Strategic Development of Electric Vehicles in Canada

BY PATRICK O. ADOBA AND MICHAEL O. DIOHA

Introduction

Transportation has been at the core of man's daily activities over the centuries as it catalyzes socioeconomic development. From hauling of goods for human survival to deployment of services, mankind is constantly developing different methods to ensure that his transit across various locations is as seamless as possible. However, today, the transport sector accounts for around 25% of the anthropogenic global CO_2 emissions which contributes to climate change (IEA 2016). Using alternative fuels and improving transportation efficiency is no doubt a perfect place to commence efforts in decarbonization which primarily entails curtailing the combustion of fossil fuels—a prominent activity in the transport industry. As the second-largest country in the world, Canada faces unique transportation challenges especially in view of the fact that the automotive industry is continuously evolving. Coupled with the continuous increase in global energy demand, the issue of climate change and Greenhouse Gas (GHG) emissions poses a significant threat to the growth of the country's transport industry.

Figure 1 highlights the transport sector as the second highest GHG emitter in Canada, contributing to a quarter of the country's total GHG emissions. In light of these disturbing trends, there is a continuous global call for a paradigm shift towards relatively eco-friendly, rechargeable and efficient vehicles with a view to fostering a greener environment (Dioha & Kumar 2020). While the transport and warehousing sector amount to a significant 3.19% to Canada's Gross Domestic Product (GDP) (Statistics Canada, 2019), the importance of using clean and viable energy sources to aid the transportation process and curb climate change cannot be overemphasized. In keeping with this motive, the past decade has witnessed notable exploration and development of alternative technology options for transportation emission reduction in form of various types of Electric Vehicles (xEVs). These trends are geared towards enhancing the effectiveness of the transport sector in line with the decarbonization "agenda".

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While the transition from fossil fuel-powered internal combustion engine (ICE) vehicles to xEVs is well-underway, the adoption of xEVs varies from country to country due to existing factors such as consumer demand, government incentives and market prices. Globally, electric vehicle sales account for 2.3% of the total vehicle sales (EV-Volumes 2019, Global EV Outlook 2019). Since the introduction of xEVs in the commercial market, there has been a 46-69% year-over-year growth in the number of light-duty EVs between 2010 and 2018 culminating to a global fleet of 5.1 million units – a 63% rise from 2017 (EV-Volumes 2019). Two million units of light-duty xEVs were sold in 2018 - a significant 68% increase from the previous year (EV-Volumes 2019). In total, eight countries - China, the

