of Edmonton is currently developing a ZEV Strategy that will help make it easier for people to own an EV.[74] The Strategy is an important part of Edmonton's Community Energy Transition and is currently being drafted. It will be presented to Council later in 2018.[75]

ZEV Infrastructure in Alberta

The City of Calgary has approximately 70 L2 publicly accessible charging points.[76] The City of Edmonton has approximately 29 public charging stations (nine of the stations are L3).[77] The Town of Canmore has seven public charging stations (3 are L2; 4 are L3).[78] Forty-three other communities have public charging stations in Alberta.

Calgary-based power producer ATCO Ltd., together with FLO, is building a charging station in each of Calgary, Red Deer and east of Edmonton. Each location will be powered by ATCOenergy and equipped with an L3 fast-charging station and a dual L2 charging station. This initiative is made possible by a partnership with Canadian Tire Corporation and Natural Resources Canada.[79]

The City of Calgary is also working with regional partnerships across southern Alberta to initiate a network of 15 to 20 L3 DC Fast Charging Stations. The infrastructure will complement the Tesla Supercharger stations that are being installed in Alberta and will facilitate ZEV travel across Southern Alberta, as well as into British Columbia and the United States. Exact locations of the proposed stations have not yet been finalized.

Other Initiatives/Notes of Interest

Electric Vehicle Association of Alberta (EVAA) (founded in 2014) works to spread awareness and promote ZEV adoption in Alberta.[80] In 2017, information and ZEV test drive events were held in Calgary and Edmonton as part of the National Drive Electric Week Event.

8.1.2 Saskatchewan

In December 2017, the Government of Saskatchewan released its climate change strategy, *Prairie Resilience: A Made-in-Saskatchewan Climate Change Strategy*. Transportation and Related Infrastructure is included but no direct mention of ZEVs is made (although one of the actions listed is "Evaluate government fleet vehicles for lower-carbon technology opportunities"[81]). The Strategy is being refined via stakeholder consultation, beginning early 2018.[82]

ZEV Infrastructure in Saskatchewan

The City of Saskatoon has 13 public charging ports (L2)[83] and the City of Regina has 10 public charging ports (L2).[84] There are 16 other communities in Saskatchewan that have public charging stations.

Sun Country Highway is installing stations by partnering with sponsoring organizations. Sun Country Highway arranges for the placement and installation of the chargers. A number of Regina businesses have participated and have sponsored a station. Stations installed under this program are located at Best Western Seven Oaks Inn, Delta Regina, and Peavey Mart Regina.[85]

8.1.3 Manitoba

The Government of Manitoba released their Climate and Green Plan in 2017. The Plan has four pillars: climate, jobs, water, and nature. While the plan does not have any direct targets or strategies related to ZEVs, it does state that "*Manitoba is an ideal place for the adoption of electric vehicles that plug-in to the electricity grid and obtain energy for motive operation. Because of our cold climate we already have more than 500,000 existing plug points at home and at work, and everyone is already accustomed to plugging in.*"[86]

ZEV Infrastructure in Manitoba

In the City of Winnipeg there are 27 public charging stations (25 are L2; 2 are L3).[87] Nine other communities in Manitoba have public charging stations.

In July 2017, it was announced that 34 FAST Charge (L3) stations will be installed along the Trans-Canada Highway roadway connecting Ontario and Manitoba– a total distance of approximately 3,000 kilometers with the stations spaced approximately 100 kilometers apart, making long trips in a ZEV much more feasible.[88]

Other Initiatives/Notes of Interest

Founded in 2010, Manitoba EV Association (MEVA) hosts the annual MEVAfest to increase public awareness of ZEVs.[89] MEVA public awareness efforts also include monthly meetings at the University of Manitoba for ZEV enthusiasts, information on ZEVs and event attendance to promote ZEVs.

8.2 ATLANTIC PROVINCES

While every province in Atlantic Canada has specifically addressed ZEVs in provincial policies and/or plans, ZEV uptake is relatively low, as seen in Table 4 below. In addition to the existing charging infrastructure listed below, Natural Resources Canada is funding the installation of 20 L3 chargers in New Brunswick (19 along major highway corridors and one at a retail centre) and 12 in Nova Scotia (along major highway corridors).[90]

TABLE 4
Overview of ZEV uptake in the Atlantic Region

	NEWFOUNDLAND AND LABRADOR	PRINCE EDWARD ISLAND	NOVA SCOTIA	NEW BRUNSWICK
Cumulative ZEV Sales (as of year-end, 2017)[91]	31	16	133	126
Are ZEVs Addressed in Provincial Policies/Plans?	Yes *Charting Our Course: Climate Change Action Plan (2011)*	Yes *Draft Recommendations for the Development of a Climate Change Mitigation Strategy (released in 2016)*[92] *Provincial Energy Strategy (2016/17)*[93]	Yes *Choose how you move: Sustainable Transportation Strategy (2013)*	Yes—specific targets for # of ZEVs (2,500 ZEVs by 2020; 20,000 by 2030) *Transitioning to a Low-Carbon Economy: New Brunswick's Climate Change Action Plan (2016)*
Current Charging Infrastructure[94]	City of St. John's: 34 public charging stations (all L2) City of Mount Pearl: 36 public charging stations (all L2) Total # of communities with public charging infrastructure: 8	City of Charlottetown: 7 public charging stations (all L2) City of Summerside: 15 (all L2) Total # of communities with public charging infrastructure: 12	City of Halifax: 10 public charging stations (9 are L2; 1 is L3) Total # of communities with public charging infrastructure: 32	City of Fredericton: 13 public charging stations (12 are L2; 1 is L3) City of Moncton: 19 public charging stations (17 are L2; 2 are L3) Total # of communities with public charging infrastructure: 37 NB Power's eCharge Network[95] includes a fast-charging corridor along the Trans-Canada Highway and a series of L2 chargers located at participating municipalities and businesses throughout the province (15 locations)[96]

8.2.1 Nova Scotia

Toward a Greener Future: Nova Scotia's Climate Change Action Plan (2009), has two main goals: reducing the province's contribution to climate change by reducing GHG emissions and preparing for changes to climate that are already inevitable.[97]

The Province's *Choose How You Move: Sustainable Transportation Strategy (2013)*[98] outlines the government's approach to sustainable transportation and commits to 28 sustainable transportation actions, with several focusing on ZEVs, specifically:

- **ACTION #23**: The province will help fund innovative projects to encourage the use of electric vehicles through a $100,000 grant to Efficiency Nova Scotia Corporation.
- **ACTION #24**: The province will research options for public recharging infrastructure and off-peak charging for electric vehicles, and conduct an assessment of the viability of integrating electric vehicles into the electricity grid

The 2013 Sustainable Transportation Strategy has resulted in investments of $3.7 million in projects to improve active transportation infrastructure, community transit services, data collection and monitoring, and EV integration.[99]

ZEV Infrastructure in Nova Scotia

There are currently over 100 public charging stations across Nova Scotia, two of which are ZEV fast chargers (Truro Power Centre and Barrington Street Superstore, Halifax).[100] The City of Halifax has 11 public charging station ports, 10 are L2 and one is L3.[101] Thirty-one other communities in Nova Scotia have public charging stations.

