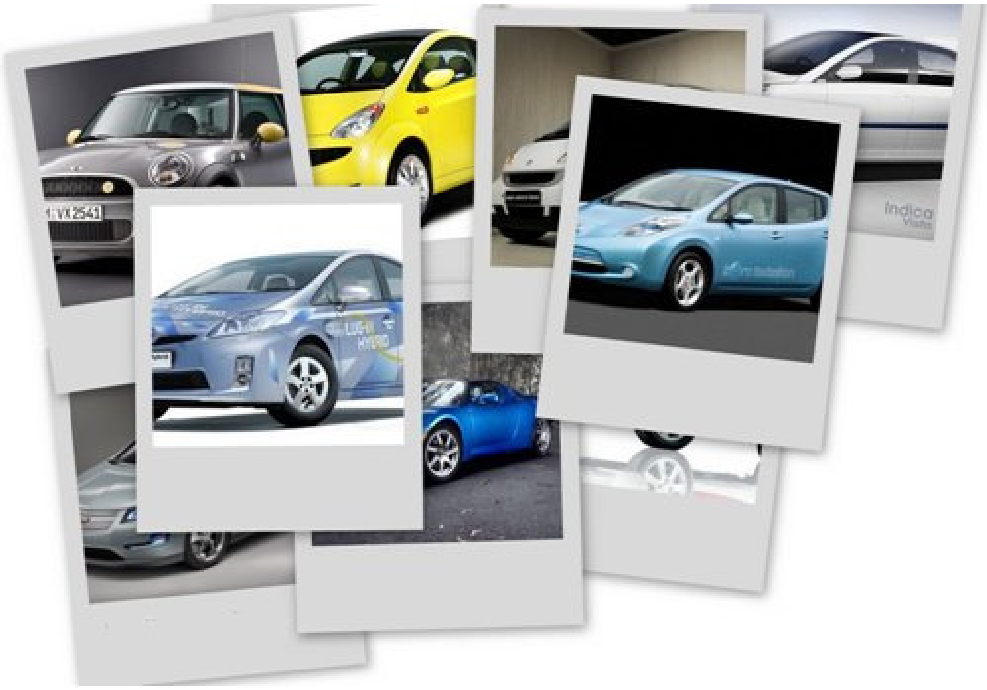

Demonstrating

Electric Vehicles in Canada

March 2010

CNTA
Centre National du Transport Avancé
National Centre for Advanced Transportation

EMC MEC
Electric Mobility Canada
Mobilité électrique Canada

Executive Summary

Transportation is responsible for more than 30 percent of Canadian CO_2 emissions,[i] and more than 40 billion litres of gasoline were sold in Canada[ii] in 2008. Electric Vehicles (EVs) are a growing alternative for internal combustion engine (ICE) vehicles, since they have no direct emissions when in electric mode. Furthermore, their energy comes from the electricity grid, which in Canada is composed of 58 percent renewable energy, such as hydro-electricity[iii]. Although EVs have been considered for a number of years, expensive battery technology and low oil prices have limited their market penetration. However, as superior battery technology and affordability seem near and as Original Equipment Manufacturers (OEMs) announce EV developments every month, EV adoption requires awareness and understanding.

The “Demonstrating Electric Vehicles in Canada” project is part of the Electrical Vehicle Technology Roadmap (evTRM) for Canada. The purpose of this demonstration study is to define the desirable characteristics of Canadian projects that demonstrate Plug-In Hybrid Electric Vehicle (PHEV) and Battery Electric Vehicle (BEV) use in real-world operation, and to determine the appropriate mechanism to collect and disseminate the monitoring data. Additionally, this study defines the desirable characteristics for a “National Aggregator” of demonstration project monitoring data and describes how such an aggregator could be established in Canada.

Electric Mobility Canada (EMC) conducted this study in collaboration with the National Centre for Advanced Transportation (CNTA), with funds provided by Natural Resources Canada (NRCan). The study authors benefited from the counsel of an Advisory Committee.

This report has three main sections:

- Current situational assessment, including demonstration project review and analyses, vehicle availability, and Canadian travel pattern evaluation;
- Demonstration project guidelines, including regulations and standards review, project definition and budget, studied parameters and monitored data, data analyses and charging infrastructure; and
- National Aggregator needs identification, conditions for success, and proposed concept.

Current situational assessment

There are currently five BEV and 11 PHEV projects in Canada, operating around 70 vehicles. Throughout the world, multiple larger-scale projects exist, sometimes operating more than 100 vehicles each, coupled with strong relationships with OEMs. Additionally, most Canadian demonstration projects to date have been focussed on PHEVs, using converted Hybrid Electric Vehicle (HEV) Priuses. Demonstration projects used to be focussed on understanding and assessing EVs’ fuel consumption, emissions, usage and drivers’ behaviour. Recently, however, the projects have expanded their scope to include the surrounding environment, encompassing grid impacts, charging behaviour, building codes, policies and regulations. To assess the potential use of EVs in Canada, an analysis of various Canadian travel patterns was done, and it was noted that commuters in smaller urban areas travel less distance than in large urban areas. Hence, contrary to the usual belief, BEVs range may, indeed, be sufficient for both large and small urban areas. However, to date, projects sizes have been relatively small and mainly focussed on vehicle usage for fleets and suburban users. Small project size, combined with reduced data sharing among projects, has limited the data available for analyses. Analyses are, therefore, only regionally based at best, on vehicles in controlled environments, such as fleets. To date, projects have also been targeted at home and work charging, whereby ownership of the charging infrastructure and billing are easily defined. Although this is satisfying for suburban users and a first step towards mass use of EVs, this data does not represent all users, such as urban users with no garage, and does not answer questions about charging infrastructure ownership, service provider and billing.

Project Guidelines

This report can be used as a preliminary guide for a demonstration project. It lists the various regulations and standards in place for vehicles in Canada. It should be noted that several EV-related regulations are still to be updated or defined, including those for the conversion of ICE vehicles to electric modes. Additionally, budget considerations and project sizing are discussed, since they are intimately related. Data monitoring is also a major aspect of a demonstration project. This document suggests the use of automatic data logging and logbooks to gather data, and it lists all the various parameters that should be monitored in a demonstration project. This list has two objectives: to help new projects in their monitoring by providing a template; and to propose a common monitoring approach to enhance communication, data sharing and results comparison among projects.

The "National Aggregator"

The proponents of recent, current and planned projects demonstrating PHEVs and BEVs in Canada are not currently using data-collection protocols to allow for comparisons of essential data among the projects. Further, since communication between projects and proponents is insufficient, as noted earlier, some demonstration project activities may duplicate each other, without benefit of information sharing on these results. These realities limit the potential benefits to be derived from projects and the dissemination of their results. In view of these findings, this study presents a proposed "National Aggregator" concept to answer these needs through a resource centre, central monitoring and reporting, and the dissemination of results and reports through a dedicated website.

As a result of this study, three main recommendations are elaborated:

Recommendation 1 - Use of the guidelines contained in this report

- R 1.1 – That Canadian proponents of demonstration projects for electric vehicles follow the guidelines offered in this document for the planning, reporting and monitoring of projects, irrespective of their size. Further, the projects should respect the various vehicle regulations in effect at the time of the projects. The benefit of following these guidelines will be a common approach to project definitions, data collection and analyses, which will allow for comparisons across the country and likely with projects outside Canada;
- R 1.2 – That data monitoring using automatic data logging, with minimum reliance on logbooks and other user entry, should be emphasized; and
- R 1.3 – That the collected data, including fuel consumption and/or emissions analyses, be compared to laboratory test data performed in a dedicated lab. This would facilitate comparison of on-road and laboratory data and improvement of laboratory test methods and reporting protocols.

Recommendation 2 - The need for more demonstration projects

- R 2.1 – That Canadian governments and their agencies at all levels collaborate with EV demonstration project proponents and expand their financial and other support to demonstration projects, to ensure their demonstration in all regions of the country and under all climatic conditions;

- R 2.2 – That demonstration projects of different sizes should be targeted based on the desired analyses. At least one major project of more than 100 vehicles should be developed to assess mass deployment impacts of EVs; and
- R 2.3 – That some demonstration projects be targeted at various user groups other than fleet users, with level 2 and off-the-street charging. Although this orientation is not mandatory in the short term, as most early users will own garages, it will assess the needs and the strategy for various users groups for broader EV usage.

Recommendation 3 - The need for a "National Aggregator"

- R 3.1 – That a national resource be established as soon as possible in Canada to act as a National Aggregator for all activities and information important and necessary for the successful management of projects designed to demonstrate EVs in passenger cars and light-duty trucks, as per the model discussed in this report, in both of Canada's official languages. Such a resource could be established within the federal government or within an appropriate external organization;
- R 3.2 – That the dissemination of analyses and reports on demonstration projects should be made readily available through the National Aggregator and targeted at a wide-audience. A dedicated website centralizing these reports should be established, and collaboration with similar agencies beyond Canada should be established; and
- R 3.3 – That all demonstration projects benefiting from public funds be required to collaborate with the National Aggregator in terms of project planning, data monitoring and reporting.

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1 Introduction

The "Demonstrating Electric Vehicles in Canada" project is part of the Electrical Vehicle Technology Roadmap (evTRM) for Canada. The purpose of this study is to define the desirable characteristics of Canadian projects that demonstrate Plug-In Hybrid Electric Vehicle (PHEV) and Battery Electric Vehicle (BEV) vehicle use in real-world operation, and to determine the appropriate mechanism to collect and disseminate the monitoring data. These demonstration projects are meant to assess the reliability and durability of energy storage and other components and the integration of these technologies in the Canadian climate. Additionally, the study defines the desirable characteristics for a "National Aggregator" of demonstration project monitoring data and how such an aggregator could be established in Canada.

Electric Mobility Canada (EMC) conducted the study, in collaboration with the National Centre for Advanced Transportation (CNTA), with funds provided by Natural Resources Canada (NRCan). The study authors benefited from the counsel of an Advisory Committee, with committee members acknowledged in Appendix 1.

Electric Mobility Canada

Electric Mobility Canada–Mobilité Électrique Canada is a national, membership-based organization not-for-profit organization dedicated exclusively to the promotion of electric mobility as a readily available and important solution to Canada's emerging energy and environmental issues.

Membership includes:

- Private sector companies engaged in the sale or distribution of vehicles or components or the delivery of professional services. These members represent all modes of surface transportation, from bicycles to trains;
- Providers of electric energy at the provincial and local levels;
- Managers of fleets from private sector companies, governments agencies and others;
- Related associations, societies, research centres and labour organizations; and
- Government agencies and individual supporters.

Technology Roadmap

The Electric Vehicle Technology Roadmap for Canada (evTRM) is the result of a Canada-wide consultative process held during 2008 and 2009 to help industry, its supply-chain, academic research groups, and governments come together to identify and prioritize the technologies, policies, regulations and other actions needed to accelerate the introduction of electric traction vehicles in Canada. The evTRM Executive Summary identifies 21 strategic initiatives of critical importance over the next five to ten years.

To view the Executive Summary – *http://www.emc-mec.ca/files/EMC-TechnologyRoadmap2009.pdf*.

CNTA – National Centre for Advanced Transportation

The CNTA is a non-profit organization headed by a board of directors drawn from the transportation industry, public services and public transport corporations, research and teaching institutions, as well as from municipal and economic development organizations. The centre has worked in the clean, advanced transportation domain since 1996.

The centre's mission is the promotion of advanced transportation development, mainly for electrical vehicles and new technologies deployment from the perspective of offering environmental, economic and energy benefits. It offers various services, such as technological surveys, expert consultation, industrial development support, product promotion and networking between businesses, clients, suppliers and various governmental levels.

1.1 Background and Intent of Study

The following were adopted at the start of the project:

- Based on real-world demonstrations, the overall goal is to provide performance data in a clear and standard format;
- For consumers, the goal is to get enough reliable information on demonstration to remove uncertainty in purchase decisions, including unique considerations for the Canadian climate;
- For vehicle manufacturers, the goal is to access enough demonstration projects in order to receive sufficient data from customers and suppliers for industry to refine EV designs for the Canadian climate;

- For battery and component manufacturers, the goal is to be certain that batteries have sufficient life under Canadian EV operating conditions;
- For utilities, the goal is to understand the distribution infrastructure requirements (how adoption rate affects generation portfolio and distribution circuits), and to understand long-term viability; and
- For all stakeholders, the goal is to define a national repository for demonstration results and perhaps to set reporting templates, performance metrics and data collection best practices.

However, the specific intent of this project is not to carry out demonstration projects, but rather:

- To define the desirable characteristics of operating Canadian EV projects, in order to demonstrate vehicle use in real-world operation to assess the reliability and durability of energy storage and other components; and
- To define the appropriate mechanism to collect and disseminate the monitoring data.

1.2 Project Scope

This study focuses on passenger cars and light-duty trucks operating in PHEV or BEV modes as defined in section 1.2. It should be noted that many of the processes, techniques and conclusions can also apply to two- and three-wheel vehicles, as well as to larger commercial vehicles.

1.3 Definitions

The following definitions, taken from the evTRM, are used in this report. It should be noted that the term EV is often used as a generic term to include both PHEVs and BEVs

Term	**Usage in this report**
Battery	A device that stores electrical energy chemically.
Battery electric vehicle, BEV	A vehicle powered solely by energy stored in a battery, or by another on-board energy-storage system that requires recharging.
Battery management system	An electronic system that controls charging and discharging of the battery pack and related functions.
Electric vehicle, EV	A vehicle that depends on one or more electric motors for some or all of its traction.
Extended Range Electric Vehicle, EREV	A vehicle that functions as a BEV (see above) for at least 16 kilometres when driven at high speed or aggressively, and that has an auxiliary energy supply that is only engaged when the battery energy is not available to sustain continued operation.
Fuel cell	An electrochemical device for providing electricity that consumes reactant from an external source, which must be replenished.

Hybrid electric vehicle, HEV	An EV (see above) for which an on-board ICE (see below) is the only source of electric power.
Internal combustion engine, ICE	An Otto-cycle or similar engine fuelled by gasoline, diesel fuel, natural gas, biofuel or another combustible liquid or gas.
Plug-in hybrid electric vehicle, PHEV	An EV (see above) that can be recharged with an off-board source of electricity and that has an on-board ICE (see above) to recharge the battery or provide traction, or both.
Plug-in electric vehicle, PEV	An EV (see above) that can be recharged with an off-board source of electricity; it includes both BEV and PHEV (see above).
Renewable energy	Energy that can be naturally replenished within a human lifespan.
Smart grid	A distribution network that allows two-way, digital communication between producers and consumers and transmits electric power in one or both directions.

