EV- Ready Cities: Accelerating the Transition to Electric Mobility

A GTHA Case Study

Prepared for

ONTARIO CLIMATE CONSORTIUM

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DISCLAIMER

This report is an academic exercise conducted by graduate students in the *Masters in Environment and Sustainability* (MES) program in the *Centre for Environment and Sustainability* (CES) at Western University, London, Ontario, Canada. The named consulting company that produced this report is a fictional entity created for the purpose of this exercise. For information on this program, please visit www.uwo.ca/enviro.

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Executive Summary

Climate change is a global issue, most recently addressed on an international scale at the 2015 United Nations Conference on Climate Change, culminating in the Paris Climate Accord. Canada agreed to reduce greenhouse gas (GHG) emissions to 30% below 2005 levels by 2030 - an ambitious goal that is achievable only with cooperation from provincial/territorial and municipal governments. Within Canada, Ontario is second in GHG production, with only oil-rich Alberta emitting higher levels. Of the GHGs being emitted in Ontario, transportation accounts for 35% of the total - mainly due to passenger vehicles and trucks used for transportation of goods (Government of Ontario, 2016). *Ontario's Five Year Climate Change Action Plan* establishes an EV and hydrogen passenger vehicle sales target of 5% by 2020 (Government of Ontario, 2016); a target that currently seems out of reach (Stevens, 2017). Ontario EVs currently represent 0.8% of the vehicle market, as of 2017 (Stevens, 2017). In provinces such as Ontario, where energy supply is derived from low-carbon sources, electric vehicles (EVs) reduce dependency on fossil fuels and can drastically reduce the GHG emissions produced by the transportation sector. The Greater Toronto Hamilton Area (GTHA) is the most populated area of Ontario; there is substantial opportunity to mitigate the impacts of emissions from conventional vehicles, reducing overall provincial GHG emissions. As a result, municipalities are beginning to seek opportunities for supporting and accelerating the uptake of EVs. However, the infrastructure and incentive strategies are complex and present a variety of options that need to be researched before implementation. The purpose of this study is to present the current opportunities, barriers, and a feasible action plan specific to the GTHA.

It is important to look to other cities that have successful EV uptake as models to examine what led to this success and what barriers arose during the transition. Model cities are used to analyze best management practices (BMPs) in the categories of policy incentives, infrastructure, education, and stakeholder relationships. These are narrowed to create a list of BMPs applicable to the context of the GTHA. Policy is a driving factor to direct consumers and policymakers towards the cleaner vehicle option and must be analyzed along with BMPs. Policy within the GTHA is assessed to reveal opportunities for municipalities to use model city BMPs to encourage EV uptake; these policies are highlighted to convey areas for amendment, alteration, or creation. An accompanying policy checklist summarizes which policies are affected in a successful transition to EV integration within GTHA municipalities. These policies will assist with regulation and enforcement of suggested BMPs.

The research shows opportunities for the GTHA to support and encourage EV uptake, including:

- ✓ Considering business subsidies for converting fleets to electric
- ✓ Giving priority to EVs for parking spaces, fees, and permits
- ✓ Implementing Low Emission Zones in the core of municipalities
- ✓ Installing standardized EV charging stations and signage in convenient locations
- ✓ Converting municipal fleets to EVs
- ✓ Creating EV working groups within municipalities
- ✓ Educating employees who interact with the public on the topic of EVs

The report concludes with a proposed Action Plan to guide municipalities of the GTHA in implementing effective EV strategies based on the recommendations made within the body of the report. The Action Plan is structured to be used as an iterative process in which municipalities are continually collecting relevant data, assessing policies, and updating targets for the improvement of EV adoption.

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Acronyms

BMP	Best Management Practice
CCAP	Climate Change Action Plan
EV	(Battery) Electric Vehicle
EVCO	Electric Vehicle Charger Ontario
EVIC	Electric Vehicle Incentive Program
EMC	Electric Mobility Canada
GHG	Greenhouse Gas
GTHA	Greater Toronto Hamilton Area
HOV	High Occupancy Vehicle
IESO	Independent Electricity System Operator
LEZ	Low Emission Zones
MTO	Ministry of Transportation Ontario
MT CO_2 eq	Megatonnes of carbon dioxide equivalent
MURB	Multi-Unit Residential Building
OCC	Ontario Climate Consortium
PHEV	Plug-in Hybrid Electric Vehicle
SWEEP	Southwest Energy Efficiency Project
TAF	The Atmospheric Fund

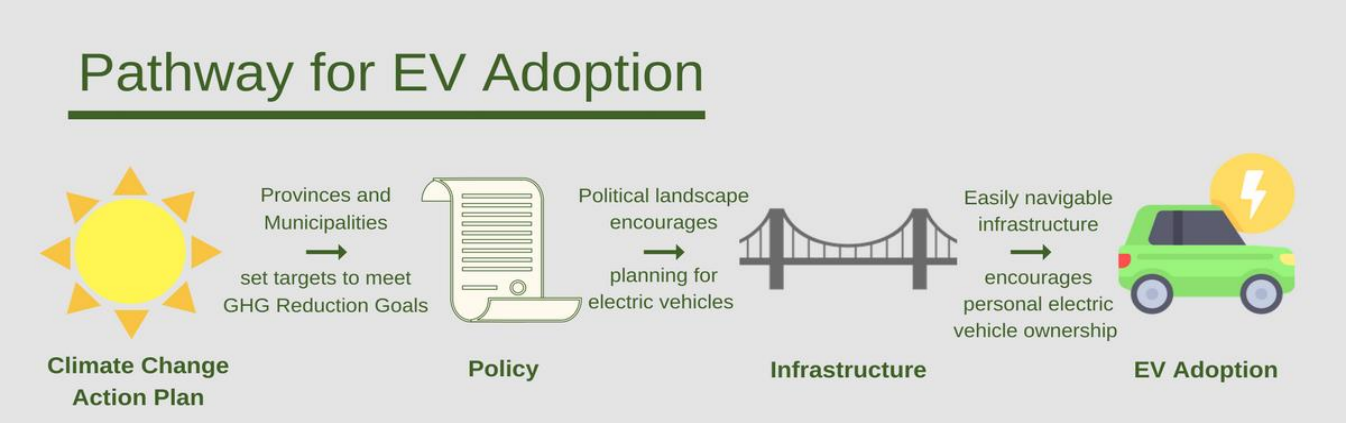
1.0 Project Overview and Scope

This project serves to guide municipalities in their transition to EV adoption, with the purpose of reducing GHG emissions as per the *Ontario Five Year Climate Change Action Plan*. A review was conducted of best management practices (BMPs) related to electric vehicle (EV) adoption in model cities and examined how these BMPs translate to opportunities for the municipalities in the Greater Toronto Hamilton Area (GTHA). Municipal policies within the GTHA were compiled to indicate areas of legislation that will be affected by BMP opportunities. The GTHA is the most densely populated area of Ontario, and will therefore have a substantial impact on GHG mitigation outcomes. Increasing EV uptake requires effective municipal policy action; their planning and by-law authority directly affect crucial components of EV BMPs. A summary of EV BMPs and relevant policy guidelines can help kickstart this policy action. This project operates under the context of climate change mitigation strategies within the Ontario Climate Consortium (OCC).

2.0 Understanding the Electric Vehicle Context

Ontario met it's 2014 GHG reduction goal of 6% below 1999 levels. Transportation has been named an "Action Area" in Ontario's plans to meet future GHG reduction goals of 15% below 1999 levels by 2020, 37% by 2030, and 80% by 2050 (Government of Ontario, 2016).

Low emission vehicles (LEVs), specifically electric vehicles, have the potential to contribute to the attainment of these goals. Given that transportation is projected to be the greatest contributor to GHG emissions in Ontario by 2020, as seen in Figure 2 (Government of Ontario, 2016), significant investment in electric vehicle infrastructure is called for. Canada is in an advantageous position, already producing much of its electricity from clean sources. By 2020, Environment Canada expects 85% of the nation’s domestically produced electricity will be from non-emitting sources. Already in some parts of the country, the emissions from six electric vehicles would be equivalent to that of one gasoline powered car (Bentein, 2017). As EV adoption increases, reduction in GHG emissions will be seen.



2.1 What is an Electric Vehicle?

The Ontario Ministry of Transportation (MTO) defines an electric vehicle as any vehicle that is partially or entirely powered by electricity and plugs-in to recharge (Government of Ontario, 2018). Modern electric vehicles build upon conventional hybrid technology, further reducing greenhouse gas (GHG) emissions and fuel consumption. When taking advantage of low carbon sources of electricity, electric vehicles can reduce GHG emissions by an average of 130gCO_2/km (Jochem, Babrowski, & Fichtner, 2015), and therefore contribute to an overall reduction in GHG emissions (Langbroek, Franklin, & Susilo, 2016).

Electric vehicles can be classified as either battery electric vehicles (EVs) or plug-in hybrid electric vehicles (PHEVs). PHEVs are vehicles that run on both an electric battery system as well as a combustion engine and are therefore powered with electricity as well as fossil fuels (Zhous, Levin, & Plotkin, 2016), while hydrogen fuel cell vehicles also run on an electric motor however do not have the same charging mechanisms as standard EVs (MTO, 2018). While PHEVs and hydrogen fuel cell vehicles offer greater GHG emission reductions than traditional combustion engine vehicles, the greatest GHG reduction benefits are received from EVs. EVs operate on an electric drivetrain - consisting of a battery, power converter, and an electric motor and are recharged solely by plugging into an external source of electricity (Government of Ontario, 2018).

EVs offer many advantages over conventional vehicles. They are highly efficient (fuel input to output ratio), emit zero tailpipe GHG emissions and can be charged overnight on low cost electricity (Andwari et al. 2017). Although EV technology has existed for more than a century, mass scale adoption began in 2008 and is still increasing. With the release of the Tesla Roadster in 2010, EVs have become part of the mainstream market in North American (DeShazo et al., 2015). Table 1 summarizes the types of chargers currently available, the range an EV can travel on one hour of charge, and the cost of installation (ChargeHub, 2017; Home Advisor, 2018; Plug 'N Drive, 2017; Schaal, 2016). The cost of installation includes both the cost of the charging unit and the cost of labor for installation, which can vary based on the presence of pre-existing conduits and the contractor's prices. However, as Andwari et al. (2017) discuss, there are still many challenges associated with EV use such as high voltage charging, which will put pressure on the grid which should be considered when developing infrastructure and managing capacity (Pollution Probe, 2017). The most significant challenge for EV adoption is confidence in the technology and infrastructure (Andwari et. al., 2017); this is important to understand when implementing charging infrastructure and EV strategies to avoid uptake barriers such as range anxiety (Langbroek et al., 2016). These barriers and opportunities to overcome it will be discussed in Section 5.2 of this report.

Summary of Standard EV Technology

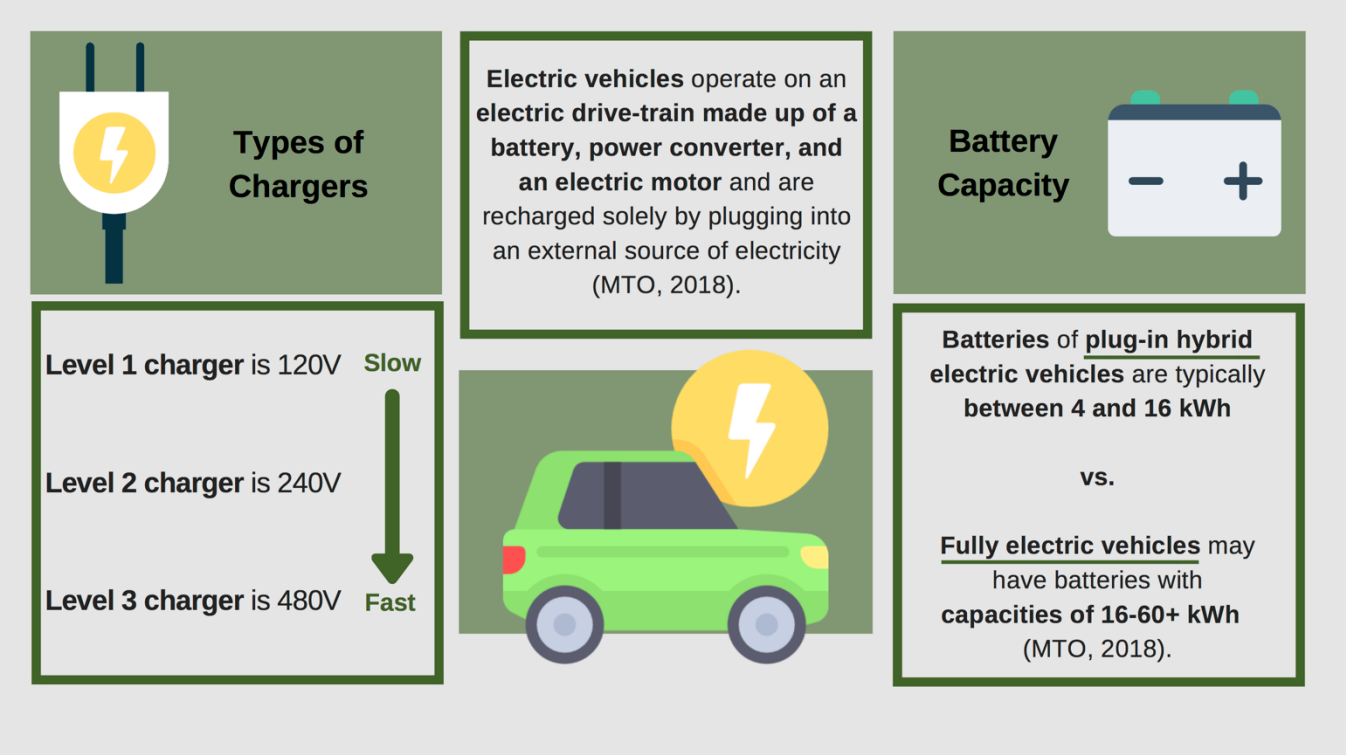


Table 1. Information on Electric Vehicle Charger Types

Type of Charger	Voltage (V)	Range on 1 Hour of Charge	Cost of Installation (CAD)	Example
Level 1	120	8 km	$1300- 2300	Home charger, often used for overnight charging
Level 2	240	30 km	$1700- 2700	Home and Public Charging. Public Level 2 chargers are ideal for workplace, malls, grocery stores
Level 3/ DC Fast Charger	480	250 km	$3300- 8000	Public Chargers, often along busy corridors- less common

2.2 Federal and Provincial Climate Change Adaptation Goals

At the Copenhagen Accord in 2009, Canada agreed to reduce GHG emissions to 611 million metric tonnes per year by the year 2030 (Government of Canada, 2016). As this deadline quickly approaches, the goal is far from being met (Figure 1). In the 2016 Paris Agreement, Canada committed, along with 195 other countries, to keep global temperature rise below two degrees Celsius (United Nations, 2015). Canada has made a 2030 goal to reduce GHG emissions to 30% below 2005 levels; this is an unlikely target to be met if the Copenhagen Accord was any indication. Environment and Climate Change Canada published the *Pan-Canadian Framework on Clean Growth and Climate Change* in 2015 to address the agreements made in the Paris Agreement (Government of Canada, 2016). It addresses how Canada plans to grow the economy while reducing emissions and building resilience to future climate change.

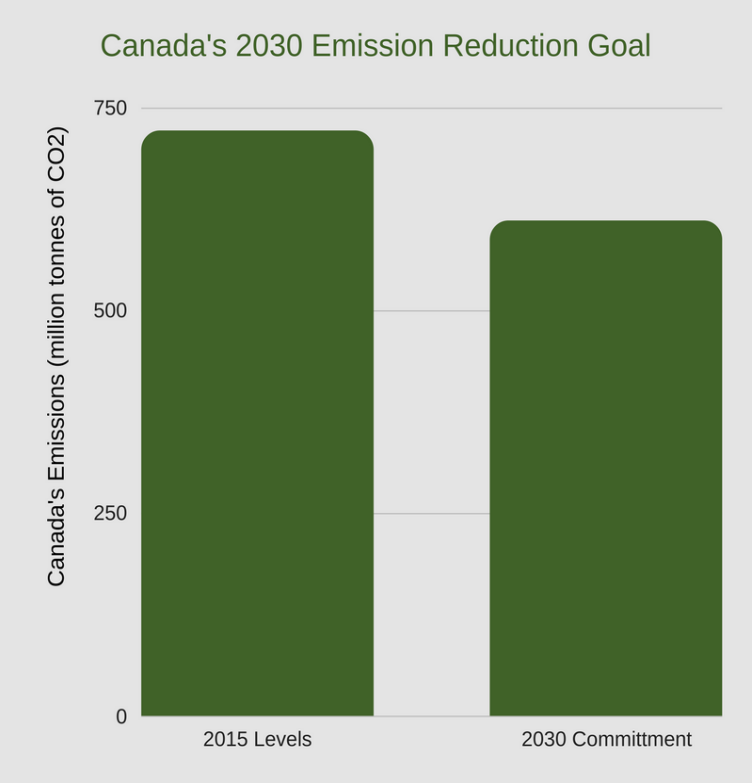


Figure 1. Canada's Current Carbon Emissions Compared to Commitment

As mentioned earlier, using clean energy to power vehicles plays an integral role in Canada's transition to a low-carbon future (Government of Canada, 2016). Traditional vehicles cannot, by nature, have clean energy powering them, whereas EVs are as clean as the energy that powers them. Therefore, locations with a low- carbon source of energy would benefit most from an increase in EV uptake. The *Pan-Canadian Framework on Clean Growth and Climate Change* also includes expanding the number of zero-emission vehicles on the roads and supports the transition to low-emitting forms of transportation, such as public transit, cycling, and walking (Government of Canada, 2016). The need for EVs to become prominent is clear - transportation will be a key player in helping Canada reach GHG emission targets, and reduce dependency on fossil fuels, as it is projected to continue to be a leading source of emissions in Ontario (Figure 2). The 2020 forecasts are based on *Ontario's Climate Change Update Report* from 2014 and the 2014 *National Inventory Report*.

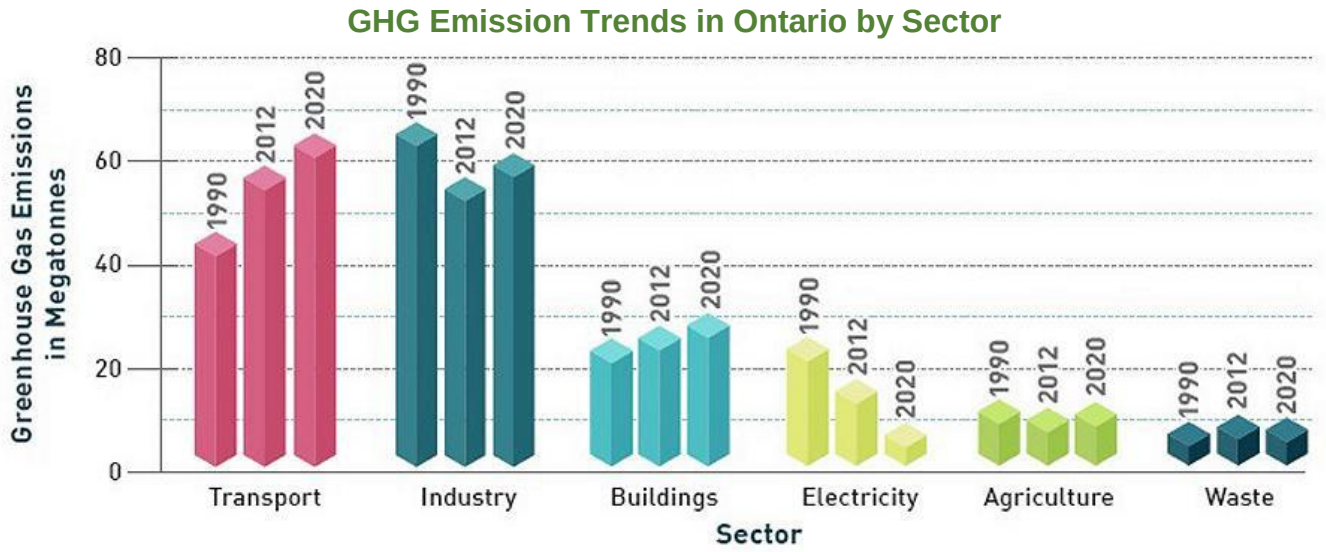


Figure 2. GHG Emissions in Ontario by Sector (Ontario's Five Year Climate Change Action Plan, 2016)

In 2015, Ontario was the nation's second highest producer of GHG emissions, contributing 166.2 megatonnes of CO_2eq (Environment and Climate Change Canada, 2017). In relation to population density, however, Ontario produces relatively lower GHG emissions when compared to provinces including Alberta and Saskatchewan, as shown in Table 2. Although GHG emissions per capita are relatively lower, the large population still resulted in high GHG emissions, which is shown in Table 2 and Figure 3. Reducing GHG emissions in Ontario can effectively help reach the federal target of reducing GHG emissions by 17% by 2020 (Environment and Climate Change Canada, 2015).