On Aug 2, 2017 Nova Scotia Power issued a public Request for Proposals (RFP) seeking a location partner and installation contractor to install 12 EV fast charging (L3) stations across the province, as part of a pilot project to study the impact of the network on the electrical system, as well as usage levels. NS Power stated that the network removes a key barrier for Nova Scotians, which is adequate charging infrastructure.[102] NS Power presented a rate-based approach, that was rejected by the province's energy regulator on January 4th, 2018, citing that this approach was not in the best interest of the ratepayers. However, NS Power still went ahead with its plan to build 12 EV fast charging stations.[103]

Other Initiatives/Notes of Interest

NS Power has a web page on ZEVs, which provides general information on models, charging, costs and GHG savings, and NS Power's role in promoting ZEVs.[104] NS Power also partnered with Plug'n Drive to produce a booklet on ZEVs in Nova Scotia and has also engaged key stakeholders through the creation of the Nova Scotia chapter of Electric Mobility Canada.

NS Power's ShareReady program aimed to raise corporate and public awareness of ZEVs and in three years, ShareReady partners:

- Drove over 250,000 km in Nissan LEAF vehicles
- Average vehicle drove 25,000 km
- Highest-use vehicle traveled 46,000 km
- More than 300 people got behind the wheel of a ZEV

The ShareReady program was a tool for organizations to test ZEVs in their fleets, but the benefits of the program lie in the additional interest and activity that it has generated in ZEVs, acting as a stepping stone for future developments in the sector.

8.2.2 New Brunswick

New Brunswick has developed a Climate Change Action Plan, *Transitioning to a Low-Carbon Economy: New Brunswick's Climate Change Action Plan (2016)* which outlines specific GHG reduction targets for the 2030 and 2050 timeframes. Total emissions are set to be reduced to 10.7 Mt by 2030 (35% below 1990 emissions levels) and 5 Mt by 2050 (80% below 2001 levels).

The Plan addresses ZEVs directly, indicating that the Provincial government will "*work to have 2,500 electric vehicles on the road in New Brunswick by 2020 and 20,000 by 2030*" as well as "*implement an electric vehicle strategy that specifies the required incentives, regulations, policies, programs and charging infrastructure to achieve the above-mentioned targets for electric vehicles*".[105]

ZEV Infrastructure in New Brunswick

The City of Fredericton has 13 public charging stations (12 are L2; 1 is L3)[106] and the City of Moncton has 19 public charging stations (17 are L2; 2 are L3).[107] Thirty-five other communities have public charging stations.

There are 9 NB Power-branded charging stations across the province.[108] NB Power is adding 10 L3 stations along the Trans-Canada Highway, from Edmundston to Aulac. It is aiming to have all 10 in operation by July, 2018.

The Province is supported by NB Power, who is committed to expanding ZEV charging access throughout NB and operates the eCharge Network. NB Power has installed seven public smart chargers in major centres around New Brunswick.[109] The eCharge Network is compatible with Quebec's Electric Circuit and the FLO charging networks and allows ZEV drivers to travel throughout New Brunswick.

8.2.3 Prince Edward Island

The Government of Prince Edward Island developed a 10-year strategy to "reduce energy use, establish cleaner and locally produced energy sources and moderate future energy price increases."[110] The *Provincial Energy Strategy 2016/17* has four major pillars:

- Energy efficiency and conservation
- Power generation and management
- Biomass and heating
- Transportation

The Plan indicates that "*a provincial transportation committee will be established. It will be given the mandate and resources to examine and implement energy saving policies. These could include incentives for the purchase of electric vehicles, installation of public charging infrastructure…*".[111] The Plan includes a section on ZEVs and indicates that the small size of the Island aligns well with the current technology, indicating that range anxiety is less of an issue. It also states the government's willingness to cooperate with electric utilities to implement smart grids, as well as consider ways to allow electricity to be sold by other entities or allow utilities to become involved in charging infrastructure (and therefore charge for electricity being used). The Plan also indicates that the government will leverage funding options to support appropriate charging infrastructure as well as consider mandating new homes be pre-wired for EV charging.

ZEV Infrastructure

The City of Charlottetown has 7 public charging stations (all L2)[112] and the City of Summerside has 15 public charging stations (all L2).[113] Ten other communities in PEI have public charging stations.

PEI's Department of Transportation, Infrastructure and Energy is seeking funding for six high speed chargers, to be spread across the province.[114]

Other Initiatives/Notes of Interest

In 2017, efficiencyPEI organized a ZEV Tour which included five loops covering Eastern, Western and Central PEI. It demonstrated a PHEV and provided information about ZEVs, including points on cost-saving rebates and energy efficiency.[115]

8.2.4 Newfoundland and Labrador

In 2011, the Government of Newfoundland and Labrador published its Climate Change Action Plan, *Charting Our Course: Climate Change Action Plan 2011* which reaffirmed the commitment to reduce GHG emissions 10% below 1990 levels by 2020, and 75-85% below 2001 levels by 2050[116]. The Province's Greening Government Action Plan outlines several goals under the following objectives:

- Procurement
- Waste Diversion
- Buildings
- Transportation
- Employee Engagement[117]

To reduce GHGs in the transportation sector, the Province committed to "*examine the state of technology, infrastructure requirements and market developments for electric vehicles (EVs).*"[118] Research carried out is presented in its 2015 report "An Examination of Electric Vehicle Technology, Infrastructure Requirements and Market Developments".[119]

ZEV Infrastructure

The City of St. John's has 34 public charging stations (all L2)[120] and the City of Mount Pearl has 36 public charging stations (all L2).[121] There are six other communities that have public charging infrastructure.

There has also been grant funding provided through the Newfoundland and Labrador Green Fund for the supply and installation of five residential and 14 commercial ZEV charging stations.