Demonstration project

A demonstration project for PHEVs and/or BEVs is one in which one or more vehicles of similar or different models are acquired and operated over an agreed period of time for the purpose of demonstrating the performance of the vehicle(s) under operating conditions agreed to by the demonstration proponent(s). During the demonstration period, certain pre-agreed performance parameters are recorded at regular intervals for the purposes of reporting on results at the conclusion of the demonstration. The demonstration project may be funded through private or public sources, or a combination of both.

National Data Aggregator

A national data aggregator is an agency mandated to receive, collate and summarize data and other information received from individual demonstration projects across Canada. This agency would adopt operating protocols that will define which demonstration projects it will enter into its national data base and which data and reports will be made available publicly.

2 List of EV Demonstration Projects

To ensure a comprehensive list of EV demonstration projects occurring in Canada, a project list was sent out to the study's Advisory Committee for review. After completion of the project list, a questionnaire was sent to individuals responsible for the projects to gather additional information. A copy of the questionnaire is available in Appendix 2.

2.1 Projects in Canada

This section contains a list of past, current and proposed demonstration projects in Canada. To qualify, these projects must be/have been on either a BEV or a PHEV car or light-duty truck; conversions of vehicles by individuals are omitted. Below is a map representing the various Canadian projects: green markers indicate PHEV and blue markers indicate BEV projects. Since some cities have more than one project, markers sometimes overlap. Such is the case with Vancouver, which has three EV demonstration projects.

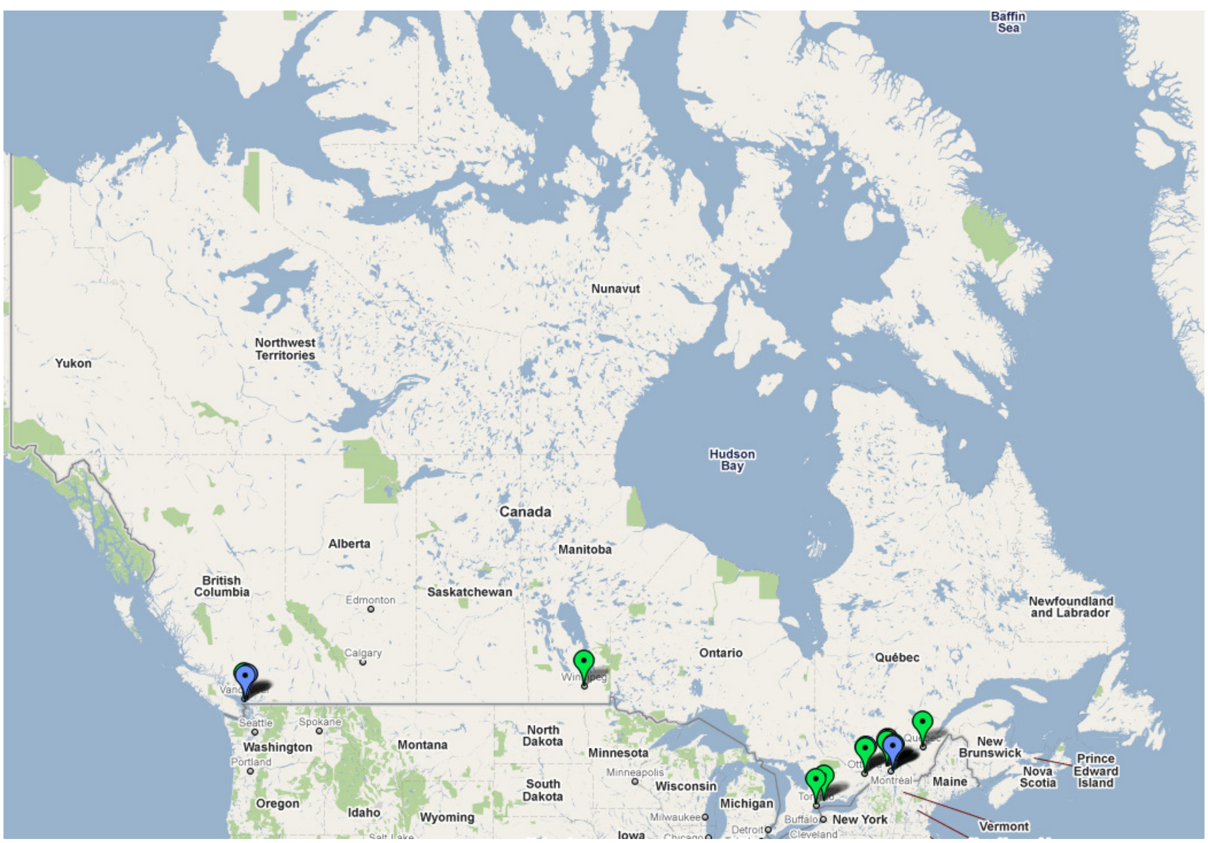


Figure 1. Canadian EV demonstration projects – BEVs are identified in blue; PHEVs are identified in green.

2.1.1 BEV Projects

The following table lists the various Canadian BEV projects. Projects before 2007 usually use Citroën Saxos and Berlingos, and Ford Rangers, while recent projects use Mitsubishi i-MiEVs and Nissan LEAFs.

Name	Year	Location	# of vehicles	Model
Montréal 2000	1999 - 2001	Montréal	24	Solectria, TH!NK, Ford Ranger EV
Hydro-Québec Electrical Vehicle Fleet	2006 - today	Laval & Boucherville	7	Citroën Saxo, Berlingo and Cleanova
St-Jérôme Electrical Vehicle Fleet	2005 - today	St-Jérôme	4	Citroën Saxo and Berlingo
Transport Canada - ecoTECHNOLOGY for Vehicles (eTV) Program	2007 - today	across Canada	4	PT Cruiser converted Tesla Roadster Mitsubishi i-MiEV (2x)
Hydro-Québec EV demonstration	2010 - today	Boucherville	50	Mitsubishi i-MiEV
BC Hydro EV demonstration	2009 - today	Vancouver	1	Mitsubishi i-MiEV
BC Hydro EV demonstration	Not started	Vancouver	N/A	Nissan LEAF
EV300 Initiative - Toronto Atmospheric Fund	Not started	Toronto	N/A	N/A

Table 1. Canadian BEV demonstration projects – Detailed project description can be found in Appendix 3

2.1.2 PHEV Projects

The next table presents the various PHEV demonstration projects in Canada. Almost all projects tested/are testing converted Priuses, using mostly the A123 Systems conversion package, formerly known as Hymotion.

Name	Year	Location	# of vehicles	Model
CNTA PHEV	2010 - today	St-Jérôme	5	Converted Prius (A123)
Toyota Prius Plug-In Hybrid Vehicle Demonstration Project	2010 - today	Canada-wide	13	Toyota Prius PHEV (OEM)
Hydro-Québec EPRI field test program	2009 - today	Boucherville	1	Ford Escape PHEV
Université Laval PHEV	2008 - today	Québec	2	Converted Prius (Modenergy and in-house)
PHEV Manitoba Hydro	2005 - today	Winnipeg	12	Converted Prius (A123 and EnergyCS)
PHEV BC Hydro	2008 - today	Vancouver	13	Converted Prius (A123)
PHEV Veridian	2006 - today	Oshawa	1	Converted Prius (A123)
PHEV ERMS - Environment Canada	2009 - today	Ottawa	1	Converted Prius (A123)
PHEV - Environment Canada	2008- today	Gatineau	1	Converted Prius (A123)
PHEV Biosphère - Environment Canada	2008 - today	Montréal	1	Converted Prius (A123)

Name	Year	Location	# of vehicles	Model
Transport Canada - ecoTECHNOLOGY for Vehicles (eTV) Program	2007 - today	across Canada	1	Converted Prius (A123)
PHEV Fleetwise - Toronto Atmospheric Fund	2007 - 2008	Toronto	9	Converted Prius (A123)

Table 2. Canadian PHEV demonstration projects – Detailed project description can be found in Appendix 3

2.2 Projects in Other Jurisdictions

Demonstration projects done outside Canada can provide very useful lessons for Canadian projects. The following list is non-exhaustive and is intended to provide an order of magnitude of demonstration projects outside our borders. It is worth noting that the U.S. Idaho National Laboratory reports currently include most Canadian and American demonstration projects in one aggregated database and study.

Name	Year	Location	# of vehicles	Model
The EV Project	2009 - today	US	4700	Nissan LEAF
EV America Idaho National Laboratory	1994 - 1999	US	250	Chrysler Epic, Ford Ranger, GM EV1, Chevrolet S-10, Toyota RAV4, Solectria Force, Solectria E10 Pickup, Baker EV100 Pickup
PHEV Idaho National Laboratory	2006 - today	US	227	Converted Prius (A123) and other vehicles
La Rochelle PSA	1992 - 1994	France	50	Peugeot 106 and Partner, Citroën AX, Saxo and Berlingo
TH!NK City EV demonstration program	2001 - 2002	US	340	TH!NK City
Elcidis – Electric vehicle city distribution systems	1998 - 2002	France, Sweden, Italy, Norway, Netherlands	39	Citroën Berlingo and Saxo, Peugeot Partner
Smart ED - Monaco	2010 - today	Monaco	10	Smart Electric Drive
Toyota PHEV	2009 - today	France	100	Toyota Prius PHEV (OEM)
Renault Projet VERT	2009 - today	France, Réunion island	50	Renault EV
BMW Mini E	2010 - today	UK (similar projects in US and Germany)	40	BMW Mini E
CABLED	2010 - today	UK	100	Mitsubishi iMiEV Smart ED Tata Indica EV Land Rover Range_e (PHEV) LTI taxis
Google.org - RechargeIT	2007 - today	US	11	Converted Prius (A123)

Table 3. International demonstration projects short list – Detailed project description can be found in Appendix 3.

3 Canadian Travel Patterns and EVs

The performance of PHEVs and particularly BEVs must meet the range expectations of Canadians; if this is not the case, the consumers may not be inclined to buy them. PHEVs do not pose range limitations, except for the size of the gasoline tank fuelling the on-board internal combustion. BEVs, however, currently have limited range, since they rely solely on their batteries and are typically understood to be primarily marketable in urban areas, where trip lengths are more restricted. This section, therefore, analyzes Canadian travel patterns from large and small urban areas and offers observations on how BEVs can meet these travel pattern needs under both conditions.

The following data is based on Statistics Canada data and analyses. Unless otherwise stated, the statistics are based on one-way trips.

3.1 Canadian Daily Commute Patterns (2006)

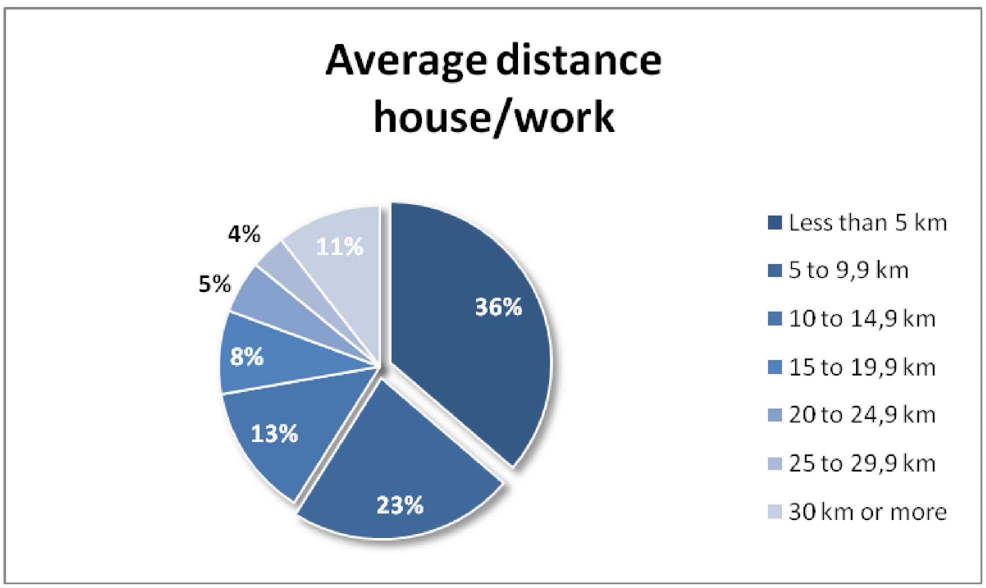


Figure 2. Average commute distance (one-way) for Canadians

In Canada[iv], 89.5 percent of the population travels less than 60 km per day on their return trip to work. Additionally, 59 percent of Canadians live 10 km or less from their work.

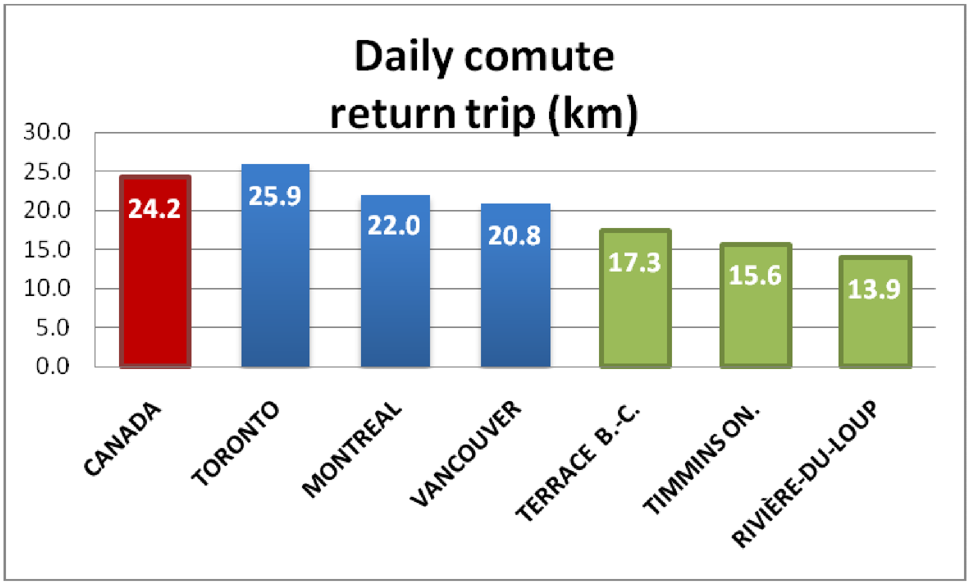


Figure 3. Average regional daily commute (return-trip) for Canadians

There seems to be a significant difference between travel patterns in large urban areas and small urban areas. In Canada, the average daily return trip to work is around 24 km. Toronto has the highest average distance of almost 26 km, above the national average. On the other hand, small urban areas such as Timmins and Rivière-du-Loup have shorter distances that are below the national average by about 10 km.

