

FRAMEWORK FOR MUNICIPAL ZERO EMISSION VEHICLE DEPLOYMENT



POLLUTION PROBE
CLEAN AIR. CLEAN WATER.



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Pollution Probe
208 – 150 Ferrand Drive
Toronto, ON, M3C 3E5
Canada

Tel: (416) 926-1907
Fax: (416) 926-1907
www.pollutionprobe.org

The Delphi Group
428 Gilmour Street
Ottawa, ON, K2P 0R8
Canada

Tel: (613) 562-2005
Fax: (613) 562-2008
www.delphi.ca

For more information, please contact:

Steve McCauley
Senior Director, Policy
smccauley@pollutionprobe.org
(416) 926-1907 x 252

Joe Rogers
Senior Director
jrogers@delphi.ca
(613) 562-2005 x 222

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Executive Summary

Despite recent improvements in vehicle fuel economy and other efficiency measures, transportation continues to be a leading source of greenhouse gas (GHG) emissions and air pollutants in Canada. This is why the Government of Canada announced its ambitious zero emission vehicle (ZEV) targets; sales of light-duty ZEVs reaching 10% in 2025, 30% in 2030 and 100% in 2040. Transportation is also the largest source of emissions in most Canadian municipalities, where its impacts on human and environmental health are felt most acutely. Consequently, cities are looking to become more engaged on actions to limit transportation-related emissions, and many are seeking support in the development of plans and strategies to reduce the impacts of the transportation sector.

The Framework for Municipal Zero Emission Vehicle Deployment presents a comprehensive suite of actions that any municipality can customize to meet its needs in reducing emissions from all modes of motorized transport through the enhanced deployment of ZEVs.

The Framework was created through the following key steps:

- A literature review focussing on best practices in municipality-led approaches to ZEV deployment
- A series of interviews with experts specializing in a wide range of ZEV deployment activities at the municipal level in Canada

- A multi-stakeholder workshop that brought together experts to discuss which elements are critical to building a municipal ZEV Matrix of Actions

Section 1 provides information on the Framework development process and objectives as well as background information relevant to ZEV deployment in Canadian municipalities. It provides a brief overview of the IEA's Global EV Pilot City Programme, as well as a high-level description of the Canadian transportation sector's contribution to climate change. It then describes the various types of ZEVs and charging infrastructure currently available to Canadians and some of the principal benefits that ZEVs offer municipalities. The section concludes with a look at ZEV adoption levels from a Canadian and global perspective, as well as adoption projections for the coming decades.

Section 2 details the key stakeholder groups that should be engaged during the planning and development of municipality-led ZEV deployment strategies. The core reasons for these groups to become engaged are noted, as are the types of activities each group is well-suited to participating in. A sampling of Canadian best practices from within each group is also provided.

Section 3 introduces readers to the two municipal Matrix of Actions developed over the course of this project. The first Matrix details categorized actions to support the deployment of privately-owned light-



duty vehicles, while the second Matrix details actions for fleets and medium- and heavy-duty vehicles. The actions in the Matrices are not exhaustive, and further, it is not essential that all the actions listed be taken in order to deliver a successful ZEV deployment strategy. Rather, these actions are intended to provide municipal stakeholders with a broad and diverse range of options to choose from, some of which may be better suited to some cities than others (based on factors such as population, available budgets and existing levels of ZEV adoption). Detailed definitions for each action, along with examples of best practices and challenges and solutions related to implementation can be found in Appendix A (privately-owned LDVs) and Appendix B (fleets, MDVs and HDVs).

Section 4 overviews the fundamental steps that should be taken when developing a municipal ZEV deployment strategy. This includes advice on the prioritization and sequencing of specific actions that municipalities choose to undertake.

Section 5 profiles best practices from three North American municipal leaders with regard to ZEV deployment: North Vancouver, BC, Montreal, QC, and Portland, OR. These profiles break actions down into categories that correspond to Matrix of Actions columns, such as: fueling and charging infrastructure, education and awareness, incentives, fleets, and complementary mechanisms. Additional case study examples are provided on an action-by-action basis throughout Appendix A and Appendix B.

Section 6 provides a brief summary of the report. It reiterates the role that ZEVs can play in achieving municipal sustainability and climate targets, as well as more generally enhancing the quality of life for citizens in Canadian cities.

Abbreviations and Acronyms

BEV – battery electric vehicle	kWh – kilowatt hour
CASE – connected, autonomous, shared and electric	LDV – light-duty vehicle
CCS – combined charging system	LEV – low-emission vehicle (includes electric and hydrogen fuel cell electric vehicles; synonymous with ZEV)
DCFC – direct current fast charger (synonymous with Level 3 charger/charging station)	MDV – medium-duty vehicle
EV – electric vehicle (includes both battery and plug-in hybrid electric vehicles)	Mt – megatonne
EVSE – electric vehicle supply equipment	MURB – multi-unit residential building
FCEV – hydrogen fuel cell electric vehicle	PHEV – plug-in hybrid electric vehicle
GHG – greenhouse gas	SAE – Society of Automotive Engineers
HDV – heavy-duty vehicle	STM – Société de transport de Montréal
HEV – hybrid electric vehicle	TTC – Toronto Transit Commission
HOV – high occupancy vehicle	V – volt
ICE – internal combustion engine	ZEV – zero emission vehicle (includes battery electric, plug-in hybrid electric, and hydrogen fuel cell electric vehicles; synonymous with LEV)
IEA – International Energy Agency	
kW – kilowatt	



About

Pollution Probe

Pollution Probe is a national, not-for-profit, charitable organization that exists to improve the health and well-being of Canadians by advancing policy that achieves positive, tangible environmental change. Pollution Probe has a proven track record of working in successful partnership with industry and government to develop practical solutions for shared environmental challenges.



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 in 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 through support from:

Bruce Power

Bruce Power is Canada’s first private nuclear generator, providing 30% of Ontario’s power. The company is committed to providing clean energy to the province beyond 2060, to help the province continue to achieve reductions in greenhouse gas emissions. 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.



Innovation at work

Ontario Power Generation

Ontario Power Generation (OPG) generates clean, safe, reliable, low-cost power for Ontario and is the province’s largest clean energy generator. As a member of the global EV100 initiative, OPG is leading the transition to electric transportation with a commitment to electrify its own fleet, where feasible, by 2030. Closing Ontario’s coal stations remains one of the world’s largest single actions to combat climate change. Now we’re ready to power the next big action – electric vehicles.



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 and The Delphi Group to undertake this study. It is anticipated that project outputs will be used by Canadian municipalities who are developing action plans to support the local uptake of ZEVs. Furthermore, this work is seen to exemplify best practices in ZEV deployment from a Canadian municipal perspective – practices that can be shared with municipal governments and key transportation stakeholders globally.



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1 | INTRODUCTION AND BACKGROUND

1.1 Project Objectives and Methodology

Despite significant public and private sector-led achievements in reducing greenhouse gas (GHG) emissions from transportation in recent decades, the sector continues to be a leading source of GHGs from national, provincial and municipal perspectives. Most Canadian municipalities have now established GHG reduction targets and timelines, and associated targets for air pollutants that have detrimental impacts on human health. The transportation sector is viewed by many stakeholders to be a “low-hanging fruit” in terms of potential GHG and air pollutant reductions, and is the focus of significant decarbonization efforts globally. Part of the reason for this focus is the fact that low-carbon transportation options have emerged in recent years that are capable of supporting a shift

from fossil fuels to lower carbon fuels with minimal changes to consumer behaviour.

Realizing the benefits to be derived from a shift to low-carbon transportation, municipalities across Canada and the world have established programs and policies to incentivize the use of low-carbon mobility options amongst their constituents. Capitalizing on local assets that might range from an affluent or well-educated populace to a clean electricity grid, certain municipalities have led the charge in integrating low-carbon transport into local practices. Some cities have focused on electrifying their public transit networks, while others have focused on making private zero emission vehicle (ZEV) ownership as effortless as possible. But with regard to emissions-free transportation, many more cities are asking the simple question: Where do we begin?

The overarching aim of this Framework is to help municipalities in Canada to begin answering that question. More specifically, the project has three foundational objectives:

- Develop a generic municipal ZEV deployment framework supported by a Matrix of Actions which could be used by local and regional governments and organizations to accelerate the deployment of ZEVs
- Establish or strengthen relationships between municipal decision-makers and enhance public and private sector awareness of best practices in municipality-led approaches to ZEV deployment
- Highlight Canadian experiences and achievements with ZEV deployment at the municipal level, which could be used to contribute to the Global EV Pilot City Programme, which is a component of the International Energy Agency's Electric Vehicle Initiative (EVI), currently being chaired by the Governments of Canada and China. The EVI was launched in 2010 under the Clean Energy Ministerial – a series of global forums involving energy ministers from around the world to promote the transition to clean, sustainable energy.

To deliver on these three objectives, the project team, led by Pollution Probe and the Delphi Group, undertook the following activities:

- A literature review focussed on best practices in municipality-led approaches to ZEV deployment
- An extensive series of interviews with experts specializing in ZEV deployment activities at the municipal level in Canada
- A multi-stakeholder workshop to gain insights from experts on specific elements that are critical to building a municipal ZEV Matrix of Actions as a framework for ZEV deployment strategies
- A final project report to share the generic municipal ZEV Matrix of Actions as well as background information, best practices, and recommendations on how to foster ZEV uptake at the municipal level, within a variety of transportation modes

The scope of work included exploring solutions to enhance the deployment of privately-owned light-

duty ZEVs as well as solutions for corporate and government fleets, and medium- and heavy-duty vehicles (MDVs and HDVs, respectively). Because accelerating the deployment of privately-owned passenger ZEVs presents a suite of challenges that are different than those faced by fleets and commercial vehicles, it was determined that a different approach was required for both groups of vehicles. Key stakeholders representing both groups of vehicles were selected for interviews, and separate workshop sessions were held in order to explicitly address challenges unique to different vehicle classes and the organizations that work on them. In addition to the secondary research undertaken by the project team, a significant amount of stakeholder input was attained throughout the project. Findings from these activities have been incorporated into this report and its appendices.

1.2 Overview of IEA's Global Pilot EV City Programme

In May of 2018, the International Energy Agency's Electric Vehicle Initiative launched the Global Pilot EV City Programme (PCP). The objective of the Programme is to build a global EV deployment knowledge-sharing network of 100 cities. Recognizing that municipalities are often at the leading edge of innovative EV deployment practices, the Programme will help to connect stakeholders from different parts of the world who are on the ground leading efforts and troubleshooting the challenges that invariably arise.¹ Cities often bear the brunt of environmental and human health impacts related to transportation, and can therefore have greater impetus for action than the broader jurisdictions that they are situated within. They also require EV deployment actions that may be unique from those undertaken by higher levels of government.

Current membership of the PCP includes eight Canadian municipalities: Calgary, AB, Halifax, NS, Montreal, QC, Richmond, BC, Stratford, PEI, Surrey, BC, Winnipeg, MB, and York Region, ON. Additional municipalities that are interested in increasing their engagement on EV deployment are welcome to join the PCP, to gain and share insights from municipal practitioners who are current or future leaders in this area.

¹ <https://www.iea.org/newsroom/news/2018/may/global-ev-pilot-city-programme-launched-at-clean-energy-ministerial.html>

The IEA’s Electric Vehicle Initiative itself is a multi-government policy forum focused on accelerating the deployment of EVs worldwide.² It is currently being co-chaired by Canada (represented by Natural Resources Canada) and China. One of its core programs is the EV30@30 campaign, which aims to leverage the co-benefits of EVs and clean electricity to reduce the environmental and human health impacts from the transportation and energy sectors. The goal of the EV30@30 campaign is to help achieve a 30% EV market share of new vehicle sales by 2030 in participating countries.³

By participating in global organizations and campaigns, Canadian cities can ensure that the innovative solutions they implement will not be limited to their jurisdictions, and that the solutions developed by pioneering global cities can be adapted to a Canadian context to streamline and optimize the impacts of any efforts undertaken here.

1.3 Transportation and Climate Change

Canada’s GHG emissions totalled 704 megatonnes (Mt) of carbon dioxide equivalent (CO₂e) in 2016. Total emissions increased by 17% between 1990 and 2016, driven primarily by increased emissions from mining, upstream oil and gas production, and transportation.⁴

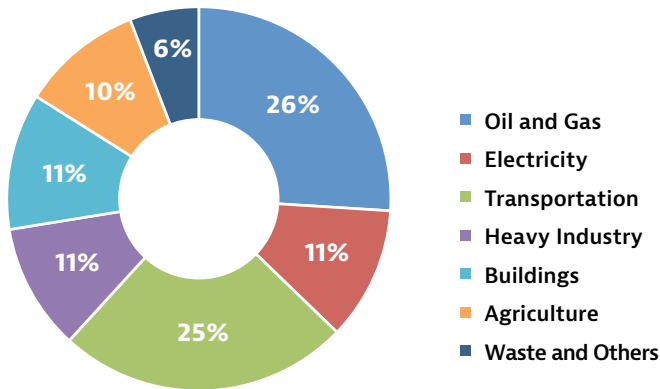


Figure 1: Canada’s GHG Emissions by Economic Sector, 2016 (Mt CO₂e)

Transportation is the second largest contributor to Canada’s GHG emissions (see Figure 1). Transportation-related emissions were 173 Mt in 2016, which represents roughly 25% of Canada’s total GHG emissions in that year. From 1990 to 2016, transport

emissions increased by 36% (53 Mt) and accounted for the equivalent of 52% of the total overall growth in Canada’s emissions. On-road transport is the main contributor to Canada’s transportation emissions, although a long-term decrease in emissions has been observed from light-duty gasoline vehicles. Despite improvements in fuel efficiency of light-duty vehicles, emissions from road transport have continued to increase due to population and economic growth, consumer shift towards SUVs, minivans and pickups for personal transportation and increased reliance on heavy trucks for freight hauling. For example, emissions from light-duty gasoline trucks increased 139% between 1990 and 2016, while emissions from heavy-duty diesel vehicles have increased by 240% since 1990 and 25% since 2005.

This is why in 2019, the Government of Canada announced its ambitious zero emission vehicle targets; sales of light-duty vehicles reaching 10% in 2025, 30% in 2030 and 100% in 2040. In support of these targets, the federal government will provide a ZEV purchase incentive of up to \$5,000 per vehicle and deploy infrastructure in multi-unit residential buildings, workplaces, commercial spaces and on streets, targeting 20,000 new Level 2 chargers.

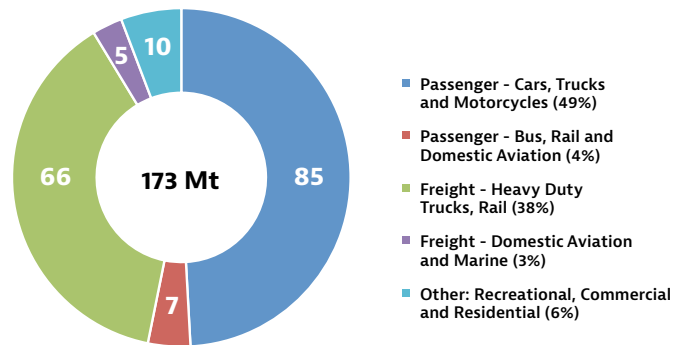


Figure 2: Canada’s Transportation GHG Emissions by Source, 2016 (Mt CO₂e)⁵

1.4 ZEVs Explained

1.4.1 ZEV options: A brief overview

There are currently four broad classes of electric passenger vehicles that are available for use on Canadian roads. The unifying feature of each class of vehicle is the ability to provide propulsion via an

² <https://www.iea.org/topics/transport/evi/>

³ <http://www.cleanenergyministerial.org/sites/default/files/2018-07/EV30%4030%20fact%20sheet%20%28May%202018%29.pdf>

⁴ <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html>

⁵ http://publications.gc.ca/collections/collection_2018/eccc/En81-4-2016-1-eng.pdf

electric motor for at least a portion of total distance driven. The four types of ZEVs are briefly described below, along with characteristics of a conventional internal combustion engine (ICE) vehicle.

Internal Combustion Engine (ICE) Vehicle: A conventional motor vehicle that burns gasoline or diesel to generate motive power. On average, ICE vehicles have efficiencies of roughly 21%.⁶ This means that almost 80% of the energy produced from burning gasoline or diesel is wasted, predominantly as heat energy. ICE vehicles are currently the norm across all vehicle modes (passenger cars and trucks, medium- and heavy-duty vehicles), and most experts expect them to continue dominating the global vehicle market for at least the next decade.

Hybrid Electric Vehicle (HEV): HEVs combine an ICE with a battery-electric propulsion system. They take advantage of regenerative braking and/or the ICE to charge the battery, and no external source of electricity is used. These vehicles, often termed “conventional hybrids,” tend to have much smaller batteries and shorter all-electric ranges than PHEVs. HEVs have been successfully deployed within almost all vehicle classes, and they have helped to achieve modest yet significant GHG reductions.

Plug-in Hybrid Electric Vehicle (PHEV): PHEVs are essentially HEVs with the option to charge the battery with an external source of electricity. In general, these vehicles have larger batteries and longer all-electric ranges than HEVs. Modern PHEVs tend to have electric ranges anywhere between 25 and 85 km. This range level allows users to conduct a significant amount of day-to-day driving exclusively using electric propulsion, while having the flexibility to make longer trips using petroleum if charging is unavailable or too time-consuming.

Battery Electric Vehicle (BEV): BEVs exclusively contain a battery-electric propulsion system. Their batteries are charged by plugging-in to an external source of electricity. In contrast to low-efficiency ICE vehicles, BEVs tend to have efficiencies of approximately 80%, and produce comparatively little

waste heat.⁷ Commercially available BEVs tend to have ranges anywhere between 150 and 540 km on a single charge.⁸

Although BEVs have zero tailpipe emissions, the quantity and location of GHG emissions and air pollutants released to power them depends on the mix of energy sources that feed into regional electricity grids. In Canada in 2017, electricity generation was over 80% emissions-free.⁹ This means that the net contribution of BEVs to emissions of air pollutants and GHGs in Canada is minimal, although grid carbon intensity does vary significantly from province to province. Environmental benefits of BEVs are further compounded due to the fact that a large majority of charging occurs overnight, when fossil fuel-powered peaker plants are typically not supplying any power to provincial grids.¹⁰

In addition to low emissions, BEVs are notable for requiring significantly less maintenance than ICE vehicles. This is due in part to the fact that ICE vehicle powertrains tend to contain roughly 2,000 moving parts, whereas BEV powertrains contain roughly 20.^{11,12}

In recent years, BEV architectures have started to emerge as viable options for almost every type of vehicle, from drones, to scooters and bicycles, motorcycles, passenger cars, delivery vehicles, buses, construction and mining vehicles, locomotives, heavy-duty on-road freight trucks, ferries and other watercraft, and even small aircraft. While the largest vehicles with the greatest power demands will likely be among the last types of vehicles that make the transition to full electrification, it is a positive sign that electric versions of these vehicles are becoming available. It will take some time for these electric versions to have performance capabilities comparable to their petroleum-powered counterparts (e.g., range, refueling times), so mode-specific solutions are required to address challenges in the near term.

Fuel Cell Electric Vehicle (FCEV): FCEVs use a fuel cell and hydrogen gas to power an electric motor which powers the propulsion system. Hydrogen (H₂) can be produced from methane (CH₄) via a process

⁶ <https://www.fueleconomy.gov/feg/atv.shtml>

⁷ <https://www.fueleconomy.gov/feg/atv-ev.shtml>

⁸ www.cheatsheet.com/automobiles/electric-vehicles-with-the-longest-driving-range.html?#a=viewall

⁹ <https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/nrgsstmpfrls/cda-eng.html>

¹⁰ <https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/fttrtd/2018-09-12hwmchrcrbndxd-eng.html>

¹¹ <https://www.cbc.com/2016/06/14/electric-vehicles-will-soon-be-cheaper-than-regular-cars-because-maintenance-costs-are-lower-says-tony-seba.html>

¹² <https://cleantechnica.com/2013/09/27/tesla-model-s-almost-maintenance-free/>

called steam reforming, or from water (H₂O) via electrolysis. Once the hydrogen is produced it must be pressurized, distributed and stored. Inside a FCEV, a fuel cell stack converts the hydrogen into electricity which is used to charge a small battery which in turn powers an electric motor. The FCEV refueling process is comparable to that of conventional ICE vehicles, and only takes several minutes to complete. The efficiency of FCEVs depends on the technologies and processes used in producing, compressing, transporting, and converting the hydrogen, but conservative estimates indicate a net efficiency of approximately 30%.¹³

The above-mentioned vehicles are often collectively referred to as zero emission vehicles, or ZEVs. Although the term is not strictly accurate, as all ZEVs produce emissions at some point during their use, manufacture, or through the production of their fuels, it is nonetheless used in literature and in government policy documents. Sometimes the term low emission vehicles, or LEVs, is used to refer to the same group of vehicles. For the purpose of this report, the term electric vehicle (EV) is used to refer to all BEVs and PHEVs.

1.4.2 EV charging: A brief overview

There are currently several options for EV recharging, each of which has unique benefits and limitations.

Level 1 Charging: This type of charging refers to an EV user plugging their vehicle into a standard electrical outlet. Standard outlets typically supply power at a rate of 1.8 kW (120 V x 15 A), so charging a fully depleted 40 kWh EV battery would take over 20 hours using this method. These outlets are ubiquitous, however, and are sometimes installed in parking facilities or on the outer walls of buildings to power equipment such as engine block heaters, appliances and tools. Level 1 charging is an option when time is not of the essence, for example, when a vehicle is parked for a long period (e.g., overnight, at work, or at a transit hub) and isn't needed right away. All production EVs are capable of utilizing this type of charging.

Level 2 Charging: This type of charging typically provides power at a rate of up to 7.2 kW (240 V x 30 A), though amperage can vary depending on the charging hardware and circuit. This is the same level of power used by clothes dryers and electric ovens, and any other device that plugs into a three- or four-pronged 240 V outlet. A standard Level 2 outlet will charge a fully depleted 40 kWh EV battery in a little more than five hours. These faster charging speeds make Level 2 charging stations much more practical for EV users who only plan to stop for an hour or two, perhaps at sites such as restaurants, parks, retail outlets, gyms, theatres, or visitor parking lots at residential buildings. Most home-based charging stations are Level 2, and can be programmed to begin the charging process during off-peak electricity usage hours, regardless of when a user actually plugs in their vehicle. SAE J1772 ports and connectors are the North American standard for Level 1 and Level 2 charging, and all production EVs are compatible with this type of charging.

DCFC (DC fast/quick charging): This type of charging is the fastest currently available, and provides direct current (DC) power – the same type of power distributed by high-voltage electricity transmission infrastructure in North America, and the same type of power stored by EV batteries. DC fast charging tends to use at least 480 V, and net power delivered can range from 50 kW up to 350 kW or greater in modern 'ultra-fast' DC chargers.¹⁴ Most modern EVs can charge at a rate of up to 50 kW, so a 40 kWh battery could be fully charged in about 45 minutes. Eventually, ultra-fast DC chargers could allow EVs with longer ranges than those of currently available models (and therefore larger batteries) to fully charge in under 10 minutes. Level 3 chargers are much more expensive to purchase, install and maintain than Level 2 stations, and as a result they are not typically used in residences. They are suitable at sites where EV users do not want to remain for any longer than necessary, such as highway rest stops or gas stations between major destinations.

¹³ <https://cleantechnica.com/2018/08/11/hydrogen-fuel-cell-battery-electric-vehicles-technology-rundown/>

¹⁴ <https://evsafecharge.com/dc-fast-charging-explained/>

Table 1: Summary of Charging Station Types

Descriptor	Level 1 AC	Level 2 AC	DCFC
EVs supported	All PHEVs and EVs	All PHEVs and EVs	Most BEVs and some PHEVs
Requirements	120-volt AC (alternating current) standard electrical outlet	240-volt AC (alternating current) connection	480-volt DC (direct current) connection
Average charging time	8 to 30 hours	4 to 10 hours	25 to 30 minutes (to 80% of full charge)
Range added per hour (approximate)	5-8 km	30-40 km	240-320+ km
Hardware and installation costs	\$1,000 in new MURB \$3,000 during renovation	\$1,000 in new MURB \$5,000 during renovation	\$50,000 - \$120,000
Applications	Long-term parking (home, work, etc.)	Long- and short-term parking (home, office, storefronts, etc.)	Long-distance travel (highways)

Source: Adapted from *Accelerating the Deployment of Zero Emission Vehicles: Atlantic Canada and the Prairies*¹⁵

A useful technical resource on specifications and installation considerations around different types of public EV charging stations is Hydro Quebec’s *Electric Vehicle Charging Stations: Technical Installation Guide*.¹⁶

1.5 Benefits of ZEVs to Municipalities

Municipalities can achieve a number of environmental, social and economic benefits by encouraging the uptake and use of ZEVs. These include GHG emissions savings, improved air quality and reduced noise pollution, all of which contribute to a healthier environment and human well-being. In addition, ZEVs can also deliver economic benefits, such as cost savings for consumers and municipal fleets, as well as helping to support local economies and jobs. The following sections provide a brief overview of some of the key benefits of ZEV adoption and use.

GHG Emission Reductions

ZEV adoption and use can help support municipal climate change strategies and GHG emissions reduction goals. Conventional fossil-fuel powered vehicles are responsible for producing tailpipe emissions of GHGs such as carbon dioxide (CO₂), methane (CH₄), ozone (O₃) and nitrous oxide (N₂O). EVs do not have tailpipe emissions, however, emissions

may be produced during generation of electricity that is used to charge the vehicle. The level of these emissions depends on the carbon intensity of the local energy supply mix. The greatest emissions savings will be achieved in municipalities that rely on low-emitting sources of electricity. However, even in areas served by carbon-intensive grids, net GHG reduction benefits can be achieved through the use of EVs as compared to petroleum powered vehicles. A 2015 study conducted by The Energy and Materials Research Group (EMRG) at Simon Fraser University found that based on current electricity grids, the use of EVs can reduce GHG emissions by 80-98% in British Columbia (a hydro-based grid), and about 45% in Alberta.¹⁷ As of 2018, Ontario’s grid is approximately 94% emissions-free,¹⁸ meaning that the use of EVs in the province will have a very minor GHG and air pollutant impact (especially considering that a large majority of EV charging occurs overnight when natural gas peaker plants are generally offline). These savings will become more significant as jurisdictions continue to decarbonize their energy grids. A 2015 study conducted by Canadian Energy Systems Analysis Research (CESAR) at the University of Calgary estimated that switching from gasoline vehicles to EVs in Alberta would result in GHG benefits of 1 to 1.5 t CO₂e per vehicle per year, which represents an approximately 33% reduction in GHG emissions for

¹⁵ <http://www.pollutionprobe.org/publications/accelerating-deployment-zevs-atlantic-canada-prairies/>

¹⁶ <http://www.hydroquebec.com/data/electrification-transport/pdf/technical-guide.pdf>

¹⁷ Axsen, J., Goldberg, S., Bailey, J. (2015). *Electrifying Vehicles: Insights from the Canadian Plug-in Electric Vehicle Study*. Sustainable Transportation Research Team Simon Fraser University. [http://rem-main.rem.sfu.ca/papers/jaxsen/Electrifying_Vehicle_\(Early_Release\)-The_2015_Canadian_Plug-in_Electric_Vehicle_Study.pdf](http://rem-main.rem.sfu.ca/papers/jaxsen/Electrifying_Vehicle_(Early_Release)-The_2015_Canadian_Plug-in_Electric_Vehicle_Study.pdf)

¹⁸ <http://www.ieso.ca/en/Corporate-IESO/Media/Year-End-Data>

new vehicles. However, GHG reductions will increase to roughly 50% by 2040 assuming that Alberta shifts from coal-fired power generation to lower emitting sources.¹⁹

Air Quality Benefits

The reduction of local air pollution is another important benefit of ZEV adoption and use, particularly in cities with particularly poor air quality. Fossil-fuel powered vehicles release criteria air contaminants (CACs), such as carbon monoxide (CO), particulate matter (PM), volatile organic compounds (VOCs) and nitrogen oxides (NOx) through their tailpipes. VOCs react with nitrogen oxides to form ground-level ozone, a major ingredient of smog. These air pollutants have been linked to a variety of health problems, including breathing, lung and heart conditions, cancers, and they can contribute to premature death.²⁰ Health Canada estimates that 14,400 premature deaths per year in Canada can be linked to air pollution.²¹ A 2015 study by the International Institute for Sustainable Development (IISD) found that approximately 7,712 premature deaths were attributable to PM_{2.5} and ground-level ozone in Canada in 2015, with an estimated \$36 billion in direct healthcare costs.²² Urban populations are particularly at risk, as many sources of criteria air contaminants, including fuel used for transportation, originate in towns and cities. Already vulnerable populations, such as young children, older adults, and people with existing health conditions, are also most at risk to experience negative air pollution health impacts.²³ In the City of Toronto alone, 1,300 premature deaths and 3,550 hospitalizations are attributed to air pollution each year, and transportation is the biggest local source.²⁴

While EVs can still lead to air pollutant emissions if fossil fuel reliant power plants are used to generate the electricity that powers them, these plants are

typically located far away from major population centres and are stationary point sources of pollution that can be more easily addressed than a large number of geographically dispersed non-point sources.