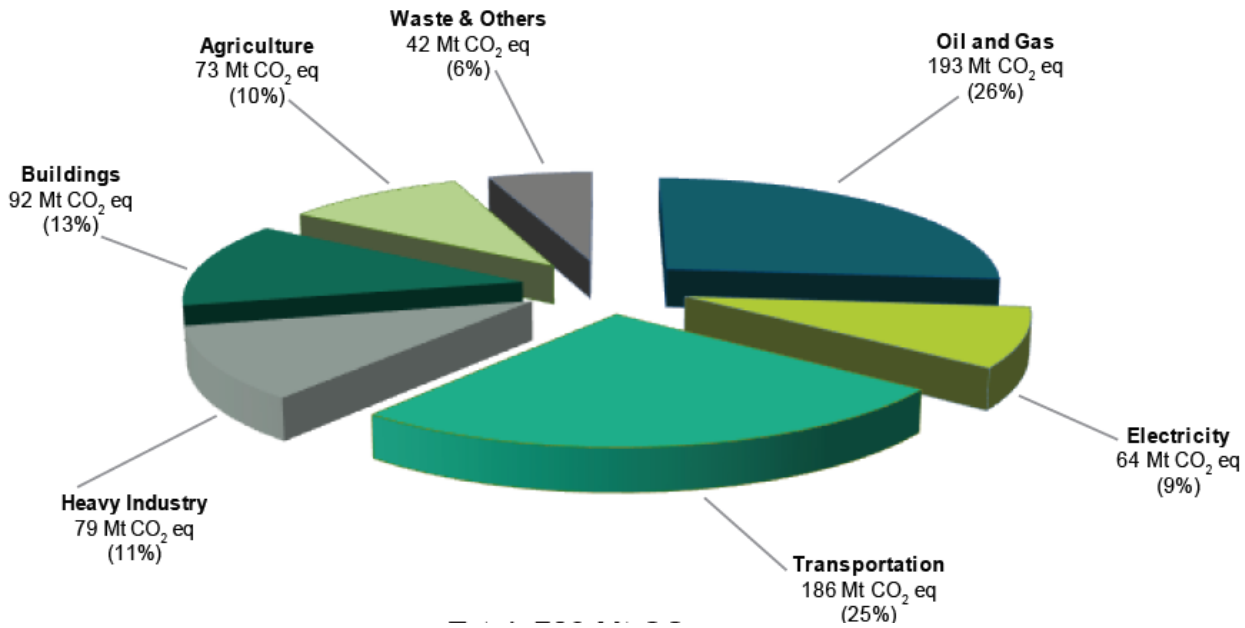

Figure 1: Canada's 2018 Greenhouse Gas Emissions Breakdown by Sector (Source: Environment and Climate Change Canada, 2020)
**Mt = Megatonnes*

United States, Norway, Germany, the United Kingdom, Japan, France and Canada - account for about 90% of the total global plug-in EVs sales (Global EV Outlook 2019, Kim et al 2020). Experts' notion that there is huge revenue accruable from the xEV market if properly harnessed. A large number of ICEs are relatively inefficient at converting fuel into usable energy, averaging between 20-40% efficiency (Fuel Economy 2018) accompanied by pollution and GHG emissions, high maintenance costs and a short car life expectancy. On the other hand, xEV technology exhibits no tailpipe emissions and improved viability resulting from low maintenance requirements. Additionally, "refuelling" xEVs can be carried out via renewable sources, such as wind, hydropower and solar outlets which are relatively cleaner and efficient. As such, the deployment of xEVs has been identified as a global strategy in tackling GHG emissions; it aids in improving air quality, while also serving to reduce noise pollution and increase energy security.

To mitigate transport-related emissions, a host of European nations have outlined plans to obsolete fossil-fuel-powered engines in the near future. India, California and China have also laid out blueprints to ensure that existing vehicles emit no more than trace amounts of air pollutants and GHGs (Planète Énergies 2019). France equally announced plans to totally phase-out ICEs in 2040 (Planète Énergies 2019). Canada is no exception (PlugIn BC 2019, Transport Canada 2019); in order to significantly lower GHG emission in the long run, the government introduced the Federal iZEV Program initiative to encourage more zero emission vehicles (ZEV) on Canadian roads by offering financial incentives on xEV purchase (Transport Canada 2019). This is reflected in its 2019 budget allocation of $300 million targeted at introducing a new federal purchase incentives program on the purchase of ZEVs across the country (Transport Canada 2018, 2019). To further encourage transition to a low-carbon system of transportation, specific targets for ZEV sales have been put in place: 10%, 30% and 100% of new light-duty vehicle sales are expected to be ZEVs by 2025, 2030 and 2040, respectively (Plug-In BC 2019, Transport Canada 2019). As a show of support, the province of British Columbia currently operates with three vehicle incentive programs - the Clean Energy Vehicle Program, BC SCRAP-IT Program and the Specialty-Use Vehicle Incentive Program – adopted by the government in order to lower the cost of purchase for electric vehicles (Plug-In BC 2019). Despite the giant strides made over the years in Canada, less than 1% of its on-road light duty vehicles (LDV) are electric. Also, Canada accounts for about 2.2% of global LDVs made, but only 0.4% of global electric vehicles made (Kim et al 2020). Consequently, this article examines the current developments in the Canadian xEV market. It assesses the possible challenges hampering the deployment of xEVs in Canada and then puts forward some recommendations to accelerate the deployment of xEVs in the country.

Status of Electric Vehicles in Canada

The adoption of electric vehicles in Canada is hinged on consumer demand, product innovations and sustainable initiatives (EY Strategy Report 2020). Despite ranking as the 10th fastest adopter of xEVs, eighth largest plug-in electric vehicle market and 12th in xEV production globally (Global-EV Outlook 2019), the ICE automobiles have exerted significant dominance in the Canadian automotive market given that only 2.32% of xEVs were accounted for on Canadian roads at the close of 2018 (Global-EV Outlook 2019). In the same year, Canada's vehicle sales peaked at 43,000 - equivalent to a 2.5% contribution to global xEV sales (BC Hydro 2018). A 165% year-over-year growth has seen the Canadian electric vehicle fleet rise to 2.2% in 2018 (Kim et al 2020). Nonetheless, of the 2 million vehicle sales, xEVs make up 0.4% of this total - a significant 80% below the global average (BC Hydro 2018).