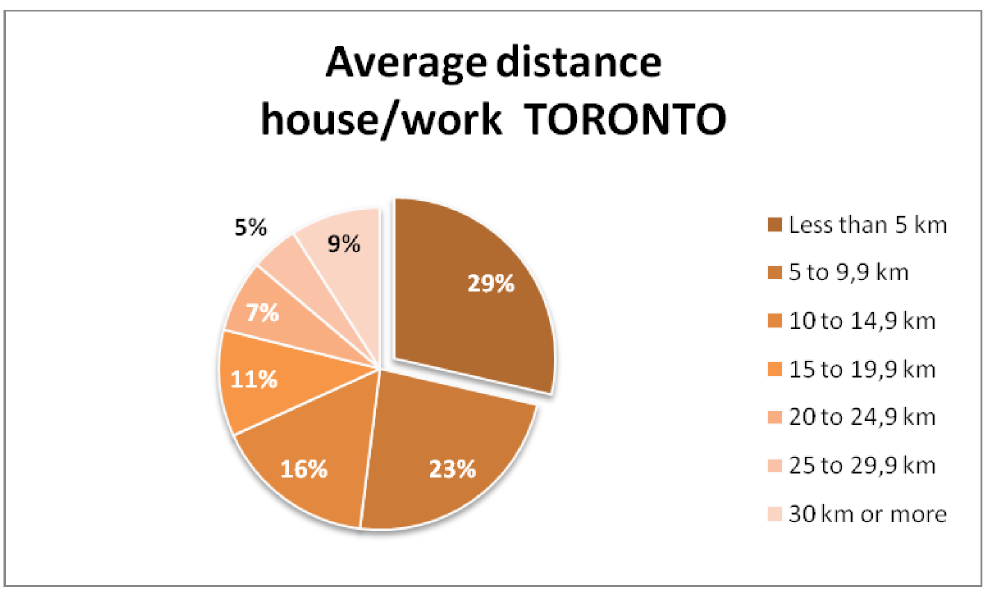


Figure 4. Average commute distance (one-way) for Toronto representing large urban areas

In large urban areas such as Toronto, Montreal or Vancouver, about one-third of the population lives less than five km from their workplace, and half within 10 km. In smaller urban areas, up to two-thirds of the population travel less than five km.

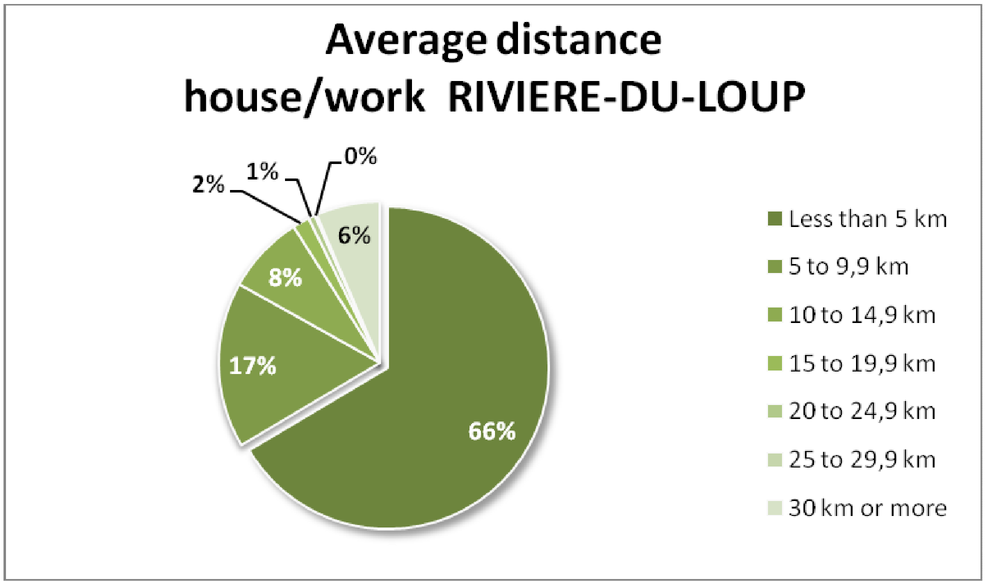


Figure 5. Average commute distance (one-way) for Rivière-du-Loup representing smaller urban areas

More than 80 percent of people live within 10 km of their workplace in smaller urban areas such as Rivière-du-Loup, compared to 50 percent for large urban area like Toronto.

3.2 EVs' Capability of Meeting this Travel Demand

In Canada, about 12 million workers[v] use their car, light-truck or van, as driver or passenger, to commute to work on a daily basis. Of that number, a large percentage could change from a conventional ICE-powered vehicle to hybrid, plug-in hybrid or electric vehicle within a few years, as coming EVs can cover commuters' needs.

The study of Canadian driving patterns shows a significant proportion of Canadians living within a reasonable distance of their work. Assuming that PHEVs will offer 25 km of all-electric range (without requiring recharging from the ICE), this would mean that about 60 percent of Canadians could commute via a PHEV without using any fossil fuels. This proportion would rise to 86 percent if they could recharge their vehicles both at work and at home, reaching a full 50 km of all-electric travel with zero direct emissions. These represent significant possibilities for switching from ICE to EV modes, with corresponding reductions in the use of fossil fuels and emissions.

The same applies to BEVs. Of course, outside temperature will have an impact on the battery capacity but will never modify the commute distance. Therefore, if a BEV designed with lithium-ion batteries offers a range of 120 km at 22°C, we can expect this range to be reduced by about 18%[vi] when outside temperature would be -18°C. This would leave 98 km of available range before the BEV would require recharging, which is enough for more than 90 percent of Canadians for their daily commute.

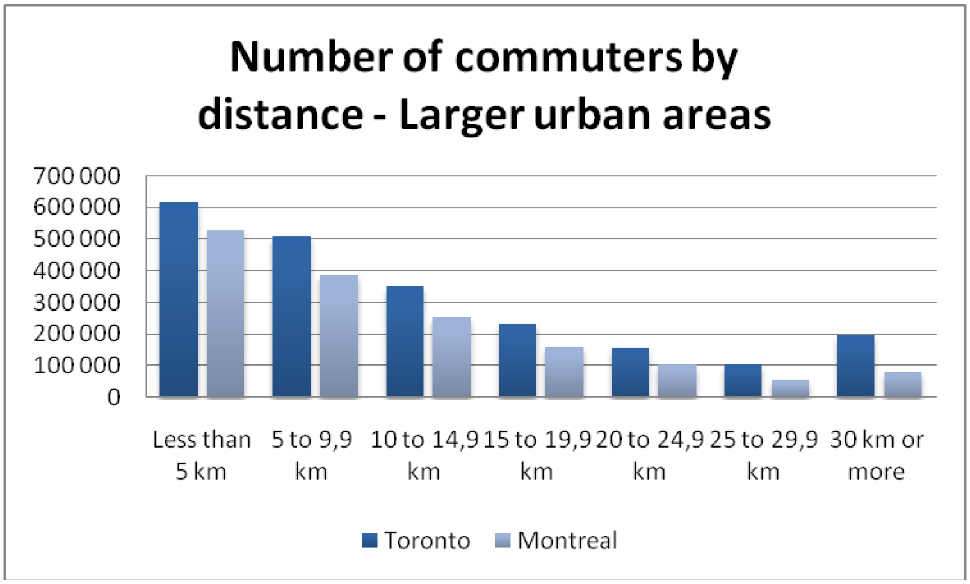


Figure 6. Number of commuters for larger urban areas

In urban areas such as Toronto and Montreal, we can observe, based on this data, that a large number of Canadians could use PHEVs and EVs to commute each day. Just in these two cities, more than two million Canadians could be using zero-emission vehicles offering a minimal range of 40 km.

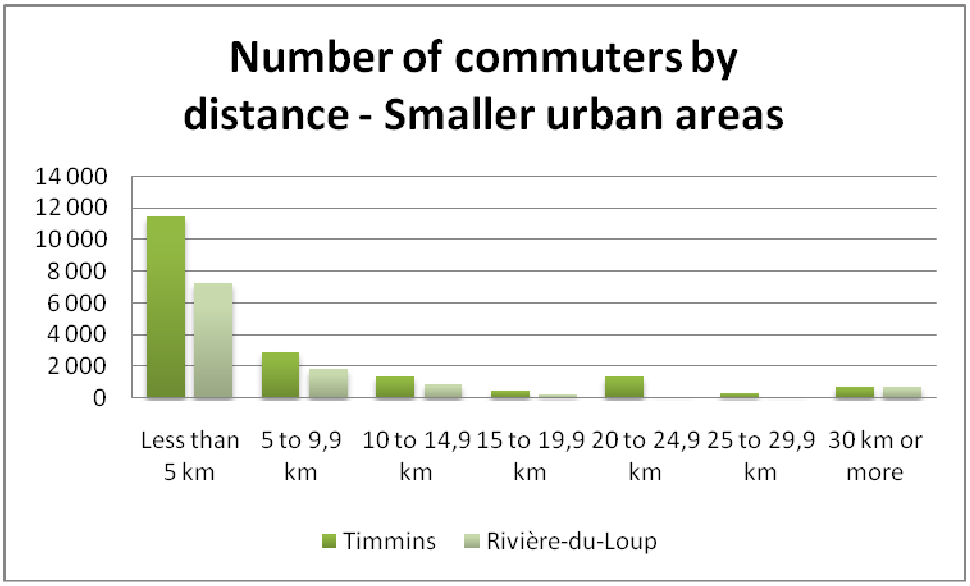


Figure 7. Number of commuters for smaller urban areas

In smaller urban centres, such as Timmins, Ontario and Rivière-du-Loup, Québec, most of the population could be satisfied with an even more range-limited vehicle for their daily commute.

Thus, BEVs and PHEVs vehicles are considered suitable for a very large number of Canadian commuters on a daily basis, on the basis of these commuter patterns. Of course, batteries will have to offer a minimum range independent of the outside temperature. Lithium-ion batteries seem to suffer about a 4.5 percent decrease in energy for each Δ-10°C[vii], which is much better than other battery chemistries used in the past. The following graph shows that Canadian temperatures can vary, on average, from 27°C in summer to -14°C in winter (see Appendix 4 for additional details). Hence, the study of temperature impacts should constitute a major analysis in any demonstration project, since battery performance could vary in very cold weather, especially at peak temperatures.

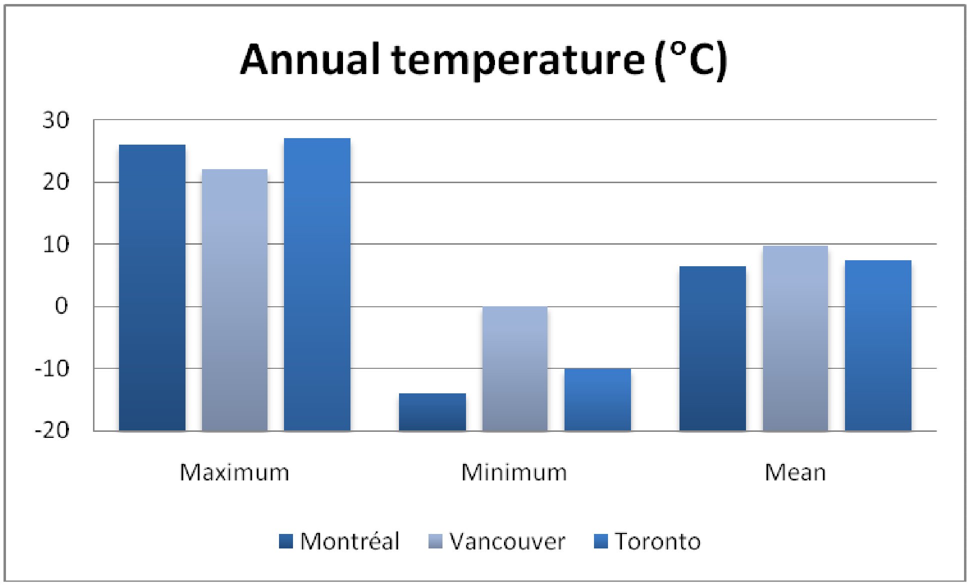


Figure 8. Daily temperature average for major cities in Canada

BEVs will also need to offer the same comfort and performance level as conventional ICE vehicles; their range may not, in fact, be the main concern for daily trips. Weekend trips and vacations may require additional range or even range extenders to increase BEV penetration in the market. This problem is not as important as it might seem at first. There are more than 13 million households[viii] and more than 20 million automobiles in Canada[ix], which makes for 1.5 vehicles per household. Thus, a large amount of Canadian households have more than one vehicle. A limited-range vehicle as a second car would not affect weekend trips, which would mostly be done in the largest car the household owns.

And yet, In fact, several demonstration projects are needed in all regions of Canada to validate the previously stated surmise that BEVs and PHEVs can answer the daily commute needs of the majority. Also, demonstration projects are needed for education purposes, since people typically don't forget to put fuel in their conventional ICE vehicles, but they might forget to plug in their vehicles overnight.

4 Availability of EVs in the Near Future

The availability of electric vehicles has been under discussion for a decade or more. Over the past three years, traditional OEMs, as well as smaller emerging companies, have been working on projects to make EVs available in the near future. The car and light-truck industry is evolving; a major change is occurring. Traditionally, the value of a car resided in the image (reliability, prestige, performance, etc.), brand and looks, as well as in the OEMs' equipment and engine, with Tier One and Two suppliers developing most of the accessories. As BEVs and PHEVs emerge, however, the key vehicle value will reside in the batteries. Most batteries are manufactured by companies not normally associated with vehicles, but more with consumer electronics, such as Panasonic, Sony, Toshiba, LG and many more. As this transition continues, the cars and light trucks, as well as the business models behind them, will be modified to include more players, beyond the OEMs, in the development, production and marketing of EVs. Newcomers will emerge, while traditional OEMs will adapt in various ways, likely probably in a much different automotive industry ten years from now. In the meantime, a list of vehicles being commercialized in the coming years is shown in Appendix 5.

4.1 BEVs in the Near Future

A number of BEVs will be available in the coming months. However, most are not planned for Canada in the near term. The smaller Canadian market is considered less attractive for manufacturers of electric vehicles, and the Canadian climate imposes additional constraints compared to a milder climate. There are other barriers to entry, such as Canadian-specific regulations on bumpers and running lights. The complete list of constraints can be found in Appendix 5.

4.2 PHEVs in the Near Future

A PHEV can be described as an electrically rechargeable vehicle equipped with an ICE. Manufacturers are using different approaches in combining mechanical and electrical power to move a vehicle, from a series hybrid to a parallel hybrid or a power-split configuration. For simplification purposes, we will not distinguish between them. Additionally, manufacturers have different strategies for all-electric range, which can vary from 10 to 60 km, largely related to the amount of on-board batteries. A number of PHEVs will be available in the Canadian market in the coming years. The market penetration of PHEVs compared to BEVs should be greater as they offer the security of an ICE and their usage is much similar to standard HEVs. The complete list can be found in Appendix 5.