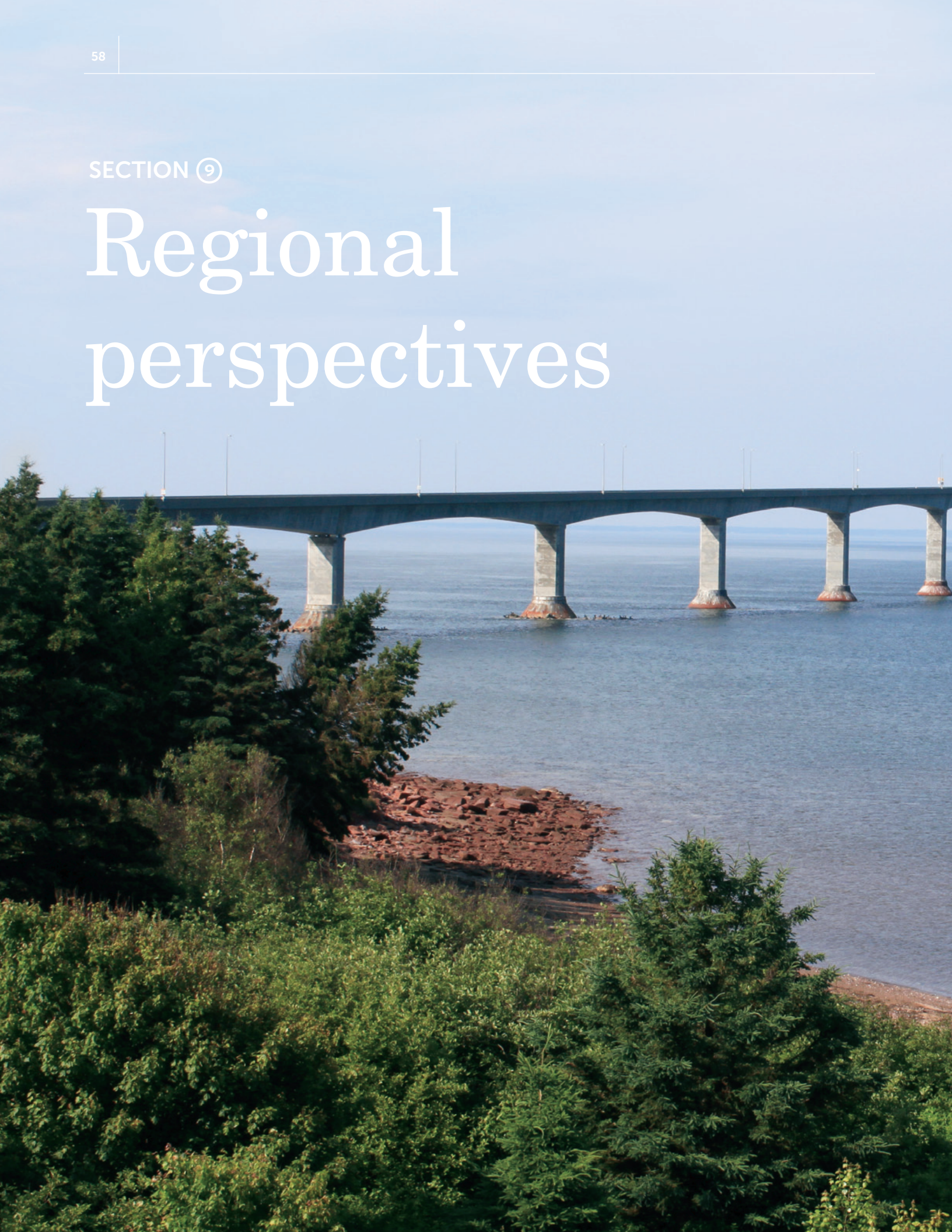
Other Initiatives/Notes of Interest

While the Government of Newfoundland and Labrador does not currently offer financial or non-financial incentives for the purchase of ZEVs or ZEV infrastructure, the Newfoundland and Labrador Credit Union offers a rebate of 2.5 to 3% when obtaining a loan for the purchase of a ZEV (up to $1,500).[122]

The government has recently launched a Vehicle Efficiency and Cost Calculator, which allows consumers to estimate the purchase and operating costs and GHG emissions associated with various vehicle types, including ZEVs.[123]

SECTION 9

Regional perspectives



9. Regional perspectives on barriers and opportunities to accelerate deployment of ZEVs in the Prairies and Atlantic Canada Region

There is a stark difference in ZEV uptake of leading jurisdictions when compared to the Prairies and Atlantic Canada. Many barriers to ZEV adoption are common across all Canadian jurisdictions, as discussed in Section 6 of this report. This study focused on gathering regional perspectives on several of these common barriers to capture the individuality of the Prairie and Atlantic Canadian provinces.

The information presented in this section is largely informed from interviews, workshops and the webinar carried out with regional experts in the ZEV landscape. These interviews, workshops and webinar allowed the research team to test and refine common barriers and best practices and understand regional perspectives on barriers and opportunities to accelerating ZEV deployment. Interviews were carried out in December 2017 and January 2018 with stakeholders from Atlantic Canada and the Prairies to inform workshop discussions.

Workshops were held in Fredericton, NB and Calgary, AB on January 23, 2018 and January 25, 2018, respectively. Workshops were four hours long and included an introduction to the project and a briefing on best practices in leading jurisdictions, followed by three break-out sessions. The first break-out session discussed regional and provincial perspectives on the matrix of actions developed in Ontario; the second break-out session aimed to identify regional barriers; and the third break-out session aimed to identify regional opportunities and prioritize near term opportunities. The workshops also had a brief full-group discussion on the ZEV outlook for heavy duty vehicles and their impacts on the transportation sector. An additional webinar was held after the workshops for Atlantic Canada stakeholders who were unable to participate in the workshop due to poor weather conditions in Fredericton.

Interview, workshop and webinar participants spanned representatives from provincial and municipal government, academia, not-for-profit organizations, utilities and the private sector, including automakers, dealers, EVSE providers and property developers.

The remainder of this section outlines the results of the workshop for each region as well as province specific information gleaned from the interviews.