There are currently two categories of Plug-in Electric Vehicles present in Canada: all-electric or battery electric vehicles (BEVs) running on rechargeable batteries powered solely by electricity, and plug-in hybrid electric vehicles (PHEVs), equipped with rechargeable batteries (or other storage devices) and ICEs which are powered by a combination of electricity and gasoline, respectively. Regarding the available units of xEVs recorded on Canadian roads in 2018, 51% of the 90,100 units of light-duty electric vehicles were BEVs with PHEVs accounting for the remaining 49% (EY Strategy Report 2019, Global EV Outlook 2019). Figure 2 depicts the breakdown of BEV and PHEV sales in Canada for the last five years. The share of light- duty xEVs has seen a significant increase from 0.3% in 2014 to 2.2% in 2018.

Available data highlights a significant number of light-duty EV manufacturers in the Canadian automotive industry. As referenced in Table 1, Tesla Model 3, Nissan Leaf and Mitsubishi Outlander lead the way accounting for a joint 40% of total electric

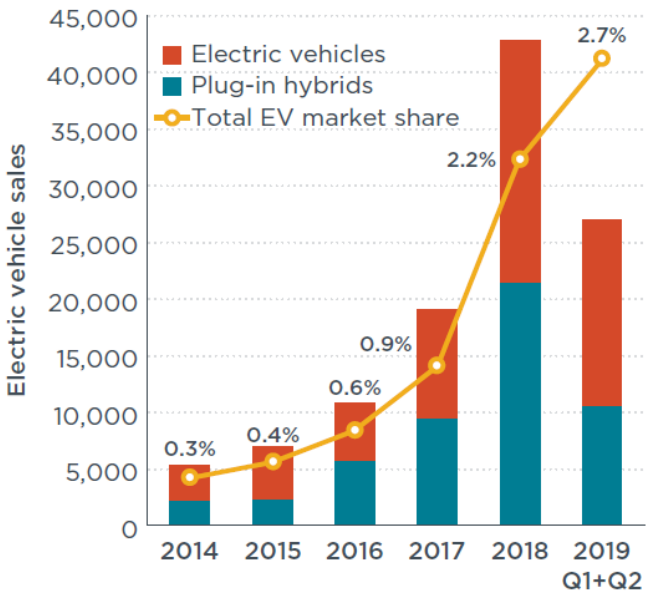

Figure 2: Breakdown of PHEV and BEV sales in Canada (Source: International Council on Clean Transportation, 2020)

Table 1: Top 10 highest – selling electric vehicle models in Canada in 2018.

Rank	Model	Sales (Units)	Assembly
1	Tesla Model 3	6,300	U.S.A
2	Nissan Leaf	5,700	U.S.A
3	Mitsubishi Outlander	5, 300	Japan
4	Chevrolet Volt	4,300	U.S.A
5	Toyota Prius Prime	3,500	Japan
6	Chevrolet Bolt	2,500	U.S.A
7	Ford Fusion Energi	1,900	Mexico
8	Tesla Model X	1,600	U.S.A
9	Chrysler Pacifica	1,400	Canada
10	Hyundai Ionic PHEV	1,400	S. Korea

Based on statistics from EV-Volume 2019. Values are rounded to the nearest hundred.

vehicle sales - about 17,300 units. PHEVs made up about 49% of the total volume electric vehicle market in 2018, with Mitsubishi Outlander, Chevrolet Volt and Toyota Prius Prime accounting for over 60% of HPEV sales. Additionally, 97% of Canada's 2018 xEV sales were imports, implying that only about 12,900 of the 43,000 xEV volume sales were domestically assembled. A breakdown of Canada's xEV sales by manufacturer (as depicted in Figure 3) details that Tesla, Nissan and General Motors (GM) are at the forefront of xEV automakers, accounting for over 27,000 units in 2018 - representing about two-thirds of xEV sales in Canada with Toyota, Ford, Volkswagen and other manufacturers rounding up the remaining one-third of the market. From 2014 to the close of the second quarter of 2019, Tesla, GM and Nissan sold roughly 30,000, 26,000 and 22,000 cumulative units of xEVs respectively. The second quarter of 2019 also witnessed the growth of Tesla's market share to 40% with Nissan, GM and Toytota accounting for 15%, 12% and 8% of the total market share respectively.

