ENCOURAGING THE RAPID ADOPTION OF ELECTRIC VEHICLES IN CANADA

A position paper by Electric Mobility Canada outlining the benefits of plug-in electric vehicles (PEVs), the current status of PEVs in Canada, their potential benefits, and what is needed to realize the benefits.

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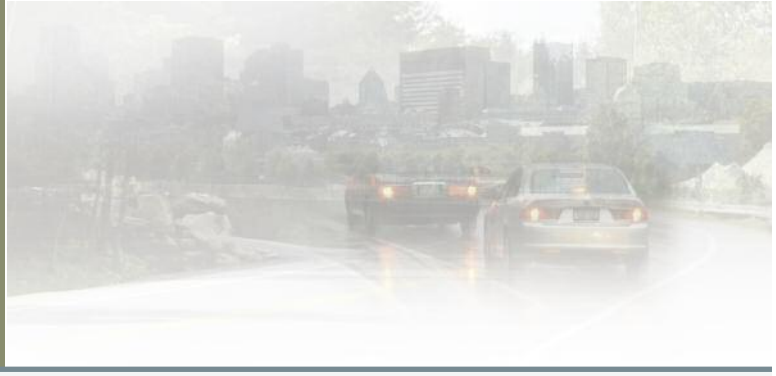
SUMMARY



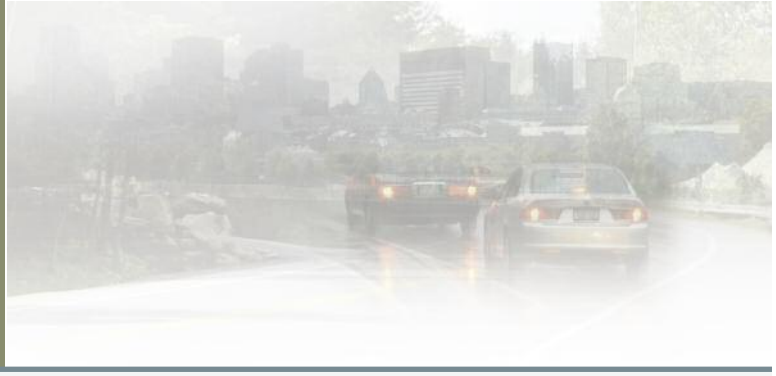
If Canada is to remain a force in electric traction and in automotive production in general, the Government of Canada must encourage the widespread adoption of plug-in electric vehicles (PEVs) in Canada by providing incentives for purchasing and manufacturing them, by supporting the installation of home, workplace, and public charging infrastructure, and by helping ensure harmonization of codes and standards for charging electric vehicles among federal departments, among provinces, and with the U.S.

THE BENEFITS OF ELECTRIC VEHICLES

Some decades from now, most land transportation will be propelled by electric motors rather than by internal combustion engines (ICEs). Currently, ICEs provide almost 100 per cent of the propulsion. The transition, which is just beginning in North America and elsewhere, is occurring for several reasons. These include:

1. **Limited supply and high cost of oil.** There is a growing understanding that the petroleum-based fuels that power ICEs – chiefly gasoline and diesel fuel – are becoming more expensive or in more limited supply, or both. Canada is among a handful of countries that are well endowed with resources for producing these fuels, but is nevertheless exposed to price and scarcity challenges. This is because Canada buys and sells oil on world markets, which determine prices within Canada, and because the lack of Canadian distribution infrastructure makes Eastern Canada heavily dependent on imported oil.

2. **Renewable and nuclear generation.** Electricity can be produced renewably, from water, sun, wind, and geothermally. Worldwide, most electricity is now generated from coal and other fossil fuels.