Table 2. Greenhouse Gas Emissions by Province or Territory

Province or Territory	2015 GHG Emissions (megatonnes of carbon dioxide equivalent)	2015 Population (thousands)	GHG emissions per capita (tonnes CO_2 eq)
Yukon (YT)	0.3	37.3	8.0
Nunavut (NU)	0.6	36.6	16.4
Northwest Territories (NT)	1.4	44.2	31.7
Prince Edward Island (PEI)	1.8	146.8	12.3
Newfoundland & Labrador (NL)	10.3	528.8	19.5
New Brunswick (NB)	14.1	753.9	18.7
Nova Scotia (NS)	16.2	941.5	17.2
Manitoba (MB)	20.8	1295.4	16.1
British Columbia (BC)	60.9	4694.7	13.0
Saskatchewan (SK)	75.0	1131.2	66.3
Quebec (QC)	80.1	8254.9	9.7
Ontario (ON)	166.2	13789.6	12.1
Alberta (AB)	274.1	4177.5	65.6

Environment and Climate Change Canada, *2015 Progress Report of the Federal Sustainable Development Strategy.*

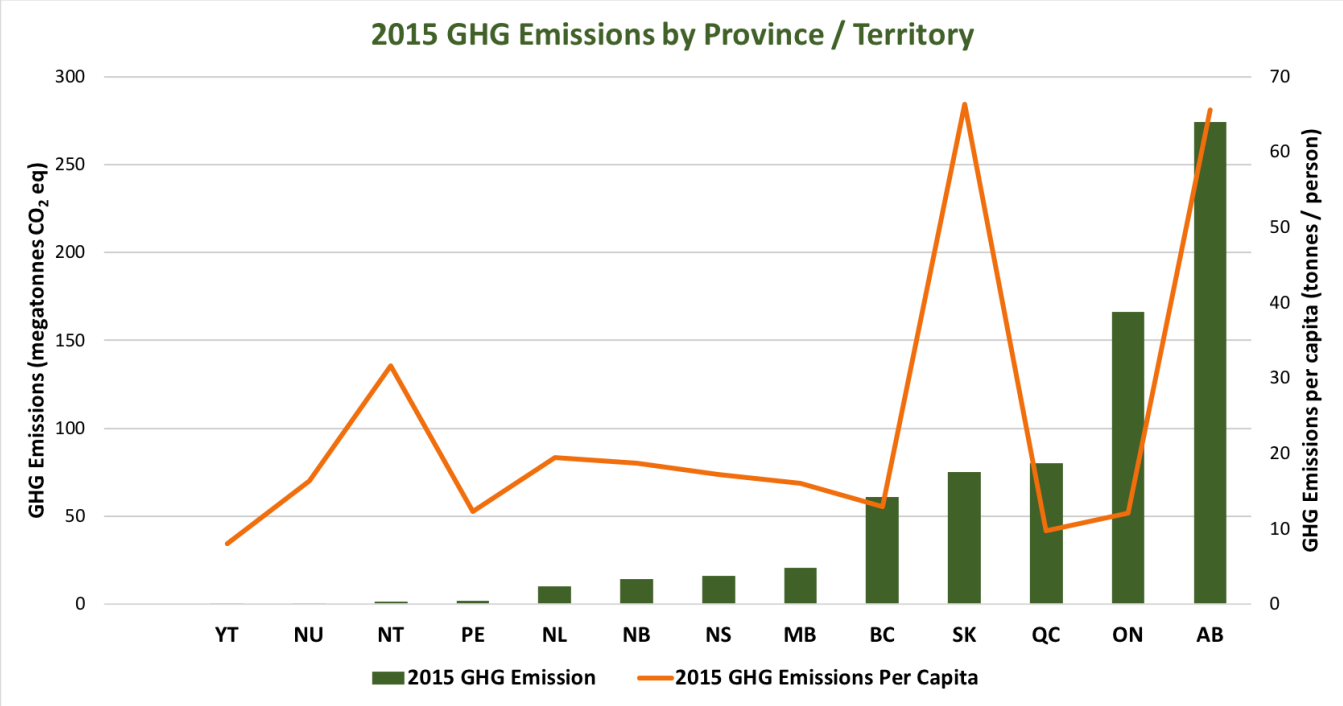


Figure 3. Provincial/Territorial GHG Emissions Per Capita

Ontario's Five Year Climate Change Action Plan (CCAP) outlines targets for reducing GHG emissions 15% by 2020, 37% by 2030, and 80% by 2050 (based on 1990 GHG emission levels). The action plan aims to create a low-carbon future for Ontario and includes (Government of Ontario, 2016):

- Creating a green bank (a program focusing on low-carbon technologies funded by the Ontario government) to help support energy efficient technologies for individuals and businesses to reduce their GHG emission levels;
- Establishing a cleaner transportation system by targeting zero-emission vehicles, cleaner transport, and public transportation systems;
- Accelerating energy efficiency of homes and buildings through education, incentives, and tools;
- Making the clean-energy system more affordable for homeowners and businesses;
- Supporting the carbon market to reduce energy use, increase productivity, and create jobs;
- Partnering with First Nations and Métis communities to address the challenge of climate change;
- Reducing GHG emissions throughout government facilities, operations, and procurement;
- Using agriculture, forest, and natural land efficiently and sustainably to help capture GHGs.

The transportation sector largely impacts GHG reduction goals as it is one the largest contributors to GHG emissions in Ontario; in 2013 it accounted for 35% of the total GHG emissions in Ontario, compared to 27% in the US and 23% in Europe (Government of Ontario, 2016; EPA, 2015; EUROSTAT, 2015). The MTO plans to invest $31.5 billion over the next 10 years for transit and transportation, including approximately $16 billion in the GTHA (Government of Ontario, 2016). The MTO has already implemented initiatives to support CCAP, including Cycle ON: Ontario Cycle Strategy, the Long Combination Vehicles (LCV) Program, and High Occupancy Vehicle (HOV) lanes (Government of Ontario, 2016). The Ontario Cycle Strategy aims to promote cycling as a viable method of transportation, while the LCV Program targets improving the efficiency of movement of goods across Ontario. HOV Lanes encourage carpooling on Ontario's busiest highways.

There are various initiatives being implemented in Ontario to encourage EV mobility including the Gas Tax Program, Electric Vehicle Charger Ontario (EVCO) program, and the modernized Electric and Hydrogen Vehicle Incentive Program (EHVIP) (Government of Ontario, 2016). Details of these programs can be found in Appendix D. Cars and trucks are responsible for more than 70% of GHG emissions in the transportation sector of Ontario (Government of Ontario, 2016). Gasoline engines produce approximately 2.3 $kgCO_2/L$ of gasoline consumed, while diesel engines emit about 2.7 $kgCO_2/L$ of fuel consumed (Natural Resources Canada, 2016). As mentioned above, energy production in Ontario is primarily from low-carbon sources (IESO, 2017), therefore, EVs can be classified as low emission vehicles in Ontario, compared to conventional vehicles. Although Ontario programs are assisting with EV adoption, successful uptake requires a joint effort from each municipality which will translate to better outcomes for climate change goals related to GHG emissions.

2.3 Greater Toronto Hamilton Area Current Electric Vehicle Policies and Initiatives

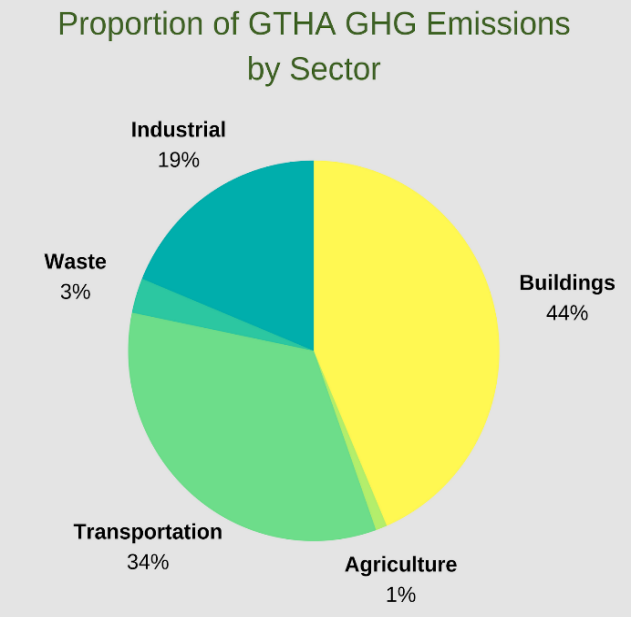


Figure 4. Proportion of GTHA GHG emissions by sector (TAF, 2017).

The GTHA is an interconnected urban region of Ontario consisting of 30 municipalities and seven million residents (representing 51% of Ontario's population). The amount of GHGs produced in this area is extensive, with 29% of Ontario's overall GHG emissions comes from the GTHA (TAF, 2017). As one of the largest GHG emitting sectors, transportation produces 34% of the overall GHG emissions in the GTHA (Figure 4). This reinforces the need for EV integration to take place within the GTHA, as it would remove high emitting vehicles, and replace them with low GHG producing technology (TAF, 2017).

Municipalities within the GTHA range in population. Transportation emissions per capita are negatively related to population, where the higher the density the lower the GHG emissions (Figure 5). Depending on the municipality, factors such as transportation, infrastructure, and urban structure can influence GHG production. Specifically, in rural environments with smaller populations, frequency of personal vehicle use may be higher due to lack of public transportation systems (TAF, 2017). Further information regarding GTHA demographics can be found in a Table of Municipality Demographics in Appendix A.

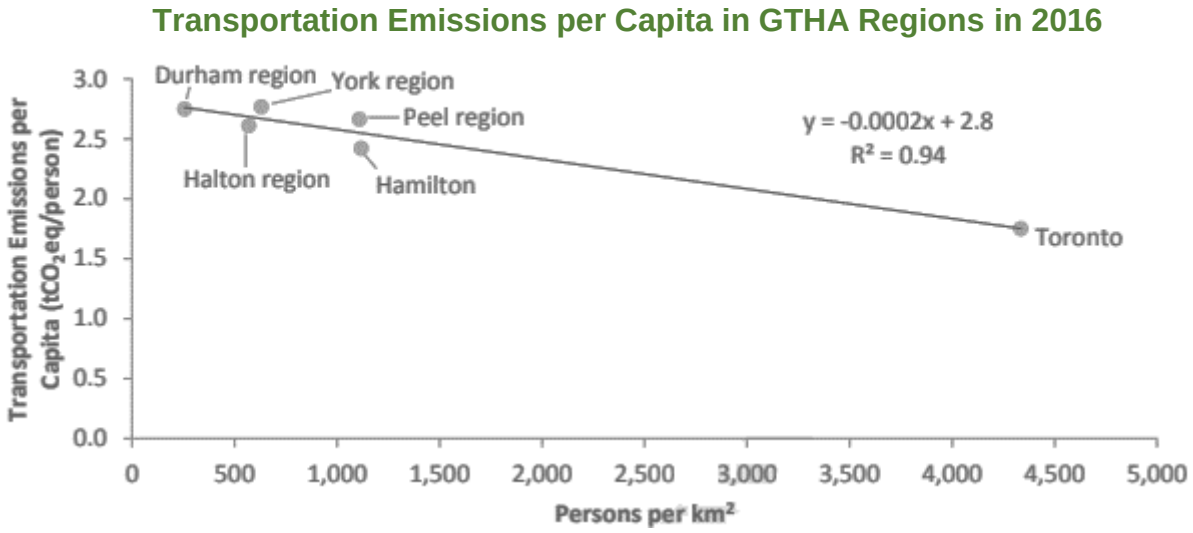


Figure 5. Relation between transportation emissions and persons/km^2 (TAF, 2017).

2.3.1 Climate Action Strategies and Targets in the GTHA

To adhere to the new clean energy standards outlined by the *Pan Canadian Framework* and *Ontario's Climate Change Action Plan*, municipalities within the GTHA are developing specific climate action strategies. These plans hope to shift municipalities to become sustainable urban centres, regarding GHG reduction, energy efficiency, ecological protection, improved water quality, and waste management. These new sustainability plans create standards for residents, businesses, industries, and government agencies moving forward with future activities. Table 3 shows a list of goals and targets that select municipalities in the GTHA are currently pursuing, as identified in their climate change action plans.

Table 3. Selected Targets / Goals in Selected Municipalities

Targets/Goals	Potential Strategies	Example of municipalities implementing these strategies
Improved Air Quality	Shift to Low-Emission Vehicles	✓ Town of Ajax ✓ City of Burlington
	Alternative modes of transportation	✓ City of Mississauga ✓ City of Brampton
Reduced Traffic Congestion	Carpool or car sharing	✓ Town of Caledon ✓ Town of Aurora ✓ City of Brampton
	Promote Active Transportation	✓ City of Markham ✓ City of Vaughan ✓ City of Hamilton
	Promote Public Transportation	✓ Town of Caledon ✓ City of Hamilton
	Increased Pedestrian Areas	✓ City of Markham
Update Transportation Infrastructure	Bike Rack Instalment	✓ Town of Ajax ✓ City of Burlington
	Green City Fleets	✓ Town of Aurora ✓ City of Brampton
	Bike Lanes	✓ City of Markham ✓ City of Brampton
	Improved public transit systems	✓ City of Vaughan ✓ Regional Municipality of Halton
	EV Charging Stations	✓ City of Vaughan
Education about Climate Change regarding transportation	Outreach and community engagement regarding Climate Change	✓ Town of Aurora ✓ Town of Oakville
	Municipal Signage	✓ City of Hamilton
	School Programs	✓ Town of Oakville
	Company and Business Workshops	✓ City of Hamilton
Policy and Bylaw Revisions	Anti-idling policy	✓ City of Vaughan ✓ Town of Oakville
	EV purchase and use incentives	✓ City of Hamilton
	Transportation demand management	✓ City of Mississauga

2.4 Need for Accelerated EV Uptake

This report explores the current opportunities and barriers in order to determine a feasible action plan specific to the municipalities within the GTHA. Without accelerating EV uptake within the GTHA, Ontario will continue to struggle to reach the climate change goals outlined in Ontario's CCAP. The opportunities outlined in this report will require the participation of the municipal governments within the GTHA as well as cooperation from the provincial government. Outcomes will impact the Ontario business sector, the general public, and the EV industry.

Adoption of EVs on a larger scale will naturally begin with smaller passenger vehicles, however, transitioning all vehicles to electric will be crucial to working toward long term GHG reduction goals. Regardless of which type of vehicle is currently emitting the most GHG, the proper infrastructure and policies must be in place to ensure a smooth, continuous transition. Currently, less than one percent of new vehicle purchases are electric vehicles (Jones, 2017). Through incentives and best management practices explored in this report, the GTHA may see an accelerated rate of EV uptake. Continuing to rely on conventional vehicles puts Ontario on a path to increasing rather than reducing GHG emissions on the transportation sector.

3.0 Methods

After assessing factors considered to be useful in transitioning a city to be EV-ready, selection criteria for potential model cities were determined. These criteria are outlined below in section 4.1. Model cities were researched and then chosen based upon meeting the criteria. A literature review of EV BMPs was conducted for these model cities, which is summarized in section 4.2, and should be considered a review of international BMPs. It is recognized that not all BMPs listed will be applicable to GTHA municipal jurisdictions, however, they are listed to provide insight into successful practices that may be considered in the future. Case studies (Section 4.3) discusses the lessons learned from BMPs within the model cities, translating them into practices suitable for the GTHA. Opportunities for implementation are presented for each BMP, while highlighting potential barriers. Model cities across the country and internationally may have different governance structures and demographics than those within the GTHA, however, value is gained from understanding these policies, practices, and methods of implementation.

The BMP assessment for the GTHA was then followed by an analysis of provincial legislation and municipal by-laws, which outline policy opportunities for EV integration. Policies and by-laws that are impacted or affected by implementing the suggested BMPs are highlighted. This guides policymakers towards important legislation that must be assessed, amended, or added for a smooth transition and continual policy regulation of EV initiatives.

4.0 Model City Analysis

The following section outlines the selection criteria used to choose appropriate model cities from which BMPs were extracted and assessed. The below BMPs are not listed as recommendations for the GTHA, rather, as an explanatory tool for understanding the current state of EV BMPs and potential opportunities.

4.1 Criteria Used to Identify Appropriate Model Cities

The selection and analysis of model cities is essential to properly suggest BMPs for municipalities in the GTHA. A literature review was conducted for model cities that have successful EV adoption or are showing exemplary planning and leadership for future EV uptake. Best practices were reviewed and assessed for their applicability to municipalities within the GTHA. The value in using a model city strategy allows for the opportunity to learn from the mistakes and success of other municipalities and provides a framework for EV implementation in the GTHA.

To be classified as a model city, a municipality must meet, at minimum, one component of each of the following criteria:

Criteria 1. The municipality has outlined one of the following strategies or initiatives:

a. An electric vehicle adoption strategy; or
b. A dedicated transportation section of the municipality's climate change adaptation and mitigation strategy

a. An electric vehicle adoption strategy

Criteria 1 aims to ensure implementation and adoption of EV uptake and infrastructure is a priority. Without dedicated policy and strategies, there is little to learn from municipalities' best management practices. The existence of a written strategy for EVs increases the accountability and permanency of the municipality's dedication to address climate change through an increase in EV usage. An EV strategy indicates that resources and research have been put into producing effective BMP proposals and pilots. Practical learnings are expected to be available from cities that have invested this level of resources and research.

b. Dedicated transportation section of a climate change action plan and mitigation strategy

The presence of a dedicated transportation section of a climate change action plan demonstrates an acknowledgement that transportation is directly linked to climate change goals and provides an opportunity for EVs to be included within the overarching strategy. The existence of a transportation section may be linked to considerations for air pollution and GHG emissions – both of which EV uptake can provide a solution (Jochem, Babrowski, & Fichtner, 2015).

Criteria 2. The municipality has begun one or more of the following:

a. Electric vehicle implementation project or pilot project
b. Significant investment in EV infrastructure
c. Development of new EV policy or incentive programs
d. Community education or outreach programs

To be considered as a leader in EV adoption and policy, a municipality must demonstrate substantial action as well as an EV strategy - the purpose of criteria 2. The implementation of the above criteria demonstrates commitment through investment in the form of time, resources, and capital. These actions also provide insight into the difference between the planning stages, actual implementation strategies, and how the outcomes can differ and evolve from original targets. These criteria illustrate the diversity of methods that can be used in implementing EV strategies and provide various perspectives from which the GTHA can learn.

a. Electric vehicle implementation project or pilot project:

It is important to consider municipal EV implementation projects and pilot projects as a selection criterion because they provide tangible actions and practices to assess. Implementing an EV project or pilot project requires a vast amount of dedication, planning, trial and error, and strategy. This not only shows commitment but provides useful tools and literature from which the GTHA can learn and adopt. This criterion aims at capturing model cities that have attempted to address public and private barriers to EV uptake and have made progress in developing best practices to move towards more EV-friendly communities. Regardless of the stage of an EV project, its implementation is a beneficial learning opportunity.

b. Significant investment in EV infrastructure:

EV infrastructure includes charging stations or the supporting structures needed for charging stations, such as parking spaces and electric conduits. To meet the criteria, the infrastructure can be in operation or can be satisfied by the earlier planning phases in which a contract has been signed and the infrastructure has been confirmed. This criterion could also be satisfied by marking an area of land that will be used in the future for specific EV activities. This criterion aims to include model cities that may be in the earlier stages of EV adoption but are making strides by increasing infrastructure for widespread EV adoption. The investment must be significant, meaning that it must be a sizeable effort (10 or more charging units) and will not be satisfied by a small-scale project such as the installation of a single charging unit.

c. Development of new EV policy or incentive programs:

The development of a policy or incentive program based on the strategy met in criteria 1a takes commitment one step further and indicates dedication to the implementation of EVs, avoiding the development of a strategy without action. Creating new policy produces regulated pathways to ensuring implementation and adoption, often through infrastructure and construction regulations, holding government accountable to their strategies and solidifying dedication to programs. This can be in the form of EV-dedicated teams or boards within council and budgeting. Policies can range from the creation or modification of by-laws, internal government policies (e.g. EV fleet procurement or government building infrastructure requirements) and phase-out

programs, which ensure that future developments meet the requirements of EV initiatives and strategies.

d. Community education or outreach programs:

Community education and outreach programs include efforts to inform the public of changes that may be happening in the municipality, now and in the future, and education about the economic and environmental pros and cons of EV uptake. This is a vital portion of implementing an EV strategy, ensuring that municipalities begin this transition through educational initiatives. As with any new technology, there are many questions and objections to be overcome before widespread adoption. Therefore, these education and outreach initiatives aim to answer questions and to inform the public on the direction their municipality is going with EVs.

Criteria 3. Have demonstrated increase in EV uptake within the municipality, measured by one or more of the following:

a. An increase in percentage of EVs sold
b. An increase in percentage of vehicle market that is electric (availability)
c. Increased frequency of EVs used
d. Improved public perception of EVs

These criteria are necessary as they show the progress made and provide measurable evidence of the impact that the chosen strategies are making to the EV adoption in the municipality. It is important to have comparative evidence based on benchmark values. Different cities may express this in various forms, however, each city must use a consistent reporting method.

a. Increase in percentage of EVs sold

An increased percentage of EVs sold is one indicator of success. An increased number of purchases is likely to correspond to an increase in EV use and illustrates the success of the EV adoption strategy. Increased uptake of EV use can stimulate a growing market sector for EV infrastructure and encourages further development of EV and transportation strategies. The percent of EVs sold is a quantifiable measure of success that can be used to inform EV uptake strategies.

b. Increase in percentage of vehicle market that is electric (availability)

An increase in EV market penetration will correspond with the availability of EVs for consumers to purchase (Infometrics, 2015). This looks at the relationship between supply and demand, where an increase in supply either represents an existing increase in EV demand or will drive future demand. If a strategy is able to convince automobile manufacturers that an increase in EV production is a beneficial business opportunity, this may indicate success in the promotion of EV use. Either way, it is a step in the right direction that can create the capacity to handle current or future demand for EVs.

c. Increased frequency of EVs used

The frequency of EVs being driven can further be considered an indicator for choosing a model city. This accounts for EVs that have been purchased but were previously not used as a primary vehicle. An increase in the number of kilometers that EVs are travelling demonstrates success of infrastructure initiatives and thus public perception. This indicator can demonstrate increased use of the vehicles rather than just showing purchases; however, range anxiety may still exist. Frequency of EV use can be measured through public surveys.

d. Improved public perception of EVs

Lastly, the improved public perception and understanding of EVs is a viable measure of success, quantified through surveys and increased public attendance at EV outreach events. Creating a public relationship of trust and understanding within the community can help build a solid foundation for continued implementation of EV initiatives. Increasing public perception of EV often comes with an increase in willingness to support EV policy, technology funding, pilot projects, and EV purchasing (Lutsey, Searle, Chambliss, & Bandivadekar, 2015). Without a correlating positive public perception of EVs, increased infrastructure availability, market availability, or increased uptake may not succeed.

Table 4 summarizes the criteria the selected model cities meet; it is important to note there is a spectrum in successful EV adoption. Not all cities will meet the same level of commitment or uptake, however, it is important to understand the levels of adoption and the opportunities present in each case. Municipalities in the GTHA can identify with certain model cities based on the criteria presented within the table, which will provide clearer insights into their own strategies or future initiatives. Links to resources containing these municipalities' climate action plans and EV strategies can be found in Appendix B.

Table 4. Satisfaction of selection criteria by model cities

Model City	Criteria 1		Criteria 2				Criteria 3			
	a	***b***	***a***	***b***	***c***	***d***	***a***	***b***	***c***	***d***
Amsterdam		✓	✓	✓	✓			✓	✓	
Atlanta		✓			✓				✓	✓
Chicago	✓				✓		✓			
Copenhagen		✓	✓	✓			✓			
Denver	✓			✓	✓	✓	✓			
London, UK	✓		✓			✓	✓			
Los Angeles		✓		✓			✓			
New York City		✓	✓	✓			✓			
Oslo		✓	✓	✓			✓	✓		
Paris		✓	✓	✓			✓			
Portland	✓		✓	✓				✓		
San Diego	✓			✓				✓		
Vancouver	✓		✓	✓	✓		✓			

4.2 Best Management Practices Learned from Model Cities

Once model cities met the selection criteria, further analysis was conducted to determine which tactics, pilot projects, or other methods are used in their EV strategies, and the general timeline needed for each city to reach its targets. The practices used were compared among the model cities to determine which strategies result in the most effective and transferrable actions – these will be classified as BMPs.

Below is a summary of the BMPs found within model cities. Not all existing practices for EV adoption have been listed, the BMPs determined to provide the best measures of success within leading EV cities remain the focus. These are not meant to be portrayed as recommendations for the municipalities of the GTHA (see section 5.0 for BMP opportunities for the GTHA). Rather, they are intended to provide insights and a substantial background of the current BMPs that are being used by EV-ready cities, for future reference by GTHA municipalities. A summary of the BMPs used by each model city, alongside an example of their application is located on Table 5.