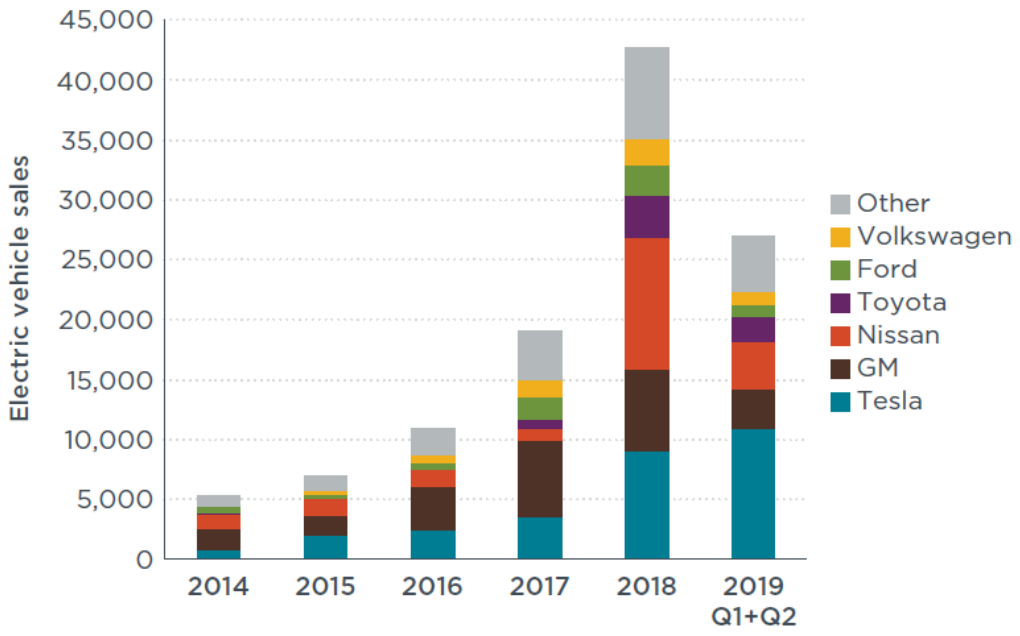

Figure 3: Breakdown of light-duty plug-in electric vehicle sales by manufacturer in Canada (Source: International Council on Clean Transportation, 2020)

Factors Inhibiting Electric Vehicle Adoption in Canada

Following the iZEV initiative, every new vehicle purchased in Canada is expected to be zero-emission by 2040. Although the blueprint for the achievement of this milestone is detailed and clearly outlined, there are a host of factors barricading the adoption of xEVs. The relatively higher upfront cost of xEVs remain a limiting factor. Although cost parity between xEVs and gasoline models is expected by 2025 (Bloomberg 2017), the initial cost of xEVs still remains a huge barrier to its adoption in Canada. A survey conducted by British Columbia (BC) Hydro revealed that 56% of British Columbians perceive xEVs to be too expensive. Data from NREL further suggests that individuals with an annual income of over $100,000 are more likely to purchase xEVs in Canada compared to lower income earners (NREL 2018). To further buttress this notion, Tesla S and Tesla X - valued at $96,000-plus and $110,000-plus, respectively - capped off 2017 as the top two highest selling BEV models in British Columbia (BC Hydro 2018). As with most commodities, the change(s) in demand for xEVs is directly linked to change(s) in cost attributes - encompassing purchase cost, running cost and total cost of ownership (TCO). Individuals in suburban and rural areas - majority of which are low and middle - income earners - will be much less willing to venture into the purchase of xEVs because even though they are much easier to maintain than conventional ICEs in the long run, the cost of purchasing or leasing xEVs are substantial. While declining battery costs and the introduction of cost incentives is a progressive step in the adoption of xEVs, the purchase of gasoline models in the current market is still more or less a viable option from a sticker cost perspective.

Limited charging infrastructures is also another factor limiting the deployment of xEVs in Canada. Apparently, the increasing units of xEVs present in Canadian roads has been seemingly overshadowed by a low return on investment (ROI) in charging infrastructure relative to crude oil infrastructure.