5 The Regulatory Framework for Demonstration Projects in Canada

Compared with ICE vehicles, EVs introduce various new parameters in vehicle regulation, such as the capacity to be recharged, and thus the necessity for a physical link with the electric grid. Additionally, the EV powertrain and accessories, such as HVAC, are different than in the usual ICE vehicle. This document presents the regulations currently in place in Canada. It also introduces the various standards that should be followed.

5.1 Federal Regulations for All Vehicles

Vehicles are subject to regulation for the duration of their life. When sold as new, the vehicles must comply with the *Federal Motor Vehicle Safety Regulations*[x]*Act* and its standards, the Canadian Motor Vehicle Safety Standards (CMVSS). These regulations are under Transport Canada's jurisdiction. The other standard that commercial vehicles must meet is the *On-Road Vehicle and Engine Emission Regulations*[xi]*,* which is under Environment Canada's jurisdiction.

The standards are written for conventional ICE vehicles and basically mirror the American legislation covered by the *National Highway Traffic Safety Administration*[xii]. There are some differences between the American and Canadian regulations that restrain vehicles sold in the U.S. market from entering the Canadian market. These differences[xiii] are being addressed by the *Canadian Automotive Partnership Council* and described by the *Regulatory Harmonization Working Group*[xiv]*.* These differences are listed below:

CMVSS #	**Title**	**Details**
CMVSS 101	Location and Identification of Controls and Display	Canadian regulation requires metric cluster (speedometer/odometer) and permits/requires ISO symbols.
CMVSS 108	Lighting System and Retroreflective Devices	Canadian standards require daytime running lights.
CMVSS 114	Immobilizer	Most new vehicles sold in Canada are currently equipped with immobilizers, which can shut the vehicle down or prevent the vehicle from operating if the ignition is by-passed.
CMVSS 201	Occupant Protection	Not as stringent as FMVSS 201 - CMVSS 201 was not amended to adopt the FMVSS Final Rule that was effective September 1, 1998
CMVSS 205	Glazing Materials	References ANSI Z26 1996, but allows testing to ANSI Z26 1990 at the manufacturer's option.

CMVSS #	Title	Details
CMVSS 208	Frontal Impact Occupant Protection Standards	Transport Canada has proposed requirements for Canadian Motor Vehicle Safety Standard (CMVSS) 208 for Frontal Occupant Protection that are not harmonized with the belted requirements contained in the recently amended U.S. Federal Motor Vehicle Safety Standard (FMVSS) 208.
CMVSS 214	Side Door Strength	Does not include dynamic test requirements; however, manufacturers have signed a Memorandum of Understanding that commits Canadian Automotive Partners to market vehicles that meet FMVSS 214 and satisfy the OOP Guidelines developed by the Alliance Transport Canada requires Canadians to make certain modifications to certain admissible vehicles imported from the U.S..
CMVSS 215	Bumpers	Canadian standards stipulate an impact to the front or rear of the vehicle at 8 km/h (5 mph) and pendulum impacts on the corner of the vehicle at 4.8 km/h (3 mph). The Canadian test allows for minimal exterior damage as long as there is no damage to or degradation of the performance of the overall vehicle safety systems or vehicle performance. The U.S. standard, by comparison, requires front and rear impacts at 2.5 mph (4.0 km/h) and pendulum corner impacts at 1.5 mph (2.4 km/h) - only half the speed of Canadian tests. The U.S. test permits no damage or permanent deformation of the vehicle, other than cosmetic scratches on bumper covers and sight shields.

Table 4. CMVSS regulations for passenger vehicles

Most automakers have commitments for BEVs and PHEVs to enter the U.S. market. This means that these vehicles will meet all FMVSS requirements, but differences between Canadian and American standards will undoubtedly delay the process for their introduction in Canada. The lack of harmonization in standards means that the automakers might wait until they feel that entering the Canadian market is worth making the efforts required to meet all CMVSS standards.

5.2 BEV Regulations

5.2.1 Federal Regulations

New electric vehicles must comply with the Schedule III[xv] of the CMVSS[xvi] regulations to be sold in Canada. The tables below list all regulations that must be met by Multi-Purpose Passenger Vehicles (MPPVs) Vehicle or Passenger Car (PCs).

CMVSS	Description	MPPV	PC
101	Location and Identification of Controls and Displays	X	X
102	Transmission Control Functions	X	X
103	Windshield Defrosting and Defogging	X	X
104	Windshield Wiping and Washing System	X	X
105	Hydraulic and Electric Brake Systems	X	

CMVSS	Description	MPPV	PC
106	Brake Hoses	X	X
108/108.1	Lighting System and Retroreflective Devices	X	X
110	Tire Selection and Rims for Motor Vehicles With a GVWR of 4 536 kg or Less	X	X
111	Mirrors	X	X
113	Hood Latch System	X	X
114	Theft Protection and Rollaway Prevention	X	X
115	Vehicle Identification Number	X	X
116	Motor Vehicle Brake Fluids	X	X
118	Power-Operated Window, Partition and Roof Panel Systems	X	X
120	Tire Selection and Rims for Motor Vehicles With a GVWR of More Than 4 536 kg	X	X
124	Accelerator Control Systems	X	X
126	Electronic Stability Control Systems	X	X
135	Light Vehicle Brake Systems	X	X
201	Occupant Protection	X	X
202	Head Restraints	X	X
203	Driver Impact Protection and Steering Control System	X	X
204	Steering Column Rearward Displacement	X	X
205	Glazing Materials	X	X
206	Door Locks and Door Retention Components	X	X
207	Anchorage of Seats	X	X
208	Occupant Restraint Systems in Frontal Impact	X	X
209	Seat Belt Assemblies	X	X
210	Anchorages Seat Belt Assembly	X	X
210.1	User-ready Tether Anchorages for Restraint Systems		
210.2	Lower Universal Anchorage Systems for Restraint Systems and Booster Cushions	X	X
212	Windshield Mounting	X	X
213.4	Built in Child Restraint Systems and Built	X	X
214	Side Door Strength	X	X
215	Bumpers		X
216	Roof Crush Resistance	X	X
219	Windshield Zone Intrusion	X	X
220	Rollover Protection	X	X
301	Fuel System Integrity	X	X
302	Flammability of Interior Materials	X	X
305	Electrolyte Spillage and Electrical Shock Protection	X	X
401	Interior Trunk Release		X
1106	Noise Emissions	X	X

Table 5. Schedule III - Canada Motor Vehicle Safety Standards (Partial C.R.C., c. 1038)

The other national standard that concerns new vehicles sold in Canada is the *Canadian Environmental Protection Act*[xvii], called the *On-road Vehicle and Engine Emission Regulations*.

CEPA	Description	MPPV	PC
P.C. 2002-2164	On Road Vehicle and Engine Emmission Regulations	X	X

Table 6. Canadian Environmental Protection Act, 1999

5.2.2 Provincial Regulations

Provincial governments may constrain the type or categories of vehicles allowed on their roads; such is the case for Low-Speed Vehicles, Electric Bicycles or Three-Wheel Vehicles. After-market conversions of vehicles are also a matter of provincial jurisdiction.

5.3 PHEV Regulations

5.3.1 Federal Regulations

An OEM's PHEV will have to meet all the same federal vehicle standards as BEVs.

5.3.2 Provincial Regulations

Provinces also refer to the federal regulations for PHEVs, and there are no issues raised at the vehicle level for the moment.

5.4 Conversion of Vehicles to Electric Traction

5.4.1 Federal Regulations

Federal regulations only apply to *new* vehicles, which must comply with all CMVSS regulations. Therefore, the federal legislation is not concerned with the conversion of ICE vehicles to PHEV or BEV mode. Regulations for these conversions are under provincial jurisdiction.

5.4.2 Provincial Regulations

Provinces currently have some regulations concerning craft-made/converted vehicles. The provinces can have additional vehicle requirements and also have the power to authorize or refuse road access to non-certified, hand-built vehicles. Although these are not covered in detail here, additional information can be found on the Ministry of Transportation website of each province, or with regulatory agencies such as the Québec SAAQ. Converted vehicles have been known to be more complicated to certify in certain provinces.

As recommended in the evTRM, harmonized regulations are needed in each province and territory, which would allow for the conversion of ICE vehicles to either PHEV or BEV without compromising the basic safety features of the converted vehicles.

5.5 Experimental or Demonstration Projects

Schedule VII[xviii] – *Declaration of Importation of a Vehicle for Exhibition, Demonstration, Evaluation Testing or Special Purposes* is a special permission given by Transport Canada to facilitate temporary importation of vehicles for specific identified purposes. This document was intended for a limited number of units being imported for certification processes or other special purposes, such as vehicle demonstration projects. This special permission is given for a 12- month period, but Transport Canada may, when the request is properly justified, renew these temporary importation permissions. The documentation and additional information may be found on Transport Canada's website. It should be noted that this permission is for imported vehicles and is not for a Canadian-made vehicle. Canadian-made vehicles need to comply for certification and can't obtain a special permission; this complicates Canadian vehicles development since, for example, a Japanese OEM could import temporarily an uncertified vehicle, but a Canadian-made vehicle could not be used until it is certified.

5.6 Electrical and Charging Infrastructure

5.6.1 Canadian Standards Association (CSA) Standards

On the infrastructure side, the Canadian Electrical Code (CEC) defines what can be connected to the grid. Any electrical apparatus, as well as the power it can draw from certain types of outlets, must comply with certain CSA standards; this can be an obstacle to certain demonstration projects. Some chargers may comply with CE or Japanese standards but may never have received approval to a CSA standard. The CEC is provincially and territorially regulated and requires approval on all electrical equipment used in electrical installations within a given jurisdiction. Without such approval, it is illegal to connect them to an electrical outlet in Canada.

In general, until the appropriate electrical safety standards are in place in Canada, approvals can be granted through a Special Inspection process. Essentially this is a one-off approval process only good for a limited time period. Although this situation is temporary for EVs, it cannot be considered a viable, long-term option for mass production. It is suitable for prototype/demonstration vehicles in limited quantities. The following CSA standards are of interest in the demonstration of PHEVs and BEVs.

CSA Standard	Description
CSA C22.1	Canadian Electric Code (v2009), specifically section 86
CSA C22.2 no. 107.1-01	General Use Power Supplies
CSA C22.2 no. 107.2-01	Battery Chargers

Table 7. CSA regulations

5.6.2 United Laboratories (UL) Standards

The following list of Underwriter Laboratories standards may be referenced for a demonstration project, but these have not yet been harmonized in Canada as standards:

UL Standard	Description
UL 62	Flexible Cords and Cables
UL 2031	Perimeter Fire Containment Systems
UL 2202	Electric Vehicle (EV) Charging System Equipment
UL 2231-1	Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements
UL 2231-2	Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems
UL 2251	Plugs, Receptacles and Couplers for Electric Vehicles
UL 2580	Investigation for Batteries for Use in Electric Vehicles (Outline of Investigation)
UL 2594	Electric Vehicle Supply Equipment (Outline of Investigation)

Table 8. UL standards

5.6.3 Society of Automotive Engineers (SAE) Standards

The SAE has also recently approved a standard connector for EV/PHEV recharging. The "J1772*-Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler" standard might very well become the de-facto standard in Canada. The lack of a unique connector has long been seen as an obstacle for massive EV deployment. Every project should try to adopt this connector. The following SAE standards are of interest in the demonstration of PHEVs and BEVs:

SAE Standard	Description
J-1766*	Recommended Practice for EV and HEV Battery System Crash Integrity Testing
J-1772	Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler
J-1797	Recommended Practice for Packaging of electric Vehicle Battery Modules
J-1798*	Recommended Practice for Performance Rating of EV Battery Modules
J-2288	Life Cycle Testing of EV Battery Modules
J-2289	Electric-Drive Battery Pack System: Functional Guidelines
J-2380	Vibration Testing of Electric Vehicle Batteries
J-2464	EV and HEV Rechargeable Energy Storage System (RESS) Safety and Abuse Testing
J-2758	Determination of the Maximum Available Power form a Rechargeable energy Storage System on a Hybrid Electric Vehicle

Table 9. SAE standards – (*) Not available for purchase at this time (under development).

5.6.4 International Standards Organization (ISO) Standards

ISO standards are universally accepted standards. Although they are not mandatory in Canada, ISO compliant vehicles are usually an indication of quality. The following ISO standards are of interest in the demonstration of PHEVs and BEVs.

ISO Standard	Description
6469-1:2009	Electrically propelled road vehicles -- Safety specifications -- Part 1: On-board rechargeable energy storage system (RESS)
6469-2:2009	Electrically propelled road vehicles -- Safety specifications -- Part 2: Vehicle operational safety means and protection against failures
11955: 2008	Hybrid-electric road vehicles -- Guidelines for charge balance measurement
12405-1	Electrically propelled road vehicles -- Test specification for lithium-Ion traction battery systems - Part 1: High power applications

Table 10. ISO Standards

5.6.5 Building Codes and Municipal Regulations

The National Building Codes serve as a model for building codes in provinces and territories. Some municipalities have their own building codes and can enforce additional regulations. In some cities there is regulation on the ventilation requirements of battery charging spaces as well as water/humidity levels in electrical equipment rooms. These can be obstacles to EV projects. Battery charging gas emissions are no longer a problem with lithium-ion chemistries but regulations do not differentiate between hydrogen producing lead-acid and more modern chemistries. Building codes can also limit the possibility of installing infrastructure outside buildings or in some residential areas. Municipal by-laws may also forbid installing public chargers on the street as they may be considered refuelling activities.

6 Desirable Characteristics of EV Demonstration Projects

The following can be described as a guideline for future BEV and PHEV demonstration projects in Canada. The purpose is to define the desirable characteristics of a project. The guideline will mainly focus on the studied parameters and the data monitored, since the ultimate goal is to include the results of all studies in a single national database. Hence, each study must have common parameters, both to compare the results and to merge them in a common database as necessary for national analysis and reporting.

6.1 Project Characteristics

Demonstration projects on EVs are initiated for multiple goals and from diverse perspectives. However, the users, the fleet managers, the utility companies or the manufacturers all have a common goal of both understanding and promoting PHEV or BEV use.

Goals adopted for EV demonstration projects usually include some of the following:

- Assist and assess users in understanding the benefits and the challenges of using a PHEV or BEV;
- Evaluate the cost and the overall financial impact of using an EV;
- Define the charging infrastructures needs, locations, market and size;
- Evaluate the impact on the grid of vehicle-charging operations;
- Identify barriers in the municipal, provincial or federal policies; and
- Evaluate the behaviour change needed for the adoption of EVs and PHEVs.