Urban Heat Island Effect

Urban heat islands are highly developed areas that become hotter than surrounding, more natural, areas due to the heat absorption characteristics of common fabricated materials and a lack of moisture. Heat emitted by vehicles and air conditioners serve to compound the severity of the urban heat island effect (UHIE).²⁵ Heat islands can worsen the impact of extreme heat events by increasing temperatures during the day and reducing cooling at night.²⁶ Heat waves are already leading to record-breaking power usage and deaths in Canadian communities^{27,28} and research predicts that heat waves will become more frequent and more deadly in Canada due to climate change.²⁹ A transition from conventional vehicles to ZEVs would help to mitigate the UHIE in Canadian cities and towns, while reducing energy use and benefitting local and global climates.

On a per kilometre basis, EVs emit only 19.8% of the heat emitted by conventional vehicles.³⁰ A 2015 study based in Beijing, China, found that if all conventional vehicles in the city were replaced with EVs, they would reduce average daily summer temperatures by 0.94 °C, and would reduce the daily electricity consumption of air conditioners by 14.44 million kWh, in addition to reducing daily GHG emissions by 10,686 tonnes.³¹ While the impact of UHIE mitigation would likely not be as dramatic in Canadian cities as in Beijing, widespread ZEV adoption would still have a measurable impact on urban temperatures. As one of the Beijing study's Michigan State University researchers said, "Heat waves kill, and in terms of climate change, even one degree can make a difference."³²

¹⁹ Layzell, D. and Straatman, B. (2016). The Potential Impact of Electric Vehicles on Alberta's Energy System. CESAR Scenarios, Vol. 1, Issue 2:1-26. <http://www.cesarnet.ca/sites/default/files/pdf/CESAR-Scenarios-Potential-Impact-EVs.pdf>

²⁰ <https://www.iisd.org/sites/default/files/publications/costs-of-pollution-in-canada.pdf>

²¹ <http://publications.gc.ca/site/eng/9.846412/publication.html>

²² <https://www.iisd.org/sites/default/files/publications/costs-of-pollution-in-canada.pdf>

²³ <https://www.canada.ca/en/health-canada/services/air-quality/health-effects-indoor-air-pollution.html#hi>

²⁴ <https://docs.assets.eco.on.ca/reports/climate-change/2018/Climate-Action-in-Ontario.pdf>

²⁵ <https://www.nature.com/articles/srep09213>

²⁶ <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/climate-change-health/climate-change-health-adaptation-bulletin-number-1-november-2009-revised-december-2010-health-canada-2009.html>

²⁷ <https://www.cbc.ca/news/canada/british-columbia/b-c-heat-wave-causes-record-breaking-power-consumption-1.4268161>

²⁸ <https://nationalpost.com/news/canada/new-research-predicts-heat-waves-in-canada-could-become-more-frequent-and-five-times-more-deadly>

²⁹ <https://nationalpost.com/news/canada/new-research-predicts-heat-waves-in-canada-could-become-more-frequent-and-five-times-more-deadly>

³⁰ <https://www.nature.com/articles/srep09213>

³¹ <https://www.nature.com/articles/srep09213>

³² <https://msutoday.msu.edu/news/2015/hidden-benefits-of-electric-vehicles-revealed/>

Energy Savings

ZEVs are more energy efficient than comparable ICE vehicles. EVs are able to convert 59%-62% of the electrical energy supplied from the grid to power at the wheels, whereas a conventional vehicle can convert only 17%-21% of the energy stored in gasoline to power at the wheels.³³ In addition, EVs are equipped with regenerative braking systems, which use the electric motor as a generator to turn some of the kinetic energy lost during braking into electrical energy which gets stored in the battery (this increases EV efficiency by an additional 17%).^{34,35} This makes EVs particularly efficient in stop-and-go traffic, which is all too common in urban settings, as well as in return-to-base fleet applications such as school buses and garbage trucks.

To help encourage energy efficient driving, Natural Resources Canada has developed a number of consumer-focused programs. It also publishes an annual Fuel Consumption Guide, which provides information on the fuel consumption of current model year light-duty vehicles to help consumers choose the most fuel efficient vehicle that can meet their transportation needs. Fuel consumption ratings are also archived for all production light-duty vehicles dating back to 1995.³⁶ Other government-supported programs related to fuel efficient driving include:

- *ecoDriving Online*, a 25 minute online course developed by Stantec Consulting with support from NRCAN to teach driving techniques that can reduce fuel costs by 25%, as well as energy use and emissions, and vehicle maintenance.³⁷
- *AutoSmart driver training*, which consists of four course modules for driving instructors that focus on: driving and the environment, five techniques to save money and protect the environment, and how to choose the most fuel efficient vehicle.³⁸
- *FleetSmart fuel-efficient fleet management*, a program designed for professional drivers, owner-operators, driving instructors and fleet managers. The program explains how energy-

efficient vehicles, driving habits and business practices can cut operating costs, reduce vehicle emissions and improve productivity. The program offers SmartDriver training for drivers in different transportation sub-sectors such as highway trucks, forestry vehicles, transit buses, and school buses.³⁹

Noise Pollution Reduction

ZEVs are much quieter than conventional ICE vehicles because they do not produce a significant amount of engine noise.⁴⁰ When traveling at lower speeds (below 30 km/h), ZEVs are almost silent.⁴¹ This is particularly beneficial in urban settings where traffic tends to move slowly. In all cities, the use of ZEVs can help reduce noise pollution associated with road traffic, contributing to a more peaceful environment and a higher quality of life for local residents.

Cost Savings for Municipal Fleets and Consumers

ZEVs tend to have higher upfront costs than comparable ICE vehicles. ZEV fueling and operating costs are lower however, and over vehicle lifetimes these savings can offset higher sticker prices. Operating costs for ZEVs are lower due in part to the fact that a typical ICE vehicle contains roughly 2,000 moving parts, whereas EV powertrains contain roughly 20.^{42,43} Electricity costs are far lower than fuel for petroleum-powered transportation on a per kilometre basis and electricity is also more predictably priced than gasoline or diesel. Fleet managers, when budgeting for future fuel costs, are often forced to set aside large portions of their total budgets to account for unpredictable gas prices, which can go up or down by significant margins in relatively short periods of time. Electricity rates, on the other hand, are far more predictable and are locked in for long periods. These cost benefits allow for more accurate mid- and long-term budgeting for fleet fuel and maintenance costs when fleets are electrified. This means that funds can be spent where they are most needed and do not have to be placed in reserve to buffer against future

³³ <https://www.fueleconomy.gov/feg/evtech.shtml>

³⁴ <https://www.fueleconomy.gov/feg/atv-ev.shtml>

³⁵ <https://electrek.co/2018/04/24/regenerative-braking-how-it-works/>

³⁶ <https://www.nrcan.gc.ca/energy/efficiency/11938>

³⁷ <http://ecodrivingonline.ca/>

³⁸ <https://www.nrcan.gc.ca/energy/efficiency/transportation/21042>

³⁹ <https://www.nrcan.gc.ca/energy/efficiency/transportation/21046>

⁴⁰ https://books.google.ca/books?id=_H2wAgAAQBAJ&pg=PA767&dq=engine+noise+dominates+at+lower+speeds&source=bl&ots=6sN2yevqAE&sig=ACFu3UzhROY7dnbYe0HE-f3pKn_tXoTiaQ&hl=en&sa=X&ved=2ahUKewiDwaSH9Y7gAhWszIMKH0qCh4Q6AEwCnoECAMQAQ

⁴¹ <https://www.fleetcarma.com/electric-vehicles-quiet/>

⁴² <https://www.cbc.com/2016/06/14/electric-vehicles-will-soon-be-cheaper-than-regular-cars-because-maintenance-costs-are-lower-says-tony-seba.html>

⁴³ <https://cleantechnica.com/2013/09/27/tesla-model-s-almost-maintenance-free/>

gas price fluctuations. FleetCarma estimated that ZEVs have three times lower overall maintenance costs per kilometre, at 1 cent per kilometre versus 3 cents for an ICE vehicle.⁴⁴ Some research suggests that ZEVs have 20-25% lower total cost of ownership than comparable ICE vehicles over an eight-year service life.⁴⁵

These considerations help make ZEVs a suitable choice for municipal fleet managers as well as individual consumers who are looking to reduce their fleet/vehicle costs.

Benefits for local economies and jobs

The use of ZEVs can support local economies and jobs by promoting the use of locally-generated electricity as opposed to fossil fuels, which are imported in many jurisdictions across Canada. ZEV policies can also be a positive market signal for the cleantech and automotive sectors, supporting research and development on emerging technologies in innovation clusters and urban tech hubs and helping to attract new talent and businesses to Canadian cities.

Canada’s cleantech sector employs approximately 274,000 people and contributed \$59.3 billion to GDP in 2016. Canada is home to many flagship companies supplying clean transportation technologies and solutions to domestic and international markets (Winnipeg-based New Flyer Industries, Mississauga-based Hydrogenics, Vancouver-based Ballard Power, and Montreal-based TM4 are just few examples).⁴⁶ The global cleantech market is expected to grow to \$2.2 trillion by 2022. Through transportation electrification initiatives, Canadian municipalities can not only create new local jobs and economic opportunities but also support Canadian cleantech companies and help with the export of Canadian expertise and solutions around the world.

1.6 Current ZEV Adoption Levels in Canada and Globally

1.6.1 Global ZEV adoption

The adoption and use of ZEVs has been on the rise worldwide, driven primarily by supportive government

policies, falling costs of lithium-ion batteries and increased ZEV offerings from manufacturers.

The IEA estimates that a record 1.1 million new EVs were sold worldwide in 2017, an increase of 54% from the previous year. Norway is the leading market for EVs in terms of new sales share, with EVs making up 39% of new sales in 2017. Iceland and Sweden follow, with 11.7% and 6.3% market share of EV sales, respectively. In China, EVs had a market share of 2.2% in 2017 but those EVs accounted for more than half of total global EV sales in that year.⁴⁷

The global stock of EVs hit 3.1 million in 2017, up 56% from the previous year. Around 40% of the global EV fleet is in China, which has more than 1 million EVs on its roads. The United States and Japan follow with 762,000 and 205,000 EVs, or 25% and 7% of the global total, respectively. Norway has the world’s highest share of EVs in its existing vehicle fleet, at 6.4%. The EV share of road-worthy vehicles was below 2% in most other countries in 2017.⁴⁸

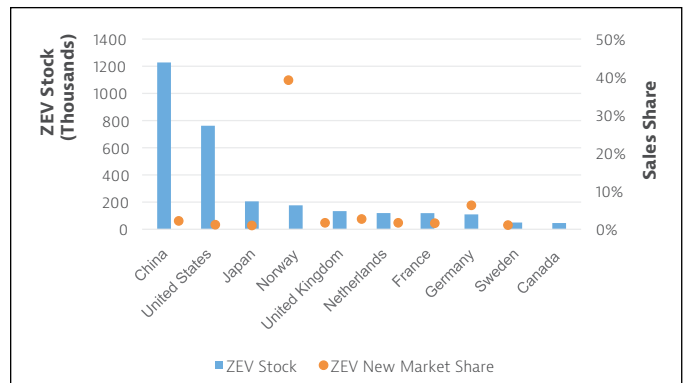


Figure 3: ZEV Stock and New Market Share in Key Markets (2017)⁴⁹

In addition to passenger EVs, there were nearly 250,000 electric light commercial vehicles (LCVs) in operation in 2017, with the largest fleets being in China (170,000 vehicles), France (33,000 vehicles) and Germany (11,000 vehicles).⁵⁰

ZEVs have started to enter the medium- and heavy-duty vehicle markets as well.⁵¹ Sales of electric buses (BEV and PHEVs) were estimated at more than

⁴⁴ <https://www.fleetcarma.com/electric-vehicles-lower-maintenance-costs/>

⁴⁵ https://www.partnersinprojectgreen.com/wp-content/uploads/2017/01/PPG_Charge-Up-Ontario_EVSE-Report-UPDATED-MARCH_1_2017.pdf

⁴⁶ https://www.international.gc.ca/investors-investisseurs/assets/pdfs/download/vp-clean_technology.pdf

⁴⁷ <https://www.iea.org/gevo2018/>

⁴⁸ <https://www.iea.org/gevo2018/>

⁴⁹ Adapted from IEA Global EV Outlook 2018. <https://www.iea.org/gevo2018/>

⁵⁰ <https://www.iea.org/gevo2018/>

⁵¹ https://www.theicct.org/sites/default/files/publications/Zero-emission-freight-trucks_ICCT-white-paper_26092017_vF.pdf

100,000 units in 2017 while the total ZEV bus stock reached 370,000 vehicles in that year. China accounts for the vast majority of these numbers, being home to more than 99% of the global electric bus stock. In addition, there are 2,100 electric buses on the roads in Europe, North America and Japan. In 2017, 250 FCEV buses were in circulation worldwide. ZEVs are also being considered for applications in the medium- and heavy-duty freight sectors; however, their use is currently limited to small demonstration fleets and targeted programmes.⁵²

1.6.2 ZEV adoption in Canada

The Canadian ZEV market has seen strong growth in recent years. Key factors that have contributed to ZEV uptake have included supportive government policies, expanded model availability and increased consumer familiarity with the technology.⁵³

FleetCarma estimates that approximately 3,254 EVs were sold in Canada by the end of 2013, but five years later, at the end of 2018, annual sales had increased more than tenfold to reach 44,175 units (see Figure 4).⁵⁴ On average, EV sales grew by more than 71% per year during each of the past five years.^{55,56} Sales have increased by approximately 130% from 2017 to 2018. Cumulative EV sales surpassed 93,000 units by the end of 2018, with sales almost evenly split between BEVs and PHEVs.⁵⁷

The EV share of total LDV sales increased from 0.2% in 2013 to 0.9% in 2017, and surged ahead to 2.2% in 2018.⁵⁸ The EV share of new passenger car sales (which excludes SUVs, pickups and minivans) reached 7.6% in 2018.⁵⁹ In 2017, there were 22,678,328 passenger vehicles registered in Canada (which includes SUVs, pickups and minivans).⁶⁰ Considering that cumulative EV sales reached 45,941 in 2017, EV share of the total passenger vehicle stock was approximately 0.2% in that year. By the end of 2018, this share rose to approximately 0.4%.

To support the federal ZEV adoption targets, Budget 2019 proposed:

- \$130 million over five years to NRCan to deploy new zero emission vehicle infrastructure (e.g., Level 2) in more focused locations such as apartment buildings and the workplace;
- \$300 million over three years to Transport Canada for a federal purchase incentive of up to \$5,000 for electric or hydrogen fuel cell vehicles for vehicles that cost \$45,000 or less;
- \$5 million over five years to Transport Canada to work with auto manufacturers to secure voluntary zero emission vehicle sales targets; and
- A full tax write-off for light-, medium- and heavy-duty ZEVs purchased by businesses, including battery electric, plug-in hybrid (with a battery capacity of at least 15 kWh) or hydrogen fuel cell vehicles

These measures are also largely aligned with the interim recommendations made by the national Advisory Council on Climate Action.

Budget 2019 also proposes to invest \$1 billion to increase energy efficiency in residential, commercial and multi-unit buildings. These investments will be delivered by the Federation of Canadian Municipalities (FCM) through the Green Municipal Fund, and projects incorporating the installation of EV charging infrastructure will be eligible for funding.

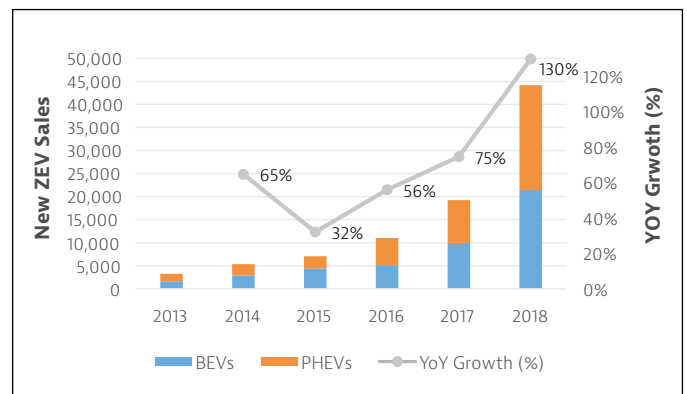


Figure 4: ZEV sales and year-over-year (YoY) growth for new EVs in Canada between 2013 and 2018⁶¹

⁵² https://webstore.iea.org/download/direct/1045?filename=global_ev_outlook_2018.pdf

⁵³ <https://www.fleetcarma.com/electric-vehicles-sales-update-q2-2018-canada/>

⁵⁴ <https://emc-mec.ca/wp-content/uploads/EMC-Sales-Report-Rapport-de-ventes-M%C3%89C-2018.pdf>

⁵⁵ <https://www.fleetcarma.com/electric-vehicles-sales-update-q3-2018-canada/>

⁵⁶ <https://emc-mec.ca/wp-content/uploads/EMC-Sales-Report-Rapport-de-ventes-M%C3%89C-2018.pdf>

⁵⁷ <https://emc-mec.ca/wp-content/uploads/EMC-Sales-Report-Rapport-de-ventes-M%C3%89C-2018.pdf>

⁵⁸ <https://emc-mec.ca/wp-content/uploads/EMC-Sales-Report-Rapport-de-ventes-M%C3%89C-2018.pdf>

⁵⁹ <https://www.fleetcarma.com/electric-vehicles-sales-update-q3-2018-canada/>

⁶⁰ <https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2310006701#timeframe>

⁶¹ Adapted from FleetCarma's Electric Vehicle Sales Update Q3 2018, Canada, and from Electric Mobility Canada's Electric Vehicle Sales in Canada in 2018. <https://www.fleetcarma.com/electric-vehicles-sales-update-q3-2018-canada/>

Most EV sales (97%) have been concentrated in the provinces of British Columbia, Quebec and Ontario. These three provinces have seen significant year-over-year growth in EV sales (see Figure 5), which has been attributed to the implementation of comprehensive EV strategies in these jurisdictions.⁶² 2018 saw the total number of EVs on the road in the three leading provinces more than double, with 8,449 units sold in B.C. (out of a cumulative total of 17,175 EVs), 17,557 units sold in Quebec (38,737 total), and 16,814 units sold in Ontario (34,052 total).⁶³

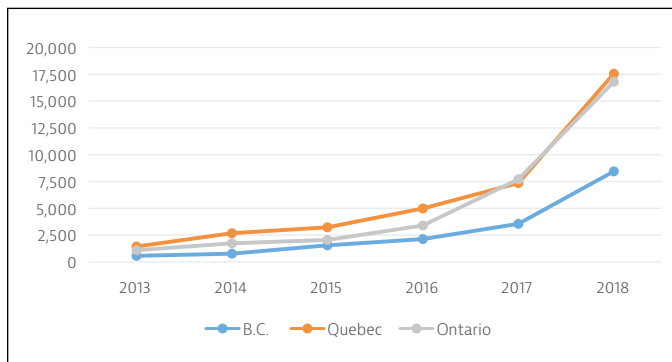


Figure 5. Annual ZEV Sales in B.C., Quebec and Ontario⁶⁴

1.6.3 ZEV adoption projections globally and nationally

Growth in ZEV sales around the world and in Canada is expected to continue in large part due to supportive government policies, falling battery costs and increased ZEV offerings from automakers.^{65,66}

The IEA estimates that by 2030, global EV sales will reach between 21.5 and 38 million, and the EV stock will number between 125 and 228 million, or 6 to 12% of the global LDV stock, depending on the scenario.⁶⁷ Bloomberg forecasts that by 2040, 55% of all new car sales and 33% of the global passenger car fleet (or 559 million vehicles) will be electric.⁶⁸

In 2017 Équiterre simulated ZEV new market share in three policy scenarios for Canada by applying the Canadian REspondent-based Preference and Constraint (REPAC) model. The model incorporated key components of ZEV demand, supply and relevant ZEV policies. The study found that ZEV new market share would grow to 6-17% by 2030 in the business as usual (BAU) scenario. In the “Strong” demand-focused policy scenario, ZEV new market share would reach 10-20% in 2030 while in the ZEV mandate scenario ZEV new market share increased to 30-48% by 2030.⁶⁹

In another study, The Sustainable Transportation Action Research Team (START) at Simon Fraser University applied the REPAC model to estimate ZEV new market share out to 2040, based on demand, supply and relevant policies.⁷⁰ The study found that under current policies, the new market share of ZEVs will reach between 8% and 17% in 2040. The study modelled the impact of three policy packages on the share of ZEV sales in 2040, including: 1) a demand-focused approach that includes long-term financial incentives for ZEVs; 2) a supply-focused approach that includes a ZEV mandate; and 3) a supply-focused approach that includes a strengthened vehicle emissions standard. The study found that each approach can meet the 40% target in 2040 but approaches differ in terms of the likelihood of achieving that target. Researchers found that a supply-focused approach that relies on a ZEV mandate provides the highest level of certainty that the 2040 ZEV sales target will be achieved.⁷¹

⁶² <https://emc-mec.ca/wp-content/uploads/EMC-Sales-Report-Rapport-de-ventes-M%C3%89C-2018.pdf>

⁶³ <http://www.pollutionprobe.org/publications/accelerating-deployment-zevs-atlantic-canada-prairies/>

⁶⁴ <https://emc-mec.ca/wp-content/uploads/EMC-Sales-Report-Rapport-de-ventes-M%C3%89C-2018.pdf>

⁶⁵ Adapted from FleetCarma’s Electric Vehicle Sales Update Q3 2018, Canada, and from Electric Mobility Canada’s Electric Vehicle Sales in Canada in 2018.

⁶⁶ <https://www.fleetcarma.com/electric-vehicles-sales-update-q3-2018-canada/>

⁶⁷ <https://emc-mec.ca/wp-content/uploads/EMC-Sales-Report-Rapport-de-ventes-M%C3%89C-2018.pdf>

⁶⁸ https://webstore.iea.org/download/direct/1045?filename=global_ev_outlook_2018.pdf

⁶⁹ <https://bnf.turtl.co/story/evo2018?teaser=true>

⁷⁰ https://webstore.iea.org/download/direct/1045?filename=global_ev_outlook_2018.pdf

⁷¹ <https://bnf.turtl.co/story/evo2018?teaser=true>

⁷² J. Axsen, S. Goldberg and M. Wolinetz. (2017). Accelerating the transition to electric mobility in Canada: The case for a zero-emission vehicle mandate. https://equiterre.org/sites/fichiers/repac_en.pdf

⁷³ Sustainable Transportation Action Research Team (START) (2017). Canada’s ZEV Policy handbook. https://sfustart.files.wordpress.com/2017/12/zev-policy-handbook_web.pdf

⁷⁴ Sustainable Transportation Action Research Team (START) (2017).Canada’s ZEV Policy handbook. https://sfustart.files.wordpress.com/2017/12/zev-policy-handbook_web.pdf



2 | STAKEHOLDERS FOR MUNICIPAL ZEV STRATEGY DEVELOPMENT

There are a variety of stakeholders that could be involved in municipal ZEV strategy development and implementation. While each stakeholder group has a core role to play, there is often opportunity for partnerships and cooperation on cross-cutting activities.

Table 2 presents the types of ZEV stakeholder, example types of activities they can be involved in

to accelerate ZEV deployment, and example best practices. The Matrix of Actions, presented in Section 3, provides a visualization of key actions and potential roles for stakeholders. Additional best practice examples are presented in Appendix A (for privately-owned LDVs) and Appendix B (for Fleets, MDVs, and HDVs).

Table 2: Stakeholders for Municipal ZEV Strategy Development

Stakeholder	Core Reasons for Participation	Other Suitable Activities	Example Best Practices
Federal Government G	<ul style="list-style-type: none"> Regulatory/policy, develop, implement, and enforce codes and standards, e.g., building and electrical codes Funding/incentive programs Strategy/targets, e.g., ZEV deployment, freight movement, etc. RD&D 	<ul style="list-style-type: none"> Infrastructure, i.e., EV charging at the national scale (highways), best practices on public procurement of charging infrastructure, etc. Education/awareness initiatives Fleets, including best practices on procurement for other fleets 	<ul style="list-style-type: none"> Large-scale demonstration and installation of curbside charging infrastructure (Electric Vehicle Infrastructure Demonstration) funded by NRCan, Energy Innovation Program, with participating cities and utilities

Stakeholder	Core Reasons for Participation	Other Suitable Activities	Example Best Practices
Provincial Government (G)	<ul style="list-style-type: none"> Regulatory/policy, e.g., building codes, condominium acts, etc. Funding/incentive programs Strategy/targets, e.g., ZEV deployment, freight movement, etc. Licensing 	<ul style="list-style-type: none"> Infrastructure, this could include standardization of signage, charging infrastructure, etc. Education/awareness initiatives Fleets RD&D 	<ul style="list-style-type: none"> Ontario Municipal Building Code Proposed BC legislation that will set targets for ZEV sales, including 100% by 2040 Quebec Transportation Electrification Action Plan
Municipal Government (M)	<ul style="list-style-type: none"> Regulatory/policy, e.g., zoning and bylaws, permitting, etc. Community plans and strategies, e.g., community energy and climate plans Infrastructure, at the local scale, e.g., city parking, curbside, etc. Fleets Public transit 	<ul style="list-style-type: none"> Funding/incentives, e.g., parking incentives Education/awareness initiatives 	<ul style="list-style-type: none"> Montreal Electrification Strategy, including network of public curbside charging stations (1,000 by 2020) Richmond zoning bylaw requiring 100% parking spaces have energized outlets capable of providing Level 2 EV charging
Utilities (U)	<ul style="list-style-type: none"> Funding/incentives RD&D, including pilot programs Infrastructure, i.e., grid and charging 	<ul style="list-style-type: none"> Education/awareness Fleets 	<ul style="list-style-type: none"> BC Hydro research and demonstration project on MURB charging
Industry – Automakers/OEMs (A)	<ul style="list-style-type: none"> Funding/incentives RD&D Vehicle availability 	<ul style="list-style-type: none"> Education/awareness Infrastructure, e.g., charging 	<ul style="list-style-type: none"> Tesla Supercharger network
Industry – EVSE companies/fueling infrastructure providers (I)	<ul style="list-style-type: none"> RD&D, including pilot programs Funding/incentives Technology availability 	<ul style="list-style-type: none"> Education/awareness, including installation design best practices 	<ul style="list-style-type: none"> Flo and ChargePoint EV charging roaming agreement
Real estate developers, construction companies (R)	<ul style="list-style-type: none"> Infrastructure, i.e., electrical and charging Sustainability-related certifications/compliance 	<ul style="list-style-type: none"> Education/awareness 	<ul style="list-style-type: none"> None identified at this time
Dealers/Dealerships (D)	<ul style="list-style-type: none"> Funding/incentives, e.g., leasing options Education/awareness, including test drives and services, e.g., pre-filling rebate forms, apps/memberships for stations, etc. Vehicle availability 	<ul style="list-style-type: none"> Infrastructure, e.g., on-site charging 	<ul style="list-style-type: none"> Dealerships in Charlotte, NC are establishing partnerships with the municipality along with other stakeholders

Stakeholder	Core Reasons for Participation	Other Suitable Activities	Example Best Practices
Civil society, academia, research organizations, NGOs, associations (CS)	<ul style="list-style-type: none"> Education/awareness, including advocacy 	<ul style="list-style-type: none"> Funding/incentives, typically as partners, e.g., administering a program Infrastructure, typically as partners RD&D 	<ul style="list-style-type: none"> Plug'n Drive Electric Vehicle Discovery Centre
Property/building owners, managers, condo/strata boards (P)	<ul style="list-style-type: none"> Infrastructure, i.e., electrical and charging Education/awareness, including advocacy Sustainability-related certifications/compliance 	<ul style="list-style-type: none"> Incentives, e.g., parking incentives Charging demonstrations/pilots, typically as partners 	<ul style="list-style-type: none"> None identified at this time
Fleet owners and operators (municipal and private) (F)	<ul style="list-style-type: none"> Infrastructure, e.g., charging Education/awareness Fleet conversion Total cost of ownership savings 	<ul style="list-style-type: none"> R&D, demonstrations and pilots Funding/incentives 	<ul style="list-style-type: none"> Saanich has eight EVs, and its police department became the first in Canada to adopt an EV Seattle partnered with Electric Power Research Institute to test charging technologies on the City's fleet vehicles



3 | MUNICIPAL ACTIONS TO ENHANCE ZEV UPTAKE

3.1 Introducing the Municipal Matrix of Actions

There is no single action, or actor, that can accelerate the deployment of ZEVs in municipalities. Rather, accelerating the deployment of ZEVs in municipalities requires multiple concurrent and consecutive actions executed by the municipality and its diverse group of stakeholders. Some of these actions can be undertaken by either the municipality or individual stakeholders, and some actions will require partnerships and/or coordinated effort. The Municipal ZEV Framework uses a Matrix of Actions approach to categorize the types of actions that must be undertaken (e.g., fueling and charging Infrastructure, education and awareness, etc.) and to identify stakeholders who can contribute to the execution of specific actions.