9.1 MATRIX OF ACTIONS

The regional workshops carried out in Fredericton and Calgary leveraged the matrix of actions developed by the Government of Ontario (discussed in more detail in Section 7.1). Stakeholders from both the Atlantic and Prairie regions were in general agreement that a range of considerations such as those identified in the matrix of actions need to be addressed to accelerate ZEV adoption. It was further agreed that a suite of coordinated actions across relevant sectors, each led by the most relevant stakeholders, would be more effective than a series of stand-alone measures. Stakeholders agreed that actions are needed on multiple fronts and that the matrix articulated many of these key considerations/issues. However, through engagement via interviews and the two regional workshops, slight deviations that reflect regional differences and realities were noted and are further described below.

Additions to the Stakeholder Legends

- Insurance companies, utilities and local developers were identified as key stakeholders to ZEV advancement in both regions, and, therefore, should be included in the matrix of actions. Insurance companies can offer discounted products and services to incent ZEV adoption. Utilities can provide and facilitate the installation of charging infrastructure, education and outreach, and mechanisms for implementing time of use pricing. Local developers can make new and renovated buildings and homes ZEV-ready.

The Education and Marketing pillar

- The concept of a ZEV showcase facility where potential ZEV consumers could learn about ZEVs, understand how they could fit their lifestyle, and test drive models did not resonate as much with stakeholders from the Prairies and Atlantic Canada. Outside of major urban centres a fixed location might not have the same reach. Stakeholders suggested that a mobile "ZEV showcase" could be more effective to bring ZEVs to a wider cross-section of provincial populations. It was noted that there are groups within provinces who do similar ZEV showcase events (e.g., the Manitoba EV Association and New Brunswick Power have brought together ZEV enthusiasts for events to promote ZEV awareness).
- The specialized licence plates for ZEVs that facilitate access to high occupancy vehicle (HOV) lanes similarly did not resonate with stakeholders from the Prairies and Atlantic Canada. This was due to the fact that HOV lanes are very uncommon in these provinces. Stakeholders did offer some modifications to this action that might reflect regional benefits, for example: free access to national/provincial parks, free/discounted vehicle registration/renewal, or free/discounted parking in larger urban centres (e.g., Calgary or Edmonton).

The Consumer Support Programs pillar

- It was noted that people in Atlantic Canada often perform maintenance and repairs on their own vehicles, and thus have a familiarity with ICEVs that could pose a barrier to ZEV adoption unless actions are taken to enhance consumer familiarity with ZEVs.

The Fleets pillar

- Stakeholders from Atlantic Canada saw an opportunity to increase incentives for fleets as early adopters for increased visibility and utility of ZEVs to promote awareness and education.
- Stakeholders from Atlantic Canada saw an opportunity to engage rental car companies in ZEV adoption initiatives as a way of increasing ZEV awareness and education amongst the general public. Rental ZEVs would provide people with an opportunity for an extended "test drive" to see how a ZEV might fit their lifestyle.
- Stakeholders from both regions acknowledged that having electric bus pilots, including transit and municipal buses (as opposed to limiting the pilots to school buses), would provide a great opportunity for action to increase awareness and reduce transportation emissions.

9.2 ATLANTIC CANADA—BARRIERS AND OPPORTUNITIES

What we heard—Barriers

Interview and workshop outcomes converged on many of the same common barriers that are discussed in Section 6. For convenience, the common barriers discussed in Section 6 include cost, technological uncertainty (i.e. charge time, range, etc.), lack of charging infrastructure, lack of public awareness and education, and ZEV availability. Due to the fundamental importance of grid readiness, this issue is addressed separately below. Key barriers identified in the Atlantic Region include:

- Lack of financial incentives and high cost of purchase
- Lack of consumer and policy-maker awareness and education about ZEVs and their benefits
- Lack of public charging infrastructure
- Lack of ZEV availability in dealerships
- Lack of available models (e.g., pickup trucks) to meet required vehicle performance specifications for large consumer demographics
- Lack of access to maintenance and repair
- Higher future ZEV deployment would displace revenue from gasoline sales tax used for road infrastructure
- Displaced revenue for dealerships from service and repairs for ZEVs.

The list of barriers above represents key barriers identified via workshop activities and are representative of the Atlantic Region as a whole. Table 5 below captures the barriers and/or challenges identified by individual provinces during interviews and/or the regional workshop and are presented here for completeness. In some instances, the barriers and/or challenges reflect unique nuances to the common barriers captured above. In some instances, barriers presented in the table below may also mimic those presented above.

TABLE 5
Atlantic Provincial Barriers

NEWFOUNDLAND AND LABRADOR	PRINCE EDWARD ISLAND	NOVA SCOTIA	NEW BRUNSWICK
Budget constraints for incentives and infrastructure programs Limited ZEV supply High near-term electricity prices Geography (rural province, rough terrain, and cold climates) Lack of public charging infrastructure and consumer confidence in charging station accessibility No incentive/ pressing need for utilities to rate-base installation of L3 charging infrastructure Lack of ZEV models with equivalent functionality of existing ICEVs (e.g., pickups) Regulatory barriers associated with behind-the-meter technologies	Lack of public charging infrastructure Lack of consumer awareness and education Regulatory barriers for utilities to install charging infrastructure Use of different voltage transformers and their ability to accommodate high volumes of ZEV charging	Lack of education on ZEVs Lack of regulatory support for ZEV infrastructure Lack of ZEV models with equivalent functionality of existing ICEVs (e.g., pickups) Regulatory barriers for utility-owned charging infrastructure Province has lots of policies on renewable energy and energy efficiency, but lacks policy related to the evolution of transportation Bylaws governing service stations and who can provide fuels for vehicles require amendments to allow gas stations to provide EV charging Regulations need modernization to accommodate emerging technologies Federal messaging on GHG reductions and alternative fuels lacks cohesiveness and broad-spectrum funding	Residents' preference to keep their vehicles for a long time and do self repair and maintenance Largely rural (but not remote) population Budget constraints for incentive programs Lack of coordinating body to lead actions and outreach Split between urban and rural divide for access to charging infrastructure Lack of ZEV models with equivalent functionality of existing ICEVs (e.g., pickups) Use of different voltage transformers and their ability to accommodate high volumes of ZEV charging High sales taxes and no purchase rebates

What we heard—Opportunities for Action

Workshop attendees were asked to prioritize three opportunities for action with a view to identifying the most urgent opportunities. It was noted that each of the priority opportunities would complement the others; not that one opportunity would necessarily be better than the others. These priority opportunities include:

- Incentives for ZEV purchases and infrastructure
- Increase public charging infrastructure
- Education and awareness campaigns by multiple groups (Government, NGOs, OEMs, etc.)