To meet the needs of a National Aggregator, as discussed in Section 8, the project description sheet should include the following:

Parameter
Project name
Project description
Project start and end date
Project goals
Number of vehicles
Location
Desired outcome
Main contact
Project Sponsor
Budget
Participants and vehicle users list and description

Table 11. Project description list for a potential National Aggregator

6.2 Vehicle Characteristics

After the project goals definition, the demonstrated vehicles' specifications and descriptions should be detailed. Section 4 and Appendix 5 present a list of available and future EVs. The vehicles used in demonstration projects may be brand new OEM vehicles, converted new or used vehicles. The decision on this is mainly based on budget and vehicle availability. Until recently, pure BEVs were not easily available from OEMs, and the existing models, if any, did not necessarily comply with Canadian regulations. Because of this, most Canadian studies are based on converting existing Toyota Priuses into PHEVs, using conversion kits available from a recognized manufacturer. Replicating the conversion in each demonstration vehicle is important to obtain comparable and useful study results, especially if the vehicle is being studied for reliability and usage. A self-made conversion kit might be useful for analysis purposes but can't be a reliable source of information if the study's conclusions are meant for more than general comprehension, discovery or high-level sizing. See section 5 for Canadian regulations on vehicles.

In order to properly define the vehicle, every demonstration project should include a specifications sheet for each vehicle model used, with common criteria. This step is essential for the analysis, the comparison between projects and to reach valuable conclusions. Listed below are the specifications needed to properly identify the vehicle – this should be done for all vehicles models in the demonstration project:

Parameter	**Unit**
Brand	-
Model	-
Brand and model of added kit (if conversion)	-
Propulsion type (EV or PHEV)	-
Vehicle type (2 doors, etc)	# of doors
Vehicle country of origin	-
Vehicle registration (temporarily imported, conventional)	-
Manufacturer specified range (all electric range for PHEV)	km
Battery chemistry and manufacturer	-
Battery capacity	kWh
Battery power	kW
Battery voltage	V
Battery cooling method	-
Battery cell equalization available	-
Battery pack useful SOC	%
Battery load curves (discharge and recharge)	-
Motor peak and constant power	kW @ rpm
Motor peak and constant torque	Nm @ rpm
Engine peak power (HEV)	hp @ rpm

Engine peak torque (HEV)	Nm @ rpm
Vehicle gross weight	kg
Vehicle net weight	kg
Capacity (seats)	# of seats
Charger location (on-board, off the vehicle, etc)	-
Charging plug standard (SAE, other)	-
Charging voltage (120V, 240V, etc.)	V

Table 12. Vehicle characteristics list

6.3 Budget Guideline for Projects

6.3.1 Funding

Demonstration projects usually don’t have direct return on investment. Hence, their funding may sometimes be problematic and tedious to achieve, which should not be overlooked in project planning. This step is crucial to the success or failure of a demonstration project. When public funds are involved, the funding agencies may ask for certain criteria that were not intended in the project’s initial plans.

For now, projects are mostly incorporated in public and private companies’ fleets, and project owners can be grouped according to the following categories:

- Utility companies (B.C. Hydro, Manitoba Hydro, etc)
- Cities
- Not-for-profit organizations (Toronto Atmospheric Fund, etc.)
- Universities (Université Laval, UOIT, etc.)
- Federal and Provincial Governments and their agencies (Natural Resources Canada, etc)
- Manufacturers (A123 Systems, Nissan, Modenergy, etc)

Most projects in Canada have so far received both private and public funds. Various support programs are available, at all levels of government, through different ministries or agencies. The PERD program from NRCan, for example, has sponsored multiple projects in recent years.

Additionally, depending on the vehicle’s end-users, the project team can diversify its funding options. For example, a vehicle-sharing project could develop a partnership with a public-transit authority and a municipality to propose a combined service offering, allowing vehicles users’ new commuting opportunities, with access to both the public-transit system and a reserved parking section near this public transit. By having both partners offering their service free of charge, for instance, their membership in this service could offset some of the project costs. Another possibility is sponsorship. For instance, a major corporation could sponsor the vehicle charging by providing free charging on its premises (Wal-Mart or McDonalds, for example) or by providing free charging when a vehicle operator is purchasing its products (buy a Coke, get a free charge). Obviously, having users pay for the vehicle and their usage is another way of reducing demonstration project costs.

6.3.2 Vehicle Purchase, Maintenance and Operating Costs

Since PHEVs and BEVs are innovative and relatively new technology, their market penetration is almost non-existent, and thus, their manufacturing and distribution costs are not yet optimized. Additionally, as their development costs have not yet been absorbed, their acquisition price can be surprisingly high. In fact, the main cost factor is usually the battery size. Hence, a BEV with a good range has intrinsically a larger battery and will cost significantly more than a short-range PHEV, everything else being equal. This might change in the future as battery technology evolves and size/cost reduces. A common rule of thumb on battery cost for 2010 is around $1000 per kWh[xix]. For this reason, the 53 kWh battery pack of a Tesla Roadster can be estimated at $53,000, and the 5 kWh battery pack of the Hymotion kit installed in a PHEV conversion for a Prius accounts for at least $5,000 of the conversion price. However, it should be noted that as more OEMs are releasing production models, such as the Mitsubishi iMiEV and the Nissan LEAF, battery manufacturers are getting up to speed and reducing their costs through increased production volumes, which consequently reduces the overall price of the vehicle. As noted by A.T. Kearney, a market researcher, the current nascent market for lithium-ion batteries for transportation use is $31.9 million; this market should grow to $21.8 billion by 2015 and $74.1 billion by 2020[xx]. Therefore, the price of an EV should decrease in the near future, as they become more available; however, demonstration projects might not be necessary once this is the case. To lower the vehicle cost aspect of a demonstration project, the vehicle acquisition or conversion cost may sometimes be paid by the project's participants. This is the case for the CNTA PHEV project, in which individuals are using their personal vehicles for the study.

Additionally, the initial maintenance costs of a BEV and PHEV will probably be considered high compared to a conventional ICE vehicle, as models and technologies are new and not yet as stable as in a standard production vehicle. Over the long term, BEVs should be less costly to maintain than standard gasoline vehicles, mainly because they contain less parts and require less servicing. For demonstration projects, however, BEV maintenance will require more attention as manufacturers have a long progression in front of them before the vehicles are as reliable as their standard ICE vehicles.

On the other hand, operational cost should be less than a standard vehicle. In fact, on top of zero direct emissions in all-electric mode, the low cost of operation is considered to be one of the main advantages of PHEVs and EVs. For example, a battery pack is usually depleted to a minimum limit of 20 percent state of charge. This means that a maximum 80 percent of the battery energy is useful; a 20 kWh battery has 16 kWh of useful energy. Thus, if the electricity cost is $0.10 per kWh, charging the fully depleted battery will cost $1.60, not taking into account efficiency losses. If the vehicle achieves a range of 100km for this battery size, this translates to a cost of $1.60/100km for a BEV, or for a PHEV while in full electric mode.

6.3.3 Charging Infrastructure Costs

The ownership of the charging infrastructure depends on its location. For instance, demonstration projects that are fleet oriented can have their charging locations on-site, in the fleet garage or in the employee parking. On the other hand, projects integrating standard commuter users will probably have the charging infrastructure at home. Additionally, for public charging locations or multi-dwelling buildings, the ownership can be complex to identify. As presented in section 6.6 of this report, the charging infrastructure not only depends on the location, but also on the charging “level”. Charging from a standard 120V outlet usually does not require special installation. However, levels 2 and 3 charging require additional infrastructure, as well as potential permits. The table below presents various cost estimates, including material and labour, for residential, commercial-fleet and public scenarios[xxi]; the estimates provided here are for information only and should not be used for actual planning purposes.

Category	**Charging Level**	**Cost estimate (per installation)**
Residential	Level 2	• $ 2,720
Fleet	Level 2	• $ 3,137.50 (based on 10 installations)
Public	Level 2	• $ 6,437.50 (based on 2 installations)
Public	Level 3	• $ 32,079.00 (based on 2 installations of 30 kW)

Table 13. Charging infrastructure installation cost estimate – Table from British Columbia Electric Vehicle Charging Infrastructure Deployment Guidelines[xxii]

6.3.4 Monitoring Costs

The main goal of a demonstration project is to gather information and data to better understand and quantify the use, maintenance, operation, impacts or any other studied aspect of BEVs and PHEVs. The monitoring aspect of the project, although probably not the most costly consideration, should not be overlooked. The monitoring phase includes the data and parameters definition, the acquisition and installation of the data logging system, and the complete project monitoring.

The monitoring data items (please see section 6.5 for more details on what is needed) require a data logger, the GPRS card, the GPS sensor, other external sensors, monthly use of GPRS network (for data sending), and other needed items. The cost for this is calculated per vehicle, since each needs its dedicated system. Additionally, budget should be allocated for the systems' installation and removal, the data gathering and the systems' configuration.

6.3.5 Reporting and Dissemination Costs

A demonstration project's "raison d'être" includes an analysis and recommendations, as well as some sort of reporting targeted at an audience. Generating the study report is a task usually done during and at the conclusion of the project, but defined at the start, when the goals and targets are established. Each study may have various types of reports, some technical, some less technically oriented to a wider audience. Some studies will have a dedicated website and public dissemination at conferences, while others may be more targeted to an in-house audience. The related costs are thus difficult to estimate and are project specific.

6.3.6 Communications and Marketing

Part of the purpose of demonstration projects is to create public awareness about EVs and their usage. Additionally, some public or private corporations often want to use demonstration projects as marketing tools to promote a "green" image. Depending on the project size and the business marketing objectives, the cost of media material and communications events can be significant and should be factored into the project. The following list presents various items that could be part of a communications and marketing project's portfolio.

- Various press events, such as the program's launch, the first vehicle arrival, the final report delivery, etc.;
- Securing sponsorship from public and private corporations;

- Obtaining endorsement by lending vehicles to public personalities, such as a mayor, a cinema star, etc.;
- Participating in events, such as auto shows, conferences, trade shows, etc.;
- Advertising of any form, such as publicity in newspapers, etc.;
- Press releases, brochure, quick fact sheets, etc.;
- A dedicated website; and
- Vehicle badges and appropriate signage if necessary.

6.3.7 Other Costs

Additional costs must also be planned, such as user training, security measure development, additional signs and indications, preventive maintenance and repairs to charging infrastructure, etc. Demonstration project management and the cost to acquire funding should also be considered. Also, matters such as Non Disclosure Agreements (NDAs), contracts with end-users or with OEMs may need the services of a law firm. Finally, insuring the vehicles and against legal actions is mandatory.

6.4 Defining the Project Size

The project size is intimately linked to the budget. A larger project provides a broader sampling, but will inevitably cost more, mainly for vehicle acquisition. One of the goals of the National Aggregator, as discussed in Section 8, is to integrate smaller demonstration projects, with less vehicles and a lesser budget, with other projects, resulting in a broader analysis, economies of scale and larger sampling not otherwise available. Analyses can be extended to more vehicles, driving style, manufacturers, usage conditions, while accessibility to project guidelines, reporting resources, contacts, best practices and widespread audience can help lower costs. Projects can be grouped in three categories size wise, as shown in the following table:

Category	Size	Description
Study and technological assessment projects	1 to 15 vehicles	• Designed to evaluate a technology, a vehicle and/or to understand the fundamentals of EVs; may also include emission related or return on investment related studies; • May serve as basis for modeling analysis; • Often performed by Universities, public entities, utilities or dedicated research centres; • Small to medium budget; • Often done in fleets or with trained and dedicated users. • Project examples: Université Laval PHEV, CNTA PHEV, etc.
Impact and regulation analysis projects	10 to 100 vehicles	• Designed to raise public awareness, to evaluate a technology impact on the grid and/or to define customer/user behaviour; • May serve as a basis for policy, regulation, standard and/or incentives program definition; • Often performed by utilities, a consortium of partners, and/or an OEM; • Medium to large budget; • Often done in fleets in a controlled environment; • Project examples: Toronto Atmospheric Fund PHEV pilot project, etc.

Category	Size	Description
Mass deployment impact evaluation projects	More than 100 vehicles	• Designed to evaluate random users' behaviours, vehicle sharing program, urbanism and infrastructure planning, and/or commercial service definition; • May serve as a basis for major modeling analysis of a transportation system; • Often performed by a consortium of partners, with the collaboration of public entities and an OEM; • Large budget; • Often done in a partially controlled environment with early adopter users or with random users; less control is required to reach the project's goals; • Project examples: TH!NK City Electric vehicle demonstration program, etc.

Table 14. Project size description

Therefore, the predefined project size depends both on the available resources and the desired outcome. However, other issues can limit the project size, not solely the goals and the budget. Vehicle availability may be limited both in quantities and in delivery time, thus limiting the project size.

6.5 Studied Parameters and Monitored Data

When the vehicle and vehicle type are identified, the data logging needs may be identified. Data logging devices from Grid Point, ISAAC Instruments, Kvaser or comparables have been used in the various studies; however, other logging devices can be used if they answer the study needs. These data logging systems are usually interfaced to the controller-area network (CAN) network of the vehicle. The CAN is a message-based communication protocol designed specifically for automotive applications and found in all production vehicles. In certain prototypes or niche vehicles, the CAN protocol might not be used. It will then be left to the people responsible for the project, in collaboration with the vehicle manufacturer, to identify external sensors that can transmit the appropriate data to the logging device. A combination of CAN and external sensors may sometimes be needed; a GPS sensor is a valuable addition that can provide information on charging and driver habits. In addition to the sensors and logging device, the data must be extracted from the logging system and sent either manually or automatically to the central monitoring system. For simplification and control purposes, it is suggested that each vehicle send its data to the central monitoring system using a GPRS card or any other data - broadcasting device through a cell phone's wireless system. Although the data could be retrieved manually from each vehicle on a periodic basis, having it sent weekly, for example, reduces the overhead in time and complexity, thus simplifying the process.