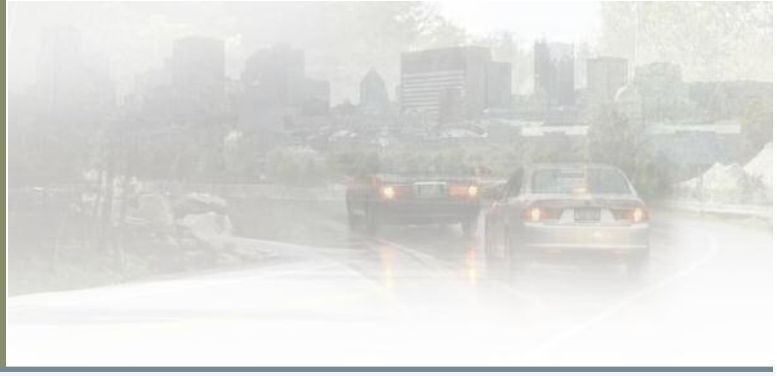
There is potential almost everywhere to provide significant amounts of electricity from renewable or nuclear resources, thereby reducing dependence on coal, oil and other fossil fuels.

3. **Electric vehicles are more efficient.** Electric vehicles use energy much more efficiently than vehicles that use ICEs. As the world's energy constraints grow and become more apparent, electric vehicles' remarkable efficiencies in the use of energy will become more appealing. Electric vehicles have other advantages over ICE vehicles, notably their rapid acceleration at low speeds and potentially low need for maintenance. Moreover, the source of electricity can change, e.g., from gas turbine to solar generation, with no change being required to the transportation system.

4. **Electricity appears to be the most readily available alternative to oil.** An alternative given much attention until recently is to continue to use ICEs but to fuel them with liquids not derived from oil, including liquids from coal and biofuels. Producing liquid fuels from coal is a costly and energy-intensive process that can have major negative environmental impacts. Current production of biofuels is energy intensive and competes with arable land for food production.

Yet another important benefit is reduced emissions both at the vehicle and overall. Over the last 40 years, automobile manufacturers have made significant progress in reducing emissions that contribute to pollution in cities and emissions that contribute to climate change. The transition to electric vehicles allows all emissions to be reduced considerably more, especially when the electricity used is not generated from fossil fuels.

For example, when electricity is generated using hydroelectric or nuclear energy – as three quarters of Canada's electricity is generated – electric traction is responsible for essentially NO greenhouse gas emissions. Road transportation is now directly responsible for 18 per cent of Canada's greenhouse gas emissions. Thus, as more and more road vehicles are propelled by electric motors rather than by ICEs, the scope for reducing emissions of greenhouse gases is substantial.



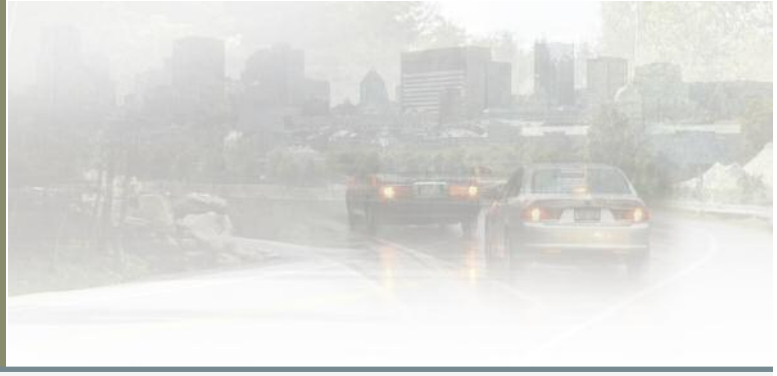
CANADA'S ADVANTAGE

Much of Canada's electricity is produced from hydroelectric sources; in four provinces the proportion is more than 95 per cent. This, together with the substantial nuclear power generation in Ontario, means that only about 25 per cent of electricity generated in Canada is from fossil fuels. This may be compared with the U.S. where more than 70 per cent of the generation is from fossil fuels. Switching to electric traction in Canada is thus much more advantageous in terms of reducing greenhouse gas emissions than in the U.S. and, indeed, more than in most other countries.

About two thirds of Canada's electricity is generated from renewable sources of energy, among the highest proportions in the world. Moreover, Canada has many opportunities to increase its renewable generation, above all through development of more hydroelectric facilities, but also from marine energy near east and west coasts, geothermal energy in western Canada, and wind energy in numerous locations.