Other opportunities identified include:

- Leverage regional opportunities (e.g., Governors of New England, Atlantic Canada Growth Strategy) to find synergies and potential resources to enable building charging infrastructure
- Develop infrastructure plan to get ready and gather stakeholders so that action can be taken when funding opportunities/resources become available
- Clarifying business cases/models for investment in infrastructure for private entrepreneurs and utilities
- Quantify ZEV and charging infrastructure benefits (e.g., lower TCO, GHG reduction levels per vehicle) and/or value propositions (e.g., increase in business for retail outlets that install EVSE) to provide public and private sector stakeholders with concise and data-supported information
- Explore accelerating ZEVs in rental fleets to act as test drive opportunities
- Simplified application process for federal ZEV charging funding

The list of opportunities above represents those identified via workshop activities and are representative of the Atlantic Region as a whole. Table 6 below summarizes the barriers and/or challenges identified by workshop participants and organized by province. In some instances these options reflect unique refinements to the common barriers captured above.

TABLE 6
Atlantic Provincial Opportunities for Action

NEWFOUNDLAND AND LABRADOR	PRINCE EDWARD ISLAND	NOVA SCOTIA	NEW BRUNSWICK
Increased awareness to the public on total cost of ownership and environmental benefits EVs currently a low priority but province can take time to learn from regulatory approaches in other jurisdictions	Priority action is the installation of L3 charging infrastructure and leveraging it for education/ awareness opportunities	Increase the number of ZEVs in showrooms Provide incentives like what is being done in leading jurisdictions Educate the public on the economic wins associated with ZEVs (i.e. lower fuel and maintenance costs) No grid readiness concerns—lots of excess power available to households to provide EV charging	Develop easily comprehensible value propositions for decision makers in governments Incorporating ZEV deployment in municipal action plans

9.3 PRAIRIES—BARRIERS AND OPPORTUNITIES

What we heard—Barriers

Interview and workshop outcomes converged on many of the same common barriers that are discussed in Section 6, with minor regional deviation. For convenience, the common barriers discussed in Section 6 include cost, technological uncertainty (i.e. charge time, range, etc.),

charging infrastructure, lack of public awareness and education, and ZEV availability. Due to the fundamental importance of grid readiness, this issue is addressed separately below. Key barriers identified in the Prairies include:

- Lack of provincial government interest/engagement
- Lack of coordination of stakeholders/activities
- The higher cost of ZEVs versus ICE vehicles and a lack of equivalent models (e.g., pickup trucks and SUVs)
- Lack of public charging infrastructure
- Lack of consumer awareness (total cost of ownership, infrastructure, safety)
- Lack of ZEVs and service capabilities at dealerships
- Technology barriers (battery performance and perceived cold weather performance)
- Lack of standardization of charging infrastructure

The list above represents key barriers identified via workshop activities and is representative of the Prairies as a whole. Table 7 below summarizes the barriers and/or challenges identified by workshop participants and organized by province. In some instances these options reflect unique refinements to the common barriers captured above. Barriers presented in the table below may mimic those presented above.

TABLE 7
Prairie Provincial Barriers

MANITOBA	SASKATCHEWAN	ALBERTA
Electricity market (only MB Hydro can sell power) Consumer preference for trucks and SUVs Lack of automaker interest (will not focus efforts on small market in MB) Government budgetary constraints to provide incentives No provincial ZEV support programs currently in place as climate plan is at early stage.	GHG intensive electricity grid Lack of public education Lack of EVs at dealerships Driving distances between major centres (e.g., Saskatoon and Regina) Cold weather performance (related to range) Consumer preference for trucks and SUVs Replacing fuel tax income that is currently used for highway maintenance Transportation sector is not a focus of Provincial government and ZEVs are not a priority Rural and dispersed population	Deregulated electricity market and the decoupling of transmission operators and energy retailers make it difficult for utilities to make a strong business case to offer incentive programs and invest in charging infrastructure GHG intensive electricity grid Misperception around the economy's dependence on oil and gas - many people have earned livings from oil and gas and ZEVs could be seen as a threat Lack of preferred vehicle models for Albertans (i.e. preference for trucks and SUVs) Long driving distances between major corridors (e.g., Calgary to Edmonton, Calgary to Rocky Mountains and return) ZEVs are not a priority to the provincial government

What we heard—Opportunities for Action

Workshop attendees were asked to prioritize three opportunities for action with a view to identifying the most urgent opportunities. The three highest priority opportunities identified to increase ZEV uptake in the Prairies included:

- Governments make ZEVs a priority
- Funding for vehicle incentives, charging infrastructure incentives and education/awareness
- Exploring future/smart mobility systems

Additional opportunities identified include[124]:

- Regulator giving direction to utilities and retailers to install charging infrastructure
- Create educational content specific to Prairies
- Government removing regulatory barriers and not creating new barriers
- Link ZEV charging to distributed energy and storage micro-hubs
- Impose vehicle km travelled tax (to supplant lost gas tax revenue)
- Develop ZEV-ready buildings strategy
- Examine a large hydrogen fleet project for heavy duty vehicles
- Consistent signage for ZEV charging
- Creating a DC Fast Charger (L3) charging station strategy
- Exploring ZEV manufacturing opportunities in Prairies
- Leveraging existing ZEV drivers in outreach and education programs

The list of opportunities above represents those identified via workshop activities and are representative of the Prairie Region as a whole. Table 8 below captures opportunities identified by individual provinces, which in some instances reflect unique refinements to the opportunities presented above.

TABLE 8
Prairie Provincial Opportunities for Action

MANITOBA	SASKATCHEWAN	ALBERTA
Provide ZEV total cost of ownership numbers to consumers—vehicle costs are a huge issue and perception is that ZEVs are expensive A partnership involving government and other stakeholders should implement an educational campaign on ZEVs	Consumer education on the benefits of ZEVs would lead to more demand Provincial government needs to start planning for ZEVs now For optimal uptake, any ZEV rebates should be offered at point of sale, not through mail-in forms or tax returns One government department should take on leadership role in ZEV deployment (currently split between Environment and Transportation)	Government support on policy decisions and incentives Government support through the Department of Energy could help spur the Alberta Utilities Commission direction to distribution companies to pilot incentive programs for the installation of L2/L3 charging stations Strategy for developing southern Alberta charging network Leverage big cities (Edmonton and Calgary) who are working on ZEV strategies and to develop charging infrastructure and market Explore ZEV charging infrastructure with stationary batteries and solar

9.4 GRID READINESS IN PRAIRIE AND ATLANTIC REGIONS

A common barrier associated with increased ZEV deployment is electricity grid readiness. Workshop findings are consistent with recent studies suggesting that current systems are not under any immediate threat, although as the number of ZEVs increase there may be impacts and actions required at the local distribution level. Such actions may include behind-the-meter charging solutions which give utilities or accredited third parties the ability to control, within the defined limits of ZEV users, the rate and timing of ZEV charging. An alternative action would be to encourage or incentivize ZEV users to only charge during on-peak hours when necessary. Such actions could help to defer other ostensibly costlier actions such as upgrading pole-top transformers in neighbourhoods with relatively high levels of ZEV ownership. Upgrading electricity distribution infrastructure to accommodate the additional loads that ZEVs will bring should be a last resort and should only be implemented when lower-cost alternatives have been exhausted.