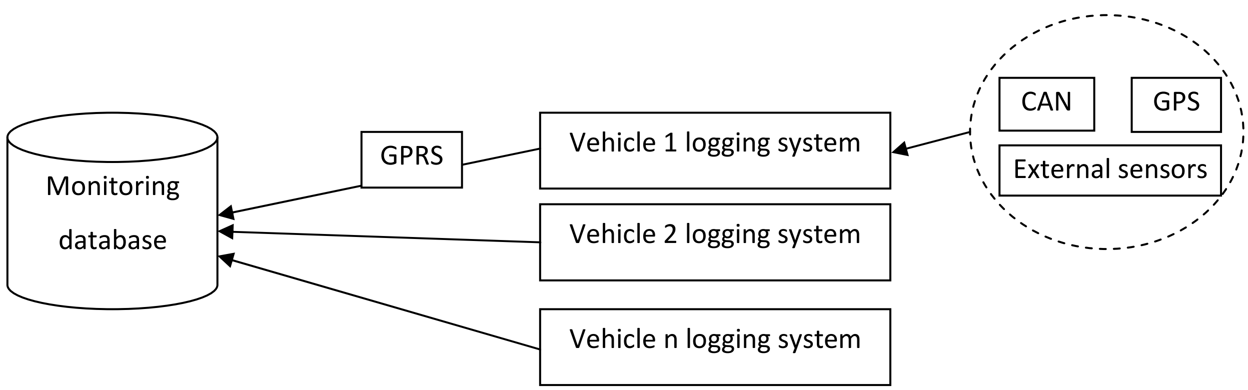


Figure 9. Example of data acquisition system setup

The data logging can be described as the backbone to most projects, as it is a way to track data in an unbiased manner. It should be noted that the accumulated data needs subsequent analysis to extract and explain the information behind the data. The following data should be logged:

Data logging

#	Parameter	Source	Unit	Priority	Purpose
1	Time	Data logger	hh:mm:ss	Essential	• For all analysis
2	Date	Data logger	yy:mm:dd	Essential	• For all analysis
3	Exterior temperature	CAN or External sensor (thermocouple)	°C	Essential	• Impacts of external temperature
4	Speed (at every second)	CAN or External sensor (vehicle speed sensor – vss)	km/h	Essential	• Mileage • Average speed • Maximum speed • Acceleration (calculated) • Driver aggressiveness (rate of change i.e. acceleration)
5	State of vehicle (active)	CAN or data logger input channel	-	Essential	• Trip date (start and stop time) • Based on gear (D, N, R) or ignition key position (on) if available.
6	Shifter position	CAN	-	Essential	• Drive pattern
7	Drive mode (economy, performance, etc.)	CAN	-	Optional	• Fuel consumption • Drive pattern
8	Latitude and longitudinal	CAN (OnStar or other) Data logger or External GPS	GPS coordinates	Optional	• Charging location (primary vs. opportunity) • Driver habits • Type of use (urban, extra-urban and highway) • Source / destination survey
9	Altitude	External GPS	GPS coordinates	Optional	• Grade calculation
10	Fuel level	CAN or External sensor	L	Essential	• Fuel consumption (high level, not reliable) • Refuelling "habits" "sequence" • Fuel added in refuelling
11	Fuel rate • Read from CAN or MAF/MAP on OBD (manifold airflow and manifold air pressure) combined with rpm and air temperature	CAN or OBD II (MAF/MAP)	g/s	Essential	• Evaluate instantaneous fuel consumption

#	Parameter	Source	Unit	Priority	Purpose
12	Battery state of charge (SOC) *for all battery packs (ex: Hymotion has two battery packs)*	CAN or digital from battery management system (BMS) or calculated from current sensor	%	Essential	• Battery SOC before and after each charge • Duration of charge • User habits • Battery health • "emergency – in case of complete discharge"
13	Battery current	CAN or External sensor (current clamp or shunt)	A	Essential	• Gives if the battery is being charged or discharged (to evaluate regenerative braking) • Efficiency of round trip (battery efficiency) • Energy transfer (calculated with time)
14	Battery voltage	CAN or External sensor (isolated voltage sensor)	V	Essential	• Combined with battery current – gives the power in and out
15	Battery temperature	CAN or External sensor	ºC	Essential	• Failure related analysis • Battery performance limitations and analysis
16	Minimum and maximum cell voltage	CAN	V	Optional	• Battery pack health analysis • Cell equalization analysis
17	Minimum and maximum cell temperature	CAN	ºC	Optional	• Battery pack health analysis • Cell equalization analysis
18	State of battery pack (discharging vs charging)	CAN or digital from battery management system (BMS)	-	Essential	• Charging time (start and stop) • Charging scenario (PHEV – does it get charge)
19	Type of charging	CAN or digital from battery management system (BMS)	120V 240V other	Essential	• Charging scenario
20	Power from the grid	Power meter *must be added to charger (on and/or off-board)*	kW	Essential	• Charging efficiency (total consumed power from grid vs. energy stored in battery) • Charger efficiency
21	Energy from the grid	Power meter *must be added to charger (on and/or off-board)*	kWh	Essential	• Total charge (kWh) per charging event
22	Motor speed (electric)	CAN or External sensor	rpm	Optional	• Traction source analysis on PHEV (% of when the motor is engaged) • Gear ratio with wheel speed (calculated from tire size and vehicle speed)
23	Motor current (electric)	CAN	A	Optional	• Find the motor drive's efficiency

#	Parameter	Source	Unit	Priority	Purpose
24	Engine speed (gasoline/diesel for PHEV)	CAN or OBD II	rpm	Essential	• Traction source analysis on PHEV (% of when the engine is engaged) • Gear ratio with wheel speed (calculated from tire size and vehicle speed)
25	Engine temperature	CAN or OBD II	ºC	Optional	• Emission related studies
26	Catalyst temperature	CAN or OBD II	ºC	Optional	• Emission related studies
27	Throttle position	CAN or OBD II	%	Optional	• Driver aggressiveness • Define car power vs. driver/road requirement (is the car is sufficiently powered)
28	Brake pedal position	CAN or External sensor (hydraulic pressure sensor)	%	Optional	• Driver aggressiveness • % of regenerative braking vs. friction braking (calculated with power flow to battery)
29	Hybrid mode (trip type) • Charge sustaining or depleting or combined mode	CAN or External sensor	-	Optional	• Analysis on hybrid mode vs. fuel consumption
30	Cabin temperature	CAN	ºC	Optional	• Driver habits vs. HVAC usage
31	HVAC state (A/C on, heater on, etc)	CAN	-	Optional	• Driver habits vs. HVAC usage • HVAC consumption related studies
32	Auxiliary battery voltage	CAN	V	Optional	• Auxiliary battery health

Table 15. Data acquisition parameters details

In addition to data monitoring by on-board data logging systems, a simple log book can be used to track additional details on the vehicle, such as the subjective usage appreciation; vehicle maintenance; charging; and various subjects, such as accident reporting.

Recommendation: automatic data logging with minimum reliance on logbooks and other user entry should be emphasized. Past studies have shown that users don't always complete logbooks properly; additionally, discrepancies exist among users' methodology and diligence, especially among fleet users.

Logbook – Maintenance (every maintenance / repair)

A maintenance logbook should be kept in the glove compartment. Because drivers are part of demonstration project, they are aware that the vehicle is different and that participation in the project suggests additional tasks. This practice should not impose a burden on drivers, since conventional ICE vehicles often have a maintenance logbook of some sort. Some fleet operators already have a maintenance tracking system and may use it if it is appropriate. This information is compiled for reliability and operating cost analysis.

#	Parameter	Units / description
1	Date	yy:mm:dd
2	Type	Scheduled / Unscheduled
3	Operations / repairs – description	Description
4	Cost	$

Table 16. Maintenance logbook details

Logbook – Other information (i.e. accident/incident reporting)

In addition to the standard data collection, a logbook should be implemented for other information. This type of information gathering is meant to broaden the analysis, as data cannot reveal the complete picture on its own. Subjective comments, appreciation evaluation, issue reporting and accidents description cannot be monitored by automatic data monitoring. Such a logbook requires more diligence from the drivers. Discipline is required to complete it. A periodic survey, for example every month or every quarter, could also provide information about the subjective use of the vehicle and the charging facilities, as well as information on accidents.

#	Parameter	Units / description
1	Date	yy:mm:dd
2	Vehicle use – performance	Compared to standard Compared to expectation
3	Vehicle use – security	Compared to standard Compared to expectation
4	Vehicle ease of charge	Charging spots availability a problem?
5	Number of time the vehicle was out of charge	Quantify
6	Description of the out of charge occurrence	What happen, what was done to solve the issue
7	Accidents linked with the project	Mention if any
8	Accidents details	Fatalities, injuries, vehicle damage description
9	Accidents – training of rescue personnel	Properly or inadequately trained
10	Cost of electricity	Affordable, expensive ($) – please quantify
11	Cost of insurance	Affordable, expensive ($) – please quantify
12	Cost of fuel	Affordable, expensive ($) – please quantify

Table 17. Subjective analysis logbook details

6.6 Charging Infrastructure

The charging infrastructure for EVs depends on many factors, such as the number of vehicles in the project, the budget and the involvement of a utility company. Charging can be done in various ways, depending on the infrastructure, charger, vehicle, and cost, but also on the allowed timeframe for charging. For simplification purposes, charging can be classified according to two types:

- Primary or usual charging
    - Primary charging is done at home or at the office and is considered the main charging source. Usually it will utilize the on-board charger, connected to a 120V or 240V power supply, and the charging will last for a long period during work or overnight.
- Secondary or opportunity charging
    - Opportunity charging is considered a top-off charge at a different charging location than usual; for example, off the street, at the shopping centre or at an airport. Charging can be standard, such as 120V or 240V, but can also be fast charging at higher voltage. For now, however, the fast-charging situation is still in the developmental stage and thus, the plug, the charger, and the charging parameters are not fully defined. Fast charging, regardless of the parameters, is considered opportunity charging.

Charger types

As the EV industry grows and evolves, charging systems are also evolving. Chargers can be on-board the vehicle, usually for 120V and 240V applications. However, current studies of fast charging in Japan and Europe involve mostly external chargers. For most PHEVs, 120V charging is sufficient, and 240V is an interesting upgrade. However, for BEVs, 240V is considered crucial, and fast charging should be planned. Access to fast-charging locations has been known to reduce the range anxiety of drivers nervous about being left with no charge in their BEVs. The charging types can be classified as following:

Charging Level	Description
Level 1	• 120 V – Single phase • Recommended for PHEVs with a dedicated circuit as cost of Level 2 charging may be prohibitive and installation may be complex. • Residential or commercial charging

Charging Level	Description
Level 2	• 208/240 V – Single phase, 20, 30 or 40 A Breaker. • Recommended for BEVs with a dedicated branch circuit in order to provide the EV owner a reasonable charge time; • Residential, commercial, work, public or fleet charging locations.

Level 3	• Not defined with but could be the following (Other configuration also possible):
	  ○ 600 V with 3-phase (actually 575V)
	  ○ 480 V with 3-phase 60 A or 125 A Breaker (US)
	  ○ 208 V with 3-phase, 125 A Breaker
	• Recommended for opportunity charging location or fast-charging;
	• Commercial, work, public or fleet charging locations.

Table 18. Charging levels description – Table from British Columbia Electric Vehicle Charging Infrastructure Deployment Guidelines[xxiii]

Charging-point location

As most past and current demonstration projects are done in fleets with a small number of vehicles, the charging locations have been relatively easy to define. They are either at home or at the fleet vehicle depot. However, as demonstration projects develop to include more vehicles and more BEVs instead of PHEVs, defining the charging point locations will introduce a new dimension in demonstration projects: available charging locations outside of a controlled area. These can be at curbside locations, at various businesses, at retail outlets and shopping malls, in public parking and even in traditional fuel service stations. Although high availability of charging stations might not be needed, as noted in a New York report[xxiv], this situation still raises new issues, mainly related to the location, the billing and access control, and infrastructure ownership. Demonstration projects will become broader when they are required to include various partners, such as municipalities, utility companies, and the owner of the charging point location, such as a retailer or a business. Additionally, who will install and pay for the infrastructure must be identified in the demonstration study, if new charging locations are required. Charging locations can be grouped in categories, such as home, work, public and multi-dwelling units. The focus of current studies tends to be on the low-hanging fruit of home and work charging locations.

Plug types

The "plug discussion" was a major topic in past years, since no standard existed. However, since January 2010, the Society of Automotive Engineering (SAE) has issued a North American standard, - SAE J1772 - that saw the introduction of a standard plug, for use in 120V and 240V applications. Additionally, the automotive industry in Europe targets using a homogenous plug for the entire European Union. This plug should support 230V single phase and 400V three-phasing up to 63A. Mennekes, a plug manufacturer, has issued a plug that could become the standard in Europe. The two standards are differently defined because the electricity from the grid differs. This will be more of a concern for vehicle manufacturers than for users, since transferring a vehicle to the other side of the Atlantic Ocean will be largely irrelevant and probably isolated, for example, to military or diplomatic situations and personnel.

Figure 10. SAE J1772 plug (left) vs Mennekes plug in Europe (right)

Although the developing North American and European standards have their pros and cons, Canadian projects should use the SAE J1772 standard as their own.

Billing

Charging by itself is not the only aspect worth considering. In early demonstration projects, since BEVs and PHEVs were considered isolated and unusual, charging stations were implemented sparingly, if at all. The electricity used for charging was either freely provided by the utility company or was included in the usual house/office electricity bill. No service provider or monitored billing system was implemented, because a main project goal was the promotion of EV usage and because the market was so marginal, no one wanted to make a business case for charging stations or take profit out of the service. However, as more and more EVs are present on the road, the billing and service around charging will become significant. Hence, the charging locations and service must be considered and planned prior to the start of the demonstration project.

Since no official billing or service provider is currently in place, all is left to decide and, thus, no recommendation on the subject can be made for now. In fact, most future and some current demonstration projects are designed to study this aspect of charging. Also, the utility situation is very variable, depending on the province. Québec, for example, has a public monopolistic situation with Hydro-Québec, and thus service and billing might be easier to define. However, Ontario, for instance, has many local utility companies, making the situation a lot more complex. Travelling from province to province, or even from country to country, offers an even higher degree of complexity and challenge for charging service billing. The charging network is starting from scratch and can evolve in different ways. It could resemble either the cell phone industry with a few major providers and roaming charges, or the current fuel distribution service, which has no roaming fees, membership or contracts, but rather a service point and on-demand fee based on the actual energy consumption.

Charging monitoring

As mentioned in the data monitoring section (section 6.5), the charging methodology must be studied thoroughly, and automatic data monitoring regarding this aspect is essential for the project's success. Data and charging parameters can only be fully reliable if they are based on a constant and precise follow-up that only automatic logging can provide. However, it can be a good practice to have a logbook for charging events, to log unusual events and additional data that can't be acquired through standard monitoring. This can contribute to the analysis and enhance the project outcome. For example, this logbook, which could be stored in the glove compartment, could be used to enter details of a technical problem with charging, or to enter details of a dead battery and what solution was found to remedy this situation.

Logbook – Charging analysis

The following table lists the charging parameters to include in a potential logbook. The collection of data on the two essential parameters can be automated.