Given the broad range of applications for ZEVs, actions have been divided into two Matrix of Actions. A matrix has been created for privately-owned LDVs and a second matrix has been created for fleets, MDVs and HDVs.

Matrices are presented in the sections below along with high-level descriptions of the categories of activities and the role of municipalities and other stakeholders with respect to these actions. Detailed definitions for each action, examples of best practices, and challenges and solutions for implementation can be found in **Appendix A** (privately-owned LDVs) and **Appendix B** (fleets, MDVs and HDVs).

3.2 Privately-owned Light-duty Vehicles: Matrix of Actions

Municipal Zero Emission LDV Matrix of Actions

Fueling & Charging Infrastructure	Education & Awareness	Incentives	Complementary Mechanisms
<p>Public charging network partnerships (including inter-municipal)</p> <p>M G U A D I R P CS</p>	<p>Public education programs and campaigns</p> <p>M G U A CS</p>	<p>Vehicle and/or charger voucher or rebate</p> <p>M G U D I</p>	<p>Advocate for changes to provincial/federal regulations: MURBs</p> <p>M G U P CS</p>
<p>Public charging stations and charging hubs including on-street parking</p> <p>M U I</p>	<p>Curriculum at local schools, colleges, and universities</p> <p>M G CS</p>	<p>E-bike/scooter voucher or rebate</p> <p>M G A</p>	<p>Advocate for changes to provincial/federal regulations: other regulatory barriers</p> <p>M G</p>
<p>Charging at municipally owned facilities</p> <p>M U I</p>	<p>Information at charging points</p> <p>M G I CS</p>	<p>Vehicle scrappage incentives</p> <p>M G D CS</p>	<p>Amend or introduce local bylaws to address barriers (e.g., anti-ICEing bylaw)</p> <p>M G</p>
<p>Seek external infrastructure funding opportunities</p> <p>M G U</p>	<p>Promotion at workplaces, Workplace Charging Challenge</p> <p>M P CS</p>	<p>Multi-unit residential building retrofit and load management incentives</p> <p>M G P</p>	<p>Explore adding ZEV infrastructure to Community Amenity Contributions</p> <p>M R</p>
<p>ZEV-ready new single-family homes</p> <p>M G U I R</p>	<p>Address knowledge gaps surrounding home charging</p> <p>M U A D I CS</p>	<p>Preferential or free parking</p> <p>M P</p>	<p>Research partnerships, innovation, and field testing</p> <p>M U A CS</p>
<p>ZEV-ready new commercial and institutional buildings</p> <p>M G U I R P</p>	<p>Provide information on city website (including charging/fueling infrastructure locations; total cost of ownership calculator)</p> <p>M</p>	<p>Toll discount</p> <p>M G</p>	<p>Collect data on usage of charging facilities, ZEV purchases, infrastructure availability</p> <p>M U D I</p>
<p>ZEV-ready new multi-unit residential buildings</p> <p>M G U I R P</p>	<p>Create resource connecting EV owners and their experiences to potential adopters</p> <p>M G CS</p>	<p>Explore instituting congestion charges for non-ZEVs in priority areas</p> <p>M CS</p>	<p>Seek regulatory clarity on charging for charging</p> <p>M G U I P</p>
<p>Address challenges and barriers to charging for multi-unit residential buildings and garage orphans</p> <p>M G R P CS</p>	<p>Troubleshooting assistance for homeowners and building managers (especially regarding charging infrastructure)</p> <p>M U I</p>	<p>Carpool lane access (HOV/HOT lane)</p> <p>M G</p>	<p>Analyze data to enhance the availability of charging where most needed</p> <p>M U CS</p>

Fueling & Charging Infrastructure	Education & Awareness	Incentives	Complementary Mechanisms
ZEV-ready retrofits for existing buildings (incorporating load management) M U I P	Enhanced and consistent signage for charging stations M G I	ZEV-only areas or Low Emission Zones (LEZs) M G	Community mobility needs assessment and social equity analysis M CS
ZEV-ready building codes and standards (for new and existing buildings) M G U I R P	Identify and promote charging facilities including locations and availability M U I CS	Incentive funding partnerships M G U A D I CS	Internal ZEV working group M U
ZEV-ready new parking facilities and retrofits M U I R P	ZEV showcase, demonstrations, and events M U A D I CS	Tax benefits for charging/refueling hosts M G P	ZEV information sharing network M G U D R P CS
Other enabling programs and policies for public charging infrastructure, such as public charging on private property M U R P CS	Targeted engagement and training: developers, architects, builders, and contractors (and respective associations) M U I R CS	Link car-share parking incentives with charging incentives M	Ongoing collaboration with public and private partners M G U A D I R P CS
Other enabling programs and policies for home and workplace charging (e.g., financing workplace charging through local improvement charges) M G U R P CS	Targeted engagement and training: landlords, property managers, and strata/tenant boards M U I P CS	Charging revenue via carbon or clean fuel credits M G	Advocate for supply-side ZEV mandate at provincial or federal level M A D CS
Incorporate electrification needs into housing/property management and planning processes M U R P	Targeted engagement and training: vehicle dealerships and sales staff M G U D I CS	Incentives in fee structure for public charging M G U I	Develop transportation electrification plans M U CS
Identify opportunities to install supporting infrastructure (e.g., charging) during public works projects M U I R	Targeted engagement and training: city building management and development staff M U I R P CS	Advocate for regulatory incentives for ZEV investments (e.g., via Clean Fuel Standard, carbon taxes) M G R P	Tax incentives to dealerships for selling ZEVs M A D
Ensure electrical grid access, readiness, and resilience M U	Targeted engagement and training: first responders M G A	Allocate points for ZEV infrastructure in evaluation of development proposals M R	

Fueling & Charging Infrastructure	Education & Awareness	Incentives	Complementary Mechanisms
<p>Explore renewable energy generation tied to ZEV charging</p> <p>M U CS</p>	<p>Encourage local utility to establish staff lead(s) to respond to public queries regarding EVSE</p> <p>M U</p>	<p>Explore potential tax benefits for ZEV infrastructure</p> <p>M G U R P</p>	
<p>Address opportunities for vehicle-to-grid and vehicle-to-building charging systems (smart microgrids)</p> <p>M G U I R P CS</p>	<p>ZEV municipal fleet adoption to enhance public awareness</p> <p>M U I</p>	<p>Explore excluding ZEV infrastructure from demand charges</p> <p>M G U P CS</p>	
<p>Develop guidance on the lifecycle management of charging infrastructure</p> <p>M G U I</p>		<p>Consider a range of possible disincentives for ICE vehicles</p> <p>M G</p>	
<p>Conduct investment and technological risk assessments on charging infrastructure</p> <p>M G U A I CS</p>		<p>Create partnerships to offer free/discounted car-share/ rental memberships and rates with ZEV purchases</p> <p>M G A D</p>	
<p>Advocate for removal of regulatory barriers to EVSE deployed by utilities to allow for cost recovery through rate base (e.g., via demand charges)</p> <p>M G U I</p>		<p>Development charge discounts for ZEV infrastructure investments</p> <p>M G I R P</p>	
<p>Develop guidance on procurement process for charging infrastructure</p> <p>M U I</p>		<p>Explore possible incentives for used ZEV market</p> <p>M G D CS</p>	
<p>Consider medium to long term hydrogen opportunities for LDVs</p> <p>M G A I</p>		<p>Streamline application process for charging/ refueling infrastructure permits</p> <p>M U I R P</p>	
<p>Identify potential ZEV charging/refueling corridors</p> <p>M G U I CS</p>			
<p>Install Level 3 public chargers (DCFCs)</p> <p>M U I P</p>			

Fueling & Charging Infrastructure	Education & Awareness	Incentives	Complementary Mechanisms
Explore opportunities for public Level 1 charging in appropriate areas (e.g., airports, workplaces, transit hubs) (M) (U) (P)			
Explore issuing green municipal bonds to finance charging infrastructure (M)			

Legend

- (M) Municipal Government
- (G) Other governments (federal and/or provincial) and arm’s length organizations
- (U) Utilities
- (A) Automakers
- (D) Dealerships
- (I) Electric vehicle supply equipment companies / fueling infrastructure providers
- (R) Real estate developers, construction companies
- (P) Property/building owners, managers, condo/strata boards
- (CS) Civil society, academia, research organizations, NGOs, associations

3.2.1 Fueling and charging infrastructure

Ensuring that an adequate amount of publicly-accessible fueling and charging infrastructure is located in strategic areas of a city is crucial to the success of any ZEV deployment strategy.

For EVs, there is a correlation between where vehicles are parked for longer periods of time and where charging solutions are most important. For example, home charging is the most important type of charging to enable EV ownership and currently most charging occurs at home (80-90%⁷²). Where close to home charging solutions are seen as reasonable but less convenient (e.g., on-street charging), having access

to workplace charging as a secondary solution can significantly improve the value proposition for EV ownership. Following home and workplace charging, public charging is currently the least-used type of charging⁷³; however, it does provide key benefits including increasing the visibility of charging stations and therefore helps to address concerns around range anxiety.

Limited or no hydrogen fueling infrastructure is one of the key barriers to market adoption of hydrogen fuel cell vehicles.⁷⁴ A network of dependable, publicly available hydrogen fueling stations (similar to gasoline/diesel fueling stations) is required to accommodate a market expansion of FCEVs.

⁷² Bruce Power, Plug’n Drive, Pollution Probe, University of Waterloo, Accelerating the Deployment of Plug-In Electric Vehicles in Canada and Ontario, 2016. <http://www.pollutionprobe.org/publications/accelerating-ev-deployment-report/>
⁷³ Hardman, S., et al. Considerations for the development of plug-in electric vehicle charging infrastructure for consumers – A review, UC Davis, September 2017. <https://phev.ucdavis.edu/wp-content/uploads/PEV-Infrastructure-Literature-Review-pdf>
⁷⁴ British Columbia, Clean Transportation Policies and Programs, Clean Energy Vehicle Program, Hydrogen Fueling Infrastructure. <https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/clean-transportation-policies-programs/clean-energy-vehicle-program/hydrogen-fuelling>

3.2.1.1 *Role of municipalities*

Municipalities typically address fueling and charging infrastructure through their primary role of policy development (e.g., zoning and bylaw amendments), city planning, and installing public charging infrastructure alone or through partnerships. Over the course of this study, several experts noted that a key role for municipalities with regard to the deployment of public charging infrastructure is to fill the gaps left by private sector charging providers, to ensure that all neighbourhoods have some access to public charging.

3.2.1.2 *Themes of action*

Actions in fueling and charging infrastructure can be grouped within the following themes.

- **Public Fueling and Charging Networks:** actions aimed at expanding the network of public fueling and charging infrastructure including feasibility assessments, funding, policies, and installation.
- **Home, Workplace, and Parking Facility Charging:** actions to increase privately and publicly owned charging infrastructure including policies and feasibility studies.
- **City Planning and Management:** actions aimed at planning for electrification needs and leveraging major public works projects.
- **Electrical Grid Infrastructure:** actions to support grid preparedness, electrification plans, and renewable energy related to charging.

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix A.1**.

3.2.2 Education and awareness

Education and awareness are frequently identified as key barriers to ZEV ownership. The benefits of ZEV ownership (e.g., environmental, total cost of ownership, etc.) along with usage information (e.g., understanding fueling and charging infrastructure) need to be expressed and communicated in a way that addresses lack of familiarity with the

technologies and specific concerns such as range anxiety for EVs and fueling for FCEVs. Active public education and awareness programs and campaigns play a critical role in boosting ZEV deployment.

3.2.2.1 *Role of municipalities*

Municipalities are not a primary source of information for individuals considering the purchase of a ZEV. Review sites, NGOs, owner associations, OEMs, peers and a number of other sources are more likely to be consulted. From that perspective, direct education and awareness by municipalities (e.g., via ZEV dedicated city websites) should be focused on municipal policies and programs impacting ZEVs and then can consider other items like the municipal charging networks. Indirectly, municipalities can support information development to be disseminated through other avenues, and can also help to direct constituents to useful informational resources. They can also use policies (e.g., on signage and point-of-sale information requirements) and their own city fleets and charging infrastructure to build awareness and promote ZEVs.

3.2.2.2 *Themes of action*

Actions within education and awareness can be grouped into the following themes.

- **Public Outreach and Education:** actions aimed at the general public to increase knowledge and awareness of ZEVs and fueling and charging.
- **Technical Assistance:** actions to assist with troubleshooting charging infrastructure.
- **Awareness of Fueling and Charging Facilities and Infrastructure:** actions to enhance accessibility and usability of public fueling and charging stations.
- **Targeted Training and Education:** targeted training actions aimed at specific stakeholder groups.
- **Hands-on and In-person Learning:** actions aimed at the general public to increase direct experience with ZEVs.

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix A.2**.

3.2.3 Incentives

Financial and non-financial incentives, as a means to promote and encourage ZEV mobility, have been attributed to successful ZEV uptake levels in leading jurisdictions.⁷⁵ Incentives include measures to help potential ZEV owners mitigate purchase and operating costs, while also optimizing convenience. For example, to address capital costs of vehicles as well as charging infrastructure (for EVs), several jurisdictions provide financial incentives, such as purchase rebates. Other financial incentives can play an important role in ZEV uptake, such as exemption from road tolls, free municipal parking, and free electricity for charging. Non-financial incentives that focus on convenience are often included in leading jurisdiction ZEV mobility strategies, such as access to bus or HOV lanes and priority parking spaces.

3.2.3.1 Role of municipalities

Financial incentives such as purchase rebates are not always feasible for municipalities due to budgetary constraints and are most often provided by other levels of government. However, municipalities have a key role to play in other financial incentives (e.g., free municipal parking) and non-financial incentives (e.g., access to HOV lanes).

3.2.3.2 Themes of action

Actions in incentives can be grouped within the following themes.

- Motorists/General Public: actions aimed at the general public around ZEV ownership and convenience of operation.
- Business: actions to benefit fueling and charging providers as well as ZEV sales.
- Landlords and Home Owners: actions specific to charging infrastructure and operation.
- Public Charging Stations: actions aimed at capitalizing on public charging.

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix A.3**.

3.2.4 Complementary mechanisms

Complementary mechanisms comprise all actions that are not directly related to the other categories (i.e., fueling and charging infrastructure, education and awareness, and incentives), but support and are likely to have a measurable impact on the ZEV sector as a whole. Complementary mechanisms are broad in nature, ranging from policy and regulations to research and data, to actions on collaboration.

3.2.4.1 Role of municipalities

Given the range of complementary mechanisms, municipalities would not have a typical role, but may be involved in areas such as municipal policy development, data collection and analysis, and developing partnerships and collaborations.

3.2.4.2 Themes of action

Actions in complementary mechanisms can be grouped within the following themes.

- Policy Development at Other Levels of Government: actions aimed at advocating for and providing input to federal and provincial regulations.
- Municipal Policy and Regulations: actions to amend or introduce strategies, policies, and bylaws that indirectly impact availability of ZEVs and fueling and charging infrastructure.
- Research Partnerships and Field Testing: actions comprising RD&D through partnerships with academic and research organizations.
- Record Keeping and Data: actions aimed at identifying, collecting, and analyzing data related to ZEV sales, fueling and charging station usage, etc.
- Collaboration: actions to promote public and private collaboration, including sharing of resources, best practices, working groups, etc.
- Other: actions to study community mobility needs and social equity considerations.

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix A.4**.

⁷⁵ The International Council on Clean Transportation. The Continued Transition to Electric Vehicles in U.S. Cities. July 2018. https://www.theicct.org/sites/default/files/publications/Transition_EV_US_Cities_20180724.pdf

3.3 Fleets, Medium- and Heavy-duty Vehicles: Matrix of Actions

Municipal Zero Emission Fleet, MDV and HDV Matrix of Actions

Fueling & Charging Infrastructure	Education & Awareness	Incentives	Municipal & Private Fleets, Public Transportation	Complementary Mechanisms
Charging and fueling network partnerships M G U A D I F CS	Public education programs and awareness campaigns (including myth-busting) M G U A CS	New and retrofit ZEV grants, rebates, tax credits, and loans M G U D	Fleet conversion feasibility and cost assessment studies M U A D I F	ZEV fleet-owner groups and networks for information sharing M G U D F CS
Test and demonstrate charging technology M U A D I F	Information at public charging/refueling points (particularly for non-return-to-base fleets) M G I CS	Financing and leasing programs (perhaps utilizing carbon tax revenue or Clean Fuel Standard credits) M G U A	Technology demonstrations and pilot projects M U A D I F	Municipal ZEV contractor and car-share preference M F
Installation of charging stations and shared charging hubs M U I F	ZEV showcases, demonstrations, and events M U A D I CS	Incentives in fee structure (preferential rate structures) for private and public charging (servicing return-to-base fleets) M G U	Establish targets and develop plans for fleet conversion M U D I F CS	Integrate public transit with shared mobility M U I F CS
Align ZEV public transportation route planning and design with infrastructure requirements M U I F	Promotion of ZEVs to fleet owners and operators M G A D F CS	Charging/refueling station grants, rebates, tax credits, and loans M G U D	Municipal ZEV purchase/procurement and fleet conversion M D F	Establish internal working group or task force to coordinate conversion plans M U F CS
Explore external funding opportunities M G U I F	Curriculum at local schools, colleges, and universities (including training programs for operators and maintenance technicians) M G CS	Vehicle scrappage incentives M G F CS	Municipal ZEV-first procurement policy (perhaps through setting emission requirement thresholds) M D F	Assess impacts on vulnerable populations and communities M F CS
Enable sharing of infrastructure between municipal and private fleets M U I F	Provide information on city website M	ZEV-only areas or Low Emission Zones (LEZs) M G	Seek external funding opportunities for fleet conversion M G U F	Inform development of new provincial/federal regulations, low-carbon policies for MDVs and HDVs M G F

Fueling & Charging Infrastructure	Education & Awareness	Incentives	Municipal & Private Fleets, Public Transportation	Complementary Mechanisms
<p>Identify opportunities to install supporting infrastructure (e.g., charging) during public works and other construction projects</p> <p>M U I</p>	<p>Provide business case development assistance to fleet owners (incorporating triple bottom line accounting)</p> <p>M G U A D F CS</p>	<p>Toll discounts</p> <p>M G</p>	<p>Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)</p> <p>M D F</p>	<p>Partner with research institutions to develop strategies and advance technologies</p> <p>M U A I F CS</p>
<p>Evaluate electrical grid capacity and upgrades needed; ensure access, readiness, and resilience</p> <p>M G U I F</p>	<p>Targeted engagement and training: municipal staff</p> <p>M G U A D F CS</p>	<p>HOV/HOT lane access for ZEV fleet vehicles</p> <p>M G F</p>	<p>Update fleet bylaws</p> <p>M F</p>	<p>Ensure ongoing collaboration and engagement with public and private partners</p> <p>M G U A D I F CS</p>
<p>Advocate for regulatory changes to remove demand charges for ZEV charging infrastructure</p> <p>M G U I F</p>	<p>Targeted engagement and training: fleet owners and operators</p> <p>M G U A D F CS</p>	<p>Incentive partnerships</p> <p>M G U A I CS</p>	<p>Require reporting of fuel use and fuel economy by municipalities and large fleet operators</p> <p>M G F</p>	<p>Encourage ZEV availability at dealers and fleet showcase events</p> <p>M A D</p>
<p>Explore options for hydrogen fueling infrastructure</p> <p>M G U I A F</p>	<p>Community engagement and education on hydrogen infrastructure</p> <p>M I F</p>	<p>Link car-share fleet parking incentives with charging incentives</p> <p>M F</p>	<p>Conduct comparative life-cycle analyses for total cost of ownership of fleets (hydrogen, EV, ICE vehicle), including the cost of carbon</p> <p>M G A I F CS</p>	<p>Identify and incentivize opportunities for electrification in off-road applications (e.g., construction)</p> <p>M A I F CS</p>
<p>Explore integrating renewable energy generation and vehicle-to-grid technologies at fleet facilities</p> <p>M U I A F CS</p>	<p>Identify and promote public charging/refueling facilities including locations and availability (particularly for non-return-to-base fleets)</p> <p>M U I CS</p>	<p>Tax benefits for charging/refueling providers (servicing non-return-to-base fleets)</p> <p>M G F</p>	<p>Establish or join fleet working group to coordinate bulk purchasing and influence vehicle supply</p> <p>M G F</p>	<p>Conduct suitability analyses for different types of ZEVs in a variety of applications</p> <p>M G U A I F CS</p>

Fueling & Charging Infrastructure	Education & Awareness	Incentives	Municipal & Private Fleets, Public Transportation	Complementary Mechanisms
<p>Gather and analyze fleet movement and usage data to facilitate charging/refueling infrastructure siting</p> <p>M U G I F CS</p>	<p>Electric school bus demonstrations</p> <p>M U I A F CS</p>	<p>Preferential parking and/or site access for ZEV fleets (e.g., tour buses, taxis)</p> <p>M F</p>	<p>Advocate for, or implement, policy requirement for ZEV taxi, ride-sharing fleets</p> <p>M G F</p>	<p>Establish or join regional goods movement network and contribute to goods movement strategies</p> <p>M G F CS</p>
<p>Provide ongoing staffing and resources for infrastructure maintenance</p> <p>M I F</p>	<p>Compile list of local and regional benefits of ZEVs for fleets (e.g., local incentives, costs, environmental, and human health)</p> <p>M</p>	<p>Explore green bonds as financing mechanism for MDV/HDV, transit electrification</p> <p>M F</p>	<p>Explore opportunities for passenger and freight modal shifts to ZEVs (e.g., electric rail)</p> <p>M G U I A F CS</p>	<p>Explore opportunities to partner with federal and provincial governments on ZEV deployment</p> <p>M G CS</p>
<p>Advocate for the standardization and inter-operability of charging hardware for fleet vehicles</p> <p>M G I A F CS</p>	<p>Create best practice documents for individual fleet segments</p> <p>M G F CS</p>	<p>Consider partnerships with other municipalities to support ZEV purchase rebates</p> <p>M G A I F</p>		
	<p>Work with local authorities to assess any required changes to emergency preparedness and planning (given widespread ZEV fleet adoption)</p> <p>M G F</p>	<p>Funding to offset costs of fleet staff retraining and other operational changes</p> <p>M G</p>		

Legend

- M Municipal Government
- G Other governments (federal and/or provincial) and arm’s length organizations
- U Utilities
- A Automakers
- D Dealerships
- I Electric vehicle supply equipment companies / fueling infrastructure providers
- R Real estate developers, construction companies
- P Property/building owners, managers, condo/strata boards
- CS Civil society, academia, research organizations, NGOs, associations

3.3.1 Fueling and charging infrastructure

Ensuring that an adequate level of fueling and charging infrastructure is located in strategic areas of a city is crucial to the successful deployment and operation of any ZEV fleet. Return-to-base fleets such as buses and garbage trucks have the option of incorporating fueling and charging infrastructure at the base. However, depending on vehicle range and fleet duty cycles, return-to-base fleets could also require dedicated fueling and charging infrastructure sited on route. Non-return-to-base fleets, such as taxis, require a network of dependable, home, work, and publicly available fueling and charging stations similar to the requirements of privately owned LDVs.

3.3.1.1 Role of municipalities

Municipalities typically address fueling and charging infrastructure through their primary role of data identification, collection, and analysis to inform planning and installation of fueling and charging infrastructure, both for municipal fleets and private fleets (i.e., public fueling and charging).

3.3.1.2 Themes of action

Actions in fueling and charging infrastructure can be grouped within the following themes.

- **Fueling and Charging Networks:** actions aimed at expanding the network of public and fleet (return-to-base) fueling and charging infrastructure including R&D, data collection and analysis, feasibility assessments, pilots, installation, funding, and policies.
- **City Planning and Management:** actions aimed at planning for location-specific electrification needs (e.g., route planning), infrastructure sharing, resourcing, and leveraging major public works projects.
- **Electrical Grid Infrastructure:** actions to support grid preparedness and renewable energy related to charging.

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix B.1**.

3.3.2 Education and awareness

Similar to privately owned LDVs, education and awareness is also a barrier to adoption of ZEVs for fleets (LDV, MDV, and HDV). In addition to effectively communicating the benefits of ZEV ownership (e.g., environmental, total cost of ownership, etc.) along with usage information (e.g., understanding fueling and charging infrastructure) to the general public, education and training is required specifically for fleet owners and operators. Active public and fleet-specific education and awareness programs and campaigns play a critical role in boosting ZEV deployment with regard to LDV, MDV, and HDV vehicles and fleets.

3.3.2.1 Role of municipalities

Municipalities are not a primary source of information for individuals considering the purchase of a ZEV; however, they can be for public and private fleets. From that perspective, municipalities could consider sharing links to useful resources provided by review sites, NGOs, owner associations, OEMs, and a number of other sources that provide detailed information on ZEVs and ZEV infrastructure. In addition, municipalities can directly provide information focused on municipal policies and programs impacting ZEVs and other items such as municipal charging networks. Municipalities can also use policies (e.g., on point-of-sale information requirements particularly for non-return-to-base fleets), ZEV showcases and demonstrations using their own fleets, and city planning including emergency preparedness changes related to ZEV fleet adoption, to build awareness and promote ZEVs among fleets.

3.3.2.2 Themes of action

Actions within education and awareness can be grouped into the following themes.

- **Outreach and Education:** actions aimed at the general public and fleet owners and operators to increase knowledge and awareness of ZEVs and fueling/charging, including demonstrations.
- **Awareness of Fueling and Charging Facilities and Infrastructure:** actions to enhance accessibility and usability of public fueling and charging stations.
- **Business Case:** actions to support fleet owners in developing a ZEV business case.

- Targeted Training and Education: targeted training actions aimed at specific stakeholder groups, including the development of academic curriculum, comprehensive resources, best practices, and planning documents.

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix B.2**.

3.3.3 Incentives

Financial and non-financial incentives as a means to promote and encourage ZEV adoption have been attributed to successful levels of ZEV uptake in leading jurisdictions.⁷⁶ This may be particularly relevant for MDV and HDV vehicles where the incremental costs of individual vehicles can be in the hundreds of thousands of dollars. The provision of fueling and charging infrastructure is then another substantial cost. Incentives include measures to help potential ZEV fleet owners mitigate purchase and operating costs, while also optimizing convenience. For example, to address capital costs of vehicles as well as fueling and charging infrastructure (for EVs), financial incentives can be used, such as purchase rebates, grants, loans, and tax credits. Other financial incentives can play an important role in ZEV uptake, such as financing and leasing programs and exemption from or discounts on road tolls. Non-financial incentives that focus on convenience are often included in leading jurisdiction ZEV deployment strategies, such as HOV lane access for ZEV fleets and preferential parking.

3.3.3.1 Role of municipalities

Financial incentives such as purchase rebates are not always feasible for municipalities to deliver due to budgetary constraints, and are often provided by other levels of government. However, municipalities have a key role to play in other financial incentives (e.g., discounted municipal parking or congestion charges for ZEVs) and non-financial incentives (e.g., access to HOV lanes, ZEV-only areas).

3.3.3.2 Themes of action

Actions in incentives can be grouped within the following themes.

- Business: actions to benefit fueling and charging providers, servicing non-return-to-base fleets, as well as options for fleet owners for return-to-base fleets.
- Owners and Operators: actions aimed at potential ZEV owners (general public, fleets) around ownership (e.g., capital, operations and maintenance costs) and convenience of operation.

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix B.3**.

3.3.4 Municipal and private fleets, public transportation

Converting municipal fleets and electrifying public transportation are common actions to support a city's transition to electric mobility. In addition to supporting their own environmental, economic, and social goals through ZEV uptake, municipal actions focused on their own fleets can be critical to increasing the visibility of ZEVs and fueling/charging infrastructure, thus raising public awareness. Natural Resources Canada released a guide to greening government fleets in order to support such conversions.⁷⁷ Typically, municipal and public transportation fleets are under different jurisdictions. Cities have direct influence over municipal fleet procurement, and local transportation authorities are responsible for municipal bus fleets. As a result, in addition to actions on their own fleets, municipalities can only support (rather than direct) the electrification of transit bus fleets. Similarly, municipalities would not have jurisdiction over private fleets, such as taxis and car-share organizations, but they can promote and support the electrification of these fleets as well.