TYPES OF ELECTRIC VEHICLES AND PLUG-IN ELECTRIC VEHICLES

There are several types of electric vehicles. The best known are vehicles powered from the grid while in motion. Electric trains, streetcars, and trolley buses are examples. In another type, the power for the electric vehicle's motor is generated on board (as in the hybrids seen on the roads today) or by a fuel cell. **This document focuses on yet another type of electric vehicle, in which electricity is generated away from the vehicle but stored on the vehicle in a battery or other storage device.** For the moment, these plug-in electric vehicles (PEVs) may offer the best opportunity to replace ICE-propelled vehicles on the road today, including many personal automobiles and smaller commercial vehicles.



There are three types of PEVs. The simplest type is the battery electric vehicle (BEV), which is propelled only by one or more electric motors powered from a battery charged from the grid when the vehicle is stationary. The second type of PEV is a BEV with a range-extender. Like other BEVs, it is propelled by an electric motor powered by a battery charged from the grid when the vehicle is stationary. The range-extender is a small on-board ICE that drives a generator that can drive the electric motor or charge the battery, or both, when the energy in the battery gained from charging from the grid is depleted.

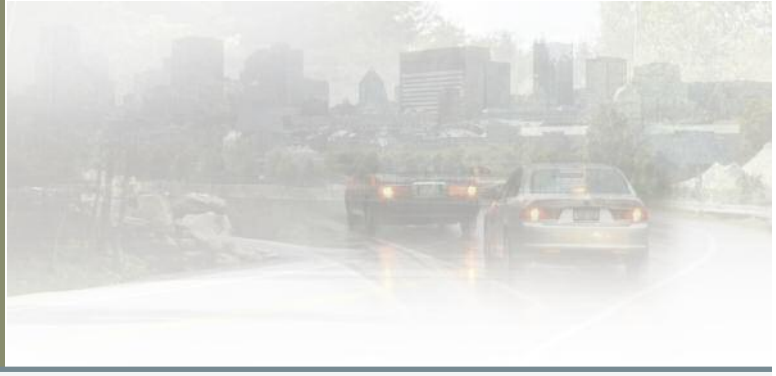
The third type of PEV is the plug-in hybrid electric vehicle (PHEV), which is propelled by an electric motor or an ICE, or both. It has a battery that can be charged from the grid while the vehicle is stationary, or on-board from a generator powered by the vehicle's ICE. PHEVs are similar to hybrid vehicles on the road today except for the big difference that their larger batteries that can be charged from the grid. The batteries in all three types of PEVs can also be charged by what is known as regenerative braking: the energy of motion is transformed into electrical energy, thereby further increasing the efficiency of electric traction.

WHERE THINGS STAND REGARDING ELECTRIC VEHICLES IN CANADA

Regarding motor vehicle production as a whole, Canada has suffered a huge slide during the last decade. In 2000, Canada had by far the largest vehicle production per capita among major producers. By 2009, Canada's vehicle production was half of what it was in 2000, and Japan, Germany, South Korea, and Spain all had higher per-capita production. The U.S. has suffered a comparable slide, but seems to be taking numerous steps to regain its former eminence in automotive manufacturing. Led by the U.S. federal government and some states, many of these steps are focussed on the development and promotion of PEVs.

Here are some of the initiatives of the U.S. federal government regarding PEVs:

- Investments of more than $2 billion are being made in facilities for



manufacturing advanced batteries and electric drive components. One goal is that the number of U.S. factories capable of producing advanced vehicle batteries will grow from two in 2009 to 20 in 2012, raising the U.S. share of world production of these batteries from a negligible proportion to 20 per cent. These investments will also support the construction of ten factories that manufacture electric drive components. These 30 factories will produce components for the production of up to 500,000 PEVs each year.

- Loans totalling more than $2.4 billion have been made to support three of the world's first electric car factories.

- Investments of $400 million are being made to support PEV deployment programs, including programs that will increase the number of public vehicle charging locations from 500 in 2010 to over 20,000 in 2012.