Table 5. Example of BMPs used by each model city

Model Cities		Amsterdam	Atlanta	Chicago	Copenhagen	Denver	London	Los Angeles	New York City	Oslo	Paris	Portland	San Diego	Vancouver	Example
Incentives	**Subsidies for the General Public**						✓			✓	✓				Paris provides a tax rebate of up to $2,464 for the installation of a home charger.
	Subsidies for Business	✓		✓	✓					✓	✓				US $14 million funded through the Chicago Department of Transportation and resources from the federal Congestion Mitigation Air Quality program to include incentives for business fleets and taxis.
	Free/ Discounted Toll Routes						✓		✓	✓					New York 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.
	Free/Discounted Parking	✓			✓	✓	✓	✓	✓	✓	✓			✓	London, UK allows free parking for EVs in some areas, other surrounding cities have followed suit, making the BMP more widespread.
	Residential Parking Permit Priority	✓													Amsterdam has given EV owners priority on the waitlist for parking permits in the city; the waitlist ranges in length from 1-27 months depending on the permit area.
	Consequences: Tow and Ticket					✓									Denver enforces ticketing and towing of non-EVs parked in EV designated spaces.
	Carpool Lane Access (HOV)		✓				✓	✓	✓	✓				✓	Los Angeles enforces accepting ZEVs into HOV lanes by using decals provided by the state of California, making it easy to differentiate them from conventional vehicles.
	Low Emission Zones (LEZ)	✓			✓	✓	✓			✓	✓			✓	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.
Infrastructure	**City-Property Charging Stations**				✓	✓	✓	✓		✓		✓		✓	Amsterdam installs city-owned charging stations based on public requests, if it is approved the city has a contractor who will install the charger.
	Expanding the Network: Readily Available Chargers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	In 2009 Amsterdam had 100 public chargers, by 2011 the city had 1,000 public chargers, and a goal has been set to have 4,000 by the end of 2018.

	Model Cities	Amsterdam	Atlanta	Chicago	Copenhagen	Denver	London	Los Angeles	New York City	Oslo	Paris	Portland	San Diego	Vancouver	Example
Infrastructure	Converting City Fleets		✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	Oslo has replaced half of its city fleet (1100 cars) and is on its way to replacing the entire fleet.
	Streetlight Charging Integration			✓			✓	✓				✓			London, UK converted their streetlight to LEDs, allowing them to support the extra burden of charging an EV. Drivers sign up for the program and are mailed a charging cord that allows them to plug in.
	Residential Construction and Upgrades		✓				✓	✓				✓		✓	Vancouver mandates all new homes to have conduits for level 2 charging stations and for 20% of all parking spaces to have the ability to support level 2 chargers.
	Portable Charging Stations												✓		San Diego makes use of the local company Mobi which supplies portable charging stations to offices and events that would otherwise not have enough charging stations.
	Electric Vehicle Working Group		✓		✓				✓			✓	✓	✓	New York City has an Electric Vehicle Advisory Committee, which has published a 22-page report of their recommendations for city council regarding supporting EV uptake and charging infrastructure.
Education	Consistent and Thorough Signage											✓		✓	Vancouver standardized all signage to remain consistent, focus on identifying charging spaces.
	Technical Assistance											✓			Portland provides a EV Hotline that provides 24/7 assistance over the phone for concerns regarding charger use, EV incentives, and infrastructure. The city also manages an infrastructure map on ChargeHub.
	Community Outreach			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	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.
Building Stakeholder Relationships	Electrifying Car-Share Programs		✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	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.
	Taxis/ Ride-Share Programs	✓	✓	✓			✓		✓	✓	✓	✓		✓	London electrified a large taxi fleet and installed 150 charging stations, and all taxis are required to be ZEV capable by 2018.
	City Contracts-EV Preference	✓						✓							Amsterdam provides contract preferences to bidders operating an EV fleet.

4.2.1 Incentive-based BMPs

Subsidies for the General Public

Switching to an EV has a few challenges, the foremost being the price tag associated with one (Zhou, Levin, & Plotkin, 2016). Although EV vehicles are often listed at higher prices, they are slowly becoming more affordable. Additionally, municipal governments can provide subsidies, often in addition to state- or provincial-level incentives (Langbroek, Franklin, & Susilo, 2016). However, it is important to note that municipal subsidies are often not at the same level as those from upper-tier government and focus less on granting funds and more on providing taxable deductions.

These subsidies create a more equal economic playing field within the vehicle market and make EVs a much more attractive and affordable option to buyers (Zhou, Levin, & Plotkin, 2016). Subsidies for the public when purchasing EVs may better allow the average person to be able to afford the initial investment, depending on municipal income demographics. There are a variety of subsidy programs that can be implemented including: rebates on EV purchases of a set amount; reducing taxes on EV purchases and associated costs; providing subsidized charging opportunities to any degree, whether it is free or discounted; and free vehicle ferry transportation. These rebates and/or discounts are often funded through the city and its partners from a designated budget.

Subsidies for Businesses Purchasing EVs and Charging Stations

Businesses are a major contributor to a municipality's GHG emission levels and poor air quality in a region due to the heavy use of delivery vehicles, trucks, and company cars (Environment and Climate Change Canada, 2017). These larger vehicles are often diesel-fueled and travel long distances throughout municipalities. The use of EVs for business decreases air pollution and contributes to meeting climate action targets. One of the largest hurdles for businesses who want to make the switch to an EV fleet is the cost. EVs are generally more expensive and the price of charging stations is an upfront cost that many businesses just cannot afford for an entire fleet. Municipalities, often supported by upper-tier government funding, can provide rebates and credits to businesses looking to not only transition to an electric fleet, but those who install charging stations. These rebates and/or discounts are often funded through municipalities and their partners from a designated grant, creating more affordable electric vehicle options for the private sector (Ontario Ministry of Transportation, 2018).

Free/ Discounted Parking

Incentives for EV users are part of what make purchasing and owning EVs desirable. Parking fees are continuously rising and are one opportunity for municipalities to incentivize owning an EV. Cities are allowing cheaper or free parking for EVs in city-owned parking spaces (Colorado Electric Vehicle and Infrastructure Readiness Plan, 2015). Similarly, municipalities can offer exclusive parking spots for EVs in optimal locations. These parking incentives are easy initiatives for a municipality to implement and gives direct benefits to EV owners.

Residential Parking Permit Priority

In densely populated cities, obtaining a parking permit can be an issue. Residents often rely on street parking and require a permit to do so, however, there are long waitlists to acquire these permits. Parking permit priority for EVs can be used to incentivize purchasing; this offers EV owners priority on the permit waitlist. For many people looking to purchase a new vehicle who are on the permit waiting list, an electric option becomes desirable. Incentives can be used to simultaneously provide a benefit to current EV users and create more pressure on conventional vehicle drivers. This has the potential to seem inequitable for those who cannot afford EVs, and therefore must be handled in a politically cautious manner.

Consequences: Tow and Ticket

While incentive programs are providing benefits, EV policy and programs are only going to be respected if there are consequences for those not following them. Making sure that designated EV parking spots and other infrastructure incentives are not abused by non-EV users is important to ensuring parking spot availability for EV drivers. This also shows support to those considering purchasing EVs; maintaining exclusive EV opportunities through by-law regulation and action is important.

High Occupancy Vehicle Lane Access

Due to the high presence of individual drivers on the road, traffic congestion is a major issue in large cities. High Occupancy Vehicle (HOV) lanes prohibit vehicles that do not contain the appropriate number of passengers to be considered a carpooling vehicle. The purpose of carpool lanes is to incentivize carpooling and reduce congestion on busy highways. Some cities are allowing EVs into the HOV lane - regardless of the number of passengers in the vehicle. Purchasing an EV may benefit those who commute in high traffic areas as it will reduce time spent due to idling in traffic for the individual. Long periods spent idling daily negatively affects fuel usage, the environment, and human health. Access to the HOV lane is an incentive that the average commuter may find valuable.

Some cities also assign designated license plates to EV drivers, making it easy to distinguish the difference between an EV and conventional vehicle. This helps to ensure EV drivers receive these incentives, while also advertising the program to other drivers as they drive passed.

It is important to note that this incentive is a short-term strategy while EV purchase rates remain relatively low in comparison to traditional combustion vehicles. As a long-term incentive, however, HOV lanes will do little to minimize congestion for EV drivers once most drivers have transitioned to EVs.

Free/Discounted Toll Routes

Similar to the HOV lane exception and the initiative for discounted or free parking, discounting toll routes is another monetary incentive for EV drivers. These benefits can be taken one step further by giving EV drivers access to toll routes for free. Initiatives such as these can directly benefit EV drivers as these toll payments quickly add up. Often through digital passes, EV toll

users receive access to the fast lane at toll payment booths, providing more efficient payment and shorter lines when passing through tolls. While incentives such as this may seem less significant than large sum subsidies, these are rebates that the user will receive for the life of the vehicle, reinforcing the benefits of EV driving to the owner.

Low Emission Zones (LEZ)

Low Emission Zones (LEZ) restrict access for higher emission vehicles with an internal combustion engine. In some LEZ, higher polluting vehicles are required to pay a higher fee/toll or are not permitted entry to the area. These zones are in populated city centres and downtown cores where pollution caused by fossil fuel-powered vehicles raises air pollution to unsafe levels, and where noise pollution can be a nuisance (Mayor of London, 2016).

LEZ are often in operation 24/7, however, the restrictions can be flexible depending on the needs of the municipality. LEZ can apply to vehicles at the city's discretion: applying the ban to heavy-duty vehicles, light-duty vehicles, or both. The use of standardized windshield stickers and electronic tags, enforced through manual or camera systems, allow LEZ to control high-traffic areas, reduce congestion, air pollution, and commute times (Fensterer et al., 2014). This provides exclusive driving access for EVs, incentivizing their purchase and use.

4.2.2 Infrastructure-based BMP

City-Property Charging Stations

One of the best ways for cities to implement change is to lead by example (Bakker & Jacob Trip, 2013). City properties supporting EV charging infrastructure can provide a guiding framework for commercial areas to invest in the technology and can demonstrate EV demand, while inciting a private sector market for EV charging infrastructure. The municipal charging stations should maintain electricity prices that are low enough to incentivize charging over purchasing fuel, yet high enough to encourage at-home charging (Vancouver, 2016). City buildings such as libraries, hospitals, government buildings, public parking lots, and service buildings are examples of frequented spaces that could be useful for implementing public charging stations.

Expanding the Network: Readily Available Chargers

Expanding the municipal network of charging beyond city properties is crucial for meeting demand and creating infrastructure exposure (Bonges & Lusk, 2016). It is important to note that drivers are accustomed to a centralized system of gas stations as opposed to a decentralized network of individual charging stations. Having visible charging stations, with a consistent look that is presented in similar planning fashion as current gas stations allows for recognition and maximum use. The report, *Siting and Design Guidelines for Electric Vehicle Supply Equipment*, prepared for the New York State Energy Research and Development Authority and the Transportation and Climate Initiative, provides insight to charging station design and effective locations.

Queueing anxiety is a term that explains why stations with three or more chargers are used much more frequently than a solo charger (Ruoff, 2016). Grouping chargers provides relief to

drivers who do not have time to wait in line to use a single station. It has been found that this is less of an issue in the early stages of implementation, when the sheer presence of chargers is more important, but in the later stages once the EVs became more popular, the redundancy of chargers is an important feature (Vazifeh, Zhang, Santi & Ratti, 2015). China saw the importance of having chargers readily available and required that all cities have one public charger available for every eight EVs on the road. These chargers are no farther than 1 km apart, essentially creating a reliable network while keeping up with demand (Hall & Lutsey, 2017).

Converting City Fleets

Similar to installing charging stations in city-owned spaces, cities can lead by example by switching their existing fleet to electric. City vehicles are recognizable and would start the conversation about EVs when residents see the switch happening in their own area. Transitioning the fleet to electric also provides a guarantee in emission reduction toward targets, and requires the presence of infrastructure, while demonstrating dedication. Making the switch gives the city insight into the challenges associated with EVs, and for municipalities who have yet to fully invest in public infrastructure. it acts as a logistics pilot project. Overhauls are not expected to be made; transitioning a percentage of the fleet annually has been shown to be an effective approach for governments to make the transition (City of Chicago, 2018).

Streetlight Charging Integration

When connecting EVs to the grid, it is efficient to make use of all existing infrastructure that can be retrofitted before starting from scratch. Streetlights are common in all municipalities and are already connected to the grid. Using them to charge EVs is an innovative solution that can provide great opportunity (Eleftheriou-Smith, 2017). While the technology is still relatively new, it is an opportunity to take note of, and has shown to be viable in model cities.

Ubitricity is a company that has been retrofitting streetlights to be able to charge vehicles. The streetlights using fluorescent lighting are switched to LED, meaning that the system can now support the extra burden of charging EVs. Drivers sign up for the program and are mailed a cable that can be used for charging throughout the retrofitted areas. Members of the program are remotely billed monthly. The added benefit of this system is the reduced need for stand-alone charging infrastructure on highly populated streets (Planner, 2017). Ebee is a company taking a similar approach, however, instead of retrofitting the entire system, a charging station is installed onto the outer surface of the streetlight post. This still uses the electrical lines already in place and has the added benefit of not having to bring one's own cord.

Planning and Development

One- and Two-Family Homes

Requiring new buildings to have the capacity to house charging infrastructure is a necessary step in the direction of electric mobility. A barrier for potential EV purchasers is the inability to charge at home, often in older houses. Requiring contractors to build homes with the electrical and technical capacity for home-charging stations provides an opportunity for homeowners to

consider an EV with fewer barriers. The ability to charge at home and overnight is more convenient for owners and prevents congestion at public charging stations. This does not address pre-existing homes; charging stations for these residences are up to the discretion of the homeowner and would be better accommodated through an increase in public charging infrastructure. The goal of this BMP is to ensure all new residential developments have the capacity for charging infrastructure to meet predicated EV demand.

Multi-Unit Residential Buildings (MURBs)

Many MURBs do not have the infrastructure within their parking systems to support existing, let alone increasing, demand for EVs. Residents of MURBs generally do not have the authority or the ability to invest in infrastructure, which is left to the discretion of the management company and is not frequently considered. This is a barrier that EV policy can address by placing the onus on the property management company. Policy requiring the addition of charging stations ensures that those living within these types of residence are still able to access the convenience of home-charging. It is up to the discretion of the municipality to determine the appropriate number of chargers required, considering future EV targets for the city and predicted future demand.

In addition to private condominiums and residences, city-owned low-income housing should also be considered valuable in the network of charging infrastructure. This maintains standards of equity for low-income residents, who may otherwise not be able to afford the infrastructure upgrades. These standards should be applied to all new and retrofitted MURBs.

Portable Charging Stations

Although home charging and street charging will suffice for most EV owners, there are some instances, such as major community events or EV conferences, where there may be many EVs in one place that require charging. Drivers may become frustrated trying to find available chargers, which is why Mobi was created in San Francisco. This is a mobile charging unit powered by FreeWire Technologies, created with batteries from EVs that are no longer useful in a driving capacity but are still able to hold charge. The concierge charging service allows drivers to park anywhere within a designated Mobi charging lot, where they then open their cellular app to request and monitor charging. An attendant operates a portable charger to charge the vehicle before the driver is scheduled to depart. Mobi also offers products for mobile EV charging with a similar concept to the concierge service but sold as units for home or business use. This is a benefit for areas that want to install charging stations but do not want to break concrete or experience other barriers preventing construction and could be considered an opportunity for municipalities when hosting events.

Electric Vehicle Infrastructure Working Group

EV working groups or subcommittees within city council consist of dedicated community and local government members interested in advocating for the continual improvement of EV infrastructure and technology. When embraced by municipal government and involved in conversations regarding EVs, these groups are a critical learning tool. In the past, EV working groups have prepared best practice materials, readiness plans, and fact sheets to ease the

transition from fossil fuel-powered vehicles. Through a supply of knowledge, research, community ties, and stakeholder engagement, working groups are integral to maintaining accountability and informed decision making about EV infrastructure. These groups differ from non-governmental organizations (NGOs), as they are municipality-specific, and are solely concerned with the actions of council on the topic of EVs.

4.2.3 Education-based BMP

When switching to a relatively new technology, it is important that the public is informed. There are many questions to be answered and ideas to be heard, and a system is needed to manage these (Bakker & Jacob Trip, 2013). Educational BMPs provide the appropriate guidance and information to the public and EV users in an attempt to ease the transition to EV adoption.

Consistent and Thorough Signage

Educational signage developed by the municipality should be standardized to ensure recognition and trust of the information and is easiest for both the municipality to generate as well as the public to engage with. Standardized stations with easily read instructions has led to both residents and visitors becoming less confused from station to station. This signage also includes information on the environmental and economic benefits of EVs. Average charging times, the distance to the next charging station, and other incentives available from the city should also be displayed.

EV exclusive parking requires the same level of standardization that charging station signage does. A consistent appearance to parking spaces creates recognizable incentives to not only EV drivers, but to conventional vehicle owners.

Technical Assistance

Charging stations are a new technology that includes a learning curve. Educational signage at charging stations and online resources help current and potential users understand the technology. Assistance can go above print, however. Even with clearly printed instructions for use, some municipalities found customers would rather speak with a knowledgeable person to discuss the operation and use of the chargers (City of Portland, 2016; Ruoff, 2016). A 24/7 hotline for customers can be is useful for receiving EV information and assistance, extending to tech support while having difficulty at the charger. Tracking the topic of the calls is useful to see where to further improve upon education strategies. Access to real-time support provides reassurance to new and potential buyers.

Community Outreach

The community outreach portion of education is vital to engage all groups, not just those who can afford an EV. This involves outreach activities targeting communities in the form of conferences, showcases, and educational pamphlets. These are opportunities for the municipality to show support to organizations running educational programs, as well as promote EV educational materials at city events with trained staff present to answer questions.

Community and workplace challenges are also useful outreach tools to create awareness and spur change.

There is opportunity for EV education to begin at a young age. Through a sustainability workshop, three Philadelphia high schools have been building and retrofitting gasoline-powered cars into EVs (Coren, 2011). Building EVs has taught students about how they function as well as including a classroom component that reinforces the need for EVs and the benefits to reach climate change targets.

4.2.4 Building Stakeholder Relationships

Electrifying Car-Share Programs

EV car-share programs allow people to test drive EVs without investing the money in a personal vehicle and removes the commitment of a purchase. Subscription- and community-based EV car-sharing programs expose customers to the practicality of the vehicle and the availability of infrastructure and incentives. In addition, car-share programs are an opportunity to decrease road congestion, a goal that can go hand in hand with EV adoption. Encouraging EV projects that allow low-income and marginalized communities to participate exposes a broader spectrum of the public to their use. This is often done through partnerships with car sharing companies, for which the municipalities provide rebates and assist in the advertising of EV availability. Car-share programs provide an opportunity for low-income individuals to access a vehicle. This is an opportunity they otherwise may not have (Kodransky, 2014).

Taxis/ Ride-Share Programs

Working with various stakeholders is key to accelerating the transition to far-reaching EV adoption (Bakker & Trip, 2013; International Economic Development Council, 2013). Taxi companies are often supported by a loyal customer base who trust their vehicles. However, they are also a major source of emissions in city centres. Working with taxi companies to provide incentives and facilitate mutually-beneficial relationships between EV manufacturers/dealers and taxis companies would be a huge step toward reducing municipal GHG emissions. This also increases awareness of EVs and demonstrates that they are reliable enough to get passengers to their destinations.

City Contracts- EV Preference

City council recognizes companies who operate an electric fleet; large contracts offered by the municipality specify that preference is given to bidders operating an electric fleet. This gives an opportunity for companies to make the switch knowing it could give them a competitive advantage. Partnering with companies who support the EV transition demonstrates, once again, a municipality's leadership and dedication to the strategy, and could encourage uptake by large businesses.

4.3 Case Studies

Below, three case studies are listed, one focusing on incentive BMPs (4.3.1), one on infrastructure BMPs (4.3.2), and one on a combination of all categories of BMPs (4.3.3), to provide context to the practical application of BMPs.

4.3.1 Amsterdam: An Example of Incentive-based Success

Amsterdam is the most populous city in the Netherlands. At approximately 2.4 million residents within the metropolitan area and a population density of about 4,908 people/km^2, it is an important hub for the Netherlands. With an oceanic climate (generally mild summers and winters), its relatively wealthy population (Netherlands GNI per capita is $53,000 CAD), and 72% of the population between the ages of 15-64, it is an important city in which to expand on EV adoption. Amsterdam has been successful at this so far; with 9.7% of the vehicle market sales attributed to EVs, and 561 public charge points for every million people, it is one of the highest EV vehicle markets in the world (Hall, Moultak, & Lutsey, 2017; The World Bank, 2018; World Population Review, 2017). Higher income homes are more likely to purchase a vehicle and younger populations more likely to embrace technological and environmental changes. Lastly, Amsterdam's mild climate removes potential cold weather barriers on the technology, such as shortened battery range in the winter months (Lambert, 2018).

Amsterdam is one of the world's leading cities in EV adoption, striving to become a zero-emission city by 2025 (Hall, Moultak, & Lutesey, 2017). The 2015 Amsterdam Sustainability Agenda specifically targets air emissions and pollution levels within the city, seeking to improve air quality and support sustainable energy (Municipality of Amsterdam, 2015). EVs contribute directly to these goals by reducing carbon emissions on the streets and efficiently using locally generated energy. With the first stages of implementation in 2009, 100 EV chargers were introduced.

By 2011, there were 1,000 chargers, 2000 by 2016, and an upcoming 4000 chargers planned for 2018. In fact, an EV owner can request a public charger be installed near their home and, after assessing and confirming if the request meets requirements, the city will install it for free. The application process is outlined in Appendix E. On top of these infrastructure successes, Amsterdam has proven to be successful at implementing EV incentive best practices. To date, the total number of EVs sold in Amsterdam is 6,645 representing 9.7% of all vehicles sold in 2015 (Hall, Moultak, & Lutsey, 2017).

Subsidies to Businesses

Amsterdam focuses its purchase subsidy strategy on heavy use vehicles including taxis, trucks, company cars, and delivery vans. Within the city, business traffic accounts for most of the vehicle miles travelled and often by heavy polluting diesel vehicles. It is estimated that 50% of the city's GHG emissions stem from motor traffic (Municipality of Amsterdam, 2015). Incentives directed to local businesses logging these miles encourage a switch to EVs to reduce air pollution concentrated within the city limits. Subsidies are awarded based on mileage tracked within the city by an EV. Funding for the city is provided by the federal government, allowing the municipality to additionally provide its own standard of subsidies to businesses: 5,000 euros is

subsidized for every electric taxi, company car, or delivery van purchased. Electric trucks and buses receive up to 40,000 euros per vehicle. By 2016, 450 companies had purchased subsidized EVs, at a value of more than 50 million euros (Hall, Moultak, & Lutsey, 2017).

Parking Privileges and Permit Priority

Electric taxis are given free parking and charging at EV parking spaces around the city to encourage fleet transitions, and personal EVs can easily find parking through designated EV spaces. To date, there are 4,000 taxis driving in Amsterdam, a quarter of which are considered clean by the Clean Taxis for Amsterdam Covenant (Giessen & Linden, 2015). In a city where street parking is heavily relied on and difficult to find, these are powerful incentives to persuading a shift in purchasing for both individuals and taxi companies.

Approximately 90% of Amsterdam residents do not have private parking on their properties and rely on street parking (Municipality of Amsterdam, 2015). Residential parking permits can carry a wait time of several years in some cases; therefore, permit priority is awarded to EV owners as an incentive, allowing them to jump to the top of the waitlist. While incentivizing EV ownership, the city is also discouraging older vehicles. Beginning April 2017, older polluting passenger cars are no longer able to receive parking permits within the city centre.