3.3.4.1 Role of municipalities

As noted, municipalities have direct control over their own fleets and can therefore convert municipal fleets to ZEVs. They can also promote and support

⁷⁶ The International Council on Clean Transportation. The Continued Transition to Electric Vehicles in U.S. Cities. July 2018. https://www.theicct.org/sites/default/files/publications/Transition_EV_US_Cities_20180724.pdf

⁷⁷ <https://www.nrcan.gc.ca/energy/transportation/alternative-fuels/resources/21314>

ZEV conversion of other fleets through education and awareness, strategy development, and policy.

3.3.4.2 Themes of action

Actions in municipal and private fleets, public transportation can be grouped within the following themes.

- Outreach and Education: actions aimed at fleet owners and operators to increase knowledge and awareness of ZEVs and fueling/charging, including demonstrations.
- Fleet Conversion: actions to assist public and private fleet owners with conversion to ZEVs, including strategy development, feasibility assessment, procurement, and funding.
- Policy: actions aimed to facilitate ZEV uptake through policy, regulation, and standardization.
- Other: other actions that improve understanding of options, including research (e.g., life-cycle analysis) and assessments (e.g., modal shift opportunities).

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix B.4**.

3.3.5 Complementary mechanisms

Complementary mechanisms comprise all actions that are not directly related to the other categories (i.e., fueling and charging infrastructure, education and awareness, incentives, and municipal and private fleets, public transportation), but support and are likely to have a measurable impact on the ZEV sector as a whole. Complementary mechanisms are broad in nature, ranging from policy and regulations to research and data to actions on collaboration.

3.3.5.1 Role of municipalities

Given the range of complementary mechanisms, municipalities do not have a typical role, but may be involved in areas such as municipal policy development, data collection and analysis, developing partnerships and collaborations, and strategy development.

3.3.5.2 Themes of action

Actions within complementary mechanisms can be grouped into the following themes.

- Policy Development at Other Levels of Government: actions aimed at advocating for and providing input to federal and provincial regulations.
- Municipal Policy and Regulations: actions to amend and introduce policies and bylaws that indirectly impact conversion to ZEVs.
- Collaboration: actions to promote public and private, internal and external, collaboration and partnerships, including sharing of knowledge, resources, best practices, etc.
- Research: actions comprising research (e.g., on vulnerable populations, off-road applications, etc.) and RD&D through partnerships with academic and research organizations.
- Strategies: actions aimed at developing and amending strategies and targets related to ZEVs, fleets, goods movement, etc.
- Other: actions to increase ZEV availability.

Individual action definitions, examples of best practice, and challenges and solutions are found in **Appendix B.5**.



4 | CREATING A MUNICIPAL ZEV STRATEGY

Creating a ZEV deployment strategy shares common elements with the creation of any strategy that incorporates cross-sectoral actions and contributions from a diverse range of stakeholders. General steps include:

- Setting initial objectives and guiding principles
- Developing a baseline
- Developing and implementing a stakeholder engagement plan
- Refining objectives and setting targets
- Choosing and sequencing actions
- Developing an implementation plan with key performance indicators
- Reviewing and revising

4.1 Setting Initial Objectives and Guiding Principles

This first step consists of determining, at a high-level, the key outcomes for the strategy and identifying some of the key considerations, or principles, that should guide strategy’s development. Initial objectives can include (but not be limited to):

- Achieving GHG and air pollutant emissions reductions in support of a municipal climate or energy action plan
- Preparing the municipality for growing ZEV ownership
- Positioning ZEVs within a broader municipal transportation strategy

- Capitalizing on local economic development opportunities

Guiding principles can include:

- Ensuring that ZEV deployment upholds principles of social equity
- Commitments to certain standards of stakeholder engagement
- Creating transparency in the strategy development process

Initial objectives and guiding principles should be set with a view towards strategy approval. They should align with how municipal decision-makers view ZEVs and any initial feedback or guidance on what elements of a successful ZEV strategy would be.

4.2 Developing a Baseline

The baseline establishes current levels of activity and adoption with respect to ZEVs in the municipality, and how a ZEV strategy fits within other municipal activities. Baseline activities could consist of collecting information on the following:

- Current publicly accessible fueling and charging infrastructure
- ZEV ownership, including geographic distribution (e.g., by neighbourhood) and owner characteristics (e.g., income, commute distance, etc.)
- Electrical grid capacity/constraints
- Provincial and federal policy contexts
- ZEV adoption rate projections

- Municipal plans and initiatives that could impact the ZEV strategy
- Local stakeholders who are already engaged in accelerating ZEV deployment

4.3 Developing and Implementing a Stakeholder Engagement Plan

Stakeholder engagement is critical during the development of a municipal ZEV strategy. Accelerating ZEV deployment within a municipality requires participation from municipal staff who oversee operations impacted by the ZEV strategy, support from council, and concerted actions by external stakeholders. Giving stakeholders opportunities to have concerns addressed and provide input into the strategy helps create the buy-in ultimately required for implementation.

Elements of the stakeholder engagement plan should include:

- Who to engage internally within the City (i.e., which departments would be required to implement activities, and/or which departments are engaged in activities to which the strategy needs to be aligned). This would include individuals who would need to sign-off on elements of the strategy pre-finalization.
- A framework for internal engagement, such as a working group, workshops, webinars, etc.
- Identification of external stakeholders per the stakeholder groups described in Section 2 of this report.
- External stakeholder engagement framework, which could consist of a working group, or engagement sessions integrated into plan development.
- A public engagement plan in the form of surveys, events, etc. to inform the strategy, prepare the public for rollout, and align with expectations from council as necessary.

Stakeholder engagement does not end with the launch of the strategy. Strategy implementation should contain an ongoing engagement plan to inform the public and further develop the partnerships required to execute increasingly complex actions.

4.4 Refining Objectives and Setting Targets

Initial stakeholder engagement can be used to collect feedback from implementation partners with respect to what they believe should be accomplished within the strategy. This feedback can be used to refine the original objectives where possible in support of further buy-in from stakeholders.

4.4.1 Setting targets

Some ZEV strategies include targets (e.g., number of charging stations installed, etc.) and some do not contain quantitative targets. Target setting provides tangible goals for outcomes reliant on multiple concurrent activities conducted by multiple stakeholders. It also lays the groundwork for monitoring the progress of strategy implementation. Where possible, quantitative targets should be set for activities within the strategy along with overall aggregate targets.

4.5 Choosing and Sequencing Actions

Municipalities aren't expected to undertake all of the actions in the matrices in order to deliver an effective ZEV strategy. Each municipality (in consultation with stakeholders) should choose those actions that are well-suited to it and are within its means of undertaking (given limited budgets and ZEV adoption levels/demand in their jurisdictions). The discussion below indicates actions that have been identified by stakeholders consulted in the development of this framework as being higher-priority, or most integral, to a municipal ZEV strategy.

With respect to sequencing, municipalities should gradually phase certain actions in (or out) over time as ZEV adoption levels increase and technologies advance. In the tables below, priority actions for inclusion are identified as near-term or longer-term. However, in some cases, the sequencing of an activity is more dependent on individual municipal circumstances and is identified as near- or longer-term.

4.5.1 Privately-owned LDVs

Highest-priority near-term actions for privately-owned LDVs address the three largest barriers to privately-owned ZEV deployment: vehicle capital cost, education and awareness, and charging infrastructure.

Near-term	<ul style="list-style-type: none"> • ZEV-ready building codes and standards (for new and existing buildings) • Public charging stations and hubs including on-street parking • Public education programs and campaigns • ZEV showcase, demonstrations, and events • Vehicle and/or charger voucher or rebate • Tax benefits for charging/refueling hosts • Advocate for changes to provincial/federal regulations: other regulatory barriers • Advocate for changes to provincial/federal regulations: MURBs • Collect data on usage of charging facilities, ZEV purchases, infrastructure availability
Near- or longer- term	<ul style="list-style-type: none"> • Advocate for removal of regulatory barriers to EVSE deployed by utilities to allow for cost recovery through rate base (e.g., via demand charges) • Consider medium to long term hydrogen opportunities for LDVs • Analyze data to enhance the availability of charging where most needed • Develop transportation electrification plans
Longer-term	<ul style="list-style-type: none"> • Identify potential ZEV charging/refueling corridors • Ensure electrical grid access, readiness, and resilience • Explore renewable energy generation tied to ZEV charging • ZEV-only areas or Low Emission Zones (LEZs) • Amend or introduce local bylaws to address barriers (e.g., anti-ICEing bylaw)

4.5.2 Fleets, MDVs and HDVs

Highest-priority actions for fleets, MDVs, and HDVs are presented below.

Near-term	<ul style="list-style-type: none"> • Evaluate electrical grid capacity and upgrades needed; ensure access, readiness and resilience • Installation of charging stations and shared charging hubs • Explore options for hydrogen fueling infrastructure • Provide business case development assistance to fleet owners (incorporating triple bottom line accounting) • New and retrofit ZEV grants, rebates, tax credits, and loans • Charging/refueling station grants, rebates, tax credits, and loans • Vehicle scrappage incentives • Conduct comparative life-cycle analyses for total cost of ownership of fleets (hydrogen, EV, ICE vehicle), including the cost of carbon • Municipal ZEV purchase/procurement and fleet conversion • Fleet conversion feasibility and cost assessment studies • Technology demonstrations and pilot projects • Conduct suitability analyses for different types of ZEVs in a variety of applications
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Near or longer- term	<ul style="list-style-type: none"> • Identify opportunities to install supporting infrastructure (e.g., charging) during public works and other construction projects • Targeted engagement and training: fleet owners and operators • ZEV-only areas or Low Emission Zones (LEZs) • Municipal ZEV-first procurement policy (perhaps through setting emission requirement thresholds) • Partner with research institutions to develop strategies and advance technologies • Assess impacts on vulnerable populations and communities • Identify and incentivize opportunities for electrification in off-road applications (e.g., construction)
Longer-term	<ul style="list-style-type: none"> • Advocate for the standardization and inter-operability of charging hardware for fleet vehicles • Explore opportunities to partner with federal and provincial governments on ZEV deployment

4.6 Developing an Implementation Plan with Key Performance Indicators

Strategies should be developed with a view towards implementation from the outset and it is critical to involve both internal and external stakeholders in the development of the implementation plan. An implementation plan identifies how each of the actions identified in the strategy will be executed and assigns roles and responsibilities – roles and responsibilities that must be agreed upon by the stakeholders impacted. Municipalities may choose not to make all parts of the implementation plan part of the public strategy document.

4.6.1 Setting key performance indicators

Each action in the plan should be assigned at least one key performance indicator (KPI) which will allow the strategy implementation team to assess progress to action outcomes. Preferably, these KPIs would be linked to milestones and targets in order to formalize the progress discussion.

4.7 Reviewing and Revising

Like any plan or strategy, a municipal ZEV strategy will contain actions and implementation strategies that do not meet milestones or prove to be significantly more successful than originally anticipated. In addition, a number of external factors are changing rapidly such as provincial and federal policies, vehicle availability, charging technology, etc. It is important to build a review cycle directly into the strategy development process to set expectations within the implementation process around how the strategy will be evolved over time.

5 | BEST PRACTICE CASE STUDIES

North Vancouver, Montreal, and Portland were identified for further examination via the following three case studies. Each of these cities is considered to be a leader in ZEV deployment. The case studies are designed to present specific examples of actions extracted from the city’s EV strategy and mapped against the actions presented in the Matrix of Actions.

5.1 North Vancouver, BC

Overview of EV Strategy:

North Vancouver developed and released an Electric Vehicle Strategy in 2018. It focuses on key actions and policies to accelerate the transition from ICE vehicles to ZEVs and guides the City on activities related to EV charging infrastructure for both public and private installations. The EV Strategy supports the goals and targets set in the 2010 Community Energy and Emissions Plan as well as in the 2014 Official Community Plan.

The stated goal of the EV Strategy is “to remove barriers to EV ownership by increasing access to charging infrastructure and providing public education about EVs and EV charging.”⁷⁸ The objectives of the EV Strategy are to:

- Maximize access to EV charging.
- Displace fossil fuel kilometres travelled with electric kilometres travelled in the City.
- Increase awareness and knowledge level of EVs and EV charging options among residents.

The EV Strategy identifies 30 actions to accelerate EV adoption in the City, categorized by charging infrastructure: new construction, charging infrastructure: existing buildings, public charging network, city fleet and equipment, and education and outreach.

Mapping of North Vancouver Strategy to the Matrix of Actions:

Category: Fueling and Charging Infrastructure

Matrix of Actions	EV Strategy Action Example
ZEV-ready new multi-unit residential buildings	Incorporate requirement of energized outlets capable of providing Level 2 charging for 100% of residential parking spaces, allowing for load management systems, in new developments into the Zoning Bylaw.
ZEV-ready new single-family homes	Incorporate requirement of energized outlets capable of providing Level 2 charging for new one- and two-unit residential developments into the Zoning Bylaw.

⁷⁸ City of North Vancouver, Electric Vehicle Strategy, September 2018. <https://www.cnv.org/city-services/streets-and-transportation/sustainable-transportation/electric-vehicles/electric-vehicle-strategy>

Category: Fueling and Charging Infrastructure

Matrix of Actions	EV Strategy Action Example
ZEV-ready new commercial and institutional buildings	Incorporate requirement for EV charging stations in a prescribed percentage of parking spaces in new commercial and industrial buildings into the Zoning Bylaw.
Vehicle and/or charger voucher or rebate	Provide funding through incentives or rebates to improve access to home charging for residents in existing multi-family buildings.
Advocate for changes to provincial/federal regulations: other regulatory barriers	Advocate for provincial regulations to require that strata corporations allow the installation of EV charging infrastructure where it is technically feasible and safe.
Address challenges and barriers to charging for existing multi-unit residential buildings and garage orphans	Review potential opportunities to amend requirements for on-site parking for existing MURBs to decrease barriers to EV charging.
Install Level 3 public chargers (DCFCs)	Deploy two to four new DC fast charging stations in partnership with NRCan, BC Hydro, and private site hosts to compensate for lack of home and workplace charging, sited close to amenities, clustered together when possible and with minimal impact on streetscape and pedestrian experience.
Public charging stations and charging hubs including on-street parking	Deploy three to five new Level 2 charging stations to expand the existing EV charging network and compensate for lack of home and workplace charging, sited close to amenities or curbside when possible with minimal impact on streetscape and potentially integrated with streetlight infrastructure.
Seek external infrastructure funding opportunities	Seek additional external funding for public charging infrastructure as new opportunities arise through NRCan, BC Hydro, and other partners.
Charging at municipally-owned facilities	Explore possibility of making charging stations used for City staff workplace charging available to the public overnight. Explore opportunities for providing charging for City staff personal vehicles during work hours.

Category: Education and Awareness

Matrix of Actions	EV Strategy Action Example
Targeted engagement and training: city building management and development staff	Provide training for building and development staff on EV charging requirements, technologies and potential configurations in building construction and retrofits which could be disseminated to builders, contractors and developers.
Targeted engagement and training: landlords, property managers and strata/tenant boards	Provide education to stratas, landlords and property managers to facilitate EV charging retrofits in existing multi-family buildings by clarifying means by which charging infrastructure can be installed in existing multi-family buildings, increasing awareness of available financial incentives and promoting resources available through www.evcondo.ca .
Promotion at workplaces, Workplace Charging Challenge	Promote installation of EV charging infrastructure at workplaces by raising awareness among employers, building managers and property owners and disseminating information about the installation process and available financial incentives.
Address knowledge gaps surrounding home charging	Address knowledge gaps surrounding home charging by clarifying options for installation of charging stations in existing homes, increasing awareness of available financial rebates and promoting online educational resources.
Public education programs and campaigns	Increase awareness of EV models available in BC and provincial incentive programs and clarify common EV misconceptions among City residents.
Information at charging points	Utilize public charging stations as an educational opportunity by enhancing signage to raise the profile of stations and disseminate EV information at the stations.

Category: Education and Awareness

Matrix of Actions	EV Strategy Action Example
Provide information on city website (including charging/fueling infrastructure locations; total cost of ownership calculator)	Further develop the City’s EV webpage to increase understanding of City EV policy and actions, EV models and available incentive programs and resources for EV charging retrofits; provide links to other informational resources.

Category: Incentives

Matrix of Actions	EV Strategy Action Example
Incentives in fee structure for public charging	Implement an appropriate fee structure for public charging stations to recover costs and increase turnover and encourage home charging, while maintaining a cost incentive compared to fossil fueled vehicles.
Preferential or free parking Carpool lane access (HOV / HOT lane)	Explore potential nonfinancial incentives for EV drivers including preferential parking spaces and EV-only passenger zones in high traffic areas to increase EV visibility and signal to residents the City’s prioritization of EVs over other private vehicles.

Category: Fleets

Matrix of Actions	EV Strategy Action Example
Municipal ZEV-first procurement policy (perhaps through setting emission requirement thresholds)	Develop an “electric-first” fleet and equipment policy for the City that prioritizes the procurement of electric versions of vehicles and equipment, given model availability and ability to perform the required function.
Fleet conversion feasibility and cost assessment studies	Conduct feasibility studies for each City facility to determine baseline capacity to install EV charging infrastructure. Complete an analysis of opportunities for replacing fossil-fueled medium- and heavy-duty vehicles at end of life with electric alternatives and complete a feasibility analysis to determine upgrades required at the Operations Centre.
Targeted engagement and training: municipal staff	Provide training opportunities to familiarize City staff with current fleet EVs and with potential options for fleet EVs and electric equipment.
Establish or join fleet working group to coordinate bulk purchasing and influence vehicle supply	Join network of fleet managers and owners sharing resources and lessons learned, and pledge to contribute to the goal of expanding the use of EVs in fleets.
Technology demonstrations and pilot projects	Consider raising the profile of EVs in City fleet through use of vehicle graphics.

Category: Complementary Mechanisms

Matrix of Actions	EV Strategy Action Example
Collect data on usage of charging facilities, ZEV purchases, infrastructure availability	Ensure EV supply equipment data from new developments is tracked in CityPAL (permits and licensing system) in a meaningful way and incorporates historical permits to have a robust database of EV charging equipped parking spaces in buildings across the City.
Municipal ZEV contractor and car-share preference	Partnerships with Car-Sharing Services: Consider electric only car-share vehicles in negotiations for car-share parking spaces in new developments.
Analyze data to enhance the availability of charging where most needed	Review current station usage to determine daily usage trends and explore opportunities to maximize access and reduce congestion through financial rate structures and parking regulations.
Link car-share parking incentives with charging incentives	Work with car-share providers to facilitate access of shared vehicles to charging infrastructure and to support transition of car-share fleets to EVs.



5.2 Montreal, QC

Overview of EV Strategy:

In 2016, Montreal developed and adopted the Transportation Electrification Strategy 2016–2020. The Strategy includes ten strategic goals, designed to establish an environment that advances innovation and supports a transition to renewable and sustainable energy in the transportation sector, including transportation electrification. In addition to concrete municipal actions (e.g., City fleet conversion), a key part of the strategy is collaboration with public and private partners. The ten strategic goals cover the following areas:

- Planning and management of housing stock
- Fleet conversion, including the municipal fleet, public transportation network, and supporting private self-serve vehicles

- Economic development action plan
- Electrification and intelligent transportation institute
- Implementing key policies
- Public charging network
- Ongoing collaboration

The City will also be developing a monitoring system to measure and evaluate the contributions of the municipal measures to GHG reductions. In addition, the Strategy is accompanied by an action plan to ensure implementation occurs from 2016 to 2020, with ongoing collaboration and annual evaluations. The City intends to play a leadership role through the implementation of this Strategy.⁷⁹

Mapping of Strategy to the Matrix of Actions:

Category: Fueling and Charging Infrastructure	
Matrix of Actions	EV Strategy Action Example
Incorporate electrification needs into housing/property management and planning processes	Incorporate electrification needs into its property management and planning processes. In new municipal real-estate buildings that include parking facilities, charging stations will be installed to meet user needs. This will also be applied to existing buildings where charging stations can be installed.
Public charging stations and charging hubs including on-street parking	Provide on street parking spaces for electric vehicles, create combination pricing including electric vehicle charging. To offer a network of approximately 1,000 charging stations by 2020 to serve the entire municipal territory.

⁷⁹ Ville de Montréal, Electrifying Montréal: Transportation Electrification Strategy 2016–2020, 2016. http://ville.montreal.qc.ca/pls/portal/docs/PAGE/PROJ_URBAINS_FR/MEDIA/DOCUMENTS/TRANSPORTATION_ELECTRIFICATION_STRATEGY_2016_2020_PDF

Category: Fleets	
Matrix of Actions	EV Strategy Action Example
<p>Explore opportunities for passenger and freight modal shifts to ZEVs (e.g., electric rail)</p> <p>Test and demonstrate charging technology</p> <p>Technology demonstrations and pilot projects</p> <p>Establish targets and develop plans for fleet conversion</p> <p>Municipal ZEV purchase / procurement and fleet conversion</p>	<p>Three main action areas:</p> <p>Reduce GHG emissions per passenger-kilometre</p> <p>Replace diesel buses with hybrid vehicles pending the arrival of electric buses (close to 1,000 during the 2016-2025 period)</p> <p>Acquire electric or hybrid service vehicles</p> <p>Increase the service offer for electric public transportation</p> <p>Bring into service 52 Azur trains, 14 of which will be used to increase the fleet and service level</p> <p>Electrify the surface network</p> <p>Purchase only electric buses as of 2025, or as soon as technology allows</p> <p>Participate in the City Mobility pilot project, which includes purchasing three fully electric vehicles and installing two charging stations to test quick-charging stations/technology under operational conditions</p>
<p>Charging and fueling network partnerships</p> <p>Municipal ZEV purchase / procurement and fleet conversion</p> <p>Explore external funding opportunities</p> <p>Seek external funding opportunities for fleet conversion</p> <p>Ensure ongoing collaboration and engagement with public and private partners</p>	<p>The electrification of the City’s vehicle fleet and the STM’s investments will help to make Montreal a choice location that attracts companies, research centres and institutions interested in transportation electrification.</p> <p>There are three specific goals being pursued in its transportation electrification investments:</p> <p>Mobilizing stakeholders in the electric transportation sector around a series of shared objectives</p> <p>Leverage transportation electrification initiatives with a view to favouring benefits for local companies and institutions</p> <p>Increasing Montreal’s attractiveness as a location for companies and institutions in this sector</p>
<p>Explore opportunities for passenger and freight modal shifts to ZEVs (e.g., electric rail)</p>	<p>High-quality service of the new Réseau Électrique Métropolitain (RÉM) project will help promote real-estate development in the areas near its 24 stations, contributing to the creation of new clientele (i.e., new public transit users).</p>
<p>Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)</p> <p>Provide business case development assistance to fleet owners (incorporating triple bottom line accounting)</p> <p>Fleet conversion feasibility and cost assessment studies</p> <p>Update fleet bylaws</p> <p>Explore municipal policy mechanisms for encouraging conversion to ZEVs</p>	<p>Implement a framework to facilitate the private-sector roll-out of a self-serve network of electric vehicles. Launched an international call to help private companies set up a city-wide system of self-service electric vehicles. The goal of this process was to identify the business model best adapted to Montreal’s conditions and demand.</p>

Category: Complementary Mechanisms	
Matrix of Actions	EV Strategy Action Example
Research partnerships, innovation, and field testing Ongoing collaboration with public and private partners	Leverage Montreal’s advantages as an innovator in intelligent transportation. Creation of a new institute on electrification and intelligent transportation will count on partnerships with the universities and the innovation district, and on the availability of land near the downtown core. It will create a world-caliber centre for developing, experimenting with and promoting innovations and new concepts in electric and intelligent transportation.
Develop transportation electrification plans Public charging stations and hubs including on-street parking Ongoing collaboration with public and private partners	The roll-out of charging stations and the undertaking of urban planning initiatives will help to make Montreal a choice location that attracts companies, research centres, and institutions interested in transportation electrification. Goals in the transportation electrification investments include mobilizing stakeholders, leveraging initiatives, and increasing Montreal’s attractiveness.
Ongoing collaboration with public and private partners	Ensure ongoing collaboration with public and private partners in electrification initiatives and in the promotion of sustainable mobility. Maximize the impact of City initiatives and implement complementary electrification projects. Ongoing collaboration with provincial government, transportation agencies, electricity services commission, Hydro Québec, Montréal taxi bureau, and private partners.

5.3 Portland, OR

Overview of EV Strategy:

Portland released its first EV Strategy, Electric Vehicles: The Portland Way, in 2010. The 2017 Electric Vehicle Strategy provides an update to reflect the significant changes in the EV market in the previous six years. The 2017 EV Strategy establishes the City’s priorities and identifies actions to take before the end of 2020 towards the electrification of the transportation sector. The EV Strategy focuses on public transit electrification, shared vehicles, and private vehicles. It also focuses on air quality, affordability, and vehicle dependent areas. Electric and plug-in hybrid cars, trucks, buses and freight vehicles, along with e-bikes and e-scooters are included in the Strategy.

Seven goals are identified for completion by the end of 2020, such as:

- Replacing at least 10,000 ICE vehicles with EVs in Multnomah County

- Doubling the number of Level 2 charging stations and DCFCs available to the public
- Adding 60 EVs to the City’s LDV fleet (an increase to 10%)
- Increasing access to affordable EV transportation options
- Prioritizing electrification of shared use vehicles, buses, and bikes

The EV Strategy also identified nearly 50 actions to be completed or underway by the end of 2020, developed in consultation with key stakeholders. The actions were categorized by charging infrastructure, fleets, personal vehicles and shared mobility, innovation and information, and economic development. The Strategy was developed to support the goals of Portland’s Climate Action Plan, Comprehensive Plan, and Transportation System Plan.⁸⁰

⁸⁰ 2017 City of Portland Electric Vehicle Strategy, December 2016. <https://www.portlandoregon.gov/bps/article/619275>

Mapping of Strategy to the Matrix of Actions:

Category: Fueling and Charging Infrastructure	
Matrix of Actions	EV Strategy Action Example
ZEV-ready new commercial and institutional buildings ZEV-ready new multi-unit residential buildings	Explore EV parking and charging infrastructure requirements in new multi-family and commercial construction projects that include parking.
Incorporate electrification needs into housing/property management and planning processes	Incorporate EV-ready provisions into the City’s green building policy for affordable housing.
Seek external infrastructure funding opportunities	Seek funding to enable affordable housing projects that have parking to be EV-ready with, at a minimum, the necessary electrical capacity and conduit to enable EV chargers.
Identify opportunities to install supporting infrastructure (e.g. charging) during public works and other construction projects ZEV-ready building codes and standards (for new and existing buildings) ZEV-ready new commercial and institutional buildings ZEV-ready new multi-unit residential buildings	Develop EV-ready provisions for construction projects that trigger the Portland Development Commission Green Building Policy.
Financing and leasing programs (perhaps utilizing carbon tax revenue or Clean Fuel Standard credits) Charging revenue via carbon or clean fuel credits Explore external funding opportunities	Develop a funding mechanism to address the upfront costs for new EV chargers for City vehicles in City-owned or -managed buildings.
ZEV-ready retrofits for existing buildings (incorporating load management) ZEV-ready building codes and standards (for new and existing buildings) ZEV-ready new commercial and institutional buildings	Partner with community partners and private industry to develop a strategy to retrofit strategic existing City-owned buildings and facilities with EV chargers. Consider EV-ready construction requirements for new City buildings or major renovation projects that have parking.
Troubleshooting assistance for homeowners and building managers (especially regarding charging infrastructure)	Work with utility and community partners to provide technical assistance to building managers and homeowners to install EV chargers, especially in existing buildings.
Targeted engagement and training: developers, architects, builders and contractors (and respective associations)	Work with partners to develop EV charging outreach and education materials and programs targeted to builders and architects.
Other enabling programs and policies for public charging infrastructure, such as public charging on private property	Develop public right of way (ROW) priorities and policies to enable installation of publicly accessible EV chargers in strategic locations and provide clear guidelines for public and private parties. Establish a policy for addressing abandoned EV chargers in the right of way.
ZEV-ready new parking facilities and retrofits	Explore the development of EV parking and charging infrastructure requirements in new and existing (public and private) parking facilities.
Identify and promote charging facilities including locations and availability	Work with community partners to increase the public’s awareness of EV chargers through improved signage, marketing and outreach.