- Also supported is research on numerous potential "game-changers" including semi-solid flow batteries, ultracapacitors, and "all-electron" batteries that could go well beyond today's best technologies.

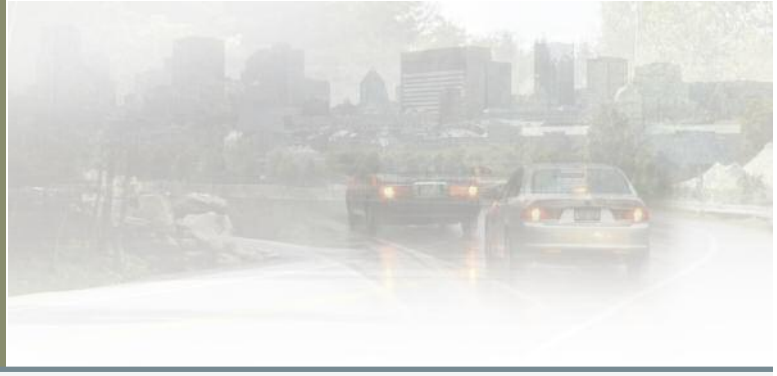
- These moves are complemented by numerous consumer incentives. These include, for example, tax credits for the purchase of PEVs that range from $2,500 to $7,500 according to vehicles' energy storage capacity, to a limit of 200,000 per manufacturer.

- Buttressing these moves have been investments in charging infrastructure, in clean electricity generation, in upgrading electricity grids, and in the development of national codes and standards related to charging and other matters vital to the development of electric traction.

Many other countries are seeking to forge or maintain major positions in the transition to electric traction, notably China but also Japan, Germany, France, South Korea, the UK, and Spain. Some countries, notably China, are making larger investments than the U.S. towards fostering domestic production and use of electric vehicles. (A 50-page table summarizing initiatives in other countries is available at the Web site of Electric Mobility Canada, at *www.emc-mec.ca/en/incentives.php.*) The case of China is especially worth following. In September 2010, Canada's Department of Foreign Affairs and International Trade issued a report on China's electric vehicle sector. It noted that China is now the world's largest automobile producer and market, that all major Chinese automakers are developing electric vehicles, and that "new energy vehicles" – chiefly PEVs – are expected to comprise at least a quarter of Chinese auto production by 2020.

Until a little more than a year ago, Canada was positioned to be at the forefront in the transition to electric traction. It was possible to say the following:

> Canada has an unusually broad range of core competencies in all areas of transport electrification.



> These competences concern batteries, EV systems integration especially for commercial vehicles and low-speed vehicles, and battery management and power management systems. Per capita, at least at the moment, these resources are substantially larger than those in the U.S. ....
> *Electric Vehicle Technology Roadmap for Canada, Page 21*

Much of this statement remains true, but the last sentence becomes increasingly difficult to assert because of the recent massive expansion of the U.S. programs noted briefly above.

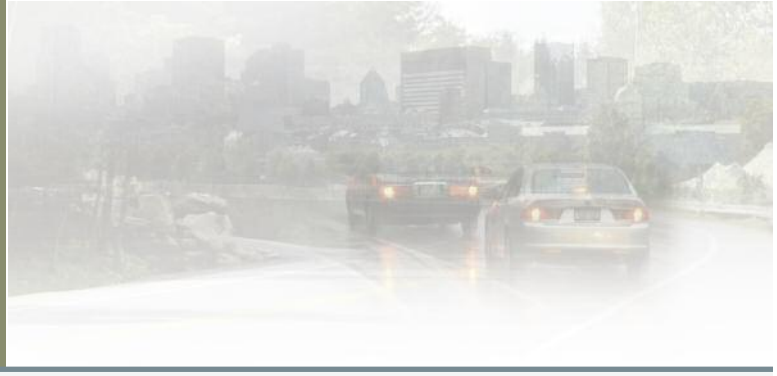
The Government of Canada has continued to invest significantly in various programs supporting energy efficiency and other improvements in ICEs but has not yet invested specifically in PEVs. It has recently taken a step in the right direction by moving to provide larger greenhouse gas emissions credits for electric vehicles sold in Canada than those available in the U.S., as part of the new fuel efficiency regulations for cars and light duty trucks. This was a recommendation of Electric Mobility Canada and is in recognition of the much lower share of generation from fossil fuels in Canada.