Low Emission Zones (LEZ)

The first LEZ was implemented in 2009, restricting heavy-duty truck access to the city centre. With an increase of other forms of polluting traffic, LEZ regulations were expanded in 2017 to include delivery trucks older than the year 2000 and are set to expand with restrictions on diesel taxis, coaches, and mopeds in 2018, which can be seen in Figure 6.

Figure 6. LEZ in Amsterdam
Urban Access Regulation (2018)

City Leadership

The city has taken action to give contract work to companies with an electric fleet, preferring to support companies who are working towards the municipality's emission reduction targets. The city seeks to set an example and show companies that they can benefit from operating an electric fleet. The city itself will transition its own fleet to be fully emission-free by 2025. Currently, all new vehicles bought by council will be the most environmentally-friendly option available, and all city council relocations are carried out using EVs.

Figure 7 presents a timeline of the EV adoption highlights by the City of Amsterdam and provides an example of implementation time frames.

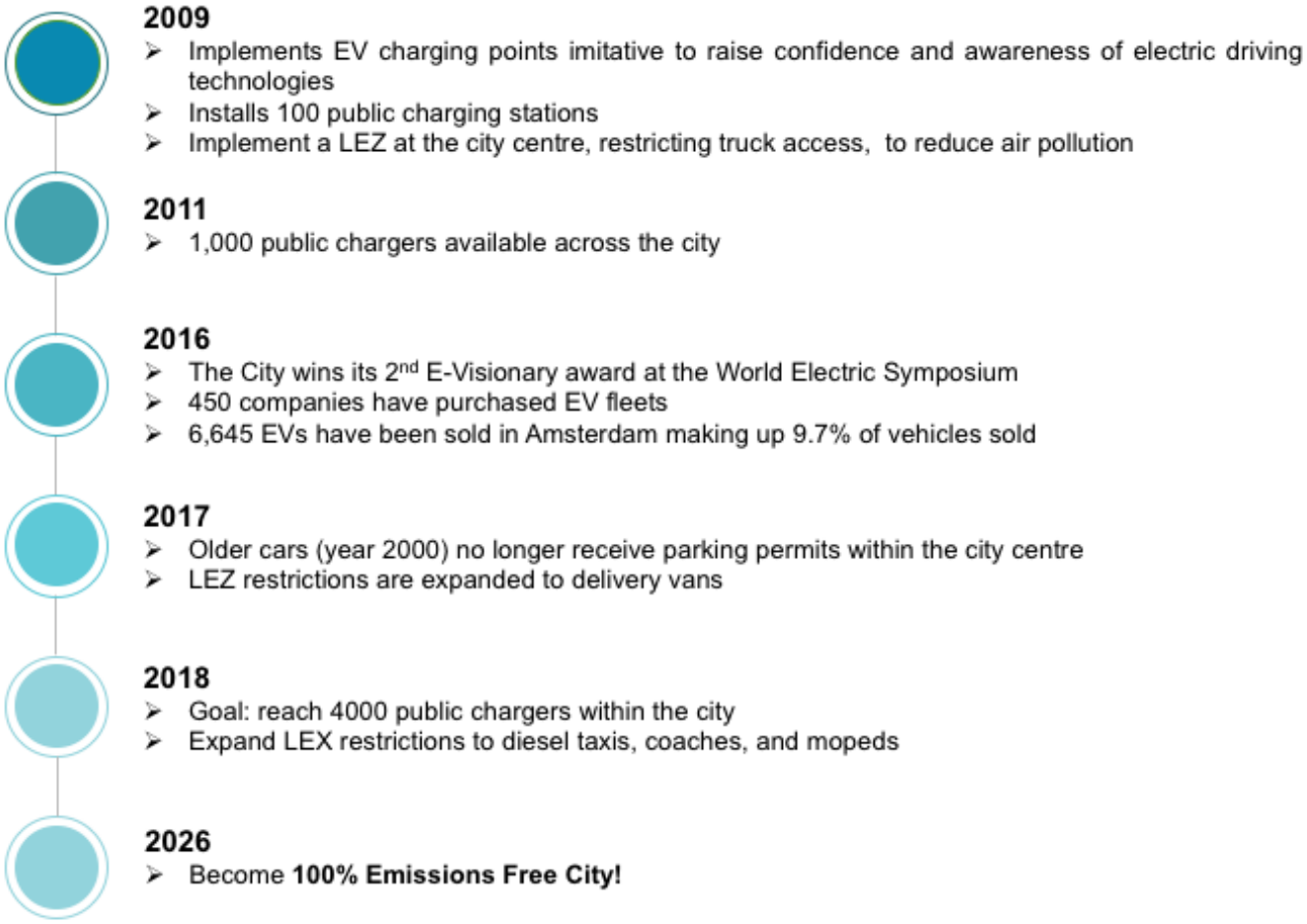


Figure 7. The City of Amsterdam's Electric Vehicle Best Practice Progression

4.3.2 Portland: An Example of Infrastructure-based Success

Portland, Oregon is a city of just under 640,000 residents with a population density of 1689 people/km^2, a moderate population density. The income per capita in Portland is just under $35000/year, coming in above the US average of $31128 (U.S. Department of Commerce, 2016). Summers are hot and dry, while the winters are rainy with an overall climate classified as Mediterranean. With just over 10% of resident workers commuting to work by public transit, many of these workers are driving alone resulting in a great amount of GHG emissions (Rose, 2014).

Portland began their EV journey in 2010 with the publication of their first EV Strategy, containing an overall goal of reducing transportation emissions (City of Portland, 2016). Portland has a wide range of income demographics and one of the main drivers of their strategy is to ensure low income citizens are able to participate in EV programs. The city's latest EV strategy, *2017 City of Portland Electric Vehicle Strategy*, was published in 2016 and clearly explains goals, targets, and action items (Portland Bureau of Planning and Sustainability, 2017). Portland's climate action plan aims to reduce transportation emissions by 25% below 1990 levels. They plan to achieve this goal through the promotion of EVs and their journey is an exemplary model for successful infrastructure BMPs.

Network: Readily Available Chargers

Portland is unique due to its vast charging network, easing range anxiety (where EV drivers worry about being unable to reach their destination or a charging station before their battery dies). To accomplish this, they focused on installing charging stations where there are multiple charging networks in the same area. With 435 chargers, the majority are a level 2 charger, with a smaller amount of them being a level 3. They also have an extensive online map created by ChargeHub showing information such as address, level, price, and user reviews. This useful information could also be converted to an app format, making it more accessible for visitors.

City Owned Charging Stations

Although Portland has an extensive charging network, the city plans to retrofit city buildings to add charging infrastructure and to require all new city buildings to be built with EVs in mind. They are investing in charging ports for city-owned parking spaces, where members of the public are likely to park frequently. This shows support to the EV community while bringing conversation and educational opportunities about EVs to the entire municipality. They are also working to increase the usage of chargers they have already installed through the creation of a map.

City Fleet Conversion

The City of Portland has already converted 20% of their fleet to EVs. They plan to continue increasing this number as technology advances and meets the demands of the rest of their fleet, including medium- and heavy-duty vehicles. The city plans to increase their fleet to 30% electric by 2020 (City of Portland, 2017).

Streetlight Charging

One of the most creative solutions in Portland's Action Plan is to implement streetlight chargers, similar to those already working in California City. Portland has shown that if you build the chargers, the EVs will come. These streetlight chargers are a plausible next step in their progress.

Residential Charging

Technology is often most available to those who have a higher income. Portland aims to change this in the context of EVs by making it a standard for affordable housing to have the capacity to charge EVs. This includes shared housing and condos for those who have a lower income.

Legislation was passed in 2017 that requires all new parking facilities to have the conduit for level 2 charging stations, making the installation of chargers in the future much easier.

Working Group

Opinions of community members are a valuable source of information that Portland has tapped into using an Electric Vehicle Working Group. The members have been tracking technology in the EV industry and have been presenting suggestions for future infrastructure deployment to the city council.

They implemented an affordable car-share program where communities share EVs for a reasonable price of $10-12/day. This is one incentive that allows all social classes to participate and could make it more likely for the members of this project to purchase an EV in the future. Portland also plans to create a technical assistance phone number for residents who have questions or need advice about their home charging station installation or repairs.

The timeline of EV uptake highlights in Portland is illustrated in Figure 8.

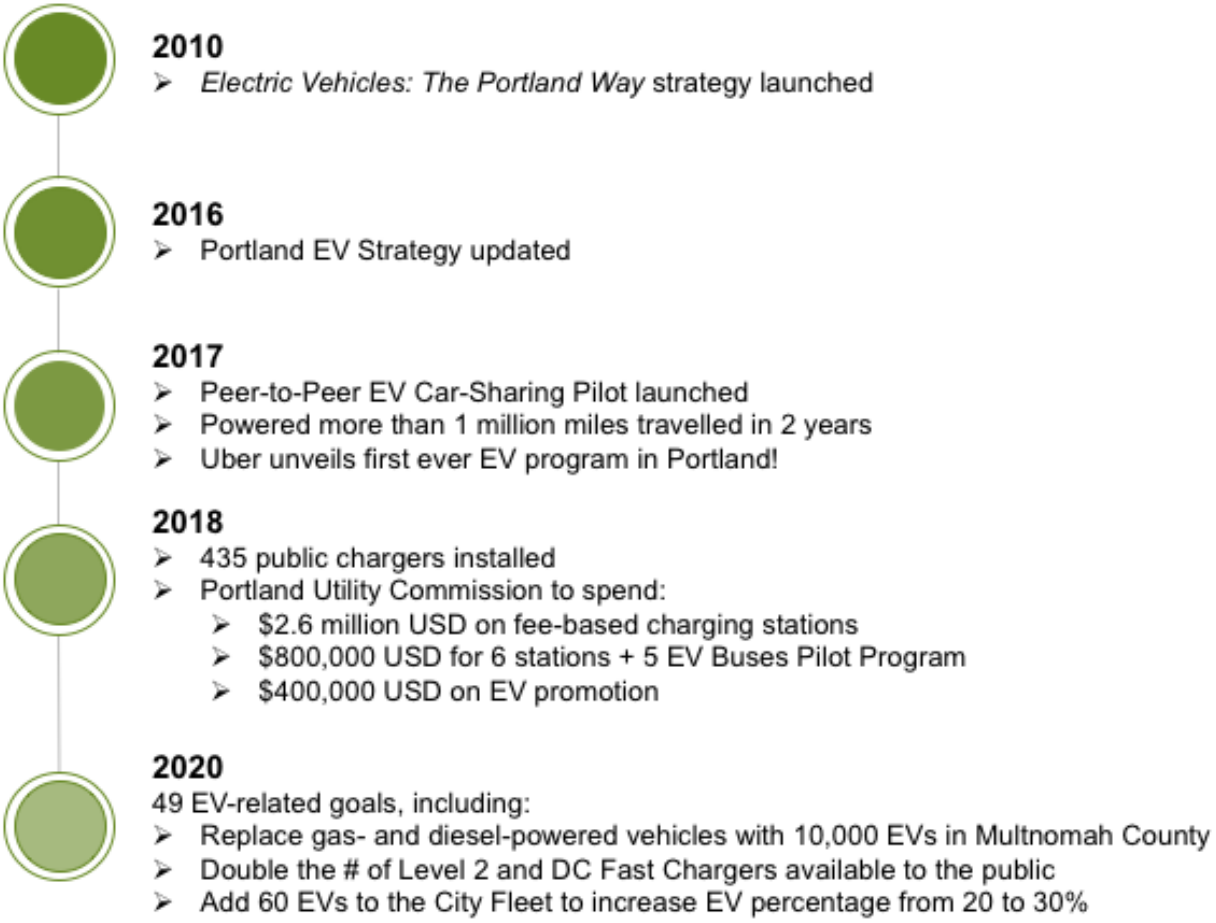


Figure 8. The City of Portland's EV Best Practice Progression

4.3.3 Vancouver: A Canadian Example of Well-Rounded BMP-based Success

Vancouver, British Columbia has a population of just over 2.4 million residents in the metro area and a population density of about 800 people/km^2. The median income is $32,000 per year, with 70% of the residents being between 15 and 64 years of age (Statistics Canada, 2017). Vancouver partnered with Project Get Ready in 2010 to develop action items to support future PHEV and EV use (Vancouver Mayor's Office, 2010). In 2016 the city published the *Vancouver Electric Vehicle Ecosystem Strategy* to further develop their goals. The primary goals of the city are 1) Accessibility, 2) Reduced Cost, and 3) Creating Economic Opportunity (City of Vancouver, 2016). Since then, Vancouver has seen a 70% increase in EVs sold since 2011 (City of Vancouver, 2017) and an increase in the frequency of EV use. One percent of all vehicles sold in the province of British Columbia were electric (Bing, 2017); despite improvements made by the city of Vancouver and their EV uptake growth, there is ample room to improve. Vancouver has been using a well-rounded strategy incorporating both incentives as well as infrastructure BMPs.

Parking Discounts

The city is implementing parking incentives where EV drivers pay a discounted rate compared to their fossil fuel counterparts, a small incentive that drivers can benefit from on a daily basis. The implementation of EV chargers in previously existing parking spaces is paired with a new EV-only access designation, creating a parking advantage for those driving EVs.

HOV Access

High Occupancy Vehicle (HOV) access perks are also offered in Vancouver, making EVs a much more attractive and affordable option in this urban area. A simple system was created for EV owners to apply for a decal that allows them access to the HOV lane without the required number of passengers, this is a program run by the province of British Columbia and enforced with the help of the Vancouver Police Department.

City Owned Charging Stations

The city currently manages 75 level 2 chargers and one level 3 charger (City of Vancouver, 2017). The City of Vancouver (2017) has found that most commuters are driving less than 30km per day. With that in mind, a level 2 charger would be able to recharge the battery to reach this capacity in less than an hour, which is why they have focused most of their resources on this level (City of Vancouver, 2016). A small fee was implemented for public charger use to encourage at-home charging and to ensure the charging stations keep a reasonable turnover rate. The city has also made plans to develop cellular repeaters in underground garages to allow increased network connections for their charging stations. These devices increase the cellular connection within traditionally unreachable zones (i.e. underground parking garages), allowing for the use of wifi-enabled charging devices (Urban Foresight, 2014). This will be beneficial not only for increasing the number of available areas for charging stations, but also prepares for the future of autonomous vehicles. Networked stations in many parkades require cellular access; cellular repeaters therefore increase infrastructure availability, in line with the first goal of the

Vancouver Electric Vehicle Ecosystem Strategy.

Vancouver has adopted a similar strategy to Japanese vehicle manufacturers Nissan, Honda, Toyota and Mitsubishi. These manufacturers created the Nippon Charge Service, a national program that unifies the charging stations, making it easy for drivers to learn how to charge, pay, and use their knowledge at any station (Morris, 2014). Vancouver has a consistent look planned for their charging infrastructure to make charging an easy and enjoyable experience (City of Vancouver, 2016).

Residential Charging

Vancouver requires single residential homes built after 2011 to have conduits supporting level 1 chargers and those built after 2013 to support level 2 chargers. This encourages homeowners to switch to EVs and take advantage of the supporting infrastructure, as well as preparing residences for future demand.

Currently Vancouver requires MURBs to provide level 2 charging at a minimum of 20% of parking stalls. By 2014, the city had assisted MURBs in moving beyond compliance, and Vancouver aims to one day allow every resident in a building with three or more units to access charging infrastructure. Access to charging at home is important for keeping public charging stations available on a regular basis.

A survey conducted for the *EV Ecosystem Strategy* revealed most Vancouverites are interested in making their next vehicle purchase an electric one, provided that barriers are removed. These barriers centered around reasonable and convenient access to charging infrastructure (City of Vancouver, 2016). While at-home charging is a priority of the city, not all residents have access to off-street parking and therefore must rely on curbside charging. Vancouver has proposed a pilot project to address this issue and is now accepting applications from residents who are interested in installing curbside stations over the course of two years. This is to ensure that all curbside charging stations are installed legally and safely.

City Fleet Transition

The City of Vancouver has committed itself to an EV fleet. Currently Vancouver has a total of 30 EVs within the city fleet, the most of any municipality in Canada. This number will continue to increase as older, light-duty vehicles are replaced with EVs (City of Vancouver, 2017). The size of the entire Vancouver fleet is complicated by their use of a car-share program for employees, providing access to over 400 vehicles. The 30 EVs within the fleet are not included in this car share, however, the city does plan to have this number increase to 115 by 2020 (Fraser Basin Council, 2016).

Educational Policies and Initiatives

The City of Vancouver requires builders and contractors to provide specific, visible labelling, and pamphlets inside new homes. These outline the option for at-home charging infrastructure as well as other incentives, including provincial and federal subsidies that are available to EV owners. The city maintains a website dedicated to mapping available public chargers and fee schedules, which helps residents stay connected to current EV news and changes.

The timeline of EV uptake highlights in Vancouver is illustrated in Figure 9.

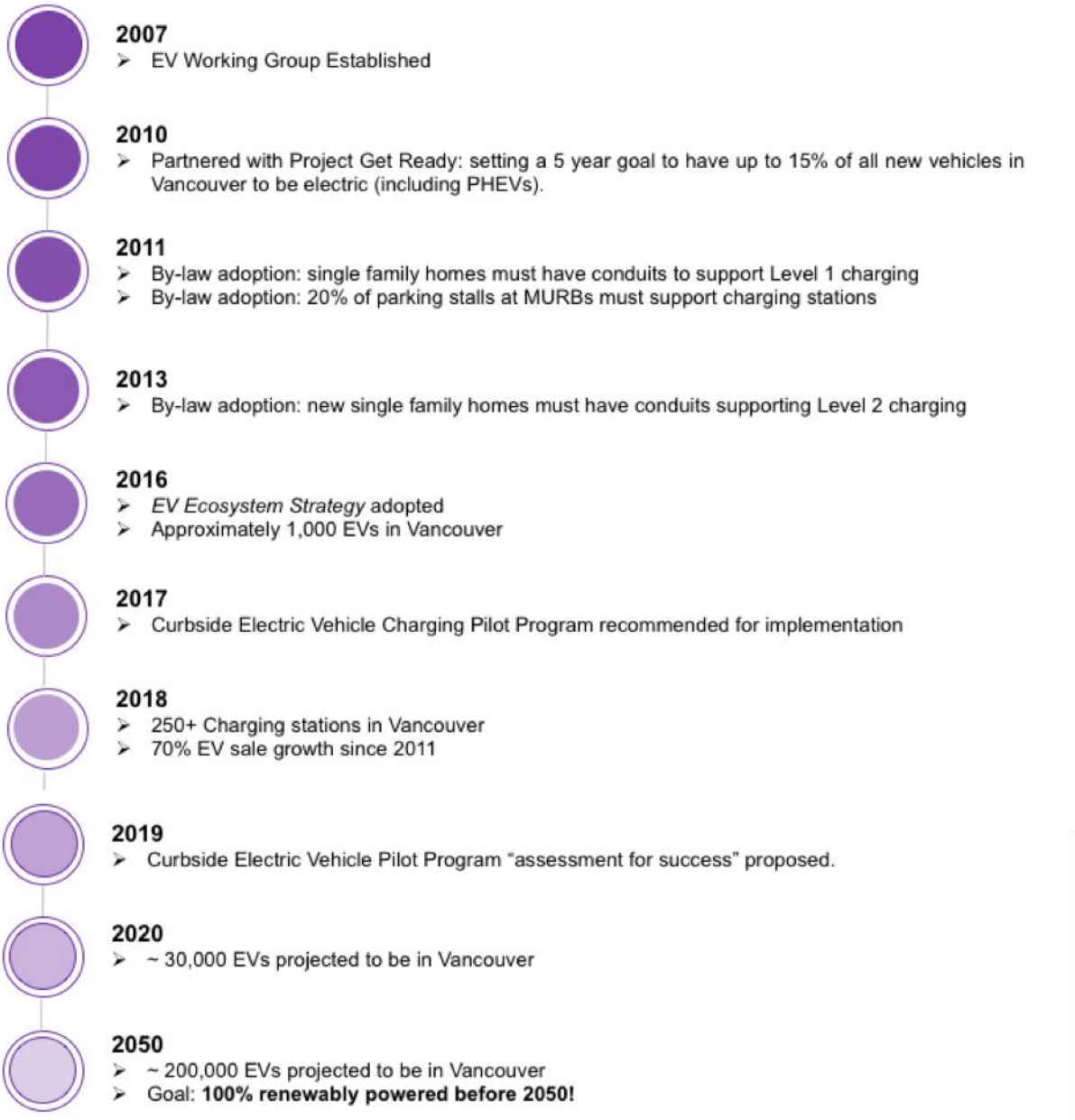


Figure 9. The City of Vancouver's Best Practice Progression

5.0 GTHA Case Study: Municipal EV Uptake

The Exclusion of the City of Toronto

The City of Toronto is not expected to benefit from this report. Adoption recommendations are targeted towards municipalities in which electric vehicle policy and infrastructure uptake will provide the greatest benefits and opportunities for EV growth. The City of Toronto is an outlier in density demographics and is already in the stages of implementing a strategy, Transform T.O. Additionally, the City of Toronto has an extensive public transportation system leading to fewer personal vehicles on the roads.

The lessons learned from BMPs within the model cities were translated into practices suitable for the GTHA. Model cities across the country and internationally may have different governance structures and demographics than those within the GTHA, however, value is gained from understanding effective policies, practices, and implementation methods used in model cities.

It is important to understand the municipal landscape of the GTHA and its encompassing municipalities to gain valuable insight from model city initiatives and strategies that may be transferable. Below, is an outline of BMPs based on opportunity in the GTHA, with region-specific barriers and the implications for provincial and municipal policy.

The population of the entire GTHA is approximately 7.2 million people. The City of Toronto itself contains 2.8 million of those people. The GTHA has a high population density of 922 people/km^2, and a land area of 8,262 kilometers square. Appendix A lists the municipalities within the GTHA and contains further statistics regarding their demographics. Located in a Humid Continental climate, the GTHA experiences the extremes of both summers and winters.

The median income of residents across the GTHA varies between municipalities, but generally ranges between $25,000 to $50,000. Additionally, the working age group of 15-64 represents, at minimum, 60% of residents in all GTHA municipalities (Statistics Canada, 2018)). This age group is an important one; working residents are more likely to purchase a new vehicle, and younger generations are proving to be more open to sustainable initiatives and technology (Nielsen, 2015). The GTHA is a relatively connected and compact urban region, however, most residents within GTHA municipalities rely heavily on personal forms of transportation. This may be because GTHA municipalities do not have as robust a transit system as the City of Toronto. The average commuter within the GTHA drives less than 40 kilometers per day (Young, 2017), with a ratio of 8:1 drivers to public transportation users. Understanding commute times, reliance on personal vehicles, access to reliable public transportation, and infrastructure will influence EV strategies. A population's reliance on personal vehicles confirms the need for an EV transition to reduce GHG emission levels. Understanding the proportion of residents' that can afford a new vehicle, daily routes, habits, and barriers they face will help to shape an adoption strategy.

It is also important to recognize that in Ontario, many responsibilities are deferred to the municipal level, putting pressure on budgetary responsibilities. At the same time, municipalities and metropolitan regions are increasingly recognized as centres of growth and national prosperity (Côté & Fenn, 2014). The balance of municipal and provincial jurisdiction and EV strategy will be considered throughout the listed opportunities for the GTHA.