#	Parameter	Units / description
1	Time	hh:mm
2	Date	yy:mm:dd
3	Charging type	Primary / usual (home, office, etc) vs Secondary / opportunity (street, parking, airport, etc)
4	Charging location	-
5	Charging voltage and current	V and A
6	Charge rate	kWh
7	Time of day of recharge	Off-peak vs other
8	Ease of access to charging stations	Location of chargers
9	Cost	$ / charge or kWh if applicable
10	Situation description	Details
11	Emergency case description	Details

Table 19. Parameters for charging analyses

6.7 Data Analysis

Data and logbook analyses are main elements in measuring the results of a demonstration project. Various types of analyses can be made and mostly depend on the project's goals. The following table offers some suggestions. It should be noted that not all collected data is valid, and before performing any analyses on this data, it should be properly filtered to remove inconsistencies, such as really high acceleration rates, corrupted data, instantaneous peaks, null values, etc.

Category	**Detail**
Trip analyses	• Average and total kilometres • Average and maximum speed • Average and maximum acceleration • Range analysis • Type of use (urban, suburban and highway)
Charging analyses	• Impacts of battery State of Charge (SOC) on charging • Impacts of external temperature • Charging time and scenario • Total energy drawn from the grid • Charging location (primary vs opportunity) • Charging and charger efficiency

Fuel consumption analyses	• Fuel consumption
	• Power demand
	• Energy consumption (electricity)
	• Range analysis
	• Impact of acceleration
	• Impacts of external temperature
	• Impacts of driving habits
	    o Driver aggressiveness
	    o Type of use (urban, extra-urban and highway)
	• Impacts of regenerative braking
	• Impacts of type of hybrid mode (charge depleting, charge sustaining, vs combined)
	• Impacts of HVAC usage

Category	Detail
Emission control analyses	• Impacts of external temperature • Impacts of battery temperature • Impacts of catalyst temperature • Impacts of engine temperature
Vehicle analyses	• Reliability analysis • Battery health analysis • Battery performance limitations and analysis • Vehicle performance analysis (is the car is sufficiently powered) • HVAC performance analysis
Costs analyses (vehicle related)	• Cost of operation • Cost to maintain • Cost to insure • Cost of acquisition • Cost per kilometre • Return on initial investment
Charging infrastructure analyses	• Impact of BEVs and PHEVs on the grid • Location and quantity of charging facilities • Billing system • Range made available by the charging infrastructure

Table 20. Details of various analyses

6.7.1 Performance under Canadian Climate Conditions

Dedicated analyses for Canadian climate conditions are mostly done by assessing the impact of external temperature on the vehicle range, on the charging scenario, and on the vehicle reliability. The following table presents the various analyses that should be in a demonstration project to properly evaluate vehicles and the infrastructure for Canada-specific conditions:

Category	Detail
Trip analysis	• Range analysis • Type of use (urban, suburban and highway)
Charging analysis	• Impacts of external temperature • Charging time and scenario • Total energy drawn from the grid

Category	Detail
Fuel consumption analysis	• Fuel consumption • Power demand • Energy consumption (electricity) • Range analysis • Impacts of external temperature • Impacts of HVAC usage • Impacts of pre-heating
Emission control analysis	• Impacts of external temperature • Impacts of battery temperature • Impacts of catalyst temperature • Impacts of engine temperature • Impacts of pre-heating
Vehicle analysis	• Reliability analysis • Battery health analysis • Battery performance limitations and analysis • Vehicle performance analysis (is the car is sufficiently powered) • HVAC performance analysis

Table 21. Details of Canadian Climate related analyses

6.7.2 Laboratory Comparison of Data Analysis

An optional component of any demonstration project could be laboratory testing for exhaust emissions, fuel consumption, electrical consumption, and charge depletion range under a variety of conditions. The vehicle could be taken out of service for ~2 weeks and tested at an exhaust emissions test facility (such as Environment Canada's facility in Ottawa). The same test procedure should be used for all demonstration vehicles that undergo laboratory testing, so that a consistent data set can be developed and compared to the on-road results. The exhaust emissions testing laboratory could work directly with a potential National Aggregator agency to compare on-road data with laboratory test results. Such a comparison could aid in the refinement of laboratory test procedures and provide context for relating laboratory results to Canadian real-world data.

7 The Canadian National Aggregator

This section addresses the need for a central Canadian resource dedicated to the collection and dissemination of results from PHEV and BEV demonstrations carried out in Canada. The section also discusses how such a resource could operate, how it could be funded and its publication responsibilities.

7.1 Observations

From an analysis of the recent and current demonstration projects in section 2, we can observe the following:

- Canada has a large number of smaller demonstration projects done with one or two vehicles, and their results are not always documented and/or published. The budget might be lacking, or the needed coordination and support might not be available. As a result, there is significant "re-inventing of the wheel" occurring with each new project, since there is no formal exchange of information;
- Each demonstration project includes the following steps: evaluate vehicles, define what data to use to monitor and analyze, compare data logging devices, gain knowledge on their installation and configuration, define analysis criteria and final report requirements, and publish results. However, it must be noted that most of the PHEV demonstration projects done in Canada to date have been linked to what can be described as a National Aggregator in the United States, the Idaho National Laboratory (see section 7.5.1).
- Canada being a large, diverse country, existing or proposed demonstrations have not always been well communicated among provinces, especially with relation to Québec, potentially due to the language issue. In fact, some studies across Canada are quite similar and may duplicate each other. Although this doesn't represent a problem in itself, good communication among the different studies would aid knowledge development and possible resource sharing. It would be a definite benefit for most and can be viewed as a win-win situation. Thus, having a single point of contact, as could be provided by a National Aggregator, would advance communication among project proponents, as well as provide a central repository for resources, such as contacts for manufacturers, contacts for suppliers, etc.

7.2 The Need for a National Aggregator

Based on these observations, it can be stated that a National Aggregator should provide the following basic services:

- A dedicated resources centre for the following information:
    - Access to contacts from manufacturers, government agencies at various levels (municipal, provincial and federal), programs and technical resources;
    - Information on recent, current and proposed demonstration projects;
    - Information on the availability of vehicles for demonstration;
    - Information on data logging systems, their installation and configuration; and
    - Information on best practices in a demonstration project.
- A central monitoring facility to gather and integrate data from the various ongoing projects into a single data source, with the capacity to draw data pertaining to individual projects;
- A central reporting facility that could perform analyses on all or selected projects and provide conclusions; and
- A central publishing function based on a dedicated website, which could properly disseminate results and conclusions for the individual demonstration projects, as well as for all projects in its database.

7.2.1 Additional Roles

The key objective of the National Aggregator is to incorporate all Canadian studies into a single database with comparable parameters, resulting in a broader and more complete analysis throughout Canada. In addition to the needs identified in Section 7.2, the National Aggregator could have the following functions:

- Participate in the classification of vehicle type. For example, PHEV might be defined with all-electric range mileage, such as PHEV 10 (10 miles) or PHEV 40 (40 miles). These have been defined in miles for the American market but as Canadians use kilometres, they might be reviewed;
- Provide input to standard-setting organizations such as CSA or SAE;
- Provide input to various government agencies in their budget planning, financial incentives required and other aspects of their involvement in demonstration projects;
- Become an information source for media or individuals;

- Link with industry via dedicated EV clusters;
- Participate in various conferences and committees across Canada and internationally;
- Help Canada become a recognized nation among EV and PHEV users;
- Identify the market segmentation occurring in the Canadian context;
- Evaluate the market penetration of PHEVs and EVs;
- Evaluate emissions savings, based on comparative analyses and models of all demonstration projects in comparison with actual vehicles sales numbers.

7.3 Conditions of Success

To be successful, a National Aggregator must have the buy-in of most people and stakeholders involved in demonstration projects. In order to obtain this buy-in, the project must meet the following criteria:

- It must have the support of the federal government and the EV industry;
- All publicly funded demonstration projects should be required to participate in the National Aggregator analyses and data monitoring;
- All publicly funded demonstration projects should be reviewed by the National Aggregator prior to their launch, particularly for the data monitoring aspect;
- There should be various privacy levels attached to the collected data. Analyses and reports should be made public, but the actual data should be kept private;
- The National Aggregator should be the main source of information on EVs in Canada.

7.4 Proposed National Aggregator Concept

The proposed National Aggregator would be in the form of a project, with defined resources and a limited timeframe, a start and an end. The defined timeframe should be about 10 years, since EV market penetration in Canada should be sufficient by 2020 to render the project unnecessary. However, other projects needing a central and national aggregation of data on EVs may emerge that could extend this timeframe. Demonstration of PHEVs and BEVs in other vehicle classes (beyond passenger cars and light-duty trucks) will likely need similar support. These needs could also extend to off-road vehicles, marine vehicles, farming equipment, etc.

The National Aggregator project would answer the previously identified needs in the following form:

Identified Need	**Solutions**
Central resource centre	• Recent, current and future project descriptions, contact names, and main aspects; • List of funding resources with contact list; • List of contacts for manufacturers, data logging systems and different suppliers for analysis equipment; • Development of a demonstration projects' manual, which would include monitored data guidelines as well as best practices.
Central monitoring	• Central database; • Results / data uploading features; • Regular contacts with project proponents, including reminders of data due dates; • Monitored data template with mandatory and optional requirements.
Central reporting	• Predefined queries; • Prebuilt report with automatic reporting features; • Ability to select various, predefined criteria (location list, project list, vehicle type, temperature range, etc) to build dynamic, predefined reports (fuel consumption, range, etc).

Report publishing	• Quarterly reports
	    ○ Automatically generated, prebuilt reports from the database with the least maintenance and manipulation possible;
	    ○ Only results compiled from the monitored data – no in-depth analysis
	    ○ Short, one-page executive summary
	    ○ Available and published on the website
	    ○ Email sent to all participants with a link.
	• Annual report
	    ○ A broader report with more thorough analysis;
	• Per project report;
	• Reports should be available in Canada's two official languages.

Identified Need	Solutions

Dissemination via a dedicated website	• Three different access levels:
	  ○ Public – for all;
	  ○ Private – only for members – must be approved members by the "National Aggregator manager". Accessible via a user login and password, this section is meant to access resources for which public disclosure would be inappropriate and unnecessary;
	  ○ Mailing list – people can join a mailing list on a voluntary basis, no approval needed – they receive the quarterly reports and the annual reports and any other necessary documentation or notice.
	• Project list section
	  ○ Short description of each project.
	• Reporting section:
	  ○ Quarterly public reports;
	  ○ Annual public reports;
	  ○ Final reports for completed projects.

Table 22. Proposed National Aggregator concept details

7.4.1 Data Sensitivity

The collected data from the different projects should remain private. However, this data will be used to create graphs and will be analyzed at various levels. The graphs, analyses and the conclusions will be part of the public reports. A predefined agreement between the project proponents and the National Aggregator could be used to determine how the data would be used and published, as this can become an issue with OEMs, who would not want their data to become public. Legal considerations and documents such as NDAs are then mandatory. It should be kept in mind, however, that even with OEMs the data will be used for analysis and reporting, which will become public. Some demonstration projects are using prototypes from OEMs; for these cases, the collected information can be greatly sensitive for OEMs. An obligation to fully disclose analyses results might become a block to performing the actual demonstration projects. These instances should be evaluated on a case-by-case basis. It should be noted that if the vehicle was purchased for the demonstration project, then the results are owned by the demonstration project stakeholders, and thus, in most cases, demonstration project results and analyses can be publicized.

7.4.2 Other Considerations

Language

The National Aggregator should offer services in Canada in both official languages, English and French. Reports and the dedicated website should be made available in both languages, as well. For data consistency, however, the data format will need to be common.

International collaboration

The National Aggregator should collaborate and exchange information with American and international organizations with similar interests. These collaborations could also exchange information on EV-specific test procedures/protocols, data sharing that focuses on development and assessment of critical battery technologies, etc. This could result in technology and testing compatible with Canadian perspectives, since the National Aggregator could provide insight on heating and pre-heating scenarios, HVAC management and control issues, and battery usage based on real-world studies in the rigorous Canadian climate. Additionally, joint reports and common analyses could be performed with these organizations. The identified collaborating partners below are mostly American, since our neighbour country will have a major impact on EV-related decisions in the near future. Also, relations with Europe, through France for instance, which can be identified as a leader in EV development, would be attractive; in fact, since France shares its official language with Canada, the collaboration and information sharing would be straightforward in that regard.

Identified International Collaborators	Description
Industry	• U.S. Advanced Battery Consortium (USABC) • Society of Automotive Engineers (SAE) • EPRI • Various OEMs • Various utility companies
Government-related collaborations	• Argonne National Laboratory • Idaho National Laboratory • U.S. Department of Energy (DOE) • National Renewable Energy Laboratory (NREL) • Environmental Protection Agency (EPA) • Oak Ridge National Laboratory • Sandia National Laboratory

Identified International Collaborators	Description
Academia	• Various universities

Table 23. International collaborations of a National Aggregator

7.4.3 Funding the National Aggregator

Self-financing a National Aggregator would be difficult. Demonstration projects are not revenue-generating activities, and thus, finding funds for them is already difficult. If they were required to partially fund the National Aggregator, small projects would not be able to participate in the National Aggregator, going against one of the goals of providing a resource to smaller projects. However, a combined funding approach could include both public funding and revenues from complementary activities. For instance, the National Aggregator could have a standard, free-of-charge offering for demonstration projects and a premium, fee-based service. The standard service would include project guidelines and methodology; project review; central resource centre access, help on defining the monitored data, central reporting, and website access. The premium service would include data logging systems installation and configuration, data monitoring support, vehicle purchase support, etc. In the United States, the National Idaho Laboratory and the Argonne Laboratory, both acting as major support institutes and partial national aggregators, are supported and funded by the Department of Energy (DOE).

7.5 Other National Aggregators

7.5.1 The Idaho National Laboratory

The Idaho National Laboratory (INL) Plug-in Hybrid Electric Vehicles (PHEV) project (see section 2) incorporates most PHEV studies across North America. These criteria and published reports can be compared to each other, since they are in a predefined format (see Appendix 6 for a report sample). As a result, the projects are able to base their findings on a broader and more reliable data sample from vehicles. This enables more certainty in the conclusions as well as a broader approach to the analyses, comparing different regions and exterior temperatures, allowing analyses not possible in minor and smaller studies. Also, participants located in smaller or remote areas operating projects on less significant budgets, will still have their results interpreted in a nation-wide report.