Context on ZEVs and Grid Readiness

While utility stakeholders from across Canada agree that ZEVs do not pose an immediate challenge from an electricity generation capacity perspective, the primary challenge that ZEVs pose is to local electricity distribution systems. This is especially true considering that ZEV adoption tends to be concentrated in certain, mostly urban, neighbourhoods. Local electricity distribution systems in such neighbourhoods may have their ability to meet the electricity needs of residential customers constrained in situations where several ZEVs plug-in to charge simultaneously in households whose power is delivered from the same pole-top transformer.

In Canada, transformer power is measured in Kilovolt-amperes (kVA). Power delivered to households and other buildings is measured in kilowatts (kW). Assuming transformers operated at 100% efficiency, their capacity in kVA would be equal to their maximum recommended output in kW. Some distribution equipment, however, operates at less-than-perfect efficiencies (determined by its power factor). The number of households serviced by the same transformer is determined by transformer capacity (typically 25-100 kVA) and average household power demand. Typically, the feeder electrical lines servicing households are intended to deliver about 5 kW per household. So a standard pole-top transformer rated at 50 kVA, with an efficiency/power factor of 80% could be expected to consistently deliver 40 kW of power. Such a transformer might therefore be utilized to deliver power to eight detached homes.

Potential problems arise when the power being drawn from a given transformer exceeds its capacity. Transformers are designed to operate beyond their rated capacity but doing so can stress them and shorten their lifespans, or in extreme cases can cause transformers to overload and fail. Commercially available ZEVs can charge at rates ranging from approximately 3.3 to 19 kW, with a typical rate of 6.6 kW when charging on full power on a standard 240 V circuit (Level 2 charging). This means that the power demand of a modern ZEV using standard Level 2 charging equipment is comparable to that of a detached house. Going back to the example of a 50kVA transformer powering eight detached homes, if half of those homes plugged in to charge a ZEV at the same time, the transformer would then be supplying the power that should be rated for 12 homes, not 8, and would be exceeding its rated capacity by 50%.

Throughout Canada, however, residential power demand tends to be lowest at night, when most lighting, electrical devices and major appliances are turned off. Night-time household power consumption is generally less than half of what it is during daily periods of peak usage (the biggest peak is from 5 to 8 pm, with a lesser morning peak between 7 and 10 am).[125] This power demand profile complements typical patterns of ZEV charging, which see most charging taking place at home, overnight. Although this is the typical pattern, there is currently nothing stopping ZEV users from plugging in to charge at 5 or 6 pm. Ontario is currently the only jurisdiction in Canada that uses time-of-use electricity pricing for residential customers, which was made possible by the installation of smart meters in over 95% of provincial households. Time-of-use pricing has certainly made Ontarians more cognizant of their electricity usage, but in lieu of additional measures even it does not prevent a ZEV user from charging during peak hours. Peak electricity prices are merely a deterrent, one which, if unheeded, could still leave neighbourhood electricity distribution systems at risk.

Due to low ZEV adoption levels in Atlantic Canada and the Prairies, utility stakeholders are understandably not worried about the threats to local grid distribution assets posed by ZEVs. At this point, the likelihood of one pole-top transformer servicing more than one or two households where ZEVs reside is very small. As ZEV adoption continues to grow, however, more electrical utilities across Canada will become engaged on ensuring the integrity of their local distribution systems. Measures may include gradually reducing the number of households serviced by each transformer or upgrading the capacity of transformers themselves. Less costly measures than these will likely be favoured however, such as the previously mentioned behind-the-meter, software-driven smart charging solutions. In order to deliver such solutions to customers, utilities may have to work through subsidiaries, as no expenses incurred for the development and deployment of these solutions can be charged to their rate bases. This is one of the biggest frustrations among utility stakeholders with regard to ZEVs. For the most part, utilities are keen to become more engaged on ZEVs, but lack the budgetary flexibility to engage meaningfully in the development and delivery of smart charging solutions.

Table 9 and Table 10 below highlight some province-specific information on this matter for the Atlantic and Prairie regions, respectively.

TABLE 9
Atlantic Perspectives on Grid Readiness

NEWFOUNDLAND AND LABRADOR	PRINCE EDWARD ISLAND	NOVA SCOTIA	NEW BRUNSWICK
98% of Newfoundland and Labrador's electricity will be from renewable resources when the Muskrat Falls hydroelectric project comes into service. Completion of construction and operation of the Muskrat Falls generating station and transmission lines will mean a link to North America's electricity grid for exports to allow for the sale of excess power to markets, helping to enable regional GHG reductions. Current levels of ZEV market penetration do not threaten local electricity grids. However as ZEV uptake increases, the effects of ZEVs on electricity infrastructure will require examination. NL Hydro has the exclusive right to sell electrical power to retailers.[126] It is expected that grid impacts could be minimized by encouraging ZEV owners to charge during off-peak periods. Measures, such as time of use pricing, would require significant metering technology changes in Newfoundland and Labrador.[127]	Approx. 25% of the province's electrical needs are met by wind, the highest percentage of any jurisdiction in North America. Further increasing electrical production from wind is a priority. The use of smart grid technology will better enable wind integration. An increase in the peak load was identified as a possible adverse impact of ZEV adoption and associated electricity use, if users charge their vehicles when they get home from work in the early evening in winter. Provincial Energy Strategy (2016/17) identifies options for mitigating potential impacts, in cooperation with electric utilities. These include linking the introduction of ZEVs to smart grid measures and harnessing vehicle batteries to manage electric load.[128]	NS Power is keen to examine the potential impacts of ZEV adoption on the provincial electrical system. The short-term impacts of L3 fast charging on the electrical system is expected to be greater than L2 charging.[129] NS Power's recent proposal to install 12 L3 chargers as part of pilot project to study the impact and usage of the charging network on the electrical system, was rejected by the Nova Scotia Utility Review Board. The majority of the existing L2 charging stations in Nova Scotia are not network-enabled, which means the opportunity for data collection on usage patterns is limited.	NB Power targets 40 % of electricity sales being provided from renewable energy, and a total of 90% of electricity generation from non-emitting sources by 2020.[130] Large GHG emissions reductions could thus be achieved from ZEV adoption. NB distribution is robust – no foreseeable grid concerns – might be local community challenges in future when adoption numbers increase. NB Power is keen on smart grids as strategy and ZEVs can play a big part (i.e. storage, vehicle-to-grid, etc.).