5.1 Applicability of Best Practices and Opportunities

The BMPs assessed from model cities have been analyzed to determine applicability and practicality in the context of the GTHA, for municipal adoption. The outlined opportunities are explained in greater detail in Best Management Practices Learned from Model Cities (Section 4.2) and Case Studies (Section 4.3).

5.1.1 BMP Opportunities for the GTHA

After assessing the context of the GTHA and analyzing best practices, opportunities have been identified to create unified educational and transparency tools to better assist municipalities in the transition to electric mobility. While not a first step in the stages of EV implementation, these are tools that will further encourage EV use amongst residents and businesses and will continue the promotion of EV strategies within municipalities.

Business Subsidies

Business vehicle travel within the GTHA is a high contributor to GHG emissions. This includes delivery vans, trucks, and company cars. Subsidies for businesses could be a reasonable option for municipalities to consider. Beginning with applications for grants, municipalities within the GTHA should begin budgeting for business purchase subsidies, emissions reductions credits, and/or tax breaks for businesses with EV vehicles that travel significant distances, per day, within their region with the grant money. Currently, the province provides subsidies for commercial vehicles, if municipalities choose to pursue this BMP, they will need to work with both provincial and NGO donors to gain funding. The model that Amsterdam used is an interesting take on the subsidy (Section 4.3.1). A similarly formatted subsidy program could directly benefit the air quality of the municipalities in the GTHA by encouraging EV adoption by local businesses.

Parking Fees

Parking fees are a more immediate practice that can take effect in the near future. Any parking spaces with chargers operated by the municipality should see a price drop for EVs. If the parking fees go towards municipal funding and cannot be reduced, the regular parking prices could be adjusted accordingly.

Residential Parking Permit Priorities

Residents among the GTHA municipalities may require parking permits for street parking. Not all residences include private parking, especially within dense city centres where street parking is common. Providing priority to those who drive EVs within permit structures is an incentive that can easily be applicable to the GTHA and incorporated into municipal permit policy structures. Should a municipality not have the demand to use this practice as an incentive, discounted parking permits can also be considered.

Tow/Ticket

Accessible parking spaces are an example of the logic as discussed in *Consequences: Tow and Ticket* (Section 4.2.1), while these permits are distributed by Service Ontario, municipalities are

the ones enforcing them and drivers avoid parking in these dedicated spots because they know they carry a hefty fine. Municipalities can use the same ticketing systems to ensure EV parking spots are not being taken advantage of by imposter conventional vehicles. The authority to ticket or tow these vehicles should be enforced by the appropriate authority within the municipality and carry a large enough fine to dissuade fossil fuel vehicle drivers from parking there.

LEZ

Implementing a LEZ in the busy core of downtown areas is an option for municipalities with high vehicle emissions. The LEZ does not have to cover a large area, even a section of a main street would be enough to improve the air quality of the area while sending a message to drivers that the future of the area is electric. This is a practice that has not been done in Canada, and would require a feasibility study, and a determination of appropriate jurisdiction.

City Property Charging Stations

Leading by example, increased implementation of city charging stations will create the foundation for charging infrastructure networks across the GTHA and encourage purchase. Many drivers residing within the GTHA often commute to other areas, having recognizable structures and City locations will encourage use. EV charging stations on city property are highly recommended for use in the GTHA. While there is already existing charging infrastructure within some GTHA municipalities, availability should be expanded. While each municipality should be responsible for determining the fee structure associated with their public charging units, it is recommended that across the GTHA charging stations and individual units follow a similar design structure and be clearly marked.

Network of Chargers

Travel across the GTHA is common, residents of one municipality may frequently visit and require charging in another municipality nearby. In the future, municipalities can look into encouraging a private market for charging which would expand the network. Each municipality strategically plans where their chargers are being placed and encourage businesses in optimal locations to install chargers. Heavily trafficked corridors should be considered first. The availability of chargers at each location as well as the distance between chargers is an important piece of information that the municipality can look into and assist in managing. While unifying the chargers in the municipality is a great first step, it can be expanded to the surrounding municipalities to keep charging stations consistent throughout the GTHA as much as possible.

City Fleet Conversion

As outlined in *Converting City* Fleets (Section 4.2.2), setting an annual target will create accountability. It is strongly urged that the municipalities of the GTHA begin the transition to EV fleets, if they have not already begun to do so. It is recommended that a minimum of 3% of the municipal fleet is transitioned annually to EVs.

Streetlights

Municipalities such as Mississauga are currently converting their streetlights from fluorescent to LED bulbs to save on energy costs. This means there will be less of a demand on the energy grid from these lights and could support EV charging, similar to what Portland (Section 4.3.2) is considering. The GTHA could explore this further as a viable technology by contracting a company to retrofit existing streetlights to include chargers, or a company to install charging stations onto the streetlight poles that are already connected to the grid.

Residential Construction and Upgrades

GTHA has an in-demand housing market, with suburb neighborhoods expanding at astounding rates (Dunn, 2016). Requiring all new homes to allow for EV chargers will remove accessibility barriers from spread out communities. Ontario Regulation 332/12: Building Code (Appendix C) requires, as of January 1, 2018, that surrounding one- and two-family homes require new constructions to have the electrical capacity to support charging infrastructure. It is recommended that municipalities build off of this new policy and require new constructions also provide informational pamphlets and stickers informing owners of the EV potential of their home. The training of building inspectors to ensure compliance and education for contractors could assist with this BMP.

Portable Chargers

Municipalities could suggest portable chargers to community members seeking solutions for charging woes or to businesses that do not have the capacity to install a charger. The municipality supporting this technology showcases the innovative solutions that are available and calms the range anxiety of potential EV drivers. The municipality can offer portable charging services in the future at large events or other gatherings that attract a high concentration of EV drivers.

Working Groups

Creating a working group specific to each municipality would greatly benefit the entire GTHA as these groups keep the municipalities accountable and assist in keeping up to date on current EV news and technology relevant to that particular area. The ease or difficulty of this practice depends on the ability to recruit dedicated members to the working groups. Municipalities should create an EV working group specific to their community- focus on the municipalities resources, needs, and climate goals in reference to EV adoption.

Consistent and Thorough Signage

This will require communication between municipalities to ensure similarities and reduce levels of confusion when EV drivers travel throughout the GTHA. It is important that this signage also includes information about regional incentives and infrastructure availability. The region would benefit from standardization across the GTHA as a whole. Standardized educational signage is recommended for charging stations within municipalities.

Outreach

The employees who are dedicated to, knowledgeable, and passionate about EVs should be the ones at the front lines of GTHA community events educating the public and correcting any misconceptions. It is recommended that each municipality should have employees who are well-versed in EV technology and policy and are able to handle even the toughest questions from community members. Municipalities should support any EV showcases or events happening in the community.

Car-Share Programs

In the GTHA, businesses such as Car2Go and ZipCar can be partnered with to expand their reach and encourage smart transportation choices. Municipalities with demand for car-sharing programs can provide incentives to these businesses and work in partnership to encourage EV use and educate the public.

Taxis/Ride-share Programs

Municipalities of the GTHA vary in taxi use, however, taxis are often on the road for hours at a time when in use. It is proposed that funding can be secured from government grants to fund GTHA municipal fleets of electric taxis. Municipality business incentive programs should be advertised to local taxi companies to encourage the switch. Partnerships with EV fleet taxi companies can encourage the transition. Drivers who have been operating an EV for Uber should also be eligible to receive subsidies. Restrictions for eligibility based on number of trips made for Uber and proof of ownership will prevent drivers from taking advantage of the system.

Contract Preference

Municipalities within the GTHA are often able to choose amongst many business opportunities, fueling competition between potential contractors. The high population and close proximity of municipalities in the GTHA provides choices for municipalities, allowing for such preferences to be made without sacrificing quality of work. Municipal purchasing policy outlining preferences for contractors using an electric fleet will encourage business fleet transitions.

Report Cards

Report cards are useful tools for accountability and motivation. While a municipality cannot create their own report card and judge themselves independently or comparatively to other cities, a coalition of municipalities can hire an independent auditor to create the document. The report card can be used as an educational tool for both the individual municipalities as well as the public. Key performance indicators can include: existing EV policies and policy opportunities, infrastructure and EV numbers, energy source (how “clean” the municipalities energy supply is), and the availability of incentives and opportunity to implement new infrastructure and pilot projects (Axsen, Goldberg, & Melton, 2016; Salisbury, 2014). Competition is common between municipalities; Denver used this to its advantage when participating in an EV report card done by the Southwest Energy Efficiency Project (SWEEP) to compare neighbouring states (Salisbury,

2014). This served many purposes including quantifying the successes related to EVs and providing a platform for municipalities to easily see what their neighbours had been completing and to adapt their own strategies. The GTHA includes many municipalities, presenting an opportunity to create an EV Coalition and an agreement to a report card system. This keeps the municipalities accountable to their goals, showcases the effort and success to the public, and can lead to further EV cooperation and cohesion within the GTHA.

Mobile App: An Education Tool

A consolidation of educational and interactive tools on a mobile application would provide EV users with an accessible and user-friendly interface. Available on all smartphones and tablets, the app would contain:

- Location
- Type of chargers
- Price
- Electricity Peak Times
- Log of kilometers charged and associated GHG emissions saved
- User reviews and comments
- Available Incentives for EV use and purchase (parking spaces, HOV lanes, subsidies, etc)

This would be best enacted as a joint venture across municipalities of the GTHA, perhaps developed by a coalition and partnership with Working Groups that have been previously recommended; consistent and an expansive network will create a more cohesive network throughout the GTHA and a more enjoyable user experience.

Table 6 outlines the opportunities for implementation and barriers for each BMP extracted from model cities within the context of the GTHA. Under the headings of Incentives, Infrastructure, Education, and Partnerships, BMPs are listed and analyzed. Checkmarks indicate whether each BMP is currently considered a viable option.

Table 6, Recommended GTHA BMPs

Best Management Practices	Analysis	Relevant Policy and Legislation	Opportunities	Applicability for GTHA Municipalities
Incentives				
General Public Subsidies	Municipal budgets within the GTHA are primarily earned through property and municipal purchase taxes, and many municipality budgets are overburdened (Côté & Fenn, 2014). Additional funding can be gained from private donors supporting environmental initiatives and from upper-tier government funding. However, as with Amsterdam, we believe these funds are more effective in reducing GHG emissions when targeted towards businesses. Comparatively, business vehicles tend to spend more time on the road than personal vehicles and are therefore considered the best recipient of these funds.	n/a	At this time in the current political structure, subsidies for resident purchases of EVs and home charging stations are not a viable option	✗
Business Subsidies	Business vehicle travel within the GTHA is a high contributor to GHG emissions. This includes delivery vans, trucks, and company cars. The model that Amsterdam used is an interesting take on the subsidy, where they track the mileage of the business vehicles and give a subsidy proportional to the number of kilometers travelled. They also put a cap on this monetary incentive to prevent it from getting out of hand. This would directly benefit the air quality of the municipality by encouraging EV adoption by local businesses. The funding would come from municipal taxes or from any private entities that have put forth money for environmental initiatives.	n/a	Subsidies for businesses could be a reasonable option for municipalities to consider. Beginning with applications for grants, municipalities within the GTHA should consider: budgeting for business purchase subsidies, emissions reductions credits, and/or tax breaks for businesses with EV vehicles that travel significant distances, per day, within their region with the grant money. Currently, the province provides subsidies for commercial vehicles, if municipalities choose to pursue this BMP, they will need to work with both provincial and NGO donors to gain funding.	✓
Free/ Discounted Toll Routes	The 407, and the attached highway 412, are currently the only 400-series roads for which tolls are collected. However, the contract for 407 Express Toll Route operation was awarded in 1998 to a private company. It is considered a Public-Private Partnership (PPP); in return for construction, maintenance, and operation of the highway, the toll funds are received by the private firm. This allows the GTHA municipalities no authority to discount these rates.	*Ontario Highway 407 Act, Ontario Highway Traffic Act and Ontario Municipal Act:* Toll Highway Regulations	The GTHA does not have municipally-owned and operated tolls route on which to provide this incentive. With the exploration of additional toll routes in the future (i.e. the now-discarded Don Valley toll in Toronto), this should be a potential best practice to consider down the line.	✗
Parking Fees	Small initiatives such as this one allow conventional vehicle drivers to see the perks that EV drivers receive in daily life and require relatively few adjustments to existing infrastructure.	*Ontario Highway Traffic Act*: Traffic By-Law	Parking fees are a more immediate practice that can take effect in the near future. Any parking spaces with chargers operated by the municipality should see a price drop for EVs. If the parking fees go towards municipal funding and cannot be reduced, the regular parking prices could be adjusted accordingly.	✓
Residential Parking Permit Priorities	Residents among the GTHA municipalities may require parking permits for street parking. Not all residences include private parking, especially within dense city centres where street parking is common.	*Planning Act:* Zoning By-Law	Providing priority to those who drive EVs within permit structures is an incentive that can easily be applicable to the GTHA and incorporated into municipal permit policy structures. Should a municipality not have the demand to use this practice as an incentive, discounted parking permits can also be considered.	✓

Table 6. Recommended GTHA BMPs

Best Management Practices	Analysis	Relevant Policy and Legislation	Opportunities	Applicability for GTHA Municipalities
Incentives				
Tow/Ticket	In order for parking signs to have authority, they must have consequences for not following them. While it is simple to install a sign saying a parking space is for EVs only, there will always be someone who tries to push the boundaries or question the authority behind it. Accessible parking spaces are an example of this logic, while these permits are distributed by Service Ontario, municipalities are the ones enforcing them and drivers avoid parking in these dedicated spots because they know they carry a hefty fine.	*Ontario Highway Traffic Act*: Traffic By-Law	Municipalities can use the same ticketing systems to ensure EV parking spots are not being taken advantage of by imposter conventional vehicles. The authority to ticket or tow these vehicles should be enforced by the appropriate authority within the municipality and carry a large enough fine to dissuade fossil fuel vehicle drivers from parking there.	✓
Carpool Lane Access	In Ontario, the HOV lane is managed by the Ontario Ministry of Transportation. GTHA municipalities do not have the authority to allow EV use of HOV lanes. The GTHA does experience high levels of rush hour commuters and associated traffic, which would make this practice an effective incentive if initiated.	*Ontario Highway 407 Act, Ontario Highway Traffic Act and Ontario Municipal Act:* High Occupancy Vehicle Lanes regulation	This is a practice that can be advocated for by municipalities within the municipal/ provincial conversation. .	✗
Low Emission Zone (LEZ)	There are challenges to consider when adopting this strategy, with the most pertinent issue being the alternative routes vehicles would take. A LEZ will be noticed by drivers for whom routes are now impacted and will create a conversation surrounding electric mobility.	*Municipal Act, Planning Act*: Mobile Licensing By-Law and Zoning By-Law	Implementing a LEZ in the busy core of downtown areas is an option for municipalities with high vehicle emissions. The LEZ does not have to cover a large district, even a section of a main street would be enough to improve the air quality of the area while sending a message to drivers that the future of the region is electric. This is a practice that has not previously been done in Canada and would require a feasibility study to determinate where the appropriate jurisdiction/ authority lies.	✓
Infrastructure				
City Property Charging Stations	Leading by example, increased implementation of city charging stations will create the foundation for charging infrastructure networks across the GTHA and encourage purchase. Many drivers residing within the GTHA often commute to other areas, having recognizable structures and City locations will encourage use.	*Ontario Building Code Act, Ontario Electrical Code Act*: Building Permit By-Law	EV charging stations on city property are highly recommended for use in the GTHA. While there is already existing charging infrastructure within some GTHA municipalities, availability should be expanded. While each municipality should be responsible for determining the fee structure associated with their public charging units, it is recommended that across the GTHA charging stations and individual units follow a similar design structure and be clearly marked	✓

Table 6. Recommended GTHA BMPs

Best Management Practices	Analysis	Relevant Policy and Legislation	Opportunities	Applicability for GTHA Municipalities
Infrastructure				
Network of Chargers	Creating a dense network of chargers operated beyond city properties increases EV accessibility and reduced fear of battery range issues, having a unified network of chargers allows users to have an enjoyable experience when charging their EVs. Travel across the GTHA is common, residents of one municipality may frequently visit and require charging in another municipality nearby. In the future, municipalities can look into encouraging a private market for charging which would expand the network.	*Ontario Building Code Act, Ontario Electrical Code Act*: Building Permit By-Law	Each municipality strategically plans where chargers are being placed and encourage businesses in optimal locations to install chargers. Heavily trafficked corridors should be considered first. The availability of chargers at each location and the distance between chargers is an important piece of information that municipalities can investigate and manage. While unifying the chargers in the municipality is a great first step, it can be expanded to the surrounding municipalities to keep charging stations consistent throughout the GTHA as much as possible.	✓
City Fleet Conversion	City fleets are common sights within municipalities and they dedication they demonstrate will encourage purchases. Fleets will need to be replaced in the coming years; these replacements should be made electric. Setting an annual target will create accountability.	*Municipal Act:* Mobile Licensing By-Law	It is strongly urged that the municipalities of the GTHA begin the transition to EV fleets, if they have not already begun to do so. It is recommended that a minimum of 3% of the municipal fleet is transitioned annually to EVs.	✓
Streetlights	Streetlight charging is an innovative way to allow EV charging without the added infrastructure. Municipalities such as Mississauga are currently converting their streetlight from fluorescent to LED bulbs to save on energy costs. This means there will be less of a demand on the energy grid from these lights and could support EV charging, similar to what Portland is considering.	*Planning Act, Ontario Electrical Code Act*: Streets and Sidewalks By-Law	Explore this solution further as a viable technology. Contract a company to retrofit existing streetlights to include chargers or a company to install charging stations onto the streetlight poles that are already connected to the grid.	✓
Residential Construction and Upgrades	GTHA is an in-demand housing market, with suburb neighbourhoods expanding at astounding rates (Dunn, 2016). Requiring all new homes to allow for EV chargers will remove accessibility barriers from spread out communities. Coinciding with the demand to live within the GTHA is the upwards moving density of its urban centres; the rate at which Multi-unit Residential Buildings (MURBs) such as downtown condominiums are being built is increasing at an alarming rate (Gray & Sopinski, 2017). However, current jurisdiction of MURBs falls to the *Ontario Condominium Act* (Lee-Shanok, 2017), which as of January 1, 2018, requires all new MURB construction to provide 20% of parking stalls with EV chargers and the remainder stalls to have conduits present for future installation.	*Ontario Building Code Act, Planning Act*: Zoning By-Law	Ontario Regulation 332/12: Building Code (Appendix C) requires, as of January 1, 2018, that surrounding one- and two family homes requires new constructions to have the electrical capacity to support charging infrastructure. It is recommended that municipalities build off of this new policy and require new constructions also provide informational pamphlets and stickers informing owners of the EV potential of their home. The training of building inspectors to facilitate compliance and education for contractors could assist with this BMP. It is recommended that, although not directly under municipal jurisdiction, municipalities work with the Province to advocate for, or request the authority for, allowing for municipal by-laws to require all MURBs (new and old) provide an increase above the provincially required 20% of parking stalls equipped with Level 2 charging capacity.	✓ ✗

Table 6. Recommended GTHA BMPs

Best Management Practices	Analysis	Relevant Policy and Legislation	Opportunities	Applicability for GTHA Municipalities
Infrastructure				
Portable Chargers	Portable chargers are a viable solution for businesses or communities who have not invested in permanent chargers but still want to participate in the EV movement. Municipalities could suggest these to community members seeking solutions to charging woes or to businesses that do not have the capacity to install a charger. The municipality supporting this technology showcases the innovative solutions that are available and calms the range anxiety of potential EV drivers.	*Planning Act:* Zoning By-Law	The municipality can offer portable charging services in the future at large events or other gatherings that attract a high concentration of EV drivers.	✓
Working Group	Creating a working group specific to each municipality would greatly benefit the entire GTHA as these groups keep the municipalities accountable and assist in keeping up to date on current EV news and technology relevant to that particular area. The ease or difficulty of this practice depends on the ability to recruit dedicated members to the working groups. A working group is a beneficial tool to unite passionate members of their community.	n/a	Municipalities should create an EV working group specific to their community- focus on the municipalities resources, needs, and climate goals in reference to EV adoption.	✓
Education				
Consistent and Thorough Signage	This will require communication between municipalities to ensure similarities and reduce levels of confusion when EV drivers travel throughout the GTHA. It is important that this signage also includes information about regional incentives and infrastructure availability. The region would benefit from standardization across the GTHA as a whole.	*Highway Traffic Act*: Traffic By-Law	Standardized educational signage is recommended for charging stations within municipalities.	✓
Technical Assistance	While not in the developed stages of EV adoption strategies, technical assistance hotlines are not priority. Municipalities should focus on providing the incentives, infrastructure, and other educational tools. A 24/7 hotline requires resources, man hours and training that are currently not available within most municipal workforces.	n/a	It is recommended that municipalities focus on implementing the foundational strategies and initiatives for EV education and outreach before moving forward with a 24/7 technical assistance line. A future alternative route suggests that municipal contracts are given preference to privately operated EV charging companies which provide a technical assistance phone number at their charging stations.	✗
Outreach	EV outreach is an opportunity for the municipalities to show the community the benefits and capabilities of EVs, demonstrating the potential for successful EV cities. The employees who are dedicated to, knowledgeable, and passionate about EVs should be the ones at the front lines of community events educating the public and correcting any misconceptions.	n/a	It is recommended that each municipality should have employees who are well-versed in EV technology and policy and are able to handle even the toughest questions from community members. Municipalities should support any EV showcases or events happening in the community.	✓
Partnerships				
Car-Share Programs	Car-sharing programs are popular in urban, densely populated areas (Metro Vancouver, 2014). In the GTHA, businesses such as Car2Go and ZipCar can be partnered with to expand their reach and encourage smart transportation choices.	n/a	Municipalities with demand for car-sharing programs can provide incentives to these businesses and work in partnership to encourage EV use and educate the public.	✓

Table 6. Recommended GTHA BMPs

Best Management Practices	Analysis	Relevant Policy and Legislation	Opportunities	Applicability for GTHA Municipalities
Partnerships				
Taxis/ Ride-Share Programs	Taxis are a major source of emissions within municipalities and are a major starting point for creating relationships and encouraging a switch to EVs. Municipalities of the GTHA vary in taxi use, however, taxi cabs are often on the road for hours at a time when in use. London, UK was able to secure enough government grants to fund a fleet of electric taxis for a pilot project- a proposal for similar funding can be made for GTHA municipalities.	*Municipal Act:* Mobile Licensing By-Law	Municipality business incentive programs should be advertised to local taxi companies to encourage the switch. Partnerships with EV fleet taxi companies can encourage the transition. Drivers who have been operating an EV for Uber should also be eligible to receive subsidies. Restrictions for eligibility based on number of trips made for Uber and proof of ownership will prevent drivers from taking advantage of the system.	✓
Contract Preference	Contracts for municipalities are economically and reputationally valuable for local businesses. Municipalities within the GTHA are often able to choose amongst many business opportunities, fueling competition between potential contractors. The high population and close proximity of municipalities in the GTHA provides choices for municipalities, allowing for such preferences to be made without sacrificing quality of work.	n/a	Municipal purchasing policy outlining preferences for contractors using an electric fleet will encourage business fleet transitions.	✓
Additional Opportunities				
Report Cards	Report cards are useful tools for accountability and motivation. While a municipality cannot create their own report card and judge themselves independently or comparatively to other cities, a coalition of municipalities can hire an independent auditor to create the document. The report card can be used as an educational tool for both the individual municipalities as well as the public. Key performance indicators can include: existing EV policies and policy opportunities, infrastructure and EV numbers, energy source (how "clean" is the energy powering the municipality's EVs?), and the availability of incentives and opportunity to implement new infrastructure and pilot projects (Axsen, Goldberg, & Melton, 2016; Salisbury, 2014). Competition is common between municipalities, Denver used this to its advantage when participating in an EV report card done by the Southwest Energy Efficiency Project (SWEEP) to compare neighbouring states (Salisbury, 2014). This served many purposes including quantifying the successes related to EVs and providing a platform for municipalities to easily see what their neighbours had been completing and to adapt their own strategies.	n/a	The GTHA includes many municipalities, presenting an opportunity to create an EV Coalition and an agreement to a report card system. This keeps the municipalities accountable to their goals, showcases the effort and success to the public, and can lead to further EV cooperation and cohesion within the GTHA.	✓
Mobile App: An Educational Tool	A consolidation of educational and interactive tools on a mobile application would provide EV users with an accessible and user-friendly interface. Available on all smartphones and tablets, the app would contain: ➢ Location ➢ Type of chargers ➢ Price ➢ Electricity Peak Times ➢ Log of kilometers charged and associated GHG emissions saved ➢ User reviews and comments ➢ Available Incentives for EV use and purchase (parking spaces, HOV lanes, subsidies, etc)	n/a	This would be best enacted as a joint venture across municipalities of the GTHA, perhaps developed by a coalition and partnership with Working Groups that have been previously recommended; consistent and an expansive network will create a more cohesive network throughout the GTHA and a more enjoyable user experience.	✓

5.2 Barriers to EV Implementation

The major barriers to EV adoption include price of EVs and charging stations, range anxiety, and lack of EV awareness (Plug' N Drive, 2017). These are discussed in this section along with the initiatives and the conversations that must be had to overcome these barriers.