7.5.2 The Argonne National Laboratory

The Argonne National Laboratory Transportation Technology R&D Center (TTRDC) focuses on the DOE's energy-resources goals, such as hybrid powertrains, batteries, vehicle systems, HEVs and PHEVs, and fuel-efficient technologies. It collaborates with the Idaho National Laboratory on vehicle development and research; the INL focuses on demonstration projects, and the ANL focuses on laboratory testing and simulation, with exhaustive facilities. ANL has, in fact, developed a Powertrain System Analysis Toolkit (PSAT) software under the direction of Ford, General Motors, and DaimlerChrysler. This forward-looking model simulates vehicle fuel economy, emissions, and performance in a realistic manner, taking into account transient behaviour and control-system characteristics. PSAT can simulate an unrivalled number of predefined configurations (conventional, electric, fuel cell, series hybrid, parallel hybrid, and power-split hybrid).

8 Conclusions and Recommendations

The findings from this report support the following conclusions:

Conclusion 1. Most Canadian demonstration projects to date have been focussed on PHEVs, converted from HEVs.

Conclusion 2. Demonstration projects used to be focussed on understanding and assessing EVs' fuel consumption, emissions, usage and driver behaviour. Recently, however, the projects have expanded their scope to also include the surrounding environment, such as grid impacts, charging behaviour, building codes, policies and regulations.

Conclusion 3. The proponents of recent, current and planned projects to demonstrate PHEVs and BEVs in Canada are not currently using data collection protocols that allow for comparisons of essential data among the projects. This limits the potential benefits derived from projects and the dissemination of their results.

Conclusion 4. Demonstration project reports and analyses are not communicated and shared properly among projects, thus reducing the potential benefits and dissemination of results.

Conclusion 5. Some demonstration project activities may be unnecessarily duplicative, since communication between the proponents is insufficient. In cases where duplication is beneficial to generate robust data, again, data and results are not currently being shared.

Conclusion 6. To date, projects are relatively small and mainly focussed on the vehicles' usage for fleets and suburban users. The small size of projects, combined with reduced data sharing between projects, limit the data available for analyses. Analyses are, therefore, only done at best on a regional basis, on vehicles in controlled environment such as fleets.

Conclusion 7. To date, projects are targeted at home and work charging, whereby ownership of the charging infrastructure and billing are easily defined. Although this is satisfying for suburban users and is a first step towards mass use of EVs, such charging mechanisms do not represent all users, such as urban users with no garage, and do not answer questions about charging infrastructure ownership, service provider and billing.

Conclusion 8. There seems to be a significant difference between travel patterns in large urban areas and small urban areas. People living in large urban areas, such as Toronto or Montreal, travel more distance to work than in small urban areas. Nevertheless, contrary to the usual belief, BEVs range may, indeed, be sufficient for both large and small urban areas

Conclusion 9. BEVs and PHEVs are considered suitable for a very large number of Canadian commuters on a daily basis. However, their evaluation in the Canadian climate is needed, and several demonstration projects will be essential in all regions of Canada to validate the premise of suitability for daily commute.

Conclusion 10. Regulations are in place in Canada to control vehicle use and security; however, several EV-related regulations are still to be updated or defined, including those for the conversion of ICE vehicles to electric modes.

The following recommendations are proposed:

Recommendation 1. Use of the guidelines contained in this report.

R 1.1 That Canadian proponents of demonstration projects for electric vehicles follow the guidelines offered in this document for the planning, reporting and monitoring of projects, irrespective of project size. Further, they should respect the various vehicle regulations in effect at the time of the projects. The benefits of following these guidelines will be a common approach to project definitions, data collected and analyses, which will allow for comparisons across the country and likely with projects outside Canada, contributing to the reliability of findings.

R 1.2 That data monitoring using automatic data logging with minimum reliance on logbooks and other user entry should be emphasized.

R 1.3 That the collected data on demonstration projects that include fuel consumption and/or emissions analyses be compared to laboratory test data performed in a dedicated lab. This would facilitate comparison of on-road and laboratory data, and improvement of laboratory test methods and reporting protocols.

Recommendation 2. The need for more demonstration projects

R 2.1 That Canadian governments and their agencies at all levels collaborate with demonstration project proponents and expand their financial and other support to demonstration projects for EVs to ensure demonstration in all regions of the country and under all climatic conditions.

R 2.2 That demonstration projects of different sizes be targeted based on the desired analysis. At least one major project of more than 100 vehicles should be developed to assess mass deployment impacts of EVs.

R 2.3 That some demonstration projects should be targeted at various user groups other than fleet users, with level 2 and off-the-street charging. Although this orientation is not mandatory in the short term, since most early users in demonstration projects will own garages, it will assess the needs and the strategy for various users groups in broader EV usage.

Recommendation 3. The need for a National Aggregator

R 3.1 That a national resource be established as soon as possible in Canada to act as a National Aggregator for all activities and information important and necessary for the successful management of projects designed to demonstrate EVs in passenger cars and light-duty trucks, as per the model discussed in this report, in both of Canada’s official languages. Such a resource could be established within the federal government or within an appropriate external organization.

R 3.2 That the dissemination of analyses and reports on demonstration projects be made readily available through the National Aggregator and targeted at a wide-audience. A dedicated website centralizing these reports should be established, and collaboration with similar agencies beyond Canada established.

R 3.3 That all demonstration projects benefiting from public funds be required to collaborate with the National Aggregator in terms of project planning, data monitoring and reporting.

9 Appendix 1 – Members of the Project Advisory Committee

Nathan Armstrong
Motive Industries Inc.

Marc-André Bois
Ministère des Transports (Québec)

Sylvain Castonguay
Centre National du Transport Avancé (CNTA)

Martha Christensen
Environment Canada

Cara L. Clairman
Ontario Power Generation

Al Cormier
Electric Mobility Canada

Luc Couillard
Ville de Montréal

Gitanjali Dasgupta
Electrovaya

Jacques DeLarochelière
Isaac Instruments

Mike Elwood
Azure Dynamics Corporation

Angelo Giumento
Hydro-Québec

Marie-Claude Guay
Services PRÉCICAD Inc.

Robert Lankin
Accelerated Systems Inc.

Ian MacIntyre
Natural Resources Canada

Ben Marans
Toronto Atmospheric Fund

Mark McDade
Nissan Canada Inc

Rod McMillan
Natural Resources Canada

Tom O'Dell
General Motors Canada Ltd.

Maxime Ouellet
Centre National du Transport Avancé (CNTA)

Wyman Pattee
Ford of Canada

Gerry Pietschmann
City of Toronto

Carmine Pizzurro
eCamion

Emile Stevens
eMileage Environmental Inc.

Alec Tsang, P.Eng., MBA
B.C. Hydro

Serge Viola
Purolator Courier

Stephen Bieda
Zero Motorcycles Inc.

10 Appendix 2 – Questionnaire to Demonstration Project Lead

Project name	
Status *(Current, Not started, Finished)*	
Location	
Sponsors	
Vehicle type and number *(EV, PHEV, conversions)*	
Start and end date	
Project description	
Studied parameters and monitored data *(no. of km, average speed, no of kWh / day, external temperatures, etc.)*	
Data collection equipment used *(ISAAC, National Instruments, etc.)*	
Issues *(administrative, political, technical and/or regulatory issues, barriers and solutions)*	
Budget and funding sources	
Project outcome if available *(Final report, etc.)*	

11 Appendix 3 – Demonstration project list

11.1 Demonstration Projects in Canada

This section contains a list of past, current and proposed demonstration projects in Canada. To qualify, these projects must be on either a BEV or a PHEV. Additionally, conversions of vehicles by individuals are omitted.

11.1.1 Montréal 2000

Project name	Montréal 2000 – Electric Vehicle Project
Status	Finished
Location	Montréal and Saint-Jérôme
Sponsors	Sponsors : Government of Canada, Hydro-Québec, Government of Québec, CEVEQ (now CNTA), ISAAC Instruments Participants: Bell Canada, Department of National Defence, Environment Canada, Hydro-Québec, Les Services électriques Blanchette, Ministère des Transports du Québec, Canada Post, Transport Canada, City of Montréal, Ville de Saint-Jérôme.
	 
Vehicle type and number	24 EVs: • 16x Ford Ranger EV • 3x Ford TH!NK city • 3x Solectria Force • 1x Solectria CitiVan • 1x Solectria (conversion)
Start and end date	Start: January 1999 End: March 2001
Project description	The project's goal was to help integrate electric vehicles (EVs) into institutional and private vehicle fleets in the greater Montréal region. The first of its kind in Canada, the project ran for 27 months and had three major thrusts: a scientific evaluation of EVs under normal operating conditions, support for participating organizations, and promotion of this mode of transportation in an urban setting.
Studied parameters and monitored data	• Technical • Total and average daily distance travelled (km) • Readiness and reliability of EVs (% of availability) • Energy use (kWh) vs external conditions (road, snow, temperature, etc) • Fuel consumption of related gasoline-powered vehicles with similar driving patterns in fleets. • Attitude

	• Familiarity with how EV performed; • Performance subjective criteria (noise, acceleration, ease of use of charging stations, etc)
Data collection equipment used	ISAAC Instruments and logbooks
Issues	• Lack of communication and understanding of issues at stake in the experiment – EV were introduced as standard vehicles; • Delays in EV delivery, perception and worries from fleet managers; • Uneven usage – Vehicle autonomy plunged with the arrival of the winter cold, and resulted in a significant decrease in use; • Vehicle availability was also reduced due to technical problems - as most vehicles were prototypes, adjustments and improvements to parts and components of the EVs were therefore inevitable.
Budget and funding sources	C$ 2,073,000 Government of Canada, Hydro-Québec, Government of Québec, CEVEQ (now CNTA), ISAAC Instruments
Project outcome if available	• The vehicles travelled a total of 96,493 km; • Travel distances from between 0 and 40 km for 77 % of the time; • Reliability : average availability of vehicles was 88 %; The attitude study clearly underscored the importance of analyzing the use for which the vehicle will be used within an organization, whether for a specific purpose or for more general use. For users and fleet managers to have confidence in this technology, the autonomy of the vehicle must correspond well to its use. It also emerged that if the decision to introduce an EV was made by the fleet manager, the integration of the vehicle was easier. Conversely, if the decision came from another level of management, use of the vehicle faced a certain reticence. Integration was longer and more difficult. Final report available at http://cnta.ca/documents/Rapports2/Montreal2000_FinalReport.pdf

11.1.2 BEV fleet for Hydro-Québec

Project name	Electrical Vehicle Fleet
Status	Current
Location	Montreal area
Sponsors	Hydro-Québec

Vehicle type and number	7 Electric Vehicles – Citroën Saxo, Berlingo and Cleanova
Start and end date	January 2006
Project description	Fleet vehicles used in regular operations; Maintenance, reparation and distance report
Studied parameters and monitored data	Number of kilometers, number of usage, cycle of recharge, problems follow-up
Data collection equipment used	N/A
Issues	User participation when filling out log-book, awareness of the users regarding good usage of the EV and proper recharging cycle to maintain autonomy of EV
Budget and funding sources	Hydro-Québec
Project Outcome if available	Annual and monthly report regarding distance and problem with EV

11.1.3 BEV fleet for Saint-Jérôme

Project name	Electrical Vehicle Fleet
Status	Current
Location	City of Saint-Jérôme
Sponsors	City of Saint-Jérôme

Vehicle type and number	4 Electric Vehicles – Citroën Saxo and Berlingo
Start and end date	July 2005
Project description	Fleet vehicles used in regular operations; Maintenance, reparation and distance report

Studied parameters and monitored data	Number of kilometers, number of usage, cycle of recharge, problems follow-up
Data collection equipment used	N/A
Issues	User participation when filling out log-book, awareness of the users regarding good usage of the EV and proper recharging cycle to maintain autonomy of EV
Budget and funding sources	City of Saint-Jérôme, EDF, City of La Rochelle, Advanced Transport Mobility Cluster
Project Outcome if available	Annual and monthly report regarding distance and problem with EV

11.1.4 Hydro-Québec Ford Escape PHEV

Project name	Ford Escape PHEV EPRI field test program
Status	Current
Location	Boucherville
Sponsors	Hydro-Québec, Ford, EPRI
	
Vehicle type and number	1x Ford Escape PHEV prototype 20x other Ford Escape are used by other utility companies
Start and end date	June 2009 – 3 year project
Project description	The project is part of a North America wide demonstration and research program on plug-in hybrid electric vehicles (PHEVs). Ford, in collaboration with the Electric Power Research Institute (EPRI), has undertaken a three-year test program on the Ford Escape PHEV designed to develop and evaluate technical approaches for integrating PHEVs into the electric grid. EPRI has identified nine utilities across North America to test drive the vehicles and collect data on battery technology, vehicle systems, customer use and grid infrastructure. In total, Ford provided 21 vehicles for the real-world trials. Hydro-Québec is the only Canadian company participating in the North American Ford PHEV Program.
Studied parameters and monitored data	Gather the data required for the seamless integration into the grid while providing real world driving experience. Collect data on battery technology, vehicle systems, customer use and grid infrastructure.
Data collection equipment used	N/A
Issues	TBD
Budget and funding sources	Budget N/A - Hydro-Québec
Project outcome if available	Current project – no outcome yet.

11.1.5 PHEV Université Laval – Project #1

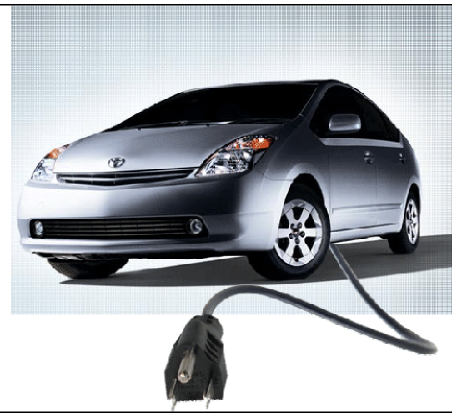
Project name	PHEV- Québec
Status	Current
Location	Université Laval, Québec City
Sponsors	Modenergy, Desjardins
	
Vehicle type and number	Toyota Prius 2005 converted with 5.6 kWh Li-Ion batteries. Ni-MH battery was removed. ALL-EV mode is possible under 55 km/h.
Start and end date	April 2008 – Now
Project description	Obtain performance data on fuel consumption and test Li-Ion battery performance over time and in low temperature conditions.
Studied parameters and monitored data	Speed, Fuel consumption, Distance driven for each run, Battery state of charge, GPS coordinates, Battery Current, Battery Voltage, External Temperature.
Data collection equipment used	ISAAC Instruments
Issues	Technical
Budget and funding sources	Université Laval, Desjardins, Modenergy, Auto21
Project outcome if available	Publications in conferences

11.1.6 PHEV Université Laval – Project #2

Project name	PHEV- Québec
Status	Current
Location	Université Laval, Québec City
Sponsors	No sponsor
Vehicle type and number	Toyota Prius 2005 converted with 4 kWh Pb