However, without further action there could be continued erosion of Canadian automotive production and technology development as the manufacture of PEVs expands in other vehicle-producing jurisdictions and displaces Canadian vehicle and component production.

WHERE THINGS NEED TO BE REGARDING ELECTRIC VEHICLES IN CANADA

The *Electric Vehicle Technology Roadmap for Canada* (at *www.emc-mec.ca/en/roadmap.php*) provides a good guide as to where things need to be.This document was prepared during 2009 by an industry-government group with federal government support. It speaks to ensuring that there are at least 500,000 highway capable PEVs on the road in Canada in 2018. If the number of light-duty vehicles on the road in Canada were to remain at the present level of near 20 million, the share of PEVs would be 2.5 per cent or higher.

This goal for Canada may be compared with the more ambitious goal for the U.S. set out in the *Electrification Roadmap*, produced in 2009 by the U.S. Electrification Coalition, an industry group. The group's overarching goal is that by 2040, 75 per cent of the distance travelled by

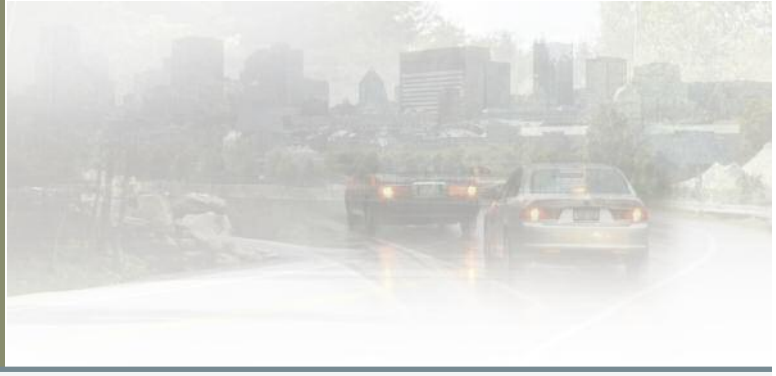


light-duty vehicles in the U.S. should be "electric miles," i.e., miles for "which the vehicle is propelled by an electric motor and not relying on a gasoline engine." A milestone for this goal is that PEVs should comprise five per cent of light-duty vehicles on U.S. roads in 2020, about 12.5 million PEVs in total. Achievement of this goal would require that PEVs comprise 25 per cent of sales of light-duty vehicles in the U.S. in 2020, which, according to the *Electrification Roadmap*, could be as many as five million sales.

The U.S. government's investments and loans noted above will go far towards meeting the Electrification Coalition's 2020 milestone. *The Electrification Roadmap* suggests that meeting the 2020 milestone of up to five million sales of PEVs a year in the U.S. will require sales of some 800,000 PEVs a year by 2015. The U.S. government's investments will provide for production of up to 500,000 PEVs in 2015. The remaining investments, as may be required, could readily come from the private sector.

No similar federal policy positions and programs exist in Canada. A focused PEV policy is needed if Canada is to remain a force in electric traction and in automotive production generally. Such a policy is needed as a temporary measure to stimulate Canada's industry and consumer adoption of PEVs during the period when electric vehicles coming to market are more expensive than ICE vehicles, chiefly because of present battery costs. What is required is that the Government of Canada embrace the modest goal for 2018 set out in the *Electric Vehicle Technology Roadmap for Canada* – ensuring there are at least 500,000 highway capable PEVs on the road – and support attainment of that goal. How this could be done is set out in the next section.

Such policy leadership is likely to be embraced by Canadians. According to a 2009 survey conducted by Environics and Pollution Probe, six in ten Canadians have an interest in purchasing PEVs, more in urban areas. Work by Electric Mobility Canada suggests that the interest among fleet owners could be even higher.