Premium Price

The cost of purchasing an EV is one of the major reasons why conventional car users do not choose to purchase electric options; one percent of respondents in a survey by Plug 'N Drive (2017) think that EVs are too expensive. Mid-range EVs cost 90% more compared to conventional vehicles. According to the survey, conventional car owners are willing to spend an average $25,000 on a new car, however, the average cost for an EV is $40,000. The Electric Vehicle Incentive Program (EVIP) can rebate $5,000 to $14,000 for an EV purchase (MTO, 2018), which is inadequate for filling the price gap between conventional vehicles and EVs. Installation and purchase of level 2 EV chargers are more access costs for EV owners. EV chargers available in Canada range from $1700 to $2700 (Plug' N Drive, 2017). Although Electric Vehicle Charger Ontario (EVCO) can rebate 50% of the purchase price of the charging station up to $500, this is still a high upfront cost. While EVHIP and EVCO can encourage EV adoption, rebate incentives may be insufficient to aid EV purchasing for some buyers.

Range Anxiety

Range anxiety, concerning EVs running out of charge and having limited stations available to charge EVs conveniently, is a factor impacting EV adoption. The range of EVs and the inconvenience of charging them is the second most cited reason why consumers choose gas vehicles instead of EVs (Plug' N Drive, 2017). Drivers who are more accustomed to conventional gasoline-powered vehicles worry that EVs will have insufficient range for travel. The range of EVs after a full charge is greater than 200 km, offering a sufficient range for the average daily commute of approx. 37 km in the GTHA (Plug' N Drive, 2017). It is estimated that average Canadian drivers only needs to charge once per week if the range of EVs is about 200 km (Plug' N Drive, 2017). In addition, implemented by MTO, EVCO is constructing public EV charging stations within cities and building network for public charging stations (CCAP, 2017). While this is true, the majority of charging stations are arranged within largely populated cities, such as Toronto and Hamilton, making it inconvenient for EV owners to commute between cities if there are not enough charging stations along highways. Investing and constructing charging stations within cities can reduce the range anxiety of EV owners, but insufficient charging stations between cities is still a concern.

Lack of Awareness

The lack of public awareness on EV policies and incentives results in the slow pace of EV adoption. The Plug 'N Drive survey shows poor knowledge of EVs and the opinion that EVs are an underdeveloped technology (Plug' N Drive, 2017). About 60% of respondents stated that they know nothing about EVs and the incentives program for purchasing them, while 70% said they know nothing about incentive programs for charging stations (Plug' N Drive, 2017). Approximately one third of gasoline-powered vehicle owners believe that EVs cannot help reducing GHG emissions (Plug' N Drive, 2017). The relationship between climate change and EVs needs to be clarified. The channel for the public to learn about EVs is relatively limited. The Ontario Government has implemented educational events for EVs and EV incentives. Based on the results of the survey, these programs need to be more effectively promoted or refined to increase awareness to the public about EVs.

5.3 Overcoming Barriers

Barriers that have been discussed previously can be overcome by implementing purchasing incentives, charging stations, and education programs. However, there are actions that need to be considered at the municipal level to complement the existing provincial programs.

Creating Timelines, Milestones and Progress Updates

Creating timelines and milestones of municipal action plans and frequent progress updates can help accelerate the implementation of EV BMP opportunities in the GTHA. Creating timelines helps push forward EV adoption for municipalities, while milestones can clarify important steps when promoting projects. Timelines and milestones are specified in the *NYC Clean Fleet Sustainability Plan* (2016) as beneficial tools. In the short- term, New York City's goal is to increase the city fleet of EVs sedans to 2000 vehicles by 2025. The municipal fleet will have 1,000 EV sedans by the end of July 2017, halfway toward the Clean Fleet goal. Currently, NYC fleet operates over 1224 on-road EVs (NYC Citywide Administrative Service, 2018). Publishing these timelines and milestones accessible to the public can keep municipalities accountable and is an important lesson from the GTHA can gain value.

Additionally, the frequency of progress updates should be clarified and published in a municipality's action plan. Frequent progress updates of EV adoption project is another way the public can push for EV adoption in municipalities. Take Ontario EV sales targets for 2020 as an example, where analysts believe that there is a zero percent chance in achieving the target due to a lack of increasing EV sales, based on 2016 data (Jones, 2017). Data for 2017 still has not been updated, and without the update, the public might lack confidence in investing in EVs. Progress updates provide benefit to the public by increasing accountability in the project and helping municipal governments move forward.

Encouraging Off-peak Charging

With the development of EV adoption projects, increasing EV charging stations will cause a heavier load on electricity supply. For Ontario, total electricity generation capacity is much higher than current power generation (IESO, 2017). Enough electricity can be produced to meet the need of EVs, but grid capacity is unknown (EMC, 2009). Although electricity supply is under provincial jurisdiction, this directly affects EV adoption and should to be considered in municipality planning for successful EV uptake.

When municipalities implement incentive programs for charging stations, EV purchasing, or projects related to BMPs, methods for encouraging EV owners to charge at off-peak periods need to be considered. If EV owners charge their vehicles at the same time or during the peak period of electricity usage, grid capacity might not be able to carry this load, and power supply could become insufficient for other users. Through awarding cheaper electricity rates for people charging between 12pm and 8am, Fleet Camera NYC reduces the load on the electricity grid from charging EVs. Similarly, to encourage EV owners to charge at the off-peak time, charging incentive programs can be implemented, such as free or relatively low charging rates during the off-peak time period. Furthermore, EV adoption strategies should discuss how to reduce the impact of increasing charging stations and EVs on electricity supply in multi-family homes.

5.4 Policy Consolidation

Legislation is used to direct the functions of each municipality, and it can play a key role in accelerating the implementation of electric mobility strategies in the GTHA. Municipal by-laws governed by provincial legislation encourage change or specific action within a municipality. A consolidation of municipal policies highlights crucial by-laws such as property standards by-laws, building permit by-laws, zoning by-laws, mobile licensing by-laws, business licensing by-laws, and traffic by-laws that affect the implementation of EV BMPs in the GTHA. Possible amendments to these by-laws can be made to normalize EV mobility in the municipal policy context.

Through an in-depth analysis of municipal policies in the GTHA, a policy checklist was created, comprising of relevant by-laws and legislation related to EVs. These policies are important to note as by-laws can directly impact the implementation of suggested BMPs and may need to be altered and/or amended to successfully integrate EVs into the municipalities. Lastly, an action plan with the first steps necessary for accelerated integration is outlined.

The policy checklist provides an overview of focus areas for municipalities taking steps toward EV-adoption. Using current bylaws as a launch pad, this checklist can be modified or adapted to generate region-specific initiatives that facilitate successful execution and implementation of programming.

Each municipality has its own set of specific by-laws that can impact EV adoption and are guided by overarching provincial regulations. By-laws can have differing terminology depending on the governing body, however, they address the same policy concerns and can be classified under the same type of by-law in municipalities across the GTHA. For example, mobile licensing by-laws are synonymous with public vehicle by-laws and taxi bylaws.

5.4.1 Significant Policies Pertaining to EV Uptake

The below sections are recommendations for areas in which municipalities are either lacking municipal by-laws and provincial legislation, can alter or amend existing by-laws, and/or should examine its existing by-law structure for more effective EV implementation, enforcement, and regulation. Furthermore, specific by-laws and regulations are highlighted in green boxes below. Not all recommendations will apply to every municipality; these are intended to guide municipalities towards impactful policy areas. For example, cities with smaller populations such King, and Uxbridge, that have more individual drivers in comparison to transit users can use these recommendations to encourage EV transportation.

Building and Development Standards

In this section, by-laws such as Property Standards by-laws and Building Permit by-laws under the *Building Code Act* and the *Electrical Code Act* are analyzed to indicate areas of legislation that will be impacted by EV implementation in the GTHA.

The *Building Code Act* is provincial legislation that outlines any rules regarding construction, demolition, change of use, occupancy, transfer of permits, and inspections of any buildings (*Building Code Act*, 1992). Specifically, the Electric Vehicle Charging guideline, within the *Building Code Act*, outlines standards and enforcement for electric vehicle charging infrastructure (*Building Code Act*, 1992).

The *Building Code Act* gives municipalities jurisdiction over the enforcement of standards outlined for each specific municipality. The council of each municipality must appoint a chief building official that is responsible for enforcing regulations under the *Building Code Act*.

The *Electricity Act* is responsible for planning and management of electricity, as well as for supply and demand of electricity resources; this *Act* ensures the safety, adequacy, and reliability of electricity supply in Ontario. It further promotes the use of clean energy sources, using the electricity efficiently and encouraging electricity conservation; furthermore, it safeguards the rights of consumers through appropriate electricity prices and quality of service (*Electricity Act*, 1998).

Property Standards By-Laws

In this section, the use of 'Property Standards By-Laws' will be observed. Note that in the GTHA, municipalities may refer to 'Property Standards By-Laws' as 'Minimum Maintenance Standards By-Laws'; these by-laws are synonymous to 'Property Standards By-Laws'.

The Property Standards by-laws prescribe the maintenance and occupancy of properties under the *Building Code Act* and the *Electrical Code Act* (City of Vaughan, 2011). Property Standards by-laws require the site on which a property is constructed to be repaired and maintained within these standards; buildings, signs, structures, debris, and refuse related to each property are affected (City of Vaughan, 2011). Failure of different properties to meet these standards result in the removal of the structures on the site. It is important for municipalities to recognize the importance of Property Standards by-laws in effective EV strategies, and to adjust accordingly.

Example 1. Electrical Systems

In accordance with the *Electricity Act*, Property Standards by-laws require all buildings to be connected and wired to an appropriate electrical supply system, and should be maintained in good working order (City of Brampton, 2016). This constitutes an adequate capacity of electrical supply to the building at all times which ensures the ability to perform appropriate functions in the building, in a safe and hazard-free environment. These standards are required to meet

compliance with the Ontario Electrical Safety Code under the *Electricity Act* (*Electricity Act*, 1998).

As a suggested BMP in 4.2.2: Infrastructure-based BMP, adding EV charging infrastructure or portable charging units to buildings will affect the overall electricity demand of the structure. Altering current municipal property standards by-laws to outline electrical capacities specific to EV technology will aid future inspections and enforcement of any future installations specific to EV infrastructure. This aligns with the new standards set out in the *Electricity Act* and Ontario Building Code. As of January 1st, 2018, in accordance with Ontario Building Code, under the *Building Code Act*, EV charging infrastructure is to be added to new building developments resultantly affecting the electrical distribution systems within these buildings (*Building Code Act*, 1992).

Furthermore, EV infrastructure capacities built into buildings must meet demands in order to function as appropriate charging infrastructure for consumers. With regards to EV chargers, level 1 EV chargers use 110 V and take about 8-20 hours to fully charge; they can be plugged into standard outlets at workplaces and households. Level 2 chargers are faster at 240 V, and can charge an electric vehicle from 0 percent to 100 percent in four to six hours (Ministry of Transportation Ontario, 2013). This outlet can be compared to a clothes dryer plug. The fastest charger, level 3 at 480 V, only takes about an hour to fully charge (Ministry of Transportation Ontario, 2013). Meeting these minimum electricity capacities in regard to chargers for EV charging infrastructure in new building developments must be explored further.
The Electrical Distribution Safety Code under the *Electricity Act* recommends regulations specific safety standards for installations of technology using 750 V or less. As a result, municipalities must reassess property standards by-laws to include appropriate charging capacities necessary for potential added EV charging technology to comply with the Electrical Distribution Safety Code (*Electricity Act*, 1998).

Streets and Sidewalk By-laws

In this section, Streets and Sidewalks by-laws, also referred to as ‘Streetlight and Electrical Standards’ under the *Planning Ac*t and *Electrical Code Act*, are analyzed. The Streetlight and Sidewalk by-laws outline regulations regarding sidewalk maintenance, lighting and street furniture construction, and special engineering or architectural features.

Example 1. Streetlight Charging Integration

In accordance with the *Electricity Act* and *Planning Act,* Streetlight and Electrical Standards require all buildings to be connected and wired to an appropriate electrical supply system, and should be maintained in good working order (City of Brampton, 2016). This constitutes an adequate capacity of electrical supply to the building at all times which ensures the ability to perform appropriate functions in the building, in a safe and hazard-free environment (*Planning Act*, 1990). These standards are required to meet compliance with the Ontario Electrical Safety Code under the *Ontario Electricity Act*.

As a suggested BMP in Section 4.2.2: Infrastructure-based BMP, listed under 'Streetlight Charging Integration', streets and Sidewalks by-laws enforce the connection of electrical systems on properties (*Planning Act*, 1990). This applies to streetlight charging integration as these potential charging outlets will need to connect to the electrical systems in streetlights. Possible construction and maintenance may occur, and the Streetlight and Electrical Standards must be adhered to.

Building Permit By-laws

Building permit by-laws, which fall under the *Building Code Act*, enforce the provision of permits required for any physical changes to structures in a municipality. This requires an application process that involves submitting complete work plans, materials used in construction, names of certified contractors, and zoning information to ensure that potential building plans are safe, structurally sound and adhere to the provincial standards outlined in the *Building Code Act* (*Building Code Act*, 1992).

Example 1. Expanding EV Charging Network

In accordance with the *Building Code Act*, Building Permit by-laws require an adequate application system to receive permits to build or perform any activity regarding structure within a municipality to ensure a safe and hazard-free environment. This application process and application requirements are representative of the standards outlined in the *Building Code Act* (*Building Code Act*, 1992).

As a suggested BMP in 4.2.2: Infrastructure-based BMP, the expansion of EV charging infrastructure in residential areas and businesses will require building permits to enable the construction of this technology. For this BMP to be feasible, the application process to receive a building permit must include work plans and proof of EV charging infrastructure as an application requirement, further adhering to the *Building Code Act*. One such standard is the requirement of designating at least 20% of parking spaces with electric vehicle supply equipment in a building (*Building Code Act*, 1992). If these application criteria referencing EV technologies and processes are not included in the building permit by-laws, proper enforcement of building construction and activity is unclear.

Zoning

In this section, by-laws such as Zoning by-laws, which fall under the *Planning Act,* are analyzed to indicate areas of legislation that will be impacted by EV implementation in the GTHA. The *Planning Act* is provincial legislation that outlines rules to regulate and enforce land use planning systems and create planning processes that are open, accessible, and efficient (*Planning Act*, 1990).

Under the *Planning Act*, the Minister of Municipal Affairs and Housing has the authority to delegate his or her powers to a municipality council who, in turn, is authorized to enforce any official regulations and standards that fall under this *Act* such as Zoning by-laws (*Planning Act*, 1990).

Zoning By-Laws

Zoning by-laws allow for different land uses through assigning each zone of land to different municipalities for various purposes under the *Planning Act*. For example, different land uses include residential, commercial, industrial, and open space (City of Brampton, 2016). By-laws for each land use contain the regulations associated with location, scale, and nature of the land (City of Brampton, 2016). Furthermore, zoning by-laws can prohibit the use of land for specific purposes or within a defined area, such as an area designated for highways, within a municipality; they can restrict the erection, location, and use of structures or buildings (*Planning Act*, 1990). Municipal zoning by-laws must be adjusted to include EV strategies and to ensure the enforcement of zoned areas.

Example 1. Low Emission Zones

Restructuring zoning by-laws and categories of land use within a municipality will integrate EV infrastructure in the GTHA. As suggested in Section 4.2.1: Incentive-based BMP, BMP regarding LEZ in which only vehicles meeting strict emission standards are permitted entry. For specific municipalities within the GTHA, to incorporate designated LEZ, current zoning bylaws may require restructuring and the addition of amendments to include the concept of environmental zones, as they are not currently considered a zoning category (City of Vaughan, 2011).

In Ontario today, LEZ have not been implemented; both provincial legislation and municipal by-laws have not explored LEZ and what they could look like in Ontario. Since this is a new area to examine, both for different levels of government and for public scrutiny, it is impossible to comment on the status of LEZ at this time. However, through the *Municipal Act*, municipalities have the authority to undertake projects and initiatives, which are eventually codified through by-laws and regulations, that are directly related to combating climate change. Thus, as demonstrated in the BMP implementing LEZ, as mentioned in Section 4.2.1: Incentive-based BMP, this is a promising strategy that can be explored further by municipalities in the GTHA.

Example 2. Parking Incentives

For BMP regarding parking incentives, referenced in Section 4.2.1: Incentive-based BMP**,** to be successful for residential, commercial, industrial, and open spaces, zoning by-laws under the *Planning Act* must be altered to include new areas specific to EVs. Without clear depiction and inclusion of EV areas, EV users cannot properly utilize these programs; likewise, enforcement officers cannot properly enforce and regulate these programs without specific by-laws in place. Restructuring zoning areas allows for a specific outline of which areas are of value and are legal for EV owners to use. Similarly, these first zoning steps are the basis for creating a specific application process for EV users to receive these incentives in the future. Without an area zoned for incentives, referenced in Section 4.2.1: Incentive-based BMP, it is unclear which areas are legally viable zones that are permitted occupancy for EV users.

Moreover, as further illustrated under BMP Section 4.2.1: Incentive-based BMP, parking spaces are in high demand. Part of reviewing zoning by-laws includes adjusting the number of spaces dedicated to EVs, which grants priority to EV users. The number of allowed parking spaces and parking permits issued must be altered so that EV users can easily access both the permits (through an efficient process), and the parking spaces dedicated to EVs (through sufficient and accessible parking spaces). Zoning by-laws focusing on these two principles shown to be successful through BMPs in Section 4.2.1: Incentive-based BMP must be reviewed for EV parking and permit feasibility.

Example 3. Accessory Structures

Accessory structures are defined as extra buildings on residential property, including but not limited to sheds, garages, gazebos, *etcetera*. (City of Brampton, 2016). Regulations on accessory structures fall under the jurisdiction of zoning by-laws; these are in place to regulate safety protocols for residents and ensure building code standards are upheld (*Planning Act*, 1990). As referenced in Section 4.2.2: Infrastructure-based BMP, with the use of residential construction and upgrades to increase charging infrastructure on residential properties, changes must be made to criteria regarding accessory structures. Zoning by-laws must consider charging stations and EV infrastructure as an accessory structure.

Business Development Guidelines

In this section, by-laws such as the Mobile Licensing by-law and Business Licensing by-law fall under the *Municipal Act* and are analyzed to indicate areas of legislation that will be impacted by EV implementation in the GTHA.

The *Municipal Act* is a provincial statute that governs the administration, creation, and management of municipalities in Ontario, excluding Toronto (*Municipal Act*, 2001). This *Act* gives municipalities the ability to create and enforce by-laws in a range of municipal sectors, including economic development services, business licensing, and social and environmental well-being of the municipality (*Municipal Act*, 2001).

The *Municipal Act* specifically allows municipalities to impose specific conditions on businesses as a requirement of obtaining, renewing and continuing to hold a licence. Therefore, under this *Act,* municipalities can provide, limit, or refuse the issuance of licences to businesses if standards issued under this *Act* are not met and adhered to (*Municipal Act*, 2001). It is important to note that under this *Act*, municipalities have the jurisdiction to pass by-laws related to economic, social, and environmental development with respect to climate change initiatives.

Mobile Licensing By-Law

In this section, the use of 'Mobile Licensing By-Law' will be observed. Note that the GTHA municipalities may refer to 'Mobile Licensing By-Law' as 'Public Vehicle By-Laws', or 'Taxi By-Laws.

In accordance with the *Municipal Act*, the mobile licensing by-law allows municipalities to administer licenses and regulate businesses that are wholly or partially carried out while mobile (*Municipal Act*, 2001). This consists of taxi cabs, taxi brokerages, or any vehicle offering a service on behalf of the business. These by-laws regulate licenses that determine which mobile businesses require an operating license (City of Brampton, 2004). When issuing these licenses, the strict regulations under the mobile licensing by-laws are considered to ensure that vehicle owners and drivers are issued and renewed business licenses. Municipal mobile licensing by-laws must be adjusted to include elements of EV strategies to ensure the enforcement and regulation of mobile business permits, licenses and operations.

Example 1. Low Emission Zones

In accordance with the *Municipal Act,* Mobile Licensing by-laws govern the distribution and issuance of mobile business permits within a municipality. In reference to the suggested BMP discussing LEZ mentioned in Section 4.2.1: Incentive-based BMP, mobile licensing by-laws must be altered. In the suggested BMP on LEZ, only low emission vehicles are permitted access. As a result, if this BMP were to be implemented, requirements to receive a permit under this by-law must align with the regulations regarding access to LEZ. Mobile Licensing by-laws, under the *Municipal Act,* do not encompass criteria specific to LEZ and businesses that qualify to operate in these spaces. An amendment to include the restrictions of LEZ to the mobile licensing by-law

creates a new standard to operate by, properly outlining which mobile businesses are able to operate in these new zones.

Currently within Ontario, provincial legislation and municipal by-laws have not approached implementing and enforcing the use of LEZ. The use of this BMP within Canada has not been tested before. As a result, it is unclear which level of government will hold jurisdiction over the regulation and enforcement of LEZ at this time. It is important to note that under the *Municipal Act*, municipalities have the jurisdiction to pass by-laws related to economic, social, and environmental development such as LEZ, if it pertains to the combatting of climate change.