In 2018, a total of 7,940 public xEV supply equipment (EVSE) - 840 fast chargers and 7,100 slow chargers (Warner 2019) - were available across urban, suburban and rural municipals in Canada, accounting for a mere 0.56 charging points per hundred kilometer (EY Strategy 2019). This figure - when analyzed against the 90,100 units of xEVs recorded on Canadian roads in the same year (EY Strategy 2019, Global EV Outlook 2019), unravels a meager 0.09 charging point per xEV plying Canadian roads. Lack of charging infrastructure will result in consumers being heavily reluctant to purchase new xEVs because they are unwilling to sacrifice their driving convenience. Moreover, the accessibility and performance of charging points - measured in terms of availability, visibility and the percentage of fast-charge units has a direct impact on the customers' decisions to purchase xEVs. In British Columbia, over six in ten surveyed individuals are reluctant to purchase or lease xEVs because they believe the province lacks adequate charging infrastructures (BC Hydro 2018). The reason for this perspective is not far-fetched. Quite clearly, there is a distinct lack of substantial investment in existing power grids by power and utility (P&U) companies to enable home and public charging, in addition to inadequate distribution networks (power grids) to foster power transmission across the country, particularly in rural districts.

Range anxiety is another issue of serious concern. Although driving range is also dependent on weather conditions, road conditions and driving habit, various models of xEVs are not adequately equipped for long-distance travel due to the state of their batteries. About 40% of surveyed British Columbians are of the opinion that the current fleet of xEVs have limited battery range for longer trips (BC Hydro 2018). While some models of BEVs can travel 200-250 km when fully charged, others are capable of 400+ km on single charge (PlugN' Drive 2019). Similarly, PHEVs, depending on the model, have a travel range spanning 20-80 km on full charge coupled with gasoline engines designed to travel an additional 500+ km after the batteries are used up (PlugN' Drive 2019). However, the range of xEVs can drop by as much as 50% under extreme conditions of cold temperature, such as - 25°C during winter (CAA 2019, EY Strategy 2019). Conventional ICEs, on the other hand, offer greater driving range by virtue of a huge tank making for convenient driving without having to worry so much about road trips. Because transportation is an integral part of the Canadian lifestyle, existing proven technology will most times overshadow the adoption of new technology, particularly considering the inherent setbacks, unless steps are deployed to convince consumers otherwise.

Lengthy charging period is another important factor inhibiting xEVs adoption in Canada. A general issue for xEVs has been the lengthy period required for charging these automobiles. For level 1 charging (otherwise referred to as slow or trickling charging) - charge using a regular wall socket - 1 hour of charging is equivalent to approximately 8 kilometers of driving range using a standard 120-V outlet (Hydro Québec 2018). Charging with a 240-V EV station (Hydro Québec 2018) - level 2 charging - ensures that approximately 30 kilometers of driving range is stored after 1 hour of charge (Hydro Québec 2018, Plug-In BC 2019). With rapid DC chargers of 400-V or higher, the charging period is reduced significantly to as low as 30 minutes for a full charge (Hydro Québec 2018). The bad news is that not every xEV is equipped with rapid charge features. While there are significantly several other factors that may influence the charging rate, the size of the battery, maximum charging rate of the charge point or vehicle and environmental factors - delays in charging time often force HPEV drivers to rely on existing oil and gas (O & G) products and infrastructure because the battery component has a limited range of 20-80 km on a full charge (EY Strategy 2020). As such, owners of ICE vehicles will be reluctant to switch to electric vehicles resulting in skepticism on the part of prospective buyers.

Options and Priorities for the Future

The growth of the Canadian xEV market has been hampered by a huge lack of demand resulting from the relatively high purchase price of xEVs. In order to foster rapid transition from the conventional ICEs to the more sophisticated and eco-friendly xEVs - in line with achieving the targets of the Federal iZEV agenda - appropriate financial and non-financial incentives should be emplaced and its execution should be judiciously monitored by relevant government parastatals. A promising move would be the practice of providing tax incentives, such as sales tax exemptions, rebates and income tax credits upon purchase of xEVs in order to buffer the sticker cost for prospective consumers. Despite being easier to operate and maintain than conventional ICEs, discounts in utility rates (or the provision of charging rebates) will also go a long way in further alleviating the burdens of upfront costs relating to operation and maintenance of xEVs. Furthermore, rules encouraging the mandatory procurement of zero or trace - emission vehicles for government institutions creates public appeal for the vast consumer base if enacted. Increase in the units of xEVs in the government's vehicular fleet results in subsequent elevation of local demand culminating in the eventual phasing-in of these eco-friendly automobiles. For urban and suburban areas where parking space and traffic congestion is often times a daily issue, preferential treatment - free parking, designated parking spaces and designated lanes - for xEV owners can serve as motivation to encourage purchase of xEVs.