TABLE 10
Prairie Perspectives on Grid Readiness

MANITOBA	SASKATCHEWAN	ALBERTA
Provincial grid is >98% emissions-free and generation capacity is well in excess of demand, which means switching from gasoline-powered vehicles to ZEVs offers large-scale GHG reduction benefits. Over 500,000 plug points at home and at work already exist in the province. Manitobans are accustomed to plugging in.[131] Manitoba Hydro estimated in 2011 that the load for ZEVs could reach 195 GWh by 2030 (relatively modest load).[132] Conversion of all gasoline-powered vehicles to electricity would require 1,200 GWh to 2,500 GWh a year. The large-scale integration of ZEV charging into the electrical grid identified as one area of focus for Manitoba's ZEV advisory committee (outlined in Manitoba's EV Roadmap 2012).	Electricity generation is the leading source of emissions in the province followed by the oil and gas sector; current priority is for government to reduce emissions in these areas rather than transportation. Currently low demand for and uptake of ZEVs in province, so ZEVs currently pose little-to-no threat to provincial grids. Province has no plans to become engaged on public ZEV charging. Government will reassess actions if and/or when ZEV adoption increases. SaskPower has the exclusive right under the Power Corporation Act[133] to supply, transmit and distribute electricity, and to provide retail services to consumers in the province, except for the Cities of Saskatoon and Swift Current.[134] Both purchase electrical power in bulk from SaskPower.	Not an issue on transmission systems. Utility capacity to incent ZEV users to charge off-peak or monitor ZEV impacts on the grid is limited because necessary advanced metering infrastructure does not exist.[135] No legislative provisions enabling utilities to rate base the cost of charging infrastructure. Future challenge on local transformer levels with larger ZEV adoption, but there are technologies and incentives for time of day charging that could help address this. A number of Alberta utilities are being proactive in planning for increased ZEV adoption and recognize emerging opportunities with respect to ZEVs and advanced energy management solutions.

9.5 OUTLOOK ON ZERO-EMISSION HEAVY DUTY VEHICLES IN PRAIRIE AND ATLANTIC REGIONS

While the electrification of light duty vehicles was the primary focus of interviews, workshops and the webinar with stakeholders from Atlantic Canada and the Prairies, consideration was also given to opportunities for electric heavy duty vehicles (HDVs) in the respective regions. The electrification of larger vehicles involved in mass transit and freight movement is generally held to be a longer-term endeavor due to the greater power demands of these vehicles. However, it is important to begin scoping out potential pathways for HDVs now, considering that GHG emissions from on-road freight transport are expected to surpass those of light duty vehicles by 2030. Any comprehensive suite of actions intended to achieve deep GHG reductions from transportation must eventually address the HDV sector.

Stakeholders from both the Atlantic and Prairie provinces recognized the important opportunities that the electrification of HDVs presents with regard to reducing GHG emissions in the transportation sector. Specific applications highlighted by stakeholders from Atlantic Canada included: electric snowploughs, boom trucks, short haul delivery trucks and hybrid river ferries. A notable initiative that is currently in the works in PEI is the introduction of electric transit buses to the T3 Transit fleet on the university route in Charlottetown. In addition to being a suitable length, the route will ensure that the technology has high exposure to university students and the general public. The bus operator is planning to continue adding electric buses to the transit system for the next seven years. While activities in the sector in the Atlantic Canada region have been limited, it was pointed out that pilots are underway to test electric HDVs in other jurisdictions and there are opportunities to learn from these experiences.

A number of participants from the Prairies highlighted electrification activities that are already happening in the medium and heavy duty vehicle sector in the region. For example, the City of Edmonton is implementing an electric bus procurement program, with the commitment to purchase and test 40 electric buses. There are also plans to look at the electrification of non-transit municipal fleets, such as pickup trucks and HDVs. One stakeholder highlighted opportunities for the oil and gas sector to use electric-diesel hybrid trucks for surface mining while another discussed an opportunity to leverage existing oil and gas infrastructure to build a hydrogen economy in Western Canada and become a global leader in hydrogen fuel cell vehicles.

There was general agreement among stakeholders from both regions that HDV electrification is a longer-term opportunity when compared to the LDV sector. Challenges and barriers highlighted by stakeholders included technological uncertainty, performance in cold climates, and high upfront costs.

10. Summary and Conclusions

Climate change is an issue that has garnered political attention over recent years and policies aimed at GHG mitigation are being developed across the country as Canada positions itself as a global leader in decarbonizing its economy.

The transportation sector represents one of the largest GHG emission sources in Canada. While no one strategy or technology alone will reduce all transportation-related GHG emissions, ZEVs represent a promising opportunity to make meaningful progress in achieving federal and provincial GHG reduction targets.

This study focused on understanding regional perspectives on ZEVs and their deployment in the Atlantic and Prairie regions of Canada, two regions that have seen minimal uptake of ZEVs. Through a series of regional workshops and interviews, insights into regional and provincial barriers and opportunities were identified.

Stakeholders from both the Atlantic and Prairie regions were in general agreement that a range of considerations such as those identified in the matrix of actions need to be addressed to accelerate ZEV adoption. It was further agreed that a suite of coordinated actions across relevant sectors, each led by the most relevant stakeholders, would be more effective than a series of stand-alone measures. Stakeholders agreed that actions are needed on multiple fronts and that the matrix articulated many of these key considerations/issues. Key barriers and priority opportunities identified for each region are summarized in Table 11.

Stakeholders in Atlantic Canada benefited from government support for increasing ZEV deployment, which has been referenced in public strategy documents. It was identified that the next step involve tailoring and prioritizing actions for spurring ZEV deployment in the region. In the Prairie Region the need for increased actions to accelerate ZEV deployment in these provinces was identified.