MOVING FORWARD WITH ELECTRIC VEHICLES IN CANADA

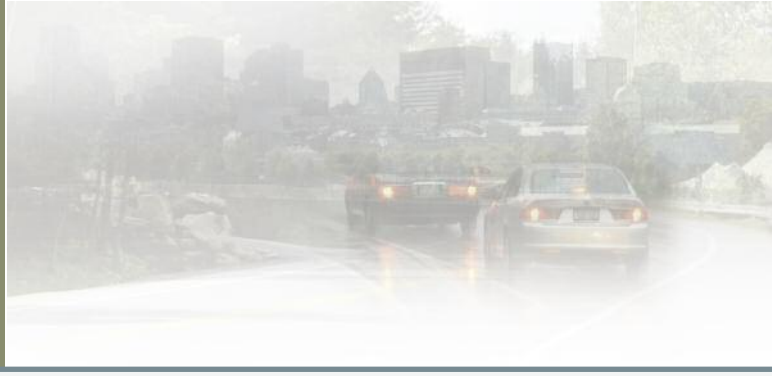
Above all, Electric Mobility Canada believes that the Government of Canada should embrace the target in the *Electric Vehicle Technology Roadmap for Canada*, which is to have at least 500,000 highway capable PEVs on Canadian roads in 2018. For this target to be reached, at least five kinds of action by the federal government will be required:

1. **Codes and standards re. charging.** Helping ensure harmonization of codes and standards among federal departments, among provinces, and with the U.S. will require leadership on the part of the Government of Canada. It will also require modest support (less than $2 million) for the work of the Canadian Standards Association and partners towards developing appropriate Canadian codes and standards.

Although this action is the one of the proposed five that requires the least funding, it is the most urgent item. Without appropriate codes and standards, PEVs may not be able to be sold in Canada, and installation of necessary charging infrastructure could be delayed.

2. **Incentives for the provision of home and business charging facilities.** Most individual and business owners of PEVs are likely to do most of the charging of their vehicles at home or at the business overnight, making the best use of overnight electricity supply surpluses and consequent low costs. This charging can be done from regular sockets – known as Level 1 charging – but could take more time than is practicable. A BEV with a 24-kWh battery could require over 21 hours for a full charge at 120 volts. A BEV with a range extender and an 8-kWh battery could require 8 hours of charging at this voltage. Charging at 240 volts – known as Level 2 charging –can reduce charging time by more than half compared with Level 1 charging. The additional equipment required for Level 2 charging could cost about $2,000 per home – more in the rare instances that the electrical service to a home needs to be upgraded.

Electric Mobility Canada believes the federal incentives for installation of charging facilities in Canada should be at least equal to those in the U.S. The U.S. incentive for home charging equipment is a tax credit of 50 per cent of the cost up to maximum credit of $2,000 per home. For a business, the maximum tax credit is $50,000. The Government of Canada should focus on supporting Level 2 charging and should temporarily refund 50 per cent of the cost of providing charging at this level. A reasonable way of limiting this program would be to terminate it



when the goal of 500,000 PEVs on the road has been reached or a total of $250 million has been refunded, whichever occurs first.

Support for home and business charging installations could be provided through the administrative arrangements available within existing federal government programs such as the ecoEnergy program. This program expires in March 2011, but could be continued as a program to support installation of charging infrastructure.