Category: Fueling and Charging Infrastructure	
Matrix of Actions	EV Strategy Action Example
<p>Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)</p> <p>Public charging stations and charging hubs including on-street parking</p> <p>ZEV-ready new parking facilities and retrofits</p>	<p>Explore opportunities to integrate e-bike charging infrastructure into the City’s bike parking Title 33 code update.</p>
<p>Identify opportunities to install supporting infrastructure (e.g., charging) during public works projects</p>	<p>Identify opportunities to install EV chargers and/or conduits in conjunction with major public works projects in strategic locations and in streetscape planning.</p>
<p>Other enabling programs and policies for public charging infrastructure, such as public charging on private property</p>	<p>Establish policies and processes that make it easier to provide publicly accessible charging on private property and encourage private property owners to do so.</p>
<p>Enhanced and consistent signage for charging stations</p> <p>Information at charging points</p>	<p>Develop policies and standards for EV signage and parking, including parking rates, time limits and “parking while charging” restrictions.</p>
<p>Public charging stations and charging hubs including on-street parking</p>	<p>Explore City ownership and maintenance of publicly accessible EV chargers, particularly in under-served areas.</p>
<p>Public charging stations and hubs including on-street parking</p> <p>Research partnerships, innovation, and field testing</p>	<p>Explore the integration of electric vehicle charging with streetlights in Portland.</p>
<p>Ongoing collaboration with public and private partners</p> <p>Installation of charging stations and shared charging hubs</p>	<p>Work with public and private partners to support the installation of multi-modal EV charging pods similar to Electric Avenue around the metro area. Include e-bike charging infrastructure in these electric mobility hubs.</p>
<p>Public charging network partnerships (including inter-municipal)</p>	<p>Work with community partners and utilities to install publicly accessible EV chargers in strategic locations. Prioritize EV chargers that serve low-income residences, including multi-family, single-family rental housing and garage-free homes.</p>
<p>Develop transportation electrification plans</p> <p>Explore renewable energy generation tied to ZEV charging</p>	<p>Partner with local utilities to finalize and implement their transportation electrification plans. Continue to advocate for the utilities to reduce the carbon content of their supply mix.</p>
<p>Charging at municipally-owned facilities</p>	<p>Encourage TriMet to continue installing and maintaining EV chargers at Park & Ride and Bike & Ride lots.</p>
<p>Public charging network partnerships (including inter-municipal)</p>	<p>Work with utilities, Neighborhood Prosperity Initiative (NPI) districts and Main Street areas to install publicly accessible EV chargers.</p>

Category: Education and Awareness	
Matrix of Actions	EV Strategy Action Example
<p>Public education programs and campaigns</p> <p>ZEV showcase, demonstrations, and events</p> <p>ZEV information sharing network</p> <p>Ensure ongoing collaboration and engagement with public and private partners</p>	<p>Continue to market Portland’s leadership in clean technologies utilizing Portland’s “We Build Green Cities” brand to drive EV business development, relocation and expansion opportunities.</p> <p>Prioritize business development visits and technical assistance to EV-related companies with middle-wage employment opportunities.</p> <p>Organize supply-chain and investor matchmaking events and trade show participation opportunities for existing EV firms to increase financing, sales and export opportunities.</p>

Category: Education and Awareness	
Matrix of Actions	EV Strategy Action Example
Public education programs and campaigns ZEV showcase, demonstrations, and events	Support efforts to bring major EV conferences to Portland.

Category: Incentives	
Matrix of Actions	EV Strategy Action Example
Incentive funding partnerships Vehicle and/or charger voucher or rebate E-bike / scooter voucher or rebate Community mobility needs assessment and social equity analysis	Work with partners to develop programs and incentives to reduce the barriers to EVs for low-income populations, communities with no or damaged credit, such as vouchers, instant rebates and EV carshare and e-bike pilot projects.

Category: Fleets	
Matrix of Actions	EV Strategy Action Example
Municipal ZEV purchase / procurement and fleet conversion Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)	Support TriMet’s efforts to transition to electric buses and encourage the electrification of other people transport fleets (e.g., tour vehicles, taxis) in Portland.
Establish targets and develop plans for fleet conversion	Work with TriMet to use new electric buses along routes through portions of the city where air quality issues have the largest impact.
Integrate public transit with shared mobility	Explore options to integrate public transit and shared EV mobility options such as e-bikes, e-scooters and EV car-share vehicles.
Integrate public transit with shared mobility	Encourage TriMet to continue accommodating e-bikes on exterior bus bike racks and on board rail vehicles in designated areas.
Charging revenue via carbon or clean fuel credits	Become a credit generator in the Oregon Clean Fuels Program for City-owned chargers. Adopt a policy to ensure that resources received from these types of credits are spent on EV-related projects.
Municipal ZEV-first procurement policy (perhaps through setting emission requirement thresholds)	Establish “electric first” guidelines directing City bureaus to purchase all-electric vehicles when the vehicle usage is compatible with available electric light-duty vehicles.
Charging at municipally-owned facilities Promotion at workplaces, Workplace Charging Challenge	Explore workplace charging for City employees working in and parking personal vehicles at City-owned and -managed facilities. Encourage City staff who must drive to work to drive EVs.
Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)	Support the electrification of medium- and heavy-duty vehicles used in Portland for the delivery of goods and materials.
Technology demonstrations and pilot projects Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)	Continue to explore urban consolidation centers and support pilot projects to electrify delivery vehicles.
Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)	Continue to explore opportunities to partially electrify Portland’s BIKETOWN bike-share program.
ZEV showcase, demonstrations, and events Ongoing collaboration with public and private partners	Support Drive Oregon’s Northwest EV Showcase initiative, including helping to market the EV group purchase program, seeking funding to support the initiative and collaborating to develop the physical space.

Category: Fleets	
Matrix of Actions	EV Strategy Action Example
<p>Community mobility needs assessment and social equity analysis</p> <p>Ongoing collaboration with public and private partners</p> <p>Assess impacts on vulnerable populations and communities</p>	<p>Work with partners to leverage existing community mobility needs assessments and conduct additional engagement as necessary to ensure that EV solutions meet the needs of low-income populations and communities of color.</p>
<p>Ongoing collaboration with public and private partners</p> <p>Community mobility needs assessment and social equity analysis</p>	<p>Support community partners such as Drive Oregon to help low-income Portlanders navigate the incentives, financing and decision-making process of buying or leasing new or used EVs.</p>
<p>Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)</p> <p>Explore municipal policy mechanisms for encouraging conversion to ZEVs</p> <p>Enable sharing of infrastructure between municipal and private fleets</p>	<p>Encourage taxi, car-share and ride-sourcing companies (such as Uber and Lyft) to utilize EVs in their fleets. Explore incentives to increase shared electric mobility options, particularly in areas with limited transportation options.</p>

Category: Complementary Mechanisms	
Matrix of Actions	EV Strategy Action Example
<p>Analyze data to enhance the availability of charging where most needed</p>	<p>Develop and utilize the best available information (e.g., charger location, EV car sales, demographics, vehicle-miles-traveled) to inform investment and policy priorities for the electrification of the transportation system.</p>
<p>Collect data on usage of charging facilities, ZEV purchases, infrastructure availability</p>	<p>Work with Oregon’s Department of Environmental Quality and Portland State University to track and share data on the number of ZEVs registered in Oregon and Multnomah County.</p>
<p>Research partnerships, innovation, and field testing</p> <p>Ongoing collaboration with public and private partners</p>	<p>Partner with public and private stakeholders to integrate EVs into Smart Cities projects.</p>
<p>Research partnerships, innovation, and field testing</p>	<p>Seek opportunities to pilot electric autonomous vehicles (AVs).</p>
<p>Ongoing collaboration with public and private partners</p> <p>Community mobility needs assessment and social equity analysis</p> <p>Assess impacts on vulnerable populations and communities</p>	<p>Build resources to connect small- to medium-sized EV manufacturers with employment opportunities for qualified underemployed and unemployed residents.</p> <p>Track effectiveness of EV economic development efforts in extending business and employment opportunities to people of color.</p>
<p>Ongoing collaboration with public and private partners</p>	<p>Work with Drive Oregon, TriMet, Metro and Greater Portland Inc. (GPI) to increase networking among local EV manufacturers and customers.</p>

6 | SUMMARY AND CONCLUSION

ZEV adoption levels are increasing at a rapid rate throughout Canada, as well as globally. ZEVs offer a wide range of potential environmental and socio-economic benefits to Canadian cities. The fact that Canadian electricity generation is over 80% emissions-free means that ZEVs offer a significant GHG reduction opportunity to the country as a whole. And because electricity generation typically takes place well outside of major cities, the air quality and human health benefits of ZEVs are substantial.

Leading cities in terms of ZEV deployment tend to work in collaboration with key stakeholder groups such as: other levels of government and/or other municipalities, electrical utilities, automakers and their dealerships, charging/refueling infrastructure providers, real estate developers, property owners/managers, civil society (NGOs, academia, etc.), and fleet operators. Leading cities also tend to engage in activities that could each be categorized within the following areas: fueling and charging infrastructure, education and awareness, incentives, fleets and complementary actions. By engaging with key stakeholders and undertaking a range of supportive activities, Canadian cities can ensure that their ZEV deployment plans or strategies will have a palpable impact.

The best practices and sample actions provided in this report may not be suitable for all Canadian municipalities. Cities should gauge the level of effort they are willing to devote to ZEV deployment, and plan to engage in a suite of activities accordingly. When selecting actions, cities should try to ensure at

least some engagement within each Matrix category, as each category contains some actions that could be undertaken with a modest amount of resources and effort, but which would nonetheless prove highly valuable to any strategy.



The appendices of this document contain detailed definitions of the actions contained in the Matrices in Section 3. Also included in the appendices are example municipal best practices, prominent challenges related to municipal ZEV deployment, and possible solutions to addressing those challenges. This content is intended to serve as a reference for municipal practitioners and other stakeholders tasked with leading actions to support ZEV deployment.

The growing popularity of ZEVs, which is punctuated by declining purchase costs, low fueling and maintenance costs, increased consumer awareness, and increasing viability across various modes of transportation, has resulted in significant year-over-year increases in ZEV market share. For most transportation experts, it is no longer a question of “if” ZEVs will become the new conventional vehicle architecture, but “when.” Although ZEVs are becoming an increasingly viable option for Canadians, adoption levels remain low in many cities and regions. However, ZEVs will play a critical role in helping to meet sustainability and climate targets for Canadian municipalities, and in improving the quality of life for their citizens. It is therefore imperative that cities begin laying the groundwork required to facilitate ZEV uptake today.




Appendix A: Privately-Owned Light-Duty Vehicle Actions


A.1. Fueling and Charging Infrastructure





Action definitions and examples of best practice are presented in the tables below.

Theme	Public Fueling and Charging Networks	
Action	Definition	Examples and Best Practices
Public charging network partnerships (including inter-municipal) 	Increase access to public charging by deploying charging stations. Charging station infrastructure would be funded by a group of partners, which could include provincial authorities, municipalities, local business, community members, utilities, and others. The locations of charging stations could also be determined by the partnership. Ownership of the stations could be municipal or private.	North Vancouver: Collaborate with provincial authorities, local business, communities, utilities and others to improve access by deploying public charging stations. Portland: Work with community partners and utilities to install publicly accessible EV chargers in strategic locations. Prioritize EV chargers that serve low-income residences, including multi-family, single-family rental housing and garage-free homes.
Public charging stations and charging hubs including on-street parking 	Increase access to public charging by deploying charging stations and hubs. Charging station infrastructure would primarily be funded and owned by the municipality. Stations could be located in areas under-served by the current charging network. Stations could be for personal vehicles or charging hubs that support cars, commercial fleets, taxis, public transportation, and car-share fleets.	Edmonton: Develop a public charging network to provide “life line” charging support as a back-up for EV users charging at home/work and to increase the profile of EVs. North Vancouver, Richmond: Deploy new charging stations to expand existing EV charging network and compensate for lack of home and workplace charging, sited close to amenities or curbside when possible with minimal impact on streetscape and potentially integrated with streetlights. Vancouver: Develop charging hubs that support residents, commercial fleets, EV taxis and EV car-sharing. Portland: Explore city ownership and maintenance of publicly accessible EV chargers, particularly in under-served areas. San Diego: Provide portable charging stations to offices and events that would otherwise not have enough charging stations.

Theme	Public Fueling and Charging Networks	
Action	Definition	Examples and Best Practices
Charging at municipally-owned facilities M U I	Increase access to public charging by deploying charging stations at municipally-owned facilities. Charging infrastructure would primarily be funded and owned by the municipality. Examples of facilities include park and ride lots, public parking lots, municipal buildings, city staff parking lot, and parking lots at municipal parks. On-street parking and integration with street lights could also be explored.	North Vancouver: Explore possibility of making charging stations used for City staff workplace charging available to the public overnight. Kingston, Amsterdam: Install public charging stations at municipality owned facilities. Portland, North Vancouver, London: Explore on-street charging options such as the integration of electric vehicle charging with streetlights. Portland: Install and maintain EV chargers at Park & Ride lots and/or encourage lot owners to install chargers.
Other enabling programs and policies for public charging infrastructure, such as public charging on private property M U R P CS	Develop policies, programs, regulations, and bylaws to enable and expand deployment of charging stations. These could include policies that make it easier to provide public charging on private property and easements.	Toronto: Develop policies and programs to expand EV use, particularly with respect to vehicle charging stations and parking. Portland: Establish policies and processes that make it easier to provide publicly accessible charging on private property and encourage private property owners to do so. Develop public right of way (ROW) priorities and policies to enable installation of publicly accessible EV chargers in strategic locations and provide clear guidelines for public and private parties. Establish a policy for addressing abandoned EV chargers in the right of way.
Seek external infrastructure funding opportunities M G U	Seek external funding for public charging infrastructure through the federal government, provincial government, municipality organizations (e.g., FCM), utilities, and others.	North Vancouver: Seek external funding for public charging infrastructure through federal government (e.g., NRCan), utilities, provincial government, and others.
Consider medium to long term hydrogen opportunities for LDVs M G A I	Light-duty hydrogen fuel cell vehicle availability is currently very constrained, in part due to lack of fueling infrastructure, but this may change in the medium to long term. If heavy duty fleets begin to transition to hydrogen power, consider taking steps to open up fueling hubs to privately-owned light-duty vehicles.	
Identify potential ZEV charging/refueling corridors M G U I CS	Examine local traffic volume maps/data to determine the most highly trafficked corridors, then look for gaps in charging/refueling infrastructure and seek to address those gaps. Along corridors that lack destinations (i.e., places where people are likely to stay for multiple hours), consider installing DCFCs to minimize charging times.	

Theme	Public Fueling and Charging Networks	
Action	Definition	Examples and Best Practices
Install Level 3 public chargers (DCFCs) 	Identify sites that are strategically situated, highly trafficked, and have an adequate power supply to support DCFCs. Seek funding/financing partners to reduce capital costs. Ensure the chargers are highly visible to raise public awareness.	
Explore opportunities for public Level 1 charging in appropriate areas (e.g., airports, workplaces, transit hubs) 	When parked for long periods of time, Level 1 charging can be useful in topping up an EV battery or fully charging the battery of a PHEV. Conduct a location scan and determine where vehicles remain parked for long periods, then install or make available standard electrical outlets for EV charging. Ensure that charging cables will not pose a barrier to pedestrians or vehicle traffic. Outlets for engine block heaters may prove useful but must be powered year-round.	
Explore issuing green municipal bonds to finance charging infrastructure 	Canadian municipalities, which tend to have low borrowing interest rates, are free to take advantage of this and issue bonds to raise capital for public works projects. The proceeds from green bonds are earmarked for projects that are focused on enhancing environmental health and sustainability.	Ottawa: In 2017 Ottawa became the first Canadian city to issue a green municipal bond. The bonds had 30-year terms and provided holders with a 3.25% annual interest rate. Proceeds from the bonds (>\$100M) were used to finance a light rail transit network.


Theme	Home, Workplace, and Parking Facility Charging	
Action	Definition	Examples and Best Practices
Other enabling programs and policies for home and workplace charging (e.g., financing workplace charging through local improvement charges) 	Collaborate with the province, local development industry and utility companies to support access to home and workplace charging. Where necessary, local improvement charges can help offset capital costs of public charging infrastructure.	Calgary: Collaborate with the province, local development industry and utility companies to improve access to home charging. Edmonton: Improvements in parking facilities (e.g., employment centres, educational institutions, etc.) where people are outside of their homes on a regular basis. Vancouver, US DOE Workplace Charging Challenge: Develop a Workplace Charging Challenge - partners set a minimum goal of providing chargers for a portion of EV-driving employees and a best practice goal of meeting all employee demand. California: The State operates the Property-Assessed Clean Energy (PACE) program, which provides increment financing for personal EVSE. The program allows a property owner to finance the up-front cost of EVSE and then pay the costs back over time.

Theme	Home, Workplace, and Parking Facility Charging	
Action	Definition	Examples and Best Practices
ZEV-ready new single-family homes 	Explore requirements for newly constructed single-family homes to incorporate outlets/wiring capable of providing ZEV charging. This could involve bylaw amendments.	North Vancouver: Incorporate requirement of energized outlets capable of providing Level 2 charging for new one- and two-unit residential developments into the Zoning Bylaw.
ZEV-ready new commercial and institutional buildings 	Explore requirements for newly constructed commercial and institutional buildings to incorporate ZEV charging facilities. This could include requirements that a set percentage of parking stalls be ready for charging.	Kingston: Update the Municipal Green Building Policy to ensure that public, fleet and employee electric vehicle charging is considered for all new facilities. Portland: Explore EV parking and charging infrastructure requirements in new commercial construction projects that include parking. North Vancouver: Incorporate requirement for EV charging stations in a prescribed percentage of parking spaces in new commercial and industrial buildings into the Zoning Bylaw. Richmond: Minimum 20% parking stalls with suitable receptacle for EV charging. Additional 25% parking stalls pre-ducted for future wiring.
ZEV-ready new multi-unit residential buildings 	Amend local bylaws to require that newly constructed MURBs meet a minimum threshold of EV-ready parking spaces (e.g., 10%, 20%). Work with developers and strata councils to ensure awareness of and compliance with new bylaw.	North Vancouver: Incorporate requirement of energized outlets capable of providing Level 2 charging for 100% of residential parking spaces, allowing for load management systems, in new developments into the Zoning Bylaw. Vancouver: Expand building requirements for EV charging readiness in Multi-Unit Residential Buildings (MURBs) such that each resident has access to EV charging in their own parking stall.
Address challenges and barriers to charging for existing multi-unit residential buildings and garage orphans 	Explore feasible options to reduce installation and usage costs while mitigating demand charges (e.g., installing a second common element meter tied to EVSE; incorporating smart load management mechanisms/hardware, such as a DCC-9). This action could require amendments to bylaws to require access to charging facilities (i.e., a “right-to-charge” standard). Explore on-street charging options for garage orphans (including mounting EVSE on utility poles and designating adjacent spaces as EV-only).	North Vancouver: Review potential opportunities to amend requirements for on-site parking to decrease barriers to EV charging in existing MURBs.

Theme	Home, Workplace, and Parking Facility Charging	
Action	Definition	Examples and Best Practices
ZEV-ready retrofits for existing buildings (incorporating load management) M U I P	Retrofit strategic existing City-owned buildings and commercial facilities with EV chargers incorporating load management technologies and practices. This could be accomplished through partnerships with local business, utilities, and others.	Portland: Partner with community and private industry to develop a strategy to retrofit strategic existing City-owned buildings and commercial facilities with EV chargers. Consider EV-ready construction requirements for major renovation projects that have parking. North Vancouver: Explore opportunities for providing charging for City staff’s personal vehicles during work hours
ZEV-ready new parking facilities and retrofits M U I R P	Explore the potential for ZEV parking and charging infrastructure requirements in new and existing (public and private) parking facilities. Leverage city-owned facilities and designate desirable parking spaces as EV-only (such spaces tend to be closest to building power supplies, which reduces installation costs).	Portland: Explore the development of EV parking and charging infrastructure requirements in new and existing (public and private) parking facilities.
ZEV-ready building codes and standards (for new and existing buildings) M G U I R P	Work with building code councils and related organizations and update codes to require EV-ready wiring in new developments and major renovations.	Seattle: Develop EV ready code packages to ensure buildings and parking infrastructure can accommodate electric vehicles. Charlotte: Work with building code councils and related organizations on codes that require EV-ready wiring in new construction and renovation

Theme	City Planning and Management	
Action	Definition	Examples and Best Practices
Incorporate electrification needs into housing/ property management and planning processes M U R P	Ensure that homes are equipped with adequate electrical hardware and capacity to support EV charging. Property managers and developers should be made aware of base requirements for EVs.	Vancouver: Incorporate electrification in management of housing stock. Vancouver: Create planning guidelines for EV infrastructure deployment. Montreal: Incorporate electrification needs into property management and planning processes.
Identify opportunities to install supporting infrastructure (e.g., charging) during public works projects M U I R	Identify opportunities to install charging stations (or conduits to power stations installed at a later date) as major public works projects are taking place. For example, street renewal projects could include wiring and infrastructure for on-street charging.	Vancouver: Integrate EV charging deployment with new developments and large re-developments. Portland: Identify opportunities to install EV chargers and/or conduits in conjunction with major public works projects in strategic locations and in streetscape planning.

Theme		City Planning and Management
Action	Definition	Examples and Best Practices
Develop guidance on procurement process for charging infrastructure (M) (U) (I)	Conduct a scan of EVSE providers and meet with them to discuss what products and services they can and can't provide, as well as costs. Update guidance on an annual basis and involve local utilities for technical assistance.	
Theme		Electrical Grid Infrastructure
Action	Definition	Examples and Best Practices
Ensure electrical grid access, readiness, and resilience (M) (U)	Work with utilities to ensure the electrical distribution system has the capacity to accommodate EV charging and identify areas where access is limited. Forecast and assess the implications of EV charging demand from residential and commercial customers.	Toronto: Infrastructure and electrical grid resilience for EV use. Ensure the electrical distribution system has the capacity to accommodate EV charging which is necessary to build a robust and reliable EV charging network. Kingston: In partnership with utilities, forecast and assess implications of future EV charging demands by residential and commercial customers.
Explore renewable energy generation tied to ZEV charging (M) (U) (CS)	Assess costs and benefits of installing dedicated renewable energy for charging facilities and hubs.	
Address opportunities for vehicle-to-grid and vehicle-to-building charging systems (smart microgrids) (M) (G) (U) (I) (R) (P) (CS)	Conduct a review of current and emerging technologies that allow for a bi-directional flow of power to and from vehicles and buildings they are plugged-in to. Ensure that candidate technologies are compatible with the local grid and are in compliance with local and provincial regulations. Explore grant or subsidy programs that may provide financial benefits.	Markham: Alectra Utilities is piloting the POWER.HOUSE project, which involves the use of rooftop solar panels and lithium-ion battery storage systems at participating customers' homes, which are controlled using intelligent software. The system allows customers to use on-site generated solar energy to power their home or send it back to the grid. Such a system enables EVs to be one component of the "power house," allowing homeowners to use stored energy to charge their vehicles.
Develop guidance on the lifecycle management of charging infrastructure (M) (G) (U) (I)	Engage with EVSE providers and hosts to formulate an annual service and maintenance budget for city-owned charging infrastructure.	
Conduct investment and technological risk assessments on charging infrastructure (M) (G) (U) (A) (I) (CS)	Ensure that EVSE come with strong warranties and have good reliability ratings. Public DCFCs should be compatible with CHAdeMO and CCS charging. Ensure stations are as future-proofed as possible and are able to be upgraded if necessary (e.g., to support wireless charging).	

Theme	Electrical Grid Infrastructure	
Action	Definition	Examples and Best Practices
Advocate for removal of regulatory barriers to EVSE deployed by utilities to allow for cost recovery through rate base (e.g., via demand charges) 	Most utilities see EV deployment as a means to expand their core business but cannot offer EV-related products and services as provincial energy authorities won't allow them to incorporate costs for such offerings into their rate bases. Allowing them to do so would bring an invaluable stakeholder group into the EV deployment landscape and could reduce the costs and complexity of government involvement in EV deployment.	

Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: ZEV-ready retrofits for existing buildings (incorporating load management)

Solutions:

- Municipalities could introduce “right-to-charge” policies to require that retrofits be done. Retrofits could be phased in over time to help address upfront costs.
- Leverage opportunities and alignment with existing capital projects (including new construction, major renovations, and maintenance). Introduce a bylaw that requires that electric mobility infrastructure is incorporated into the work.
- Create a requirement in policies or bylaws to incorporate smart energy management and load management mechanisms. Retrofits could be funded through local improvement charges. Rebates or other incentives (such as low interest loans) could also help with moving this action forward.

Challenge: Ensure electrical grid access, readiness, and resilience

Solutions:

- Consult closely with local utilities and ensure that they are provided with up-to-date data on

topics such as EV adoption levels and locations, EV charging rates and capacities, local driving patterns, and neighbourhood-level demographic profiles.

- Clustering of EVs (adoption hotspots) will need to be specifically addressed (e.g., through understanding and forecasting new loads, transformer upgrades, aggregated smart charging, etc.). Work with utilities on EV cluster challenges.
- Regarding DCFs (Level 3), engage utilities early on in the deployment planning process and ensure that candidate sites have adequate electrical capacity to support Level 3 charging.

Challenge: Develop guidance on procurement process for charging infrastructure

Solutions:

- Standardized procurement documents would help municipalities streamline the process of reaching out to vendors to help with the installation of public charging networks.
- Considerations may include: conduct a scan of local EVSE providers and gain clarity on the range of services that each can provide (as well as associated pricing); review local zoning and electrical bylaws to identify areas where EVSE installations are possible; develop or adopt existing safety guidelines for the installation and use of public charging infrastructure; and ensure that EVSE are as accessible to the public as possible (e.g., they have an open protocol payment platform, they are located in areas that are accessible 24/7).

- Consult with other municipalities who have already gone through the procurement process.

The following additional cross-cutting challenges (i.e., relate to more than one action) were identified by municipalities and key stakeholders. Each action is presented with possible/suggested solutions.

Challenge: Access to home charging for rental units (including garage-orphans and MURBs)

Solutions:

- Amend or introduce bylaws and regulations (e.g., all parking spaces in new multi and single residential developments are required to be EV-ready). Note in many cases such standards fall under provincial jurisdiction, so working closely with provincial regulators is important.
- Right to charge regulations (though depending on province, cities have limited ability to address this issue, as they don't have jurisdiction over governance of rental buildings or condos).
- Engage closely with utilities on addressing MURB and garage-orphan charging. Advocate for giving utilities the ability to rate base infrastructure costs.
- Identify other interested champions for MURB and garage-orphan EV infrastructure and involve them in planning and deployment.
- Develop financial investments/solutions (e.g., rebate on EVSE; MURB incentive programs; some jurisdictions force landlords to cover part of cost of retrofit installs in MURBs). Municipalities can partner with other levels of government if financially constrained themselves.

Challenge: Insufficient public charging network

This challenge is applicable to both private LDVs and municipal fleets that depend on public infrastructure.

Policy Solutions:

- Policy options, such as charter amendments to allow municipal installation of EVSE in new commercial and mixed residential developments. Municipal governments can implement new zoning regulations to determine how many EVSE can be installed in a given area.

- The use of building codes and zoning bylaws could help to achieve ZEV-ready new parking facilities and retrofits (even by installing 120 V electrical outlets in parking lots). Possible source of funding for this action is a green municipal bond program.
- Advocate for amending acts and regulations that currently inhibit the private sector from investing in the deployment of EVSE (e.g., being able to re-sell electricity).

Network Siting Solutions:

- Increase site options by installing public fueling and charging infrastructure on city-owned property. Municipalities are able to use public, municipality-owned spaces, and can take advantage of economies of scale to build out bigger networks.
- Develop an EVSE deployment strategy. EVSE strategies should assess the public and private charging networks to identify gaps. Municipalities play a coordinating role amongst stakeholders and potential partners to site and finance public EVSE to target these gaps. Strategies should consider existing travel patterns. Public Level 2 charging should be sited where people typically park for a couple of hours (e.g., streets, malls, movie theatres, restaurants, etc.) whereas Level 3 charging is needed where people will not remain parked for very long (e.g., highway corridors). The strategy can also consider the use of EVSE to encourage people to spend time at a specific place (e.g., civic sites, tourist destinations, etc.).
- Cities with high density and lots of MURBs and/or garage-orphans may want to look at on-street Level 2 and DCFC hubs as a key part of their strategy.
- Smaller cities with lower numbers of MURBs and garage orphans may want to focus primarily on getting charging into family homes with a secondary focus on workplaces.
- EVSE planning should also consider that PHEVs need greater access to away-from-home charging than BEVs to deliver more all-electric kilometres.

Collaboration Solutions:

- Collaboration will be critical to deploying a comprehensive charging network. Consider public

- charging network partnerships (including inter-municipal).
- A subsidized network of DCFCs with multiple partners, e.g., utilities, provinces, municipalities, etc. will be required, including at locations between cities, where use will be lower (at least to start) and there is currently no business case for it (difficult to make an ROI case for DCFCs). Facilitating these partnerships between stakeholder groups is a key role for municipalities.
- Municipal governments need to get more local utilities involved, as utilities will be a key partner, especially with regard to ensuring grid readiness for DCFCs.

fueling and charging networks (i.e., stations that are out of commission) than having no public fueling and charging stations at all. Municipalities need to ensure that service level agreements are well crafted (e.g., tight performance metrics for promptly addressing issues and repairs) and include open data to support real-time apps.