In accordance with the *Municipal Act*, the mobile licensing by-law allows municipalities to administer licenses and regulate businesses that are wholly or partially carried out while mobile (City of Brampton, 2004). This consists of taxi cabs, taxi brokerages, or any vehicle offering a service on behalf of the business. These by-laws regulate licenses that determine which mobile businesses require an operating license (City of Brampton, 2004). When issuing these licenses, the strict regulations under the mobile licensing by-laws are considered to ensure that vehicle owners and drivers are issued and renewed business licenses (City of Brampton, 2004). Municipal mobile licensing by-laws must be adjusted to include elements of EV strategies to ensure the enforcement and regulation of mobile business permits, licences and operations.

Business Licensing By-Law

In accordance with the *Municipal Act,* the business licensing by-law authorizes municipalities to administer a system for licensing, regulating and governing stationary (*Municipal Act*, 2001). Specifically, under this by-law, municipalities are able to refuse granting licenses, impose specific conditions to obtain and renew licenses as well as impose conditions to continue holding a business license over a period of time (*Municipal Act*, 2001). This ensures that businesses are conducted in a manner that will not adversely affect the health and safety of persons associated with the business, including consumer protection and nuisance control (City of Brampton, 2013). Furthermore, this by-law specifies that any actions undertaken by stationary businesses must not result in illness, hazardous conditions, loss, or injury (City of Brampton, 2013).

Example 1. City Contract - EV Preferences

In accordance with the *Municipal Act,* Business Licensing by-laws allow municipalities to administer specific guidelines to regulate and govern the distribution of business licences within a city. In reference to the suggested BMP discussing EV preferences for city contracts, mentioned in Section 4.2.4: Incentive-based BMP**,** business licensing by-laws must be altered. Municipalities that decide to implement this suggested BMP for business contracts within a city will offer preference to businesses operating with electric fleets.

As a result, if this BMP were to be implemented in cities within the GTHA, requirements outlined in the application to receive a business licence, under this by-law, must change to specify the preference for businesses operating with EV fleets. Business Licensing by-laws, under the *Municipal Act,* do not currently indicate an EV preference for business contracts within a city.

Therefore, for this BMP to be feasible, specification of this preference in the application process for business licences regulated by the business licensing by-law must occur. By doing this, businesses that are pursuing contracts with cities implementing this BMP are aware of this preference, and this will largely affect the distribution and application process for business licences. This adjustment of the by-law, will also aid the enforcement, regulation, and distribution of business permits and operations in cities that implement this BMP.

Example 2. Low Emission Zones

Similarly, as referenced in Section 4.2.1: Incentive-based BMP, implementing LEZ will affect and require a change in the type of vehicles that have access to this zone. Thus, the issuance of business permits, under the business licensing by-laws, must indicate this restriction in the permit application process. This ensures businesses operating within LEZ adhere to the required low emission standards. Interactions with businesses operating outside of the LEZ must be observed, such as whether the business' fleets adhere to LEZ requirements.

Transport Infrastructure

In this section, the by-laws, such as Traffic by-law, and regulations such as *High Occupancy Vehicle Lanes,* that fall under the *Highway Traffic Act* are analyzed to indicate areas of legislation that will be impacted by EV implementation in the GTHA.

The *Highway Traffic Act* is a provincial statute that governs the administration and licensing of vehicles, enforcement and classification of traffic offences and regulates any related transport issues within Ontario (*Highway Traffic Act*, 1990). Specifically, this *Act* classifies parking areas and designates highway lanes for particular purposes. In particular, the Highway Traffic Act specifies lanes designated for specific purposes, such as high occupancy lanes or toll lanes and can limit access to these lanes (*Highway Traffic Act*, 1990). This *Act* issues criteria necessary to enforce provincial regulations and by-laws in a range of municipal sectors.

The *Municipal Act* specifically allows municipalities to enforce specific conditions on regarding traffic and parking issues. Therefore, under this *Act,* municipalities are able to provide, limit, or refuse the issuance of licenses to drivers if standards issued under this *Act* are not met and adhered to (*Municipal Act*, 2001). This *Act* can grant municipalities power to maintain and operate toll highways as well as enforce and collect tolls that are imposed.

The *Highway 407 Act,* is a provincial statute that outlines the enforcement criteria and regulation of toll highways in Ontario (*Highway 407 Act*, 1998). Specifically, this *Act* depicts tools necessary for collecting tolls as well as outlining who is exempt from payment of these toll routes.

Toll Highway Regulations

The *Ontario Highway 407 Act*, *Ontario Highway Traffic Act* and *Ontario Municipal Act* all control and regulate the maintenance and enforcement of toll highways. These provincial acts outline the process involved in regulating payment of toll highway usage, as well as criteria and conditions for usage and exemption of payment for these highways. Regulations under acts specify who is responsible when using and maintaining these highways, as well as indicating the authority each municipality has over these highways.

Example 1. EV Road Incentives

In accordance with the *Municipal Act*, *Highway Traffic Act* and *Highway 407 Act*, Toll Highway Regulations designate toll highways in Ontario and regulate the usage and payment for these highways (*Highway Traffic Act*, 1990). Specifically, these regulations outline the size accommodation of these highways and permit allowances and payment exceptions. In reference to the suggested BMP discussing discounted toll routes for EV mentioned in Section 4.2.1: Incentive-based BMP**,** Toll Highway Regulations must be altered. Municipalities that decide to implement this suggested BMP for toll highways will offer discounted access fees for EV drivers that wish to use toll highways.

If this BMP were to be implemented through cities within the GTHA, requirements and restrictions outlined under these regulations must change to specify that EV vehicles will receive these discounts when entering these highways. Toll highway regulations, under the *Municipal Act*, *Highway Traffic Act* and *Highway 407 Act,* do not currently permit discounted toll fees for EV drivers (*Highway Traffic Act*, 1990). For this BMP to be feasible, indication of this incentive in the provincial regulation must occur. Specifically, under these regulations, specific signage specifying toll discounts for EV users must be conveyed in every city these highways are part of. Similarly, toll device systems regulated by these acts, must be updated to include these discounted fees. By doing this, enforcement and restriction of these areas are clear and EV drivers are able to utilize these spaces without receiving penalties or complications from enforcement officials.

High Occupancy Vehicle Lanes Regulation

The *High Occupancy Vehicles Lanes* regulation (O. Reg. 620/05), under the *Highway Traffic Act*, is a provincial regulation that designates areas of the highway exclusively for the use of carpooling vehicles, specifically with two or more persons in the vehicle (*Highway Traffic Act*, 1990). HOV lanes are indicated by white markings such as painted white diamonds placed periodically along the length of the lane, as well as white markings indicating buffer zones where vehicles may enter and exit the lane (*Highway Traffic Act*, 1990). Vehicles are prohibited to enter/exit anywhere other than the buffer zone, i.e. they may not enter/exit mid-lane, unless lawfully permitted (such as with law enforcement, emergency vehicles, authorized tow trucks *etcetera*). The *High Occupancy Vehicles Lanes* regulation enforces a system responsible for monitoring and governing these restricted traffic lanes (*Highway Traffic Act*, 1990).

Example 1. EV Road Incentives

In accordance with the *Highway Traffic Act, High Occupancy Vehicle Lanes* regulations designate and regulate different highway lanes for specific purposes. Specifically, the *High Occupancy Vehicle Lanes* designate left lanes on a highway as a carpool lane for two or more passengers within a vehicle (*Highway Traffic Act*, 1990). In reference to the suggested BMP discussing carpool lane access for EV mentioned in Section 4.2.1: Incentive-based BMP, *High Occupancy Vehicle Lane* Regulations must be altered. Municipalities that decide to implement this suggested BMP for carpool lanes will offer carpool lane access for EV drivers as an incentive regardless of whether there are two or more passengers in the vehicle.

As a result, if this BMP were to be implemented in cities within the GTHA, requirements and restrictions outlined under this regulation must change to specify that EV vehicles receive access to these particular areas. HOV Lane regulations, under the *Highway Traffic Act,* do not currently allow additional access for EV drivers that are not also carpool vehicles (*Highway Traffic Act*, 1990). Therefore, for this BMP to be a feasible indication of this incentive, the provincial regulation must occur. Under the jurisdiction of this regulation, signage specifying the access of EVs, regardless of passenger numbers, must be displayed in every city where these carpool lanes are found. By doing this, enforcement and restriction of these areas are clear and EV drivers can use these spaces without confusion or complication.

Traffic By-Laws

In this section, the use of 'Traffic By-Laws' will be observed. Most of the municipalities observed in the GTHA refer to traffic regulations as 'Traffic By-Laws'. Note that different municipalities may refer to Traffic By-Laws as 'Transportation By-Laws', or 'Parking By-Laws'; these are synonymous to Traffic By-Laws.

In accordance with the *Highway Traffic Act*, the traffic by-law enforces specific standards regarding the use of highways, freeways, and parking in the GTHA and distributes penalties as a result of the infringement of these standards (City of Mississauga, 2010). Under this regulation, traffic by-laws issue forms for permits, regulate and ensure that designated areas are being used for appropriate purposes specific to the zoned area (*Highway Traffic Act*, 1990). For example, traffic by-laws ensure that areas zoned as loading spaces are not being used for other purposes. Similarly, these by-laws dictate the locations as well as the duration at which vehicles can be parked, and the distance one can park from specific developments and structures (City of Mississauga, 2010).

Example 1. Parking Incentives

To implement any future changes to parking standards and zoning, traffic by-laws must also be updated to ensure that land use areas within municipalities are used for their designated purpose. With regards to parking incentives, such as the EV parking areas referenced in Section 4.2.1: Incentive-based BMP, enforcement standards must be updated to include new EV programs. Without updated standards, enforcement officers are unable to regulate the proper use of future EV parking areas and reprimand users that do not qualify for these incentives.

Traffic by-laws further include the issuance of parking permits in specific areas and toll route access for certain periods of time. As referenced in Section 4.2.1: Incentive-based BMP on discounted tolls, discounted fees, and parking spaces, the application process to obtain these incentives must be altered to include a specific process regarding the future issuance of EV parking permits and discounted toll issuances. Without a specific application process regarding these incentives under the traffic by-laws, EV drivers will not have legal access to these designated spaces. In turn, regulations regarding the permit application process must be altered to include various new EV programs.

Example 2. Towing and Ticketing

The *Highway Traffic Act* regulates the enforcement of designated parking spaces, as referred to in Section 4.2.1: Incentive-based BMP on towing and ticketing and fall under a municipality's traffic by-laws (City of Brampton, 2013). This includes any designated EV parking spaces that must be under strict surveillance to ensure that EV users are benefiting from EV parking (City of Burlington, 2016). This by-law must be amended to provide procedures on how to enforce these regulations, specifically within towing and ticketing non-EVs parked in designated EV spaces. Regulations would consist of determining the general penalty provision for the offence listed under the by-law with the appropriate fine value.

Example 3. Signage

One specific area to focus on under traffic by-laws for EV transition in the GTHA is signage. Signage specifically related to EVs consists of HOV lanes, parking permits, and towing & ticketing (City of Brampton, 2016). For example, in areas where only EV parking is permitted, and all other vehicles will be towed, tow away zone signs indicating the area designation must be present (City of Brampton, 2016). Section 4.2.3: Education-based BMP, under Consistent and Thorough Signage, illustrates that educational signage about EVs is key in increasing public knowledge and understanding. Furthermore, this signage plays an important role in communicating EV policies to everyone in EV parking lots and charging areas.

5.4.2 Policy Checklist

Policy Checklist

A consolidated checklist of municipal policies in the GTHA, crucial to the integration of EV in municipal planning and development. Policies that should be considered, altered or amended to include EV process, discussions, technology, awareness and infrastructure.

Policy Standards	Provincial Regulations and Municipal By-Laws	Example of Related Best Management Practices	Completed
Building and Development	Property Standards By-Law	Some best management practices that are affected by the Property Standards By-Law are: EV Charging Infrastructure, Portable Charging Units and (Section 4.2.2.)	
	Streetlight and Sidewalk By-Law	The best management practices that is affected by Streetlight and Sidewalk By-law is: Streetlight Charging Integration (Section 4.2.2.)	
	Building Permit By-Law	Some best management practices that are affected by the Building Permit By-Law are: EV Charging Infrastructure in residential areas and at businesses (Section 4.2.2)	
NOTES:			
Zoning Regulations	Zoning By-Law	Some best management practices that are affected by the Zoning By-Law are: Low Emission Zones (LEZ), EV Parking Spaces, EV Parking permits, and residential charging stations (Section 4.2.1)	
NOTES:			
Business Development Guidelines	Mobile Licensing By-Law	The best management practice that is affected by the Mobile Licensing By-Law is LEZs (Section 4.2.1)	
	Business Licensing By-Law	Some best management practices that are affected by the Business Licensing By-Law are: city contract EV preference and LEZs (Section 4.2.4 and Section 4.2.1)	
NOTES:			
Transportation Infrastructure	Traffic By-Law	Some best management practices that are affected by the Traffic By-Law are: Parking space incentives, towing and ticketing, appropriate EV signage (Section 4.2.1 and Section 4.2.3)	
	Toll Highways Regulations	The best management practice that is affected by toll highway regulations is toll highway incentives. (Section 4.2.1)	
	High Occupancy Vehicle Lanes Regulations	The best management practice that is affected by high occupancy vehicle Lanes Regulations is carpool lane access for EV. (Section 4.2.1)	
NOTES:			

6.0 Action Plan

The below Action Plan is intended to provide guidance for municipalities of the GTHA in implementing effective EV strategies, based on the recommendations made within the body of the report. It is an easy-to-follow plan conveying the steps to be taken towards EV integration in the GTHA. Beginning with policy review using the Policy Checklist in Section 5.4.2, to continuous EV uptake through education and outreach as a final step, the checklist can be used by municipalities to guide them through their EV implementation goals. The Plan is structured to be used as an iterative process in which municipalities are continually collecting relevant data, assessing policies, and updating strategies for the improvement of EV adoption.

Action Plan

EV mobility

STEPS TO SUCCESS

01 Review Municipal Policy

Conduct policy gap analysis using the Policy Checklist as a guide.

02 Research and Review Best Management Practices

Decide which best management practices, planning methods, procedures, and strategies are applicable to municipality.

03 Establish Stakeholder Communication and Engagement

Key stakeholders include:

-Local utility boards
-NGOs
-local communities
-Businesses in the energy and/or sustainability sectors

04 Develop EV Planning Strategy

Draft municipal EV planning strategy. Set attainable goals based on gap analysis and best management practices.

EVolution

05 Develop System to Track Progress

Develop system that allows for EV adoption tracking progress. This helps keep municipalities accountable.

06 Develop Pilot Projects Based on Best Management Practices

Develop detailed pilot projects based on best management practices with a defined purpose, scope, timeline, milestones, and deliverables.

07 Apply BMP Projects on Larger Scale

Reflect on and assess pilot projects. What worked/didn't work? Apply these projects on a larger scale.

08 Education and Outreach

Generate large-scale education and outreach programs on EVs for all different sectors, which encourages EV normalization and uptake. Be visible, be creative, and maximize your outreach.

EVolution

Continual Improvement...

As with any project, continual improvement is crucial for its success. This is accomplished through:

- Routine maintenance and development of project infrastructure
- Continued outreach initiatives
- Fostering relationships, increasing dialogue, and promoting collaboration with stakeholders
- Routine checks on projects and initiatives; can be in form of audits, policy alterations, progress updates etc.

7.0 Appendices

Appendix A – Table of GTHA Municipality Demographics

Municipality	Population	Population Density (km^2)	Area (km^2)	Age Demographics (%) 0-14 | 15-64 | 65+			Individual Median Income ($)	Driver to Transit Ratio
Ajax	119,677	1,786	67	19.8	69.3	11	36,107	4:1
Aurora	55,445	1,112	50	17.8	69.2	13.1	40,382	7:1
Brampton	593,638	2,228	266	20.3	68.6	11.2	29,092	5:1
Brock	11,642	27	423	16.1	63.2	20.7	30,917	84:1
Burlington	183,314	946	186	16.7	64.0	19.3	42,551	8:1
Caledon	66,502	96	688	18.6	68.2	13.2	41,476	32:1
Clarington	92,013	150	611	18.6	67.7	13.7	41,820	16:1
Durham	645,862	255	2,524	18.0	67.6	14.4	37,755	7:1
East Gwillimbury	23,991	97	245	17.1	68.3	14.5	40,571	18:1
Georgina	45,418	157	288	16.5	68.8	14.7	35,140	29:1
Halton	548,435	568	964	19.5	65.5	14.9	42,557	7:1
Halton Hills	61,161	221	276	18.7	67.9	13.4	43,568	24:1
Hamilton	536,917	480	1,117	16.2	66.5	17.3	32,917	7:1
King	24512	73	333	18.1	66.5	15.3	43,274	17:1
Markham	328,966	1,548	212	16.8	68.0	15.2	28,106	25:1
Milton	110,128	230	363	26.7	64.9	8.4	42,790	10:1
Mississauga	721,599	2,467	292	16.8	69.1	14.1	31,311	4:1
Newmarket	84,224	2,190	38	17.6	68.7	13.7	36,197	9:1
Oakville	193,832	1,314	139	18.9	66.5	14.5	42,152	4:1
Oshawa	159,458	1,027	146	16.7	66.8	16.5	33,492	8:1
Peel	1,381,739	933	1,247	18.3	68.9	12.8	30,715	5:1
Pickering	91,771	396	232	16.3	69.1	14.1	38,466	5:1
Richmond Hill	195,022	1,928	101	16.7	68.7	14.6	30,038	5:1

Municipality	Population	Population Density (km^2)	Area (km^2)	Age Demographics (%) 0-14 | 15-64 | 65+			Individual Median Income ($)	Driver to Transit Ratio
Scugog	21,617	46	475	14.5	64.4	21.1	39,190	60:1
Uxbridge	21,176	50	421	15.7	66.6	17.7	39,625	25:1
Vaughan	306,233	1,119	274	18.8	67.0	14.2	35,540	6:1
Whitby	128,377	875	147	19.9	67.2	12.9	42,242	6:1
Whitchurch-Stouffville	45,837	222	206	20.3	63.7	16	40,915	13:1
York	1,109,909	586	1,762	17.6	67.8	14.6	32,994	6:1

Appendix B – Model City Climate and EV Action Plans

Listed below are the titles and links to the chosen Model City EV strategies and Climate Action Plans.

Amsterdam

Sustainability Strategy:
Sustainable Amsterdam
https://www.amsterdam.nl/publish/pages/.../sustainable_amsterdam_27-3-2015.pdf

Electric Vehicle Deployment:
Electric Mobility is Here
https://www.amsterdam.nl/publish/pages/799470/planam-03-2016_art1.pdf

Amsterdam's demand-driven charging infrastructure
https://www.amsterdam.nl/publish/pages/799470/planam-03-2016_art2_2_1.pdf

Atlanta

Sustainability Strategy:
City of Atlanta Sustainability Plan
http://www.atlantaga.gov/Home/ShowDocument?id=539

Electric Vehicle Deployment:
Municipal Best Practices Study
http://www.10xe.orwww.10xe.org/Content/Files/Atlanta%20EV%20Readiness%20Study%20.pdf

Atlanta Electric Vehicle Development Coalition
https://atlantaevdc.com/237-2/

Promoting the Transition to Electric Vehicles
https://www.electrifythesouth.org/ev-policy

Chicago

Climate Action Plan:
Chicago Climate Action Plan
http://www.chicagoclimateaction.org/filebin/pdf/finalreport/CCAPREPORTFINALv2.pdf

2015 Sustainable Chicago Action Agenda 2012-2015 Highlights and Look Ahead
https://www.cityofchicago.org/content/dam/city/progs/env/Sustainable_Chicago_2012-2015_Highlights.pdf

Electric Vehicle Deployment:
Drive Electric Chicago
https://www.cityofchicago.org/city/en/progs/env/drive_electric_chicago.html

Copenhagen

Climate Action Plan:
Copenhagen Climate Plan: Copenhagen Carbon Neutral by 2025
https://www.energycommunity.org/documents/copenhagen.pdf

Denver

Climate Action Plan:
City and County of Denver Climate Action Plan 2015
https://www.denvergov.org/content/dam/denvergov/Portals/771/documents/Climate/CAP%20-%20FINAL%20WEB.pdf

Opportunities for Vehicle Electrification in the Denver Metro Area and Across Colorado
https://www.denvergov.org/content/dam/denvergov/Portals/771/documents/EQ/EV/EVFinalReport.pdf

Electric Vehicle Deployment:
Colorado Electric Vehicle Plan
https://www.colorado.gov/governor/sites/default/files/colorado_electric_vehicle_plan_-_january_2018.pdf

Los Angeles

Sustainability Strategy:
*P**LA**N:* Transforming Los Angeles
http://plan.lamayor.org/wp-content/uploads/2017/03/the-plan.pdf

2nd Annual Report 2016-17: P**LA**N
http://plan.lamayor.org/wp-content/uploads/2017/03/sustainability_pLAn_year_two.pdf

New York City

Climate Action Plan:
1.5 C: Aligning New York City with the Paris Climate Agreement
https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/1point5-AligningNYCwithParisAgrmt-02282018_web.pdf

Sustainability Strategy:
PlaNYC: Building a Greener, Greater New York
http://www.nyc.gov/html/planyc/downloads/pdf/publications/planyc_2011_planyc_full_report.pdf

Electric Vehicle Deployment:
NYC Clean Fleet
http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/NYC%20Clean%20Fleet.pdf

Oslo

Climate Action Plan:
Climate Change Adaptation Strategy for the City of Oslo
https://www.oslo.kommune.no/getfile.php/13166782/Content/English/Politics%20and%20administration/Green%20Oslo/Plans%20and%20programmes/Climate%20Change%20Adaptation%20Strategy%20for%20the%20City%20of%20Oslo%202014-2030.pdf

Climate and Energy Strategy for Oslo
https://www.oslo.kommune.no/getfile.php/13166797/Content/English/Politics%20and%20administration/Green%20Oslo/Plans%20and%20programmes/Climate%20and%20Energy%20Strategy%20Oslo.pdf

Electric Vehicle Deployment:
The Electric Vehicle Capital of the World
https://www.oslo.kommune.no/english/politics-and-administration/green-oslo/best-practices/the-electric-vehicle-capital-of-the-world/#gref

Paris

Climate Action Plan:
Paris Climate and Energy Action Plan
http://large.stanford.edu/courses/2016/ph240/tarhuni1/docs/paris-1325.pdf

Electric Vehicle Deployment:
Electric Vehicles in France
http://www.iddri.org/Publications/Collections/Analyses/ST0817_OS%20et%20al._EVs%20financing.pdf

Portland

Climate Action Plan:
Climate Action Plan - Local Strategies to Address Climate Change
https://www.portlandoregon.gov/bps/article/531984

Electric Vehicle Deployment:
2017 City of Portland Electric Vehicle Strategy
https://www.portlandoregon.gov/bps/article/619275

San Diego

Climate Action Plan:
City of San Diego Climate Action Plan
https://www.sandiego.gov/sites/default/files/final_july_2016_cap.pdf

Electric Vehicle Deployment:
San Diego Regional Plug-In Electric Vehicle Readiness Plan
http://www.sdforward.com/pdfs/DraftAppendixU12-SanDiegoRegionalPlugInElectricVehiclesReadinessPlan.pdf

London

Climate Action Plan:
London's Response to Climate Change
https://www.denvergov.org/content/dam/denvergov/Portals/771/documents/Climate/CAP%20-%20FINAL%20WEB.pdf

Electric Vehicle Deployment:
An Electric Vehicle Delivery Plan for London
https://www.polisnetwork.eu/uploads/Modules/PublicDocuments/electric-vehicles-plan_london.pdf

Vancouver

Climate Action Plan:
Greenest City 2020 Action Plan
http://vancouver.ca/files/cov/Greenest-city-action-plan.pdf

Electric Vehicle Deployment:
Vancouver EV Ecosystem Strategy
http://vancouver.ca/files/cov/EV-Ecosystem-Strategy.pdf

Additional Readings:

Electric Vehicle Capitals of the World: Demonstrating the Path to Electric Drive by Dale Hall, Marissa Moultak, and Nic Lutsey (2017)
https://www.theicct.org/sites/default/files/publications/Global-EV-Capitals_White-Paper_06032017_vF.pdf

Electric Vehicles in Europe by the European Environment Agency
https://www.eea.europa.eu/publications/electric-vehicles-in-europe/download

EV City Casebook: 50 big ideas Shaping the Future of Electric Mobility - Urban Foresight
http://urbanforesight.org/wp-content/uploads/2015/07/urbanforesight_ev_casebook.pdf

Appendix C – O. Reg 332/12: Building Code Amendment

The entirety of O.Reg 332/12 can be found at https://www.ontario.ca/laws/regulation/120332.