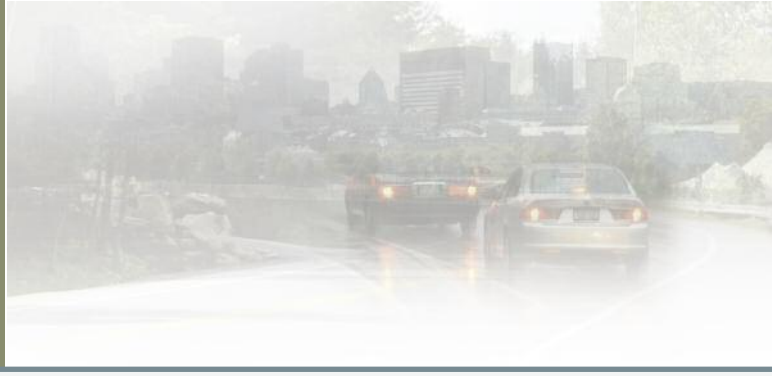
3. **Public charging fund.** Public charging stations will also be required. Initially, incentives may be needed to encourage establishment of public charging stations that provide confidence to PEV users concerned about range anxiety. Public stations will typically provide fast charging – also known as Level 3 charging, at 480 volts or higher – capable of providing a significant charge in minutes. They could cost up to $100,000 per station. Public charging stations could be designed to provide only Level 2 or even Level 1 charging, at much lower cost.

Public charging facilities could be funded through a temporary expansion of the Green Municipal Fund administered by the Federation of Canadian Municipalities. Municipalities that undertake to encourage installation of at least one public charging station for every 50,000 of population could be given the means to refund up to 50 per cent of the installation cost. As for home and business charging, a public charging program could be terminated on attainment of the goal for PEVs on the road or on total expenditure of an agreed amount, whichever occurs first.

4. **Investments and loans in support of electric vehicle production.** As noted above, the governments of other countries with automotive industries, notably the U.S. and China, are investing heavily in electric vehicle production, including advanced batteries and electric drive components. To sustain the Canadian automotive industry, the Government of Canada should provide comparable investments and loans.

These investments and loans could be in proportion to those being made in the U.S. and, as in the U.S., support achievement of specific targets for industrial development. Funds required for investment over the next few years would be in the order of $200 million to $500 million, according to whether the proportion reflects population or size of the automotive industry. Similar amounts would be available for loans.

5. **Incentives for the purchase of electric vehicles by individuals and for fleets.** Electric Mobility Canada believes the incentives provided by the Government of Canada should at least equal those provided by the U.S. government, described above. As in the U.S., federal incentives



should be in addition to incentives provided by provinces and municipalities. These other incentives include, for example, the rebates of between $5,000 and $8,500 per vehicle provided by the Ontario government and up to $8,000 provided by the Quebec government.

The cost to the federal government of such a program would be up to $700 million, assuming an average incentive of $7,000 per vehicle for a limit of 100,000 vehicles. This amount, and the incentives to Canadian electric vehicle production proposed above, could well be what sustain Canada as a major automobile producer.

Electric Mobility Canada believes that endorsement by the Government of Canada of its goal of 500,000 PEVs on the road by 2018 and the temporary actions indicated above will help establish Canada as a leader in the adoption of this environmentally 'game-changing' technology. Furthermore, Canada will be taking full advantage of its massive resource of clean electrical energy, and potential for much more.

ELECTRIC MOBILITY CANADA

Electric Mobility Canada – Mobilité électrique Canada – is a national not-for-profit organization dedicated to the promotion of electric mobility as a readily available and important solution to Canada's emerging energy and environmental issues. The membership of EMC-MEC includes companies engaged in the sale or distribution of vehicles or components or the delivery of professional services, representing all modes of surface transportation from bicycles to trains. Membership also includes providers of electric energy at the provincial and local levels; managers of the vehicle fleets of companies, governments, agencies, and others; related associations, societies, research centres and labour organizations; governments and their agencies; and individual supporters.

Members and non-members of Electric Mobility Canada have been involved in preparation of the present document through a series of meetings and conference calls.

ABBREVIATIONS USED IN THIS DOCUMENT

BEV	Battery Electric Vehicle (vehicle is propelled electrically; battery is charged only from the grid)
ICE	Internal Combustion Engine (propels almost all vehicles today, fuelled by gasoline or diesel fuel)
PHEV	Plug-in Hybrid Electric Vehicle (propelled electrically and by an ICE; battery chargeable from the grid and by and ICE-powered generator)
PEV	Plug-in Electric Vehicle (includes BEV and PHEV and also BEV with range-extender, which is an on-board ICE used only to charge the battery)