- Ensure that the EVSE deployment strategy addresses EVSE ‘deserts’
- Link the EVSE deployment strategy to an education and awareness campaign targeting vehicle performance and the existing/proposed charging network. Range anxiety can still be a barrier to ownership despite widespread public charging availability.
- Increase signage at public charging to raise awareness

Challenge: Consumer range anxiety for EVs







Solutions:

- In terms of perceived risks to EV ownership, it is considered to be worse to have unreliable public

A.2. Education and Awareness

Action definitions and examples of best practice are presented in the tables below.

Theme	Public Outreach and Education	
Action	Definition	Examples and Best Practices
Public education programs and campaigns M G U A CS	Develop education and outreach programs for the general public to increase awareness and knowledge of the benefits of ZEVs. Education and awareness campaigns can and should involve multiple groups where possible (Government, NGOs, utilities, OEMs, etc.).	Charlotte: Increase visibility and knowledge of the benefits of ZEVs broadly through news media and in a more targeted way through social media, and owner testimonials. Calgary: Work with the private sector and non-profit organizations to develop an EV education program for the public and businesses. North Vancouver: Increase awareness of EV models available in BC and provincial incentive programs and clarify common EV misconceptions among City residents.
Curriculum at local schools, colleges, and universities M G CS	Work with local schools and post-secondary institutions to incorporate ZEV education into curriculums. Help to ensure that the drivers of tomorrow are well-informed regarding clean mobility options.	Charlotte: Work with local schools to incorporate EV considerations into their curriculums. Work with local community colleges and universities.

Theme	Public Outreach and Education	
Action	Definition	Examples and Best Practices
Information at charging points 	Utilize public charging stations as an educational opportunity by enhancing signage to raise the profile of stations and disseminate ZEV information at the stations.	Vancouver: Develop public charging points to be sources of information for non-EV drivers. North Vancouver: Utilize public charging stations as an educational opportunity by enhancing signage to raise the profile of stations and disseminate EV information at the stations.
Promotion at workplaces, Workplace Charging Challenge 	Promote installation of ZEV charging infrastructure at workplaces by raising awareness among employers and property managers. This could include developing a Workplace Charging Challenge.	North Vancouver: Promote installation of EV charging Infrastructure at workplaces by raising awareness among employers. Vancouver, US DOE Workplace Charging Challenge: Develop a Workplace Charging Challenge - partners set a minimum goal of providing chargers for a portion of EV driving employees and a best practice goal of meeting all employee demand.
Address knowledge gaps surrounding home charging 	Provide information to homeowners on installation options, incentives/benefits, charging best practices, and costs.	North Vancouver: Address knowledge gaps surrounding home charging by clarifying options for installation of charging stations in existing homes, increasing awareness of available financial rebates and promoting online educational resources.
Provide information on city website (including charging/fueling infrastructure locations; total cost of ownership calculator) 	Provide information on the city’s website related to available ZEV models and basic specs, available incentives, charger installation options, ownership costs, etc.	North Vancouver: Further develop the City’s EV webpage to increase understanding of City EV policy and actions, EV models and available incentive programs and resources for EV charging retrofits; provide links to other informational resources.
Create resource connecting EV owners and their experiences to potential adopters 	An online portal where those interested in becoming ZEV adopters could go to ask practical questions to existing owners would greatly help with demystifying and disseminating facts on ZEVs. Such a portal could be tied to other educational resources.	
ZEV municipal fleet adoption to enhance public awareness 	ZEV adoption within municipal fleets will not only help to address local GHG and air pollutant emissions, but will serve to regularly expose members of the public to ZEV technologies. A portion of associated charging infrastructure could be made available for public use as well.	Saanich: Since 2007, to help achieve objectives laid out in its Official Community Plan and Climate Action Plan, the District of Saanich has been actively integrating low-carbon vehicles into its fleet. It now has eight fully electric vehicles in its fleet, and its police department became the first in Canada to adopt an EV.

Theme	Technical Assistance	
Action	Definition	Examples and Best Practices
Troubleshooting assistance for homeowners and building managers (especially regarding charging infrastructure) (M) (U) (I)	Provide technical assistance (i.e., installation guidelines, troubleshooting) and educational materials to building managers and homeowners to help simplify the integration of ZEVs.	Portland: Portland provides an EV hotline that provides 24/7 assistance over the phone for concerns regarding charger use, EV incentives, and infrastructure. Worked with utility and community partners to provide technical assistance to building managers and homeowners to install EV chargers, especially in existing buildings.

Theme	Awareness of Fueling and Charging Facilities and Infrastructure	
Action	Definition	Examples and Best Practices
Enhanced and consistent signage for charging stations (M) (G) (I)	Develop consistent and easily identifiable signage for public charging stations in collaboration with other municipalities and levels of government.	Vancouver: Vancouver standardized all signage to ensure consistency, with the focus on helping ZEV users and the general public with identifying charging stations.
Identify and promote charging facilities including locations and availability (M) (U) (I) (CS)	Use media (including apps) and websites to promote public charging stations and fleets (i.e., municipal fleets, car-share or rental fleets). This could involve mapping the existing charging network and providing locations on municipal websites. Graphics on vehicles could be used to promote the city's ZEVs.	Kingston: Use existing media instruments to promote the availability of charging stations at municipal facilities.
		Charlotte: Map existing network and disseminate information.
		Portland: Work with community partners to increase the public's awareness of EV chargers through improved signage, marketing and outreach. North Vancouver: Consider raising the profile of EVs in City fleet through use of vehicle graphics.

Theme	Targeted Training and Education	
Action	Definition	Examples and Best Practices
Targeted engagement and training: developers, architects, builders, and contractors (and respective associations) (M) (U) (I) (R) (CS)	Work with partners to develop ZEV charging outreach and education materials and programs targeted to housing and commercial building developers, construction companies, architects, and tradespeople. Focus on required steps for wiring for ZEV-ready buildings.	Portland: Work with partners to develop EV charging outreach and education materials and programs targeted to builders, architects. Charlotte: Educate developers about prewiring for EVSE during new construction. Educate electrical contractors on proper installation.

Theme	Targeted Training and Education	
Action	Definition	Examples and Best Practices
<p>Targeted engagement and training: landlords, property managers, and strata/tenant boards</p> <p>M U I P CS</p>	<p>Work with partners to develop ZEV charging outreach and education materials for landlords, stratas, condo management and property managers to advance deployment of charging at multi-unit residential and rental buildings.</p>	<p>Vancouver: In coordination with other levels of government, provide education to stratas, landlords and property managers to further acceptance of MURB EV charging retrofits.</p> <p>North Vancouver: Provide education to stratas, landlords and property managers to facilitate EV charging retrofits in existing multi-family buildings by clarifying means by which charging infrastructure can be installed in existing multi-family buildings, increasing awareness of available financial incentives and promoting resources available through www.evcondo.ca.</p>
<p>Targeted engagement and training: vehicle dealerships and sales staff</p> <p>M G U A D I CS</p>	<p>Work with partners to develop ZEV outreach and education materials for vehicle dealerships. Provide authoritative third-party information and training for car dealers. Work with automakers to ensure that sales staff is knowledgeable on ZEVs to encourage customer purchases.</p>	<p>Charlotte: Provide authoritative third-party information about EVs to dealerships to help them respond to prospective EV driver concerns.</p> <p>Edmonton: Undertake EV education and marketing activities targeted at professionals in the car dealership industry who have potential to influence EV purchasing decisions. Accelerate EV uptake in the short/medium-term by shifting the perspective and purchasing decisions of sellers.</p>
<p>Targeted engagement and training: city building management and development staff</p> <p>M U I R P CS</p>	<p>Work with partners to develop ZEV outreach and education materials for city staff involved in property development to encourage ZEV-ready new builds and retrofits.</p>	<p>North Vancouver: Provide training for building and development staff on EV charging requirements, technologies and potential configurations in building construction and retrofits which could be disseminated to builders, contractors and developers.</p>
<p>Targeted engagement and training: first responders</p> <p>M G A</p>	<p>Work with local first responders to ensure the provision of proper training and equipment to safely handle accidents involving ZEVs. A specific focus on EV battery and hydrogen fuel tank safety is recommended.</p>	
<p>Encourage local utility to establish staff lead(s) to respond to public queries regarding EVSE</p> <p>M U</p>	<p>Support local utilities in allocating staff and resources to a dedicated EV hotline and/or website to respond to questions on technical aspects of EVSE installation and use.</p>	

Theme	Hands-On and In-Person Learning	
Action	Definition	Examples and Best Practices
ZEV showcase, demonstrations, and events 	Partner/collaborate to build a facility (or repurpose an existing facility) where the public can go to learn about ZEVs and EVSE, gain hands-on experience, and test drive vehicles. Collaborate with dealerships, automakers and others to run demonstrations at public events and/or in a dedicated showcase centre.	Edmonton: Implement and showcase demonstration EV(s) and infrastructure at municipal facilities and projects. Collaborate with automobile industry and non-profit organizations. Create opportunities to learn about EVs through vehicle associations and driving schools. Collaborate with ride-sharing to promote an “EV experience” to build public support for EV technology. Portland: Support Drive Oregon’s Northwest EV Showcase initiative, including helping to market the EV group purchase program, seeking funding to support the initiative and collaborating to develop the physical space. Toronto: Plug’n Drive’s Electric Vehicle Discovery Centre provides free test drives and educational materials to members of the public interested in ZEVs. The Centre has a wide range of ZEVs and EVSE available to provide the public with hands-on experience without any pressure to buy a vehicle.

Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: Targeted engagement and training: developers, architects, builders, and contractors (and respective associations); Targeted engagement and training: landlords, property managers, and strata/tenant boards

Solutions:

- Municipalities and partners such as NGOs and EV Societies can develop targeted material on emerging considerations for existing and new developments (ZEV trends, fueling and charging infrastructure, municipal policies etc.) They can then engage and partner with professional associations and other key information dissemination channels
- Municipalities can lead engagement of strata/tenant boards as well as property managers and landlords. Municipalities can consider

partnering with other stakeholders to support this engagement/training (e.g., advocacy/citizen groups/NGOs, EVSE suppliers, etc.).

The following additional cross-cutting challenges (i.e., relate to more than one action) were identified by municipalities and key stakeholders. Each action is presented with possible/suggested solutions.

Challenge: Training for municipal staff

Solutions:

- Ploughs and street sweeping equipment can damage charging equipment. Cord management is important to keep them off the ground and out of the way. Municipal operations and maintenance staff need to be trained so they don’t inadvertently damage public chargers.

Challenge: Myth busting and general awareness

General Education Solutions:

- Issues with range anxiety, fueling costs, improving EV literacy, public safety, etc. need to be addressed.

- With respect to EVs, municipalities can address some aspects of range anxiety through better education (e.g., provided via city websites, events, etc.). Education should focus on providing a comprehensive overview/map of the public charging network, understanding charging times, providing information on the rapid advancement of EV technology/batteries (and therefore range), cold weather driving/range, etc. Municipalities could consider targeting key public anxieties and misinformation in their general outreach.
- Access to other information is also critical (e.g., how to access public charging, preparing your home for EVSE installation, etc.) and advocacy/citizen/NGO groups, social media, and city websites are a great resource for this type of information. Municipalities could consider partnering with other groups to present a full suite of ZEV-related information.
- With respect to public safety and regulations around hydrogen storage and fueling, public perception needs to be managed carefully and municipalities can assist with this through information dissemination, having FCEV fleets, and hosting events and workshops.

Targeted and Hands on Outreach Solutions:

- Hands on experiences help with myth busting and general awareness. Pressure-free environments (e.g., discovery centres, ride and drive events, city-hosted demonstrations/showcase events, etc.) where people can experience and learn about EVs contributes to their comfort in purchasing an EV. Municipalities can host or support hands on outreach initiatives, including introducing policies to support EV car-sharing.
- Targeted awareness campaigns would also help with general awareness. For example, university students are within the key demographic of prospective EV buyers (higher potential earnings, higher education). There's an opportunity to educate them on benefits/suitability of EVs through on-campus exposure (e.g., university EV fleets, events and demonstrations, etc.). Municipalities could partner with universities and OEMs on raising EV awareness within their region.

Improved Accessibility/Signage Solutions:

- Range anxiety could also be helped through enhanced and consistent signage for charging stations to make them more visible and make the public more aware of them. Signage should be consistent across Canada (ideally across North America) to increase consumer familiarity with charging stations. Governments and stakeholders should issue communications (through press releases, advertisements, etc.) to enhance consumer awareness regarding public charging.







Challenge: Up-front capital cost of ZEVs

Solutions:

- There is a public perception that ZEVs are more expensive to own due to purchase prices than ICEVs. Sticker shock is a significant barrier to ownership, and many can't afford the upfront costs of ZEVs even if total cost of ownership (TCO) is lower. Municipalities should do more to communicate TCO upfront to consumers. A TCO calculator could be provided on the city website. Municipalities could also work with dealerships or OEMs to create an app that calculates TCO or savings for different makes/models, with buyer input for driving patterns, etc.
- Municipalities might also be able to play a role in financing for ZEV ownership to reduce sticker cost. Municipalities can advocate to provincial and federal governments for financial incentives for ZEVs to reduce the price gap.

A.3. Incentives

Action definitions and examples of best practice are presented in the tables below.

Theme	Motorists/General Public	
Action	Definition	Examples and Best Practices
Vehicle and/or charger voucher or rebate 	Provide a financial incentive for the purchase of vehicles and/or charger installation, e.g., cash rebate, voucher, a tax deduction or credit. Governments should set timelines or price targets for phasing out financial incentives (i.e., when ZEVs reach price parity with comparable conventional vehicles, which most experts agree will happen in the mid-2020s).	Edmonton: Address and limit the impact of the financial barrier to purchase an EV and install home-charging infrastructure. Provide non-permanent financial incentives, aimed at residents, to reduce the cost of EV purchase and charging as compared to ICE vehicle costs. Laval: Offers citizens a purchase rebate on EVs (\$2,000) and e-bicycles (\$400). The program was over-subscribed, and Laval expanded its budget to accommodate the higher than anticipated demand. The rebates are additive to those offered by the Province of Quebec. Portland: Work with partners to develop programs and incentives to reduce the barriers to EVs for low-income populations, communities with no or damaged credit, such as vouchers, instant rebates. Paris: Paris provides a tax rebate of up to \$2,464 for the installation of a home charger.
E-bike/scooter voucher or rebate 	Provide a financial incentive for the purchase of e-bikes, e.g., cash rebate or voucher.	Portland: Work with partners to develop programs and incentives to reduce the barriers to EVs for low-income populations, communities of coloured individuals with no or damaged credit, such as vouchers, instant rebates and e-bike pilot projects.
Vehicle scrappage incentives 	Provide vehicle owners a cash incentive or rebate for scrapping older vehicles and purchasing a new or used ZEV, e-bike or scooter.	Vancouver: Cash incentive or rebate for scrapping older vehicle and replacing with an e-bike or EV.
Preferential or free parking 	Allow ZEV owners to park for free or in preferential parking spaces. Fast-track ZEV owners for parking permits if there is a wait list.	North Vancouver: Preferential parking spaces. London (UK): London allows free parking for EVs in some areas, other surrounding cities have followed suit. Amsterdam: Amsterdam has given EV owners priority on the waitlist for parking permits.
Toll discount 	Provide ZEV owners a discount on tolls and/or access to fast lanes at toll booths.	New York City: NYC has provided a 10% discount on the E-Z Pass for EVs, used on the city toll ways. The pass also provides access to the fast lane at toll booths.
Carpool lane access (HOV/HOT lane) 	Allow ZEV owners to access HOV lanes regardless of passenger requirements.	Los Angeles: Los Angeles enforces allowing EVs to access HOV lanes by using decals provided by the state of California.

Theme	Motorists/General Public	
Action	Definition	Examples and Best Practices
ZEV-only areas or Low Emission Zones (LEZs) M G	Low emission zones restrict access to portions of a city (typically the downtown core) to newer or low-emitting vehicles.	Amsterdam: Amsterdam created an LEZ in the downtown core from which heavy-duty vehicles and delivery trucks older than the year 2000 are restricted entry. The city plans to further restrict access to diesel taxis, coaches, and mopeds in 2018.
Incentive funding partnerships M G U A D I CS	Partner with other organizations, business, and/or governments to secure funding for financial incentives.	Charlotte: Encourage local partners to develop monetary and non-monetary incentives (Chambers of Commerce, retail businesses, etc.).
Explore instituting congestion charges for non-ZEVs in priority areas M CS	Congestion charges are typically established in the downtown cores of major cities to help improve air quality, optimize public transit usage and alleviate congestion.	London (UK): London's Congestion Charge zone waives all charges to vehicles with an all-electric range greater than 32 km.
Consider a range of possible disincentives for ICE vehicles M G	Disincentives for ICE vehicle usage include the establishment of congestion charges, low emission zones, municipal gas taxes, and EV-only parking spaces.	Montreal, Vancouver, Victoria: These three cities have introduced a municipal gas tax ranging from 3 cents per litre (Montreal) to 11 cents (Vancouver). Proceeds go towards funding public transit and other clean transportation initiatives.
Create partnerships to offer free/discounted car-share/rental memberships and rates with ZEV purchases M G A D	Providing ZEV buyers with discounted access to ICE vehicles through car-sharing/rental services is an effective way to address range anxiety (by making long-distance trips or trips to remote areas more worry-free). It can also help single-vehicle households to confidently make the switch to a ZEV.	
Explore possible incentives for used ZEV market M G D CS	Expanding the market for used ZEVs through providing incentives can help to address high purchase costs and limited local/regional ZEV availability. Municipality-led ZEV rebate programs should incorporate used vehicles. This would also make ZEV ownership more feasible for lower-income households.	

Theme	Business	
Action	Definition	Examples and Best Practices
Tax benefits for charging/refueling hosts M G P	Consider providing tax benefits to workplaces and commercial buildings that provide access to charging.	Vancouver: The City will conduct a review of the taxation and labour implications of employers providing EV charging as an employee benefit.

Theme	Business	
Action	Definition	Examples and Best Practices
Explore potential tax benefits for ZEV infrastructure M G U R P	Carbon credits, property tax rebates, and other financial mechanisms should be oriented to rewarding public and private EVSE providers and hosts.	
Streamline application process for charging/refueling infrastructure permits M U I R P	Reducing the administrative burden for organizations that wish to provide public ZEV charging/refueling will help to ensure that more resources are available to put towards installing and maintaining the infrastructure.	

Theme	Landlords and Home Owners	
Action	Definition	Examples and Best Practices
Link car-share parking incentives with charging incentives M	Provide preferential rates and exclusive access to certain locations to car- and ride-share companies who utilize ZEVs and install ZEV charging/refueling infrastructure.	Vancouver: Develop in-building “Innovation Zones” that link incentives for car-share parking with creation of EV charging at car-share parking stalls. The City will develop means by which various innovative and sustainable technologies that occur in parking areas can be co-located to increase awareness.
Multi-unit residential building retrofit and load management incentives M G P	Develop a financial incentive to encourage multi-unit residential buildings to install charging facilities, with added incentives for smart charging. Consider combining with other programs and incentives such as energy retrofits.	Vancouver, North Vancouver: Each City will develop a financial incentive program that will encourage multi-family buildings and workplaces to carry out EV charging retrofits. Where possible, this program will leverage other building energy retrofit programs already underway or under development.

Theme	Public Charging Stations	
Action	Definition	Examples and Best Practices
Charging revenue via carbon or clean fuel credits M G	Explore mechanisms for generating revenue for charging providers such as carbon credits and clean fuels credits. Such credits will help to offset capital costs and enhance the business case for charging infrastructure installation.	Vancouver: Investigate potential carbon credit mechanisms that can encourage investment in public charging. Portland: The City generates carbon credits from its network of charging stations through the Oregon Clean Fuels Program. It ensures that resources received from these types of credits are spent on EV-related projects.
Incentives in fee structure for public charging M G U I	Develop a fee structure for municipal charging stations to recover costs while maintaining low refueling costs relative to fossil fuels.	North Vancouver: Implement an appropriate fee structure for public charging stations to recover costs and increase turnover and encourage home charging, while maintaining a cost incentive compared to fossil fueled vehicles.

Theme	Public Charging Stations	
Action	Definition	Examples and Best Practices
Advocate for regulatory incentives for ZEV investments (e.g., via Clean Fuel Standard, carbon taxes) M G R P	Advocate to higher levels of government for a greater share of tax revenue to be allocated to clean transportation initiatives.	
Allocate points for ZEV infrastructure in evaluation of development proposals M R	Incorporate a points system for the provision of EVSE in development proposals to encourage developers to deploy associated technologies.	
Development charge discounts for ZEV infrastructure investments M G I R P	Provide a development fee discount to developers proportional to the amount of EVSE installed. This will help to offset additional costs related to EVSE.	
Explore excluding ZEV infrastructure from demand charges M G U P CS	Work with utilities to explore a means by which to exclude EVSE power usage from demand charge measurements.	

Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: Multi-unit residential building retrofit and load management incentives

Solutions:

- Encourage financial sector stakeholders to offer preferential financing rates for EV charging in MURBs.
- Ensure that load management mechanisms are included in retrofit plans (this will mitigate costs to building managers and occupants alike).
- Provide MURB managers and owners with educational materials and resources on EV charging retrofits.

Challenge: ZEV-only areas or Low Emission Zones (LEZs)

Solutions:

- Municipalities should advocate for having greater flexibility to designate LEZs without provincial oversight or permission.
- LEZs should incorporate multiple mobility options, including public transit and active transportation.
- Introduce areas and zones gradually. Consider the use of progressive policies to signal the eventual adoption of a LEZ (e.g., designated green zones) and/or bunding with congestion-reducing initiatives.

The following additional cross-cutting challenges (i.e., relate to more than one action) were identified by municipalities and key stakeholders. Each action is presented with possible/suggested solutions.

Challenge: Funding upfront costs of ZEVs and infrastructure

Solutions:

Capital cost support





- Upfront financial incentives/rebates/tax credits for ZEVs and infrastructure can be provided by different stakeholders (e.g., federal, provincial, municipal governments). Municipalities can look for funding partners in higher levels of government, or within utilities or other

electricity system stakeholders (especially if these organizations have a public charging program).

- Explore property tax increment financing (municipal) or on-bill financing (utility) for personal EVSE purchase.
- Municipalities could seek provincial and federal involvement in scrappage programs.
- Create a used EV car portal to increase accessibility of EVs (i.e., lower capital costs on used cars). Municipalities could partner or support other groups in developing and running these portals.

A.4. Complementary Mechanisms

Action definitions and examples of best practice are presented in the tables below.

Theme	Policy Development at Other Levels of Government	
Action	Definition	Examples and Best Practices
Advocate for changes to provincial/federal regulations: MURBs 	Advocate for regulatory changes or new regulations at the provincial and federal level to advance the deployment of ZEVs. This could include regulations to address charging challenges at multi-unit residential buildings.	North Vancouver: Advocate for provincial regulations to require that strata corporations allow the installation of EV charging infrastructure where it is technically feasible and safe.
Advocate for changes to provincial/federal regulations: other regulatory barriers 	Advocate for regulatory changes or new regulations at the provincial and federal level to remove barriers and advance the deployment of ZEVs. This could include regulations that enable private charging facilities to become electricity retailers.	Edmonton: Work with other levels of government to develop strategies and policies, seek to remove provincial or federal barriers or restrictions that prevent adoption of EVs (e.g., regulations that did not consider the possibility of EVs when they were written), and access to funding. Vancouver: Advocate with the provincial government, BC Utilities Commission, BC Hydro for exemptions or streamlined regulations to enable private sector station hosts to charge fees for electricity under the BC Utilities Commission Act.
Seek regulatory clarity on charging for charging 	Advocate to higher levels of government and energy authorities for a modern, straightforward set of rules governing the sale of electricity and EV-related products and services, as well as specifying the parties that are eligible to do so.	
Advocate for supply-side ZEV mandate at provincial or federal level 	If local/regional demand for ZEVs is far surpassing supply, explore the potential of advocating for a ZEV mandate at the provincial or federal level.	

Theme	Municipal Policy and Regulations	
Action	Definition	Examples and Best Practices
Amend or introduce local bylaws to address barriers (e.g., anti-ICEing bylaw) M G	Amend or introduce bylaws to help limit barriers to increase the availability of EVs and charging infrastructure at residences, workplaces, and commercial buildings.	Edmonton: Amend bylaws to help limit barriers to increase the availability of EVs and charging infrastructure at residences and workplaces. Denver: The City enforces ticketing and towing of non-EVs parked in EV spaces.
Explore adding ZEV infrastructure to Community Amenity Contributions M R	Consider adding public charging to the engineering list of Community Amenity Contributions (i.e., amenity requirements for developments that require rezoning).	Vancouver: Subject to Council, Engineering and other necessary approvals, add public charging to Engineering list of Community Amenity Contributions.
Develop transportation electrification plans M U CS	Collaborate with local stakeholders to develop and implement transportation electrification plans. Assess appropriate targets, timelines and budgets for local ZEV adoption across all modes of transport.	Montreal: Create an institute on electrification and intelligent transportation. Portland: Partner with local utilities to finalize and implement their transportation electrification plans.

Theme	Research Partnerships and Field Testing	
Action	Definition	Examples and Best Practices
Research partnerships, innovation, and field testing M U A CS	Partner with post-secondary institutions, the private sector, and other research organizations to advance research and field testing of ZEVs and charging technologies as well as to advance city-specific research into costs and benefits of ZEVs, GHG reductions, infrastructure requirements, goods movement and public transit planning, etc.	Calgary: Partner with post-secondary institutions and the private sector to advance research and field testing of low emission technologies, and to advance Calgary-specific research into goods movement GHG reduction actions and policies. Seattle: Partner with the Electric Power Research Institute (EPRI) to test a range of charging technologies on the City’s fleet vehicles at the SeaPark Garage. The project will help City Light (and the City’s Fleet Management Division) understand ways to leverage managed charging technology to mitigate the need for utility and customer infrastructure upgrades.

Theme	Record Keeping and Data	
Action	Definition	Examples and Best Practices
Collect data on usage of charging facilities, ZEV purchases, infrastructure availability M U D I	Track development of ZEV charging and other supporting infrastructure in city databases. Track usage of municipal charging facilities. Track the number of ZEVs sold in the municipality.	North Vancouver: Ensure EV supply equipment data from new developments is tracked in CityPAL in a meaningful way and incorporates historical permits to have a robust database of EV charging equipped parking spaces in buildings across the City.

Theme	Record Keeping and Data	
Action	Definition	Examples and Best Practices
Analyze data to enhance the availability of charging where most needed M U CS	Analyze data collected such as charging station usage, daily traffic volume and ZEV sales to enhance the availability of charging where most needed.	<p>North Vancouver: Review current station usage to determine daily usage trends and explore opportunities to maximize access and reduce congestion through financial rate structures and parking regulations.</p> <p>Portland: Develop and utilize the best available information (e.g., charger location, EV car sales, demographics, vehicle-miles-traveled) to inform investment and policy priorities for the electrification of the transportation system. Work with Oregon’s Department of Environmental Quality and Portland State University to track and share data on the number of zero emission vehicles registered in Oregon and Multnomah County.</p>

Theme	Collaboration	
Action	Definition	Examples and Best Practices
Ongoing collaboration with public and private partners M G U A D I R P CS	Establish relationships with fleet managers, governments, dealerships, building owners and property managers, and other stakeholders who can support and advance ZEV deployment. Designate a staff member to maintain relations with key low-carbon transportation stakeholders.	<p>Montreal: Collaboration in electrification initiatives and in the promotion of sustainable mobility to maximize the impact of its initiatives and implement complementary electrification projects.</p> <p>Charlotte: Establish key partnerships with fleet managers, local governments, and dealerships.</p>
Internal ZEV working group M U	Create an internal working group to study municipal issues surrounding the use and deployment of ZEVs and to make recommendations on ways to promote the use of ZEVs amongst the general public.	New York City: NYC has an Electric Vehicle Advisory Committee which has published recommendations for city council regarding supporting EV uptake and charging infrastructure.
ZEV information sharing network M G U D R P CS	Create or join a multi-stakeholder network to share information and best practices on ZEV deployment and municipal issues. Stakeholders in the working group may include municipal staff, local utilities, politicians, car dealerships, environmental organizations, and others. The working group could coordinate with other municipal working groups to share best practices.	The International Energy Agency’s Electric Vehicle Initiative recently launched the Global EV Pilot City Programme. The Programme aims to build a network of 100 global cities to share resources, best practices and experiences on accelerating ZEV deployment. There are currently seven Canadian members: Halifax, Stratford (PEI), Montreal, Winnipeg, Calgary, Surrey, and Richmond.
Tax incentives to dealerships for selling ZEVs M A D	Consider offering vehicle dealerships tax incentives proportional to the number of ZEVs each sells. Cities could also promote exemplary dealerships via ZEV-related educational resources.	