On the supply side, the relevant parties should ensure the development of battery science which is the major contributor to cost disparity between xEVs and conventional ICEs. Measures should be adopted to encourage robust investments in the Research and Development (R&D) of various xEV batteries to improve battery efficiency in order to lower the cost of xEVs and improve their driving range. The provision of tax credits, loans and grants as R&D incentives by

the government is a necessary tool to aid battery and vehicle manufacturers develop cheaper and better batteries in ensuring a smooth, swift and efficient transition to xEVs. In addition to providing financial support for xEV manufacturers and suppliers, the government can encourage the circulation of xEVs in the Canadian automotive market by adopting a differentiated tax system - taxation of new vehicles on the basis of their GHG emission levels, to foster demand and procurement of energy-efficient and low emission xEVs. Additionally, workforce programs geared towards training workers in a host of new skills encompassing design of xEV batteries and relevant infrastructure, grid upgrade and servicing of xEVs should be adopted by government and relevant business owners to boost its widespread adoption.

There is little doubt that improvements in the accessibility and performance of charging infrastructures is a key instrument in the growth of xEV market. Given the plethora of gas stations available in practically every location in Canada, the xEV industry will require adequate checks and balances to eventually rival the catholicity seemingly inherent in gas stations. The sparse density of charging points in public locations - typically concentrated in urban municipals - and limited driving range of xEVs makes it difficult to accommodate both short and long distance travel. Expansion of the current charging infrastructures requires high-ticket investments and intensified cooperation amongst relevant parties while also allowing the forces of time and patience to play their part. On the part of private investors, the hesitance to invest in public charging infrastructures is due in part to the obvious massive upfront cost required and the lack of substantial local demand by consumers. Nonetheless, this circumstance creates a casualty dilemma: customers will be unwilling to purchase xEVs unless adequate and accessible charging points are duly installed. To combat this issue, local and state governments should intensify efforts geared towards investment in public charging infrastructures. Government should foster policies encouraging the provision of grants, tax credits or rebates and low-interest loans to prospective investors who are interested in the installation of new changing stations or the repair of faulty existing chargers. Additionally, local communities can liaise with the private sector to increase the density of charging stations accessible to xEV road users. The public-private partnership will serve not just to ensure that adequate xEVs are available for consumers, but it will also drive down the purchase cost of xEVs due to economics of scale.

Although a host of factors - battery performance, range anxiety, inaccessibility to charging stations and higher upfront cost all contribute to suppressing demand for xEVs in Canada, the role of consumer perception cannot be overlooked. Regardless of the notion that consumers often site the aforementioned challenges as primary reason(s) halting their switch to xEVs, some of these factors are merely perceived by individuals owing to the fact that humans are skeptical to change, more often than not. This is where an efficiently outlined consumer education plan steps in. By educating prospective buyers on the latest trends in xEV technology, dedicated government and economic development agencies can help to dispel myths relating to xEVs. Emphasis on fuel savings offered by xEVs is a major selling point to ordinary consumers who are attuned to the status quo that conventional ICE vehicles offer more reliability. In the short-term, dissemination of information regarding the location of public charging stations will help ease range anxiety. The private sector can play a role in keeping drivers updated about required charging needs and options by developing innovative applications - as seen in “My Ford Mobile” - which will aid to locate nearby charging stations, provide details on current state of battery charge, estimate charging time required for various charge levels and provide users with calculated information about various probable travel distances depending on the battery charge level of the xEV. Economic developers should ensure that they stay abreast with the various means deployed towards executing these polices, while also keeping up with latest and advanced trends in battery science and technology.

In sum, Canada’s transport sector accounts for about a quarter of the country’s total GHG emissions. Although the past decade has witnessed a relatively slow transition to energy-efficient and low emission vehicles in Canada, the Canadian automotive market still remains a potent tool in the achievement of the United Nations SDGs and the provision of lucrative investment opportunities for the private and public sector. To accelerate the adoption of xEVs in Canada, there should be a national call for heightened emphasis on the importance of R&D in xEV technology, and the provision of robust fiscal policies and financing mechanisms geared towards curbing transport GHG emissions as well as enhancing the demand for xEVs in the country.

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