A common challenge associated with increased ZEV deployment is electricity grid readiness. Workshop findings are consistent with recent studies suggesting that current systems are not under any immediate threat, although as the number of ZEVs increase there may be impacts and actions required at the local distribution level.

TABLE 11
Summary of Key Regional Barriers and Priority Opportunities for the Atlantic and Prairie Regions

ATLANTIC CANADA		PRAIRIES	
BARRIERS	**OPPORTUNITIES**	**BARRIERS**	**OPPORTUNITIES**
Lack of incentives and high purchase costs	Incentives for vehicle purchases and infrastructure	Lack of provincial government interest/ engagement	Governments make ZEVs a priority
Lack of consumer and policy-maker awareness and education	Increase public charging infrastructure	Lack of coordination of stakeholders/ activities	Funding for vehicle incentives, charging infrastructure incentives and education/awareness
Lack of public charging infrastructure	Education and awareness campaigns by multiple groups (Government, NGOs, OEMs, etc.)	The higher cost of ZEVs vs ICEVs and lack of equivalent models (e.g., pickup trucks and SUVs)	Exploring future/ smart mobility systems
Lack of ZEV availability	Leverage regional opportunities (e.g., Governors of New England, Atlantic Canada Growth Strategy)	Lack of public charging infrastructure	Regulator direction to utilities and retailers
Lack of models (e.g., pickup trucks) to meet required vehicle performance specs for large consumer demographics	Simplified application process for federal ZEV charging funding	Lack of consumer awareness (total cost of ownership, infrastructure, safety)	Create educational content specific to Prairies
Lack of access to maintenance			Government to remove regulatory barriers

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3 See The Pan-Canadian Framework on Clean Growth and Climate Change, 2016: https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html

4 Canada has experienced a 42% (51 Mt CO_2e) increase in transportation emissions from 1990 to 2015. See: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions/canadian-economic-sector.html

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16 Information on electricity generation in Canada from Canada's National Inventory Report 2017, as submitted to the UNFCCC. See: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php

17 PEI imports a large volume of electricity from New Brunswick.

[18] Other fuels include refined petroleum products (light fuel oil, heavy fuel oil, diesel), petroleum coke, still gas and other fuels not easily categorized.

[19] Environment and Climate Change Canada National Inventory Report 1995-2015: Greenhouse Gas Sources and Sinks in Canada Part 3

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36 See: http://www.pollutionprobe.org/publications/accelerating-ev-deployment-report/

37 See: https://avt.inl.gov/sites/default/files/pdf/EVProj/SAEHybridEVSympFeb2014.pdf

38 **Environics Research Group. World Wildlife Fund Canada – Electric Vehicle Survey 2014.

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40 Note: The EV market share of total vehicle sales represents the market share for British Columbia and the Territories because historical auto sales data are not available for the individual jurisdictions. This is not expected to have a material impact on market share estimates due to relatively low car sales in the Territories compared to British Columbia.

41 EV Sales data represents PHEVs and BEVs only and was found to be relatively consistent with other sales estimates from FleetCarma which only report sales data for those two vehicle types. Ultimately, Matthew Klippenstein's Canadian EV sales data was selected over FleetCarma data because it includes sales data for the full year of 2017. See: https://docs.google.com/spreadsheets/d/1dLFJwZVdvNLRpmZqPznlzz6PB9eHMe5b-bai_ddRsNg/edit#gid=5

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43 See: http://vancouversun.com/news/local-news/electric-car-buyers-in-b-c-can-now-save-up-to-11000-after-trade-in-deal-doubles

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45 The program's list of eligible vehicles consists of 38 EVs – two are FCEVs and 36 are either PHEV or BEVs.

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54 EV Sales data represents PHEVs and BEVs only and was found to be relatively consistent with other sales estimates from FleetCarma which only report sales data for those two vehicle types. Ultimately, Matthew Klippenstein's Canadian EV sales data was selected over FleetCarma data because it includes sales data for the full year of 2017. See: https://docs.google.com/spreadsheets/d/1dLFJwZVdvNLRpmZqPznlzz6PB9eHMe5b-bai_ddRsNg/edit#gid=5

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93 See: http://www.peiec.ca/uploads/6/6/6/4/66648535/eg0031_energy_strategy_15march2017.pdf

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100 See: https://www.nspower.ca/en/home/for-my-home/heating-solutions/electric-vehicles/EV-NS.aspx

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103 See: http://www.cbc.ca/news/canada/nova-scotia/tesla-supercharger-stations-atlantic-canada-1.4497981

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[114] See: http://www.cbc.ca/news/canada/prince-edward-island/electric-cars-charger-funding-pei-1.4474532

[115] See: https://www.princeedwardisland.ca/en/news/hybrid-vehicle-tour-spotlights-energy-efficient-transportation

[116] See: http://www.exec.gov.nl.ca/exec/occ/publications/climate_change_summary.pdf

[117] See: http://www.exec.gov.nl.ca/exec/occ/pdf/greening_government_action.pdf

[118] See: http://www.exec.gov.nl.ca/exec/occ/publications/climate_change.pdf

[119] See: http://www.exec.gov.nl.ca/exec/occ/publications/electric_veh_report.pdf

[120] See: https://chargehub.com/en/countries/canada/newfoundland-and-labrador/st-johns.html?city_id=2138

[121] See: https://chargehub.com/en/countries/canada/newfoundland-and-labrador/mount-pearl.html?city_id=2074

[122] See: https://www.nlcu.com/Home/ProductsAndServices/YourFinancing/VehicleLoans/EcoFriendlyVehicleLoanRebate/

[123] Calculator available at: http://www.turnbackthetide.ca/vehicle-efficiency-and-cost-calculator.html

[124] Realizing there are some overlap between opportunities (education, government direction/regulation, incentives), these opportunities are presented here to capture the views of regional stakeholders.

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[129] See: https://nsuarb.novascotia.ca/sites/default/files/M08224%20Decision.pdf

[130] See: https://www.nbpower.com/en/products-services/electric-vehicles/benefits-of-evs

[131] See: https://www.gov.mb.ca/asset_library/en/climatechange/climategreenplandiscussionpaper.pdf

[132] See: https://www.gov.mb.ca/jec/energy/pubs/elec_vehicle_road_map.pdf

[133] See: http://www.publications.gov.sk.ca/freelaw/documents/English/Statutes/Statutes/P19.pdf

[134] See: https://ccsknowledge.com/pub/documents/publications/saskpower-boundry-dam/About%20Saskpower.pdf

[135] Source: Pollution Probe EV Grid Gap Analysis Study, 2017