Theme	Other	
Action	Definition	Examples and Best Practices
Community mobility needs assessment and social equity analysis (M) (CS)	Work with partners to assess the impacts of ZEVs and ZEV strategies on community mobility needs and social equity. Ensure that marginalized communities have access to electric mobility comparable to that of affluent communities. This may involve prioritizing electrified transit deployment, or electric micro-mobility options, in marginalized communities.	Portland: Work with partners to leverage existing community mobility needs assessments and conduct additional engagement as necessary to ensure that EV solutions meet the needs of low-income populations and communities of colour.

Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: Community mobility needs assessment and social equity analysis

Solutions:

- Leverage Statistics Canada or other data to identify areas of the city with higher socio-economic vulnerability
- Engage neighbourhood and/or other organizations to provide insight into how proposed actions may impact municipal areas with high socio-economic vulnerability

- Explore alternative means other than personal vehicle ownership to ensure benefits of a ZEV strategy accrue across the municipal population. These can include actions to incent ZEV adoption in car-sharing programs, ZEV public transportation, integration of ZEVs in first and last mile transportation solutions and other forms of zero emission mobility such as e-bikes and scooters.
- Ensure that charging solutions, especially in MURBs, are ‘user pays’
- Consider providing income-based incentives. Partner with other levels of government if resource constrained.
- Provide preferential tax treatment to dealerships who demonstrate innovative equity-focused solutions with regard to ZEV sales.



Challenge: Amend or introduce local bylaws to address barriers (e.g., anti-ICEing bylaw)

Solutions:

- Other levels of government and local conservation authorities may be able to help municipalities with bylaw amendments or introductions.
- Municipal zoning and bylaw jurisdiction as they relate to parking lots (interior and exterior parking) is important to look at to support EVSE. Ensure that parking lot bylaws are modified to allow for all levels of charging and that parking bylaws include rules around ICE vehicles parking in EV charging spots, and for EV vehicles not to park in charging spots while not actively charging.
- Municipalities could also require parking spaces to be EV ready, particularly for indoor parking, as this will be more of a challenge.
- When municipal bylaws are further subdivided (e.g., by borough), provide a model bylaw and support (e.g., education, resources, etc.) to facilitate adoption and revision of bylaws.

The following additional cross-cutting challenges (i.e., relate to more than one action) were identified by municipalities and key stakeholders. Each action is presented with possible/suggested solutions.

Challenge: Supply of vehicles

Solutions:




- Municipalities cannot directly address the challenge of vehicle supply (i.e., cars on lots for test drives, vehicle availability at dealerships, and suitability and availability of makes and models such as pickup trucks and SUVs). Municipalities can advocate for other levels of government to address this issue, including conducting surveys (e.g., secret shopper surveys) and studies to inform the advocacy.
- Municipalities can also work with dealerships and OEMs to encourage the supply and promotion of ZEVs.
- Municipalities could partner with other level of government to draw ZEV manufacturing into their region.







Appendix B: Fleet, MDV, HDV Actions

B.1. Fueling and Charging Infrastructure

Action definitions and examples of best practice are presented in the tables below.

Theme	Fueling and Charging Networks	
Action	Definition	Examples and Best Practices
Charging and fueling network partnerships 	Increase access to fleet charging by deploying charging stations and hubs. Charging station infrastructure could be funded by a group of partners, which could include provincial authorities, municipalities, private businesses, transit agencies, utilities, and others. The locations of charging stations could also be determined by the partnership. Ownership of the stations could be municipal or private.	Shenzhen: To ensure recharging does not disrupt bus services, bus operators collaborated with charging infrastructure providers to build charging facilities along the bus routes; the ratio of charging outlets to the number of e-buses is 1:3. Shenzhen transportation providers collaborated with utility companies to ensure that electricity is provided to the charge point and charging times are coordinated to charge buses fully overnight, when electricity demand (and prices) are lower.
Test and demonstrate charging technology 	Support technology demonstrations that would provide charging infrastructure required for large fleets, including those with medium- and heavy-duty vehicles. Work with fleet managers and infrastructure providers to determine candidate technologies, then select optimal locations for charging stations/hubs working with local utilities. Consider opening charging hubs to the public once they are up and running.	Montreal: Participate in the City Mobility pilot project, which includes purchasing three fully electric vehicles and installing two charging stations to test quick-charging stations/technology under operational conditions. The three electric buses and charging equipment will undergo testing until December 31, 2019. This demonstration period will help learn more about the quick-charging technology under operational conditions. Vancouver: City of Vancouver is partnering on a project that will demonstrate an overhead bus charging system to support electric buses in downtown Vancouver and the route to Burnaby and help to demonstrate the commercial and technical potential for integrated, standardized electric bus charging systems.
Explore external funding opportunities 	Seek external funding for charging infrastructure through federal government (e.g., NRCan, Canada Infrastructure Bank), utilities, provincial government, and others.	Edmonton: The City secured \$21.5 million in federal, \$10.8 million in provincial, and \$10.8 million in municipal funding for its new fleet of 25 electric buses. A portion of this \$43 million in funding will be spent on providing required charging and facility infrastructure at the Kathleen Andrews Transit Garage.

Theme	Fueling and Charging Networks	
Action	Definition	Examples and Best Practices
Enable sharing of infrastructure between municipal and private fleets 	Establish partnerships and a price structure for granting private fleets access to a portion of municipal charging infrastructure. Partnerships should allow for a reduced capital cost burden on municipalities, and/or an additional revenue stream.	Shenzhen: In Shenzhen, the charging facilities for buses are also open to private cars and taxis at a subsidized price. This helps improve the financial performance of the charging infrastructure.
Gather and analyze fleet movement and usage data to facilitate charging/refueling infrastructure siting 	Work with fleet managers, infrastructure providers and utilities to determine optimal fleet charging station/hub locations. Leverage city-owned property where possible. Identify which vehicles in a fleet are amenable to electrification based on their duty cycles and prioritize charging for those vehicles.	Sacramento: Sacramento is assessing truck routes and concentration of freight activity in the city and exploring options for ZEV freight applications that could serve both regional and interstate operations.
Advocate for the standardization and interoperability of charging hardware for fleet vehicles 	A lack of standards around e-bus charging creates additional barriers for e-bus operators in terms of interoperability of the vehicles with different chargers. It often leaves e-bus operators locked in to one bus or charger maker. Standardization is crucial to overcome those barriers, and cities need to work collectively with national governments to push for the adoption of national and global standards.	
Installation of charging stations and shared charging hubs 	Provide support to fleets that are considering transitioning to ZEVs by installing public charging stations and hubs accessible to both the general public and the private sector.	Oslo, Norway: The Vulkan project on the city's outskirts provides over 100 EV multi-speed charging facilities and offers battery reserve and vehicle-to-grid technologies. The system is fully digitized, providing pre-booking for fleet operators and car-sharing services. The project is a public-private partnership between the city, a utility company and a real-estate firm. Sacramento: The City is identifying priority areas to co-locate charging infrastructure that will support both LDVs and HDVs. The city is also working with its fleet providers to enable co-location of charging at central sites that can support multiple transit, MDV, and HDV fleets.

Theme	City Planning and Management	
Action	Definition	Examples and Best Practices
Identify opportunities to install supporting infrastructure (e.g., charging) during public works and other construction projects M U I	Identify opportunities to install EV chargers and/or conduits in conjunction with major public works projects in strategic locations that take into consideration the electrification of fleets.	
Advocate for regulatory changes to remove demand charges for ZEV charging infrastructure M G U I F	Work with the provincial government and utilities to explore demand charge exemptions or discounts for fleet charging infrastructure.	
Explore options for hydrogen fueling infrastructure M G U I A F	Consult with local fleet operators to gauge level of interest in hydrogen fuel cell vehicle adoption. Help to streamline fueling infrastructure installation process and to identify potential sites that could be expanded upon.	Aberdeen, UK: The city examined hydrogen production and distribution options and committed to research best options for siting additional hydrogen refueling stations. The city aims to expand production and distribution of renewable hydrogen and develop hydrogen refueling infrastructure to support the roll out of hydrogen buses.
Provide ongoing staffing and resources for infrastructure maintenance M I F	Ensure that municipal agencies tasked with the roll out of charging infrastructure have sufficient resources to monitor, maintain and troubleshoot equipment.	
Align ZEV public transportation route planning and design with infrastructure requirements M U I F	Existing bus depots, terminals or bus stops may be located in areas where the power supply is insufficient to charge e-buses. Grid-constrained areas throughout a city can also make deploying e-buses on new routes difficult. Involving local utilities and grid operators from the beginning of planning e-bus deployment should help address these challenges.	

Theme	Electrical Grid Infrastructure	
Action	Definition	Examples and Best Practices
<p>Evaluate electrical grid capacity and upgrades needed; ensure access, readiness, and resilience</p> <p>M G U I F</p>	<p>Infrastructure and electrical grid resilience for EV use. Ensure the electrical distribution system has the capacity to accommodate EV charging for fleets. In partnership with utilities, forecast and assess implications of future EV charging demands by public transport and HDV fleets. Employ load management technologies and practices where possible.</p>	<p>Seattle: To address charging infrastructure issues related to fleet electrification, Seattle City Light will test various charging technologies on Seattle’s fleet vehicles to understand how it can manage charging technology to mitigate utility and customer infrastructure upgrades. In addition, the city expects significant charging infrastructure expansion, as King County Metro brings 120 all-electric buses into service by 2020. To prepare for this expansion, Seattle City Light will address electric service opportunities and develop a strategy that meets Metro’s need for flexibility while ensuring City Light’s ability to optimize load on the distribution network.</p>
<p>Explore integrating renewable energy generation and vehicle-to-grid technologies at fleet facilities</p> <p>M U I A F CS</p>	<p>At fleet charging hubs, it may be economical to integrate renewable energy generation (e.g., solar PV arrays) and/or stationary battery storage to save on power costs and reduce demand. Also consider using a portion of standby vehicles in vehicle-to-grid applications working with the local utility company.</p>	<p>Grande Prairie: Has explored and is pursuing a solar power project that will entail installing an array of panels on a transit garage, along with a battery storage system. Solar power will collect energy during the day for storage in the batteries. The batteries will charge the electric buses, and electrical power from the grid will be used as a supplement.</p> <p>Sacramento: The city committed to work with universities to investigate and pilot managed charging or vehicle-to-grid technologies to address impacts on the grid and/or support the integration of renewable energy generation into the grid.</p>

Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: Evaluate electrical grid capacity and upgrades needed; ensure access, readiness, and resilience

Solutions:

- Conduct grid resilience evaluation to assist with planning for locating charging infrastructure. For example, if DCFCs operate at 100-200 kW, the amount of infrastructure required to provide that electricity to a single charger is substantive. Gas stations with about 12 pump heads are the norm,

but the grid infrastructure needed to provide that energy is significant. Therefore, EV infrastructure may need to be more widely distributed to even out electricity demands. This may be especially true for HDVs with their significantly larger batteries and electricity requirements

- Conduct site-specific readiness assessments (e.g., electricity infrastructure redesign may be required at centralized fleet facilities) in addition to community-wide capacity assessments.
- Acknowledge and account for possible deviations from projected future energy demands.

Challenge: Advocate for regulatory changes to remove demand charges for ZEV charging infrastructure

Solutions:

- Advocate to higher levels of government for time-based fees for public EV charging (rather than power-based fees).
- Review emerging research on this topic from Measurement Canada and the British Columbia Utilities Commission.

Challenge: Explore integrating renewable energy generation and vehicle-to-grid technologies at fleet facilities

Solutions:

- Ensure that the facility's province offers net metering services and determine which program would best suit a potential project.
- Conduct a technology scan for the highest efficiency and/or lowest cost micro-scale renewable energy options for a given locality.
- Conduct a needs assessment (for vehicle electrical supply) and a power generation assessment incorporating a variety of vehicle and generation technologies.
- Conduct a scan for locally available renewable/low-carbon energy grants or other financial benefits (e.g., carbon credits) to help offset capital costs.
- Determine a projected payback period for upgrades

Challenge: Provide ongoing staffing and resources for infrastructure maintenance

Solutions:

- If municipal government staffing capacity is limited, consider contracting a third-party provider to maintain public charging infrastructure.
- Ensure that charging stations have connectivity and can report any issues autonomously, in real-time, to save on labour costs.

The following additional cross-cutting challenges (i.e., relate to more than one action) were identified by municipalities and key stakeholders. Each action is presented with possible/suggested solutions.

Challenge: Urban planning strategies for fleets

Solutions:

- Government-owned buildings could all be equipped with EV charging stations.
- Municipal fleet managers need to look carefully at the duty cycles of fleet vehicles and match them with appropriate alternative fuel vehicles. Then they should plan a refueling infrastructure network around the duty cycles and route operation of their vehicles. For example, in some cases, FCEVs may be best suited to some operations and PHEVs to others, each type of ZEV requiring different fueling infrastructure.
- To maximize infrastructure usage, fleet fueling, and charging hubs could be located at transit hubs (if this makes sense operationally). This could provide flexibility to provide fueling and charging to other fleets or the general public.
- Encourage/enable EVSE charging at dedicated parking for car-sharing fleets.
- e-HDV charging will have a larger footprint than LDV charging, which needs to be considered in urban planning.






Challenge: Turn-key solutions for e-HDV charging systems

Solutions:

- High power charging systems used by HDV fleets need to be resilient and must operate smoothly for 24 hours a day. Use of turn-key service providers that monitor EVSE operations in real-time 24/7 and can therefore react quickly to any operational issues could help alleviate reliability concerns.
- Public-private partnerships may be needed to effectively plan and deploy HDV charging, as there currently aren't any companies that focus on the rollout of HDV charging as their core business.

B.2. Education and Awareness





Action definitions and examples of best practice are presented in the tables below.

Theme	Outreach and Education	
Action	Definition	Examples and Best Practices
Public education programs and awareness campaigns 	Educating local residents on the merits of e-bus adoption and the need for chargers at bus stops could help overcome public perception issues.	Winnipeg: Electric Bus Demonstration project - The prototype bus was used in conjunction with a variety of public awareness and promotion activities, including ZEV related events, showcases, etc.
Electric school bus demonstrations 	School buses are most often part of return-to-base fleets with ample down-time for charging. An electric school bus fleet would offer human health and GHG benefits as well as help to expose the next generation of drivers to EVs. Incorporate smart charging technologies and practices into the demonstrations.	Winnipeg: Electric Bus Demonstration project - Promotional activities included rides for dignitaries and media representatives.
ZEV showcases, demonstrations, and events 	Help to provide individuals and businesses with first-hand experience with ZEVs by hosting events and demonstrations that showcase ZEV technology. For demonstrations, ensure that educational materials are made available to all users. For events, ensure that experts are on hand to respond to questions and comments. Use events to help direct users to a web-based resource.	Winnipeg: Electric Bus Demonstration project - Announcement of events were well covered by the local media, including radio, television, etc. Two video segments were prepared regarding the prototype bus and shared on a dedicated webpage by Winnipeg Transit.
Curriculum at local schools, colleges, and universities (including training programs for operators and maintenance technicians) 	Work with local schools and discuss the need for ZEV training and technicians. Consider offering a co-op program to work with municipal fleet operators. Explore opportunities for internal ZEV experts to guest lecture or present to students.	Winnipeg: Work with local community colleges and universities to incorporate electric HDV considerations into their curriculum. Advanced Transportation and Energy Centre at Red River College provides educational programming related to electric buses.
Provide information on city website 	Create a one-stop shop informational web portal that provides locality-specific ZEV info (e.g., available rebates and incentives, environmental benefits, TCO calculator, testimonials, a discussion forum, charging station maps, model profiles and comparisons, performance specs, maintenance tips, links to service providers, etc.). Promote and advertise the website through all available channels.	Winnipeg: Winnipeg provides information on the electric bus demonstration project and provides links to other informational resources.

Theme	Outreach and Education	
Action	Definition	Examples and Best Practices
Promotion of ZEVs to fleet owners and operators (M) (G) (A) (D) (F) (CS)	Provide educational materials to private fleet owners and operators focusing on technology options, the benefits of electric fleets, TCO, and links to supporting organizations.	Sacramento: The city is working to increase the visibility and awareness of electric MDV and HDV technologies using strategies such as events, fleet recognition programs, and other partnership efforts. It is also supporting partners in their efforts to replace conventional bus fleets with ZEV models.
Community engagement and education on hydrogen infrastructure (M) (I) (F)	Work with hydrogen infrastructure providers and fleets to develop educational material focused on safety, benefits, and availability of hydrogen and fuel cell vehicles.	Aberdeen, UK: The City aims to support uptake, improve awareness, and encourage acceptance of hydrogen technologies by stakeholders, including the public, businesses, and government agencies by communicating high profile demonstration projects such as the Aberdeen Hydrogen Bus Project and undertaking a public engagement/outreach program.
Compile list of local and regional benefits of ZEVs for fleets (e.g., local incentives, costs, environmental, and human health) (M)	ZEV benefits list should be shared directly with local fleet operators, via the City’s website, and at local fleet trade shows and events. Try to find a ZEV champion fleet to provide a testimonial.	

Theme	Awareness of Fueling and Charging Facilities and Infrastructure	
Action	Definition	Examples and Best Practices
Identify and promote public charging/refueling facilities including locations and availability (particularly for non-return-to-base fleets) (M) (U) (I) (CS)	Ensure that publicly-available EVSE locations, type, and availability are viewable from popular EVSE locator maps/apps (e.g., ChargeHub, PlugShare, CAA). Promote newly launched locations via popular and social media, and on municipality and partner websites.	
Information at public charging/refueling points (particularly for non-return-to-base fleets) (M) (G) (I) (CS)	Consider providing information via signage and app/web links on benefits and best practices associated with ZEV usage. Include comparisons with ICE vehicles where possible. Environmental (e.g., carbon intensity of regional grid) and cost benefits should be emphasized.	

Theme	Business Case	
Action	Definition	Examples and Best Practices
Provide business case development assistance to fleet owners (incorporating triple bottom line accounting) (M) (G) (U) (A) (D) (F) (CS)	Drawing on municipality and partner experiences with ZEV fleets, develop guidelines and resources for local fleets, with focus on local practices and organizations. Include approaches to minimizing costs and available incentives.	Winnipeg: The Joint Task Force on Transit Electrification evaluated and communicated the economic business case and GHG emissions profiles of electric buses and alternative options.

Theme	Targeted Training and Education	
Action	Definition	Examples and Best Practices
Targeted engagement and training: municipal staff 	Educate City staff on the technology options and benefits of electric cars, trucks, and buses, with a focus on TCO and vehicle performance and requirements.	
Targeted engagement and training: fleet owners and operators 	Provide training guidelines to fleet operators related to electric cars, trucks, and buses. These guidelines need not be unique to a given municipality and can be drawn from external sources.	Edmonton: As part of its electric bus implementation program, the City will provide training to bus operators, ETS inspectors, superintendents, instructors, fleet and facility staff, and first responders.
Create best practice documents for individual fleet segments 	Conduct a literature review focused on different types of ZEV fleets and consult with existing ZEV fleet operators. Compile information in fact sheets and share with relevant fleet operators.	
Work with local authorities to assess any required changes to emergency preparedness and planning (given widespread ZEV fleet adoption) 	Ensure that local first responders are familiar with ZEV technologies and how to safely deal with them in the case of accidents. Draw on best practices from other jurisdictions or guidance from higher levels of government where necessary. Guidance might also be available from automakers.	Edmonton: As part of its electric bus implementation program, the City will provide training to bus operators, ETS inspectors, superintendents, instructors, fleet and facility staff, and first responders. Tesla First Responders Information: To address safety concerns related to accidents and battery fires, Tesla developed a website with guidance for first responders (https://www.tesla.com/en_CA/firstresponders).

Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: Compile list of local and regional benefits of ZEVs for fleets (e.g., local incentives, costs, environmental, and human health)

Solutions:

- Work with local academic institutions to compile research and findings. When conducting research, where municipality-specific data is not available, consider using regional data and approximating it based on the local population and travel patterns.

- Municipalities could work with OEMs to better understand costs, including ROI models and TCO calculators.
- Municipalities that are part of showcase events for the public could use these same event information kits for internal events aimed at their own fleet operators to share information on incentives, costs, etc.

The following additional cross-cutting challenges (i.e., relate to more than one action) were identified by municipalities and key stakeholders. Each action is presented with possible/suggested solutions.

Challenge: Business case

Solutions:

- With regard to municipal corporate deployment within fleets, the biggest challenge is understanding what vehicles can be transitioned

and making the business case for this. A major barrier is the lack of information and certainty on the business case for adopting EVs. Solutions include talking to other municipalities, conducting fleet studies, and studying data and analytics.

- Municipalities can also work with OEMs to better understand the business case (e.g., TCO) and suitability of vehicles. OEMs can help cities to decide which ZEV applications make sense (e.g., if fleet vehicles have very limited daily mileage, they probably aren't ideal for replacing with ZEVs, as ZEVs provide a faster ROI the more kilometres that they are driven).
- In some cases, the purchase prices of ZEVs can make the business case problematic. Cities need to raise awareness and education on longer-term business case planning (e.g., look at TCO over ten years or so). Bids for ZEVs integration into their fleets would look more competitive over the long-term.
- Fleets could incorporate the impact of carbon prices on fuel costs into their fleet budgeting activities to help with the business case.
- Apart from suitability and financing, ensuring that clean transportation objectives are expressed in municipal procurement plans is critical as well, as this will motivate fleets to look closely into replacing ICE vehicles with ZEVs. When municipal fleet managers are looking at new vehicles, it's important that they are encouraged or mandated to look at low-carbon options.


Challenge: Operations training and capacity building

Solutions:

- Education is important to make sure vehicles are used and fueled/charged properly, to maximize costs and environmental benefits, and minimize maintenance requirements. User education should be done by dedicated ZEV experts who can teach new users about many aspects of optimizing ZEV use.
- Municipal fleet maintenance teams need to have appropriate training. EVs require less maintenance, so making sure each city has a plan in place to guide the proper servicing and maintenance of EVs and their batteries is important.
- Municipalities can work with local academia and institutions to create programs to provide EV-related training. For example, current transit bus maintenance staff whose expertise is in diesel mechanics would need to be retrained for high-voltage components. A similar approach could also be taken towards FCEVs.
- Municipalities can also work with OEMs on both driver and maintenance staff training.
- Limited staff resources cannot always be addressed, but sharing of information and knowledge exchanges (e.g., peer network forums) can help empower and equip existing staff. These types of networks can be particularly helpful to smaller municipalities in building internal capacity.






B.3. Incentives



Action definitions and examples of best practice are presented in the tables below.

Theme	Business	
Action	Definition	Examples and Best Practices
Incentives in fee structure (preferential rate structures) for private and public charging (servicing return-to-base fleets) 	Work with utilities to explore options for specific rate structures for transit agencies, school buses, and other fleets to reduce costs of charging.	San Gabriel and Pomona Valley: By providing beneficial rate structures for electric bus charging, and supporting charging infrastructure, utilities can help speed the adoption of electric buses. Foothill Transit in California negotiated with its utility for lower demand charges during its electric bus pilot, which helped reduce costs.

Theme	Business	
Action	Definition	Examples and Best Practices
Charging/refueling station grants, rebates, tax credits, and loans M G U D	Explore the range of financial incentives that could be offered to fleets that install charging/refueling infrastructure to help offset capital costs and incentivize installation (including incentives related to carbon pricing or property taxes).	
Incentive partnerships M G U A I CS	Seek out partnerships with local businesses and organizations, as well as higher levels of government, to provide attractive incentives for the incorporation of ZEVs into fleets. Electricity system stakeholders and EVSE providers should be prioritized in outreach efforts.	California: Encourage local partners to develop monetary and non-monetary incentives to encourage HDV fleet electrification. For example, utilities could enter agreements with transit agencies to help finance charging infrastructure and bus batteries.
Link car-share fleet parking incentives with charging incentives M F	Consider providing preferential parking spaces and charging rates to car-share fleets that adopt ZEVs and/or install EVSE.	
Tax benefits for charging/refueling providers (servicing non-return-to-base fleets) M G F	Explore the possible range of tax benefits that could be offered to ZEV charging/refueling infrastructure providers to incentivize installation across a range of locations.	
Explore green bonds as financing mechanism for MDV/HDV, transit electrification M F	Canadian municipalities, which tend to have low borrowing interest rates, are free to take advantage of this and issue bonds to raise capital for public works projects. The proceeds from green bonds are earmarked for projects that are focused on enhancing environmental health and sustainability.	Ottawa: In 2017 Ottawa became the first Canadian city to issue a green municipal bond. The bonds had 30-year terms and provided holders with a 3.25% annual interest rate. Proceeds from the bonds (>\$100M) were used to finance a light rail transit network. Vancouver: TransLink, Metro Vancouver’s transit authority, issued a Green Bond in 2018, valued at \$400 million, to fund green transit projects including battery-electric buses.
Funding to offset costs of fleet staff retraining and other operational changes M G	Seek funding from higher levels of government, or seek additional budget allocation for fleet services, to cover the costs of operator and technician training and required operational changes. Focus rationale for additional funding on environmental and human health benefits.	

Theme	Owners and Operators	
Action	Definition	Examples and Best Practices
<p>New and retrofit ZEV grants, rebates, tax credits, and loans</p> <p>M G U D</p>	<p>Explore a range of grants, rebates, tax credits or low-interest loans that would be possible to offer to HDV fleet owners and operators to encourage ZEV retrofits while offsetting capital costs.</p>	<p>Shenzhen: A Shenzhen public bus operator is granted a total of 500,000 yuan (approximately \$97,000 CAD) worth of subsidies every year for each EV that it operates – 400,000 yuan from Shenzhen authorities and 100,000 yuan from the central government. For Shenzhen and many Chinese cities, policy incentives such as national and local subsidies play a major role in closing the cost gap between e-buses and conventional diesel buses.</p> <p>Alberta municipalities: Alberta Community Transit Fund provides municipalities with funding to cover 50% of eligible costs of zero-emission buses (i.e., electric or hydrogen-electric buses).</p> <p>Winnipeg Transit: Winnipeg’s Amalgamated Transit Union estimated that a \$7-million interest-free loan to cover the difference in cost for 20 electric buses (“pay as you save model”) would enable Winnipeg Transit to pay back the loan with revenue from operating efficiencies generated from the electric buses in six years.</p> <p>California: California’s voucher program, the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) - fleet operators can apply for vouchers (\$80,000 - \$175,000 USD) (approximately \$105,000 - \$230,000 CAD) for one electric transit bus and (\$25,000 - \$220,000 USD) (approximately \$33,000 - \$289,000 CAD) for electric school buses, and up to \$20,000 USD (approximately \$26,000 CAD) to invest in inductive charging systems. HVIP also offers incentives for eligible zero-emission and hybrid trucks.</p> <p>New York City: NYC’s Hunts Point Clean Trucks Program offers rebates for upgrades, retrofits or replacements of trucks to reduce emissions. Funding is available for the South Bronx business communities of Hunts Point and Port Morris for replacing Class 3 to Class 8 trucks with a model year 2016 or newer compliant truck, including hybrid diesel-electric and/or battery electric truck.</p>

Theme	Owners and Operators	
Action	Definition	Examples and Best Practices
Financing and leasing programs (perhaps utilizing carbon tax revenue or Clean Fuel Standard credits) 	Utilize financing and leasing programs perhaps through carbon tax revenue, Clean Fuel Standard credit, or bus manufacturers (if locally produced).	Shenzhen: Instead of directly procuring e-buses at the subsidized prices (around \$90,000 - \$120,000 USD) (approximately \$118,000 - \$157,000 CAD) like many other Chinese cities, some bus operators in Shenzhen lease vehicles from manufacturers. This saved operators' upfront investments and reduced the need for debt financing. <hr/> US cities: Proterra operates a battery leasing program in the US which allows customers to buy an electric bus at the same cost of a diesel bus. Proterra retains ownership over the battery. Customers pay for the usage of the battery each year, over a 12-year agreement, thereby reducing the barrier of higher upfront capital costs. ark City Transit (in Utah, U.S.) bought six fully electric buses this way.
Vehicle scrappage incentives 	Cash incentive or rebate for scrapping older buses, trucks or other HDVs and replacing with a ZEV.	New York City: NYC's Hunts Point Clean Trucks Program offers rebates for upgrades, retrofits or replacements of trucks to reduce emissions. Funding is available for the South Bronx business communities of Hunts Point and Port Morris for replacing Class 3 to Class 8 trucks with a model year 2016 or newer compliant truck, including hybrid diesel-electric and/or battery electric truck. Scrappage of an old truck is a mandatory requirement for receiving the rebate.
ZEV-only areas or Low Emission Zones (LEZs) 	Low emission zones restrict access to portions of a city (typically the downtown core) to newer or low-emitting vehicles. If fleet ZEV adoption is positioned as a means to significantly enhance productivity, it will encourage certain fleets to begin making the transition.	Amsterdam: Amsterdam created an LEZ in the downtown core from which heavy-duty vehicles and delivery trucks older than the year 2000 are restricted entry. The city plans to further restrict access to diesel buses in 2018. Standards will be tightened for trucks in 2020.
Toll Discounts 	Provide toll discounts or exemptions to ZEV fleet vehicles. This includes bridge, ferry, road, and other tolls as applicable.	New York City: NYC has provided a 10% discount on the E-Z Pass for EVs, used on the city toll ways. The pass also provides access to the fast lane at toll booths. <hr/> Germany: The German government has exempted electric trucks from national road toll charges in 2019-2020 to encourage ZEV uptake among medium- and heavy-duty fleets.
HOV/HOT lane access for ZEV fleet vehicles 	Allow ZEVs to access HOV/HOT and/or bus/transit lanes regardless of number of passengers.	Los Angeles: Los Angeles enforces allowing EVs to access HOV lanes by using decals provided by the state of California.