Amendment to Building Code targeted at Electric Vehicle (EV) charging system integration in new houses and workplace buildings.

A Summary of Changes to O. Reg. 332/12

Summarized by Travis Allan of *Demarco Allan LLP* (Allan, 2017):

The changes cover parking spaces in "Part 3" and "Part 9" Buildings. **Part 3 Buildings** exceed 600 square metres of building area or are taller than three storeys and have occupancies including residential, business, personal services, mercantile, and retirement home. **Part 9 Buildings** are smaller than 600 square metres and shorter than three storeys, and have occupancies including residential, business, personal services, and mercantile. The changes do not apply to apartment buildings or parking spaces located outside a building.

Part 3 and Part 9 Buildings (except apartments and detached houses, semi-detached houses or row houses containing no more than two dwelling units served by a garage, carport or driveway) must have the following, unless a code official approves of an alternative solution:

- **20% electric vehicle supply equipment (EVSE) installed**—Not less than 20% of the parking spaces in the building must be provided with EVSE that is installed in accordance with s. 86 of the ESC (Building Code ss. 3.1.21.1(1) and 9.34.4.1(1)).
- **Remaining spaces ready**—The remaining spaces must be designed to permit future EVSE installation that conforms with s. 86 of the ESC (Building Code ss. 3.1.21.1(1) and 9.34.4.1(2)).

Detached houses, semi-detached houses or row houses* containing not more than two dwelling units served by a garage, carport or driveway are required to have installed, unless a code official approves of an alternative solution:

- **200 amp**—A minimum 200 amp panel board;
- **Conduit**—A conduit that is not less than 27mm trade size and is equipped with a means to allow cables to be pulled into the conduit; and
- **Outlet box**—A square 4'11/16" trade-size electrical outlet box installed in the garage or carport or adjacent to the driveway (Building Code ss. 3.1.21.1(3) and 9.34.4.1(3)).

* Houses that are not connected to an electrical distribution system or used or intended to be used as a seasonal recreational building are exempt from these requirements (Building Code ss. 3.1.21.1(6) and 9.34.4.1(6)).

1.4.1.2. Defined Terms

Electric vehicle supply equipment means electric vehicle supply equipment as defined in Rule 86-100 of the Electrical Safety Code adopted under Ontario Regulation 164/99 (Electrical Safety Code) made under the Electricity Act, 1998.

…

House means a detached house, semi-detached house or row house containing not more than two dwelling units.

3.1.21 Electric Vehicle Charging

3.1.21.1 Electric Vehicle Charging Systems

(1) Except as provided in Sentence (3), where vehicle parking spaces are located in a building, other than an apartment building, not less than 20% of the parking spaces shall be provided with electric vehicle supply equipment installed in accordance with Section 86 of the Electrical Safety Code adopted under Ontario Regulation 164/99 (Electrical Safety Code) made under the Electricity Act, 1998.

(2) The remaining parking spaces located in a building described in Sentence (1) shall be designed to permit the future installation of electric vehicle supply equipment that conforms to Section 86 of the Electrical Safety Code.

(3) Except as provided in Sentence (6), where a house is served by a garage, carport or driveway, the following shall be installed to permit the future installation of electric vehicle supply equipment that conforms to Section 86 of the Electrical

Safety Code:

(a) a minimum 200 amp panel board,

(b) a conduit that is not less than 27mm trade size and is equipped with a means to allow cables to be pulled into the conduit, and

(c) a square 4-11/16in. trade size electrical outlet box.

(4) The electrical outlet box described in Clause (3)(c) shall be installed in the garage or carport or adjacent to the driveway.

(5) The conduit and electrical outlet box described in Clauses (3)(b) and (c) shall provide an effective barrier against the passage of gas and exhaust fumes.

(6) A house need not comply with Sentence (3) where it, (a) is not connected to a distribution system, as defined in subsection 2(1) of the Electricity Act, 1998, or (b) is used or intended to be used as a seasonal recreational building described in Section 9.36.

9.34.4 Electric Vehicle Charging

9.34.4.1 Electric Vehicle Charging Systems

(1) Except as provided in Sentence (3), where vehicle parking spaces are located in a building, other than an apartment building, not less than 20% of the parking spaces shall be provided with electric vehicle supply equipment installed in accordance with Section 86 of the Electrical Safety Code adopted under Ontario Regulation 164/99 (Electrical Safety Code) made under the Electricity Act, 1998.

(2) The remaining parking spaces located in a building described in Sentence (1) shall be designed to permit the future installation of electric vehicle supply equipment that conforms to Section 86 of the Electrical Safety Code.

(3) Except as provided in Sentence (6), where a house is served by a garage, carport or driveway, the following shall be installed to permit the future installation of electric vehicle supply equipment that conforms to Section 86 of the Electrical Safety Code:

(a) a minimum 200 amp panel board,

(b) a conduit that is not less than 27 mm trade size and is equipped with a means to allow cables to be pulled into the conduit, and

(c) a square 4-11/16 in. trade size electrical outlet box.

(4) The electrical outlet box described in Clause (3)(c) shall be installed in the garage or carport or adjacent to the driveway.

(5) The conduit and electrical outlet box described in Clauses (3)(b) and (c) shall provide an effective barrier against the passage of gas and exhaust fumes.

(6) A house need not comply with Sentence (3) where it, (a) is not connected to a distribution system, as defined in subsection 2(1) of the Electricity Act, 1998, or (b) is used or intended to be used as a seasonal recreational building described in Section 9.36.

The transition regulation (O.Reg 563/17, under *Building Code Act, 1992, S.O. 1992, c.23*) was released on December 20, 2017 by the Ministry of Municipal Affairs (MMA) and come into effect January 1, 2018, for building not exempted by the transition provisions.

ONTARIO REGULATION 563/17

made under the

BUILDING CODE ACT, 1992

Made: December 13, 2017

Filed: December 19, 2017

Published on e-Laws: January 30, 2018

Printed in The Ontario Gazette: January 6, 2018

AMENDING O. REG. 332/12

(BUILDING CODE)

1. (1) Sentence 3.1.21.1.(1) of Division B of Ontario Regulation 332/12 is amended by striking out "Sentence (3)" and substituting "Sentences (2.1) and (3)".

(2) Article 3.1.21.1. of Division B of the Regulation is amended by adding the following Sentence:

(2.1) Parking spaces located in a *building* need not comply with Sentence (1) where,

(a) before January 1, 2018,

(i) an agreement was entered into between the owner of the land on which the *building* is to be constructed and a distributor, as defined in subsection 2 (1) of the *Electricity Act, 1998*, that sets out the conditions for the connection of the *building* to a distribution system, as defined in subsection 2 (1) of that Act, or

(ii) a plan for the land on which the *building* is to be constructed respecting the siting and sizing of lines, transformers or other equipment used for conveying electricity was approved by a distributor, as defined in subsection 2 (1) of the *Electricity Act, 1998*, and

(b) an application for a permit to *construct* the *building* was made before January 1, 2020.

(3) Sentence 3.1.21.1.(3) of Division B of the Regulation is amended by striking out "Sentence (6)" in the portion before Clause (a) and substituting "Sentences (6) and (7)".

(4) Article 3.1.21.1. of Division B of the Regulation is amended by adding the following Sentence:

(7) A *house* need not comply with Sentence (3) where,

(a) before January 1, 2018,

(i) an agreement was entered into between the owner of the land on which the *house* is to be constructed and a distributor, as defined in subsection 2 (1) of the *Electricity Act, 1998*, that sets out the conditions for the connection of the *house* to a distribution system, as defined in subsection 2 (1) of that Act, or

(ii) a plan for the land on which the *house* is to be constructed respecting the siting and sizing of lines, transformers or other equipment used for conveying electricity was approved by a distributor, as defined in subsection 2 (1) of the *Electricity Act, 1998*, and

(b) an application for a permit to *construct* the *house* was made before January 1, 2020.

2. (1) Sentence 9.34.4.1.(1) of Division B of the Regulation is amended by striking out "Sentence (3)" and substituting "Sentences (2.1) and (3)".

(2) Article 9.34.4.1. of Division B of the Regulation is amended by adding the following Sentence:

(2.1) Parking spaces located in a *building* need not comply with Sentence (1) where,

(a) before January 1, 2018,

(i) an agreement was entered into between the owner of the land on which the *building* is to be constructed and a distributor, as defined in subsection 2 (1) of the *Electricity Act, 1998*, that sets out the conditions for the connection of the *building* to a distribution system, as defined in subsection 2 (1) of that Act, or

(ii) a plan for the land on which the *building* is to be constructed respecting the siting and sizing of lines, transformers or other equipment used for conveying electricity was approved by a distributor, as defined in subsection 2 (1) of the *Electricity Act, 1998*, and

(b) an application for a permit to *construct* the *building* was made before January 1, 2020.

(3) Sentence 9.34.4.1.(3) of Division B of the Regulation is amended by striking out "Sentence (6)" in the portion before Clause (a) and substituting "Sentences (6) and (7)".

(4) Article 9.34.4.1. of Division B of the Regulation is amended by adding the following Sentence:

(7) A *house* need not comply with Sentence (3) where,

(a) before January 1, 2018,

(i) an agreement was entered into between the owner of the land on which the *house* is to be constructed and a distributor, as defined in subsection 2 (1) of the

Electricity Act, 1998, that sets out the conditions for the connection of the *house* to a distribution system, as defined in subsection 2 (1) of that Act, or

(ii) a plan for the land on which the *house* is to be constructed respecting the siting and sizing of lines, transformers or other equipment used for conveying electricity was approved by a distributor, as defined in subsection 2 (1) of the *Electricity Act, 1998*, and

(b) an application for a permit to *construct* the *house* was made before January 1, 2020.

Commencement

3. This Regulation comes into force on the later of January 1, 2018 and the day it is filed

Appendix D – Ontario's Transportation Initiatives

Cycle ON: Ontario's Cycling Strategy

More and more people are choosing cycling as their preferred way to get around. Ontario's Cycling Strategy provides a route map to support and encourage this growth in cycling over the next 20 years.

Increasing the number of cyclists in Ontario holds many potential long-term benefits. Ontario's Cycling Strategy supports Ontarians adopting healthier and active lifestyles, the tourism industry, as well as the achievement of environmental and economic objectives.

The province will play a leadership role in striving to achieve our cycling vision, but we are asking municipalities, the public, road users, businesses and non-governmental organizations to partner with us to create a more cycling-friendly future for Ontario.

Taking action now to improve cycling

Ontario is taking action to implement #CycleON: Ontario's Cycling Strategy through a series of ongoing, multi-year action plans. The first, #CycleON Action Plan 1.0, identifies clear actions that Ontario government ministries and agencies will be working on in 2014 and beyond to make Ontario a more cycling-friendly province. This is the first of many actions plans. The cumulative effect will be to help all of us - individuals, communities and governments - reap the benefits of increased cycling.

More information for Cycle ON Strategy at
http://www.mto.gov.on.ca/english/publications/ontario-cycling-strategy.shtml

Long Combination Vehicle (LCV) Program

The Long Combination Vehicle (LCV) Program supports the efficient movement of goods across the province and beyond.

A typical LCV is up to 40 metres long, consisting of a tractor pulling two full-length semitrailers. A standard LCV replaces two 23-metre tractor-trailers.

MTO gradually introduced LCVs onto Ontario roadways by issuing a limited number of permits to a limited number of carriers. This has allowed for a carefully controlled and closely monitored program as part of an effort to build a stronger, greener economy.

The Canada Safety Council reports that LCVs are involved in at least 40% fewer collisions than regular tractor-trailers.

Economic Benefits

LCVs are good for manufacturers and consumers. They allow Ontario retailers and manufacturers to bring light-weight, bulky goods to market at a lower cost.

Environmental Benefits

By using less fuel to carry goods, LCVs reduce the greenhouse gas emissions (GHGs) associated with shipping goods by approximately one-third.

Safety

LCVs have been on the road in Western Canada, Quebec, and numerous American states for decades. They have an excellent safety record, with fewer collisions reported than single-trailer trucks.

A major study of LCV operations in Alberta showed that LCVs of the type allowed in Ontario had 60 per cent fewer collisions than the conventional tractor-trailers they replace.

As each LCV replaces two conventional tractor-trailers, the number of collisions is expected to be reduced by 80% as compared to moving the same freight by conventional tractor-trailer.

Requirements and Restrictions

Rules for LCVs include that they:

- Can only operate on designated divided highways (primarily 400-series highways).
- Can only access destination terminals within two kilometres of highway interchanges, and only if routes have been carefully assessed and approved.
- Must have special safety equipment, including enhanced braking requirements and an electronic stability control system.
- May not drive in or through the Greater Toronto Area or the City of Ottawa during rush hours.
- May not carry more weight than existing multi-axle tractor-trailers.
- May not operate at the start and end of long weekends.
- May not carry dangerous goods that would require a warning on the vehicle's exterior.
- May not carry livestock.
- Must avoid driving in bad weather or slippery conditions.
- May not exceed 90km/hr.

Special requirements for LCV drivers include that they:

- Must be experienced tractor-trailer operators with a good safety record.
- Must obtain and carry an LCV Driver’s Certificate based on specialized and comprehensive training and road testing.

More information for LCV Program at http://www.mto.gov.on.ca/english/trucks/long-combination-vehicles.shtml

High Occupancy Vehicle (HOV) Lane

High Occupancy Vehicle (HOV) lanes help move more people on Ontario's busiest highways. They are restricted to certain types of vehicles carrying at least 2 people. Make sure you know and follow the rules for entering and exiting HOV lanes.

Locations

Ontario has HOV lanes on Highways 403, 404, 417 and the QEW. To find them, look for:

- HOV signs marking the far left lane.
- Markers painted on the road, including diamond markers and a striped buffer zone that separates the HOV lane from other lanes.

Using HOV lanes

You can use an HOV lane if you have **at least two people** (including the driver) in one of these vehicles :

- cars
- motorcycles
- vans or light trucks
- commercial trucks less than 6.5 meters long with a gross weight of 4,500 kg or less.

If you are towing a trailer, you can still use the HOV lane if the combined vehicle-trailer length is less than 6.5 meters.

The following vehicles have unrestricted access to HOV lanes, no matter how many passengers they are carrying:

- buses of all types
- licensed taxis and airport limousines until June 30, 2018
- emergency vehicles
- vehicles with Ontario green license plates

Benefits of HOV Lanes

HOV lanes help move more people faster on Ontario's highways by encouraging people to carpool and take transit. This is important during peak travel times when other lanes can be slow and congested.

Benefits to Drivers

- **Save time:** You can avoid congestion and arrive at your destination more quickly than those who don't carpool.
- **More reliable commute:** Avoiding congestion means a quicker and more consistent commute time.
- **Save money:** It costs less to ride a bus or to share a ride than to drive alone every day. Regular carpooling could your cut fuel costs by 50%.
- **Conserve fuel:** You waste less fuel than sitting in traffic.

- **Less stress:** Letting someone else drive – or taking turns – gives you a chance to relax on the drive to work.

Benefits to Ontario

- **Manage congestion:** An HOV lane can handle a lot of growth in demand. Once a general traffic lane reaches capacity, it becomes congested and moves fewer vehicles.
- **Make better use of infrastructure:** One highway lane can carry 1,500 to 2,200 vehicles each hour. A lane full of buses and carpools moves many more people than a standard traffic lane.
- **Transit priority:** Buses and transit rider have priority. A single transit bus can replace 57 single-occupant cars!
- **Provide choices:** HOV lanes make carpooling and public transit more effective and reliable choices for commuters.
- **Support mobility:** Taxis and airport limousines that use HOV lanes can return to duty faster after dropping off a fare or arrive sooner to pick up a fare.
- **Support electric vehicles:** Vehicles with **Ontario green licence plates** are allowed on all provincial HOV lanes - even with only one person in the vehicle.

More information for HOV Lane at http://www.mto.gov.on.ca/english/ontario-511/hov-lanes.shtml

Gas Tax Program

The gas tax program is a long-term source of transit funding that municipalities can count on. The program provides stable and predictable transit funding for Ontario municipalities by providing two cents per litre of provincial gas tax to improve and expand transit.

More information for Gas Tax Program at http://www.mto.gov.on.ca/english/service-commitment/gas-tax-program.shtml

Electric Vehicle Charger Ontario (EVCO) Program

With this unprecedented expansion in new charging infrastructure across the province, electric vehicle owners can now plan longer trips with more confidence because charging stations will be more readily available, similar to gas stations.

Upon completion, close to 500 charging stations (over 200 **Level 3** 'fast-chargers' and close to 300 **Level 2**) will be installed across Ontario at approximately 250 locations, making the EVCO network the largest public network of Level 3 stations in Canada.

EVCO charging stations have been installed at a wide variety of locations across Ontario. The specific location of each station can be found on the map above or by visiting the Ontario 511 Traveller Information Service.

EVCO was an application-based program that launched in December 2015. Applications were accepted until February 2016. The program received an overwhelming number of applications (over 200) where applicants identified what they felt were good locations for electric vehicle charging stations. The most competitive applications were chosen to create

an optimal network of electric vehicle charging stations to support both city to city and in-city travel. Through the evaluation process, the appropriateness of the sites and the number of stations per site were carefully considered, with a focus on the connectivity of the network.

- The Level 3 charging station locations are generally strategically placed (e.g. near highways) to promote inter-city travel where cars can get up to 80% charge within 20 to 30 minutes.
- The Level 2 charging station locations are generally strategically placed at locations close to major trip attractors and workplaces to promote in-city travel and charging for people who plan to spend more time at a given location.

The use of all EVCO charging stations will be carefully monitored going forward. This will help the province better understand if there are service gaps or areas where the charging stations are over-capacity or underutilized.

The station location data will also be posted on the Ontario Open Data Catalogue. This initiative supports government efficiency, effectiveness, and innovation. By making this data freely and widely available, members of the public, app developers, and organizations that support travelers (e.g., Google, Canadian Automobile Association) will find innovative ways to leverage this data to enable electric vehicle drivers to find electric vehicle charging stations on their smartphones, tablets, or even in-car navigation systems.

Transportation emissions in Ontario pose one of the province's greatest challenges in achieving the government's GHG emission reduction targets. Building the EVCO network is helping electric vehicle drivers contribute to tackling this challenge every time they plug in.

More information for EVCO at http://www.mto.gov.on.ca/english/vehicles/electric/electric-vehicle-chargers-ontario.shtml

Electric and Hydrogen Vehicle Incentive Program (EHVIP)

Accelerating the shift to low- and zero-emission vehicles will be crucial if Ontario is to achieve its climate change goal of reducing greenhouse gas emissions (GHG) to 15% below 1990 levels in 2020, 37% in 2030 and 80% in 2050.

The Electric and Hydrogen Vehicle Incentive Program (EHVIP) supports the adoption of electric vehicles (EVs) and hydrogen fuel cell vehicles (HFCVs) by providing incentives for the purchase and/or lease of eligible EVs and HFCVs.

On March 9, 2018, the Electric Vehicle Incentive Program (EVIP) became the Electric and Hydrogen Vehicle Incentive Program, with the following changes:

- Incentives of up to $14,000 will be provided for eligible hydrogen fuel cell vehicles (HFCVs);
- Incentives for eligible battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) are now determined based on each vehicle's all-electric range and seating capacity. The updated incentives vary from $5,000 to $14,000;
- Incentives will no longer be provided for PHEVs or BEVs with a Manufacturer's Suggested Retail Price (MSRP) of $75,000 or more; and
- Incentives will no longer be provided for PHEVs or BEVs leased for less than three years.

Please consult the EVIP Eligible Vehicle and Incentives List for a detailed listing of updated incentive values as of March 9, 2018. Note that incentives will be provided under the previous EVIP program for EVs ordered prior to March 9, 2018, provided that the EV is delivered and the application is submitted by September 7, 2018.

For more detailed information about EHVIP and program requirements, please refer to the Electric and Hydrogen Vehicle Incentive Program Guide. Please note that updated forms and guides will be available on March 12, 2018.

Also on March 9, 2018, eligibility for the Electric Vehicle Charging Incentive Program (EVCIP)was expanded to include all registered EV owners who have not previously received an EVCIP incentive for their current EV.

More information for EVHIP at http://www.mto.gov.on.ca/english/vehicles/electric/electric-vehicle-incentive-program.shtml

Appendix E – Requesting a Charger in Amsterdam

City of Amsterdam ten steps to install a new charge point:

1. The (new) electric driver makes a request online for expansion of the public charging network.
2. Nuon/Heijmans check that the request meets the requirements and whether a new charge point is needed in the area concerned. Their considerations include:
    a. The walking distance to the nearest existing or planned charge location
    b. The occupancy rate of the nearest charge location (based on data available)
    c. Previous requests which have been turned down
3. Amsterdam city council will ultimately decide whether a new location will be installed.
4. If a new charge point is going to be installed, Nuon/Heijmans will draw up an installation plan in consultation with the grid operator and the relevant city district (the road authority).
5. As the road authority, Amsterdam council will formally give permission for the installation plan and publish its decision in the Staatscourant (Dutch official journal of record) – after which the six-week period to challenge or amend the decision starts.
6. The location and the plan are published online on a map and communicated to the electric drivers in the area.
7. The contractor will request connection to the network from the grid operator.
8. Amsterdam council instructs the installation of the charge point and the design of the location.
9. Following a soil survey, the grid operator will allocate the connection to Nuon/Heijmans and release the location for installation. Nuon/Heijmans can now start planning the work.

The contractor will install the charge point, set up the location(s) and connect it/them to the electricity network. This will take a minimum of four hours. The locations and current availability of charge points are available through a number of apps and websites (open data).

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