Theme	Owners and Operators	
Action	Definition	Examples and Best Practices
Preferential parking and/or site access for ZEV fleets (e.g., tour buses, taxis) 	Designate a portion of preferential parking spaces at highly trafficked destinations as ZEV-only. Consider establishing rules around ZEV fleet access at certain destinations (e.g., ZEV-only taxis/ride-share vehicles at airports).	Amsterdam: Electric taxis can park and charge for free at parking spaces around the city. This policy aims to encourage taxis, as heavy usage fleets, to deploy ZEVs. Dortmund, Germany: The city is developing incentives for “last mile” delivery companies to electrify their fleets by allowing ZEVs with extended access to the city centre.
Consider partnerships with other municipalities to support ZEV purchase rebates 	Join or create a network of municipal fleet managers and fleet operators to share resources and lessons learned, and further expand the use of ZEVs in fleets. Consider offering a coordinated ZEV purchase rebate program across multiple municipalities.	

Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: Financing and leasing programs (perhaps utilizing carbon tax revenue or Clean Fuel Standard credits)

Solutions:

- Finance through avoided costs from carbon pricing or revenues from the monetization of credits in the emerging Clean Fuel Standard.⁸¹
- Consider issuing a green bond to finance programs.
- Allocate a portion of the licensing fees collected from taxi companies to fund taxi fleet electrification efforts. This funding could include support for EVSE installation, driver and maintenance staff training, EV purchase rebates, and pilot projects co-led by taxi companies. Pilot projects could be used to collect data on total EV costs for fleets and GHG emission reductions. Pilot projects and EV taxis would also serve to educate

members of the public on EVs and provide them with valuable direct exposure to these vehicles.

- Seek out private sector partners to lead financing and leasing programs.

Challenge: ZEV-only areas or Low Emission Zones (LEZs)

Solutions:

- This action would only likely be applicable to a handful of Canada’s largest cities.
- Consider exempting privately-owned passenger vehicles from these zones, and only restrict access to commercial vehicles.
- To placate pushback, limit congestion charges to HOV/HOT lane access.
- Mobility pricing could be introduced to address congestion, and at the same time providing a new revenue stream for municipalities. The revenue could be used to help provide incentives to ZEV ownership – in fleets and with individuals. As a greater share of the market becomes electric, municipalities can tweak pricing mechanisms.

⁸¹ The Clean Fuel Standard (CFS) will aim to reduce GHG emissions from fuels by 30 million tonnes annually by 2030 by promoting the broad use of lower carbon fuels, energy sources and technologies. This will be achieved by setting lifecycle carbon intensity requirements for liquid, gaseous, and solid fuels used in transportation, industry, and buildings that will become increasingly stringent over time. Fossil fuel primary suppliers who are subject to the regulations can meet the requirements through a number of flexible, performance-based compliance pathways, including actions that reduce the carbon intensity of the fuel throughout its lifecycle (i.e., process improvements in refineries, upgraders and oil sands) or supplying low carbon fuels (i.e., blending ethanol with gasoline) or specified end-use fuel switching (i.e., a site host putting in place EV chargers at their retail site). Other voluntary credit generators could participate under the regulation (i.e., a distribution utility installing EV charging stations, low carbon fuel producers), but there is no obligated compliance under the CFS for these parties.

Challenge: Explore green bonds as financing mechanism for MDV/HDV, transit electrification

Solutions:

- Examine the City of Ottawa’s green bond program for guidance.

The following additional cross-cutting challenges (i.e., relate to more than one action) were identified by municipalities and key stakeholders. Each action is presented with possible/suggested solutions.


Challenge: Reducing costs through other means

Solutions:

- Bulk purchase discounts for corporate fleets. Small municipalities don’t always have the financial means to undertake ZEV related initiatives. Bulk procurement of ZEVs and fueling equipment/EVSE in collaboration with other municipalities could help address this.
- Engage with utilities, as some utilities are helping cities cover the costs of electricity for ZEV fleets.

B.4. Municipal and Private Fleets, Public Transportation






Action definitions and examples of best practice are presented in the tables below.

Theme	Outreach and Education	
Action	Definition	Examples and Best Practices
Technology demonstrations and pilot projects 	Launch demonstration/pilot projects focused on the deployment of ZEV fleets and associated infrastructure. Work with automakers and infrastructure providers to determine which technologies would be best suited to local requirements.	Charlottetown, PEI: T3 Transit in Charlottetown began conducting an electric bus demonstration in 2018. Winnipeg: Electric Bus Demonstration project - Winnipeg Transit is using up to four New Flyer Xcelsior® battery-electric transit buses in daily service as part of an electric bus demonstration. Montreal: STM has been testing three electric buses in customer service since 2017 under the City Mobility project. Edmonton: Edmonton conducted several field trials that demonstrated that e-buses can operate effectively on Edmonton roads and throughout winter months. New York City: NYC is piloting 10 all-electric buses beginning in 2018; and will purchase an additional 60 all-electric buses.

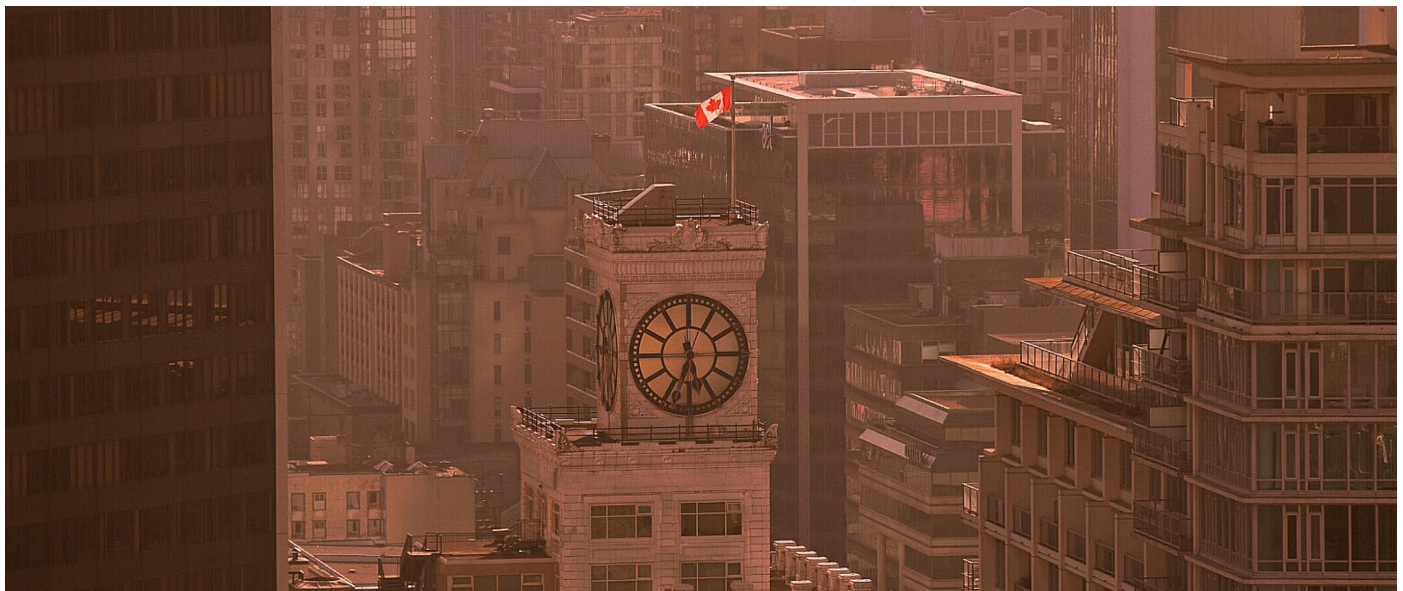
Theme	Fleet Conversion	
Action	Definition	Examples and Best Practices
<p>Fleet conversion feasibility and cost assessment studies</p> <p>M U A D I F</p>	<p>Conduct feasibility studies to examine the potential for converting city fleets (LDVs, MDVs, and HDVs) to ZEVs. This could include technology and cost assessments, determining infrastructure requirements and costs, assessing conversion options of specialty equipment, etc.</p>	<p>Toronto: The TTC has commissioned a feasibility assessment study focused on bus depots and the requirements for charging, energy storage, effort, timeline, and cost. Another modelling study was also conducted focusing on bus routes, charging options and types of buses that may be required.</p> <hr/> <p>Edmonton: Edmonton will conduct a thorough transit facility assessment that will provide the data needed to develop a long-term strategy on electric buses. The City will also be monitoring the industry in relation to standardization and improvements in technology.</p> <hr/> <p>North Vancouver: Complete an analysis of opportunities for replacing fossil-fueled medium- and heavy-duty vehicles at end of life with electric alternatives and complete a feasibility analysis to determine upgrades required at the Operations Centre.</p> <hr/> <p>Kingston: Assess the feasibility as technologies continue to change to electrify public transit and purchase heavy-duty electric or hybrid options on a case by case basis.</p> <hr/> <p>Winnipeg: The City of Winnipeg administration is considering a study, which would report back in four months, to provide cost estimates on purchasing 12 to 20 battery-electric buses and will also include how and where they would be charged, and maintenance costs. The report would include how to get possible funding from the provincial and federal governments.</p>
<p>Seek external funding opportunities for fleet conversion</p> <p>M G U F</p>	<p>Seek external funding for fleet conversion through the federal government, provincial government, municipality organizations (e.g., FCM), utilities, and others.</p>	<p>Kingston: Kingston Transit will evaluate recent funding opportunities through the Ontario Municipal GHG Challenge Fund to potentially procure electric bus units for use on a pilot scale basis.</p> <hr/> <p>Winnipeg: The Joint Task Force has identified federal funding availability for electric buses as highly positive, such as The Low Carbon Economy Leadership Fund (LCELF).</p>

Theme	Fleet Conversion	
Action	Definition	Examples and Best Practices
<p>Municipal support for private fleet conversion including delivery and shared mobility (rental cars, taxis, car-share, bike-share)</p> <p>M D F</p>	<p>Support/partner with private fleet owners to advance the conversion of delivery and rental vehicles, taxis, ride-sharing, and bike sharing. This could include requirements/bylaws for fleet conversion, incentives such as free charging at city facilities, subsidies or grants to fleet owners, etc. Focus on fleets that transport both freight (e.g., mail and food delivery) and passengers.</p>	<p>London (UK): London electrified a large taxi fleet and installed 150 charging stations. All taxis are required to be ZEV by 2018.</p> <p>Orlando FL: Under Drive Electric Orlando, anyone who rents one of 15 Nissan Leaf cars from Enterprise Rent-A-Car will be able to charge the car for free. The Program was developed by Washington, D.C.-based Electrification Coalition who worked with local officials and other organizations.</p> <p>Portland: Portland made EVs accessible to low income communities by supporting a car-share program for an affordable price. This allowed members to drive an EV without committing to the financial investment. Portland is also continuing to explore opportunities to partially electrify its BIKETOWN bike-share program.</p> <p>Montreal: The city committed to establish a regulatory framework to encourage the deployment of 1,000 car-share EVs by the private sector.</p>
<p>Explore opportunities for passenger and freight modal shifts to ZEVs (e.g., electric rail)</p> <p>M G U I A F</p> <p>CS</p>	<p>Replace fossil fuel buses and trains with zero emission or hybrid vehicles. Install electrification and charging infrastructure. Leverage environmental and human health benefits.</p>	<p>Portland: Support TriMet’s efforts to transition to electric buses and encourage the electrification of other people transport fleets (e.g., tour vehicles, taxis) in Portland. Work with TriMet to use new electric buses along routes through portions of the city where air quality issues have the largest impact.</p> <p>Montreal: Replace diesel buses with hybrid vehicles pending the arrival of electric buses (close to 1,000 during the 2016-2025 period). Acquire electric or hybrid service vehicles. Purchase only electric buses as of 2025, or as soon as technology allows. Participate in the City Mobility pilot project, which includes purchasing three fully electric vehicles and installing two charging stations to test quick-charging stations/technology under operational conditions.</p>

Theme	Policy	
Action	Definition	Examples and Best Practices
<p>Municipal ZEV purchase/procurement and fleet conversion</p> <p>M D F</p>	<p>Commitments to city fleet conversion/procurement of electric HDVs and MDVs.</p>	<p>Vancouver: One of the 2050 priorities in Renewable City Strategy for commercial transport is to transition heavy-duty (commercial) vehicles to sustainable fuels, including electricity. The city’s Green Fleet Program has set a target of reaching over 200 electric vehicles by 2021, including, medium- and heavy-duty trucks including garbage trucks, tractor trailers, and delivery vans (and long-range passenger vehicles).</p> <p>Toronto: Convert freight and transit vehicles to electric or low-carbon renewable fuels. Electrify all city-owned vehicles by 2040.</p> <p>Los Angeles: Increase the procurement of electric trucks and buses and move to zero emissions goods movement. Use leading-edge technologies and approaches, including EVs and alternative fuel infrastructure for heavy-duty vehicles.</p> <p>New York City: The Department of Transportation (DOT), in partnership with the Mayor’s Office of Sustainability (MOS), will develop a long-term plan for further reductions in emissions from the cars and trucks in NYC. This will include greater use of low- or zero-emission vehicles.</p> <p>Chicago: Purchase or begin the procurement process for all-electric HDVs and MDVs, including 15 medium-duty trucks with various installed bodies, such as delivery trucks and flatbed trucks.</p> <p>The City intends to purchase heavy duty all-electric trucks based on the results of testing of one electric refuse truck (completed). Chicago has contracted Motiv to provide up to 20 electric garbage trucks and the city is also processing a contract for all-electric semi tractors. Chicago has made an overarching commitment to buy green vehicles for its entire fleet.</p>

Theme	Policy	
Action	Definition	Examples and Best Practices
Establish targets and develop plans for fleet conversion 	Establish strategies for ZEV incorporation into city fleets (LDV, MDV, and HDV), including targets, budgets and timelines. Some cities have set targets to transition a percentage of their fleet by a year set in the future (e.g., Toronto plans to transition 45% of its fleet by 2030).	Calgary: Evaluate and incorporate electric, hybrid and other low carbon vehicle technologies into City fleets and facilities. Edmonton: Electrify both buses and municipal fleets where possible. Toronto: Establish a green fleet plan to transition 45% of City-owned fleet to low-carbon vehicles by 2030. Seattle: Install 200 new charging stations for fleet vehicles in 2017/18 and achieve 40% electrification of current light-duty municipal fleet.
Municipal ZEV-first procurement policy (perhaps through setting emission requirement thresholds) 	Incorporate ZEV purchase requirements in the city’s vehicle procurement policies. Some cities have set “electric first” or “ZEV first” policies to prioritize procurement of ZEVs and equipment.	North Vancouver: Develop an “electric-first” fleet and equipment policy for the City that prioritizes the procurement of electric versions of vehicles and equipment, given model availability and ability to perform the required function. Portland: Establish “electric first” guidelines directing City bureaus to purchase all-electric vehicles when the vehicle usage is compatible with available electric light-duty vehicles.
Update fleet bylaws 	Create/update bylaws to require or encourage the use of ZEVs in private fleets.	
Require reporting of fuel use and fuel economy by municipalities and large fleet operators 	Collect and compile fuel use and economy data from municipal fleet segments and other major fleets operating locally. Use data to share best practice examples with fleets. Consider publishing a list of the best performing fleets, and/or offering added incentives to successful fleets.	
Advocate for, or implement, policy requirement for ZEV taxi, ride-sharing fleets 	Introduce policy requiring taxi and ride-sharing fleets to transition to, or reward, ZEV usage.	Toronto: By-law No. 503-2014 requires taxis to be replaced with alternative fuel/hybrid vehicles at time of replacement. London, UK: All taxis new to licensing in London are required to be Zero Emission Capable (ZEC) from January 2018.

Theme	Other	
Action	Definition	Examples and Best Practices
<p>Establish or join fleet working group to coordinate bulk purchasing and influence vehicle supply</p> <p>M G F</p>	<p>Engage with other municipalities to combine the bulk purchasing power of multiple jurisdictions. This will help to reduce costs and could help to harmonize ZEV fleet technologies in use in a given region. Knowledge-sharing on best practices could also be a core component of working group.</p>	<p>North Vancouver: Join network of fleet managers and owners sharing resources and lessons learned, and pledge to contribute to the goal of expanding the use of ZEVs in fleets.</p> <p>King County and San Francisco: Agencies can partner with other cities to create a bigger agreement with private bus contractors in order to secure better rates on electric buses. In 2013, King County Metro (Washington, U.S.) entered into a contract with New Flyer, for the procurement of 500 electric trolley buses over a five-year period, with an option to expand the contract with 200 additional trolleybuses. Following this announcement, the city of San Francisco entered into a ‘Bus Options Assignment Agreement’ with King County and New Flyer, under which King County assigned to the city the right to purchase up to 333 trolleybuses from New Flyer from the options under the bus procurement contract – a move that ensures both King County and SFMTA receive the most competitive pricing.</p>
<p>Conduct comparative life-cycle analyses for total cost of ownership of fleets (hydrogen, EV, ICE vehicle), including the cost of carbon</p> <p>M G A I F CS</p>	<p>Provide a TCO calculator or tool that is customizable for fleets of various sizes and provides TCO for different types of vehicles and fuels. Include available incentives and regional carbon pricing mechanisms. Also incorporate the level of budget variability required to account for future fuel prices (i.e., electricity prices are more stable than petroleum).</p>	



Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: Municipal ZEV-first procurement policy (perhaps through setting emission requirement thresholds)

Solutions:

- Work on removing regulatory barriers for municipal (ZEV) procurement. For example, setting specific emissions requirements for municipal fleets might help overcome trade or regulatory barriers of a ZEV-first strategy.
- The ZEV-first procurement policy would need to consider which vehicles are amenable to electrification and begin rolling out those vehicles. It will start with LDVs but will eventually roll into MDVs and HDVs.
- Transit operators are important players, and the procurement of e-buses can serve an important symbolic role. In addition to health and air quality benefits, they help familiarize people with EV

technology. Such exposure may make people more likely to buy an EV for their next vehicle purchase – it’s a great promotional opportunity. Municipalities can work with transit authorities on ZEV procurement policies.

- Emissions requirements (or other standards or policies) could be expanded to private fleets, such as taxis and ride and car-share vehicles/services (e.g., develop greening taxi and private hire strategies, policy, etc.).

Challenge: Explore opportunities for passenger and freight modal shifts to ZEVs (e.g., electric rail)

Solutions:

- Introduce a green vehicle procurement policy, or stringent emissions limits, for local transit authorities and other passenger and freight fleets.
- Seek funding from provincial and federal agencies (e.g., Canada Infrastructure Bank) and seek private sector partnerships to leverage that funding.
- Review global best practices from comparable jurisdictions.



B.5. Complementary Mechanisms

Action definitions and examples of best practice are presented in the tables below.

Theme		Policy Development at Other Levels of Government	
Action	Definition	Examples and Best Practices	
Inform development of new provincial/federal regulations, low-carbon policies for MDVs and HDVs (M) (G) (F)	Participate in inter-governmental working groups, conferences, etc., and advocate for more stringent standards with regard to MDV and HDV emissions and related topics.	Calgary: Monitor and provide input to new medium- and heavy-duty low emission vehicle policies and regulations by other orders of government.	
Explore opportunities to partner with federal and provincial governments on ZEV deployment (M) (G) (CS)	Where possible, participate in pilot programs to demonstrate benefits of low-carbon fleets. Support the ZEV-related work of higher levels of government and share municipal perspectives on programs.	Korean cities: Korea’s central government, six municipalities, and manufacturers have signed a cooperation agreement to collectively promote an FCEV pilot project and deploy hydrogen buses. The pilot project will involve putting a total of 30 hydrogen buses into operation in the cities of Seoul, Gwangju, Ulsan, Changwon, Asan, and Seosan. The project will support the goal of introducing 1,000 FCEV buses by 2022.	

Theme		Municipal Policy and Regulations	
Action	Definition	Examples and Best Practices	
Municipal ZEV contractor and car-share preference (M) (F)	Consider giving preference to contractors or car-sharing companies with ZEV fleets or those committed to increasing the number of ZEVs in their fleet.	Amsterdam: Amsterdam provides contract preferences to bidders operating an EV fleet. North Vancouver: Consider electric only car-share vehicles in negotiations for car-share parking spaces in new developments.	

Theme		Collaboration	
Action	Definition	Examples and Best Practices	
ZEV fleet-owner groups and networks for information sharing (M) (G) (U) (D) (F) (CS)	Take advantage of the convening power of municipalities to establish a network of local fleet operators to share information, experiences and best practices regarding ZEV integration.	Vancouver, Surrey, Seattle and other west coast cities: Member cities participate in the Pacific Coast Collaborative (PCC) West Coast Electric Fleets Initiative which provides public and private fleet managers with a toolkit and resources to help assist with ZEV deployment.	
Integrate public transit with shared mobility (M) (U) (I) (F) (CS)	Assess which local transit hubs or corridors would be best suited to hosting ZEV shared mobility (including e-bikes and scooters). Ensure that the “last mile” of travel can be completed using ZEVs. Consider infrastructure upgrades if necessary (e.g., dedicated bike lanes). Provide preferential access to ride and car-sharing providers that offer ZEV options.	Portland: The city has committed to explore opportunities to integrate public transit with shared mobility options, such as e-bikes, e-scooters and electric car-share vehicles.	

Theme	Collaboration	
Action	Definition	Examples and Best Practices
Establish internal working group or task force to coordinate conversion plans M U F CS	Form an internal task force on connected, autonomous, shared and electric mobility (CASE). Strive for representation from as many relevant departments as possible. Invite expert guests to present to the group on various topics.	Winnipeg: The City of Winnipeg and Manitoba government formed a Task Force on Transit Electrification to consider how the Winnipeg transit system could be transitioned to being largely electric.
Ensure ongoing collaboration and engagement with public and private partners M G U A D I F CS	Solicit regular feedback on planned and ongoing ZEV initiatives. Provide a contact person/department for comments and inquiries. Ensure that links to further information are provided on signage, etc. at public-facing project sites. Host community consultations in neighbourhoods where significant ZEV-related development will occur.	Sacramento: The city has committed to collaborate with a range of agencies and partners to promote local deployment of ZEVs and charging infrastructure. Sweden: CLOSER is a platform for collaboration, knowledge, and innovation between businesses, industry, academics, cities, regions, and government agencies. CLOSER works toward increased transport efficiency from the R&D stage to demonstration projects. There are six focus areas – urban mobility, high capacity transport, digitized and connected logistics, energy supply and logistics, multimodal solutions, and horizontal cooperation.

Theme	Research	
Action	Definition	Examples and Best Practices
Assess impacts on vulnerable populations and communities M F CS	Ensure that vulnerable communities are: a) consulted on potential ZEV actions; b) provided with access to ZEV options (e.g., electrified transit, micro-mobility, car/ride sharing, public EVSE); and c) not disproportionately subjected to negative impacts from transportation (e.g., pollution, congestion). Identify vulnerable communities and incorporate them into ZEV deployment planning. Consult with local social equity organizations on the transportation needs of vulnerable and mobility-impaired populations.	Montreal: STM plans to conduct a demonstration project with two paratransit vehicles in order to test electric transportation in that context, by reaching a private agreement with a partner, Transport adapté. Portland: Work with TriMet to use new electric buses along routes through portions of the city where air quality issues have the largest impact.

Theme	Research	
Action	Definition	Examples and Best Practices
<p>Partner with research institutions to develop strategies and advance technologies</p> <p>M U A I F CS</p>	<p>Leverage local brain power and research capacity to partner on strategy development, technological assessments, action implementation, outreach/ education, and technical issues.</p>	<p>Vancouver, York Region, Brampton: These three Canadian municipalities, along with bus and charging station manufacturers, are participating in the Pan-Canadian Electric Bus Demonstration and Integration Trial, led by the Canadian Urban Transit Research and Innovation Consortium (CUTRIC). The first phase of the trial will involve the deployment of 18 buses and the installation of charging stations on bus routes in the three cities. The project will help demonstrate advanced zero emissions transit technology.</p> <hr/> <p>Sweden, Germany: Electrified road trials (charging in motion) for HDVs are being conducted in Sweden and Germany. The trials are being run by consortiums including federal, state, and local governments, OEMs, businesses, industry, academics, etc.</p>
<p>Conduct suitability analyses for different types of ZEVs in a variety of applications</p> <p>M G U A I F CS</p>	<p>Assess the performance specs of ZEVs and match them with fleet segment duty cycles. Prioritize adoption of ZEVs that exceed duty cycle requirements at reasonable costs. Partner with external organizations where necessary and explore best practices from other jurisdictions.</p>	

Theme	Strategies	
Action	Definition	Examples and Best Practices
<p>Establish or join regional goods movement network and contribute to goods movement strategies</p> <p>M G F CS</p>	<p>On-road freight movement is the fastest growing source of transportation emissions. Establish or join goods movement network and focus on low-carbon and fuel-saving options and practices. Explore range of incentives and disincentives municipalities can provide to reduce emissions and congestion from freight movement.</p>	<p>Germany: National Platform on Future of Mobility - This task force will develop proposals on how to reach the national target of emission reductions in the transport sector. The platform and working groups comprise federal, state, and local governments, businesses, unions, and transport and environmental NGOs.</p> <hr/> <p>Sweden: Freight Transport Strategy was launched in June 2018, the first of its kind in Sweden. The strategy covers all modes and elements related to freight transport, with a focus on renewables, research and innovation, biofuels, and energy-efficient vehicles. As part of this strategy, the National Freight Transport Council comprises state authorities, municipalities and county councils, industry, associations, research institutes, universities and colleges, and others.</p>

Theme	Other	
Action	Definition	Examples and Best Practices
Encourage ZEV availability at dealers and fleet showcase events (M) (A) (D)	Encourage automakers to showcase ZEV offerings to local fleet operators and consider providing incentives to those who do so. Showcase city-owned ZEVs at fleet-related events.	Sacramento: The city is working to increase the visibility and awareness of electric MDV and HDV technologies using strategies such as events, fleet recognition programs, and other partnership efforts.
Identify and incentivize opportunities for electrification in off-road applications (e.g., construction) (M) (A) (I) (F) (CS)	Encourage city contractors who operate off-road vehicle fleets to incorporate ZEVs and hybrids. Include fleet fuel economy and/or fuel type as an evaluation metric in city contracting bids. Encourage companies to promote and advertise ZEVs in their off-road fleets.	Sacramento: The city encourages ZEV usage in off-road applications at public facilities, such as airports, corporation yards, and freight centers.

Challenges and solutions for individual actions and cross-cutting challenges are presented below.

The following actions were identified by municipalities and key stakeholders as presenting the biggest challenges. Each action is presented with possible/suggested solutions.

Challenge: Integrate public transit with shared mobility

Solutions:

- Consider providing shared mobility ZEVs with preferential or exclusive access to transit hubs.
- Use ZEV micro-mobility options like e-bikes and e-scooters at high-traffic transit hubs to conserve space.

Challenge: Encourage ZEV availability at dealers and fleet showcase events

Solutions:

- Because there is a small market for electric MDV and HDV fleet vehicles, it might be most effective to connect fleet managers and ZEV OEMs via an annual and semi-annual event organized by the municipal government.

The following additional cross-cutting challenges (i.e., relate to more than one action) were identified by municipalities. Each action is presented with possible/suggested solutions.

Challenge: Research and strategy development

Solutions:

- Municipalities and academia could work together with regard to electric mobility planning (e.g., strategizing routes, etc.) and evaluating the range of vehicles that would be suitable for different duty cycles. Academia can independently measure and verify electric mobility programs and policies and can assess performance metrics related to programs. Academia can also research issues related to upstream energy supply and downstream impacts of EVs from a life-cycle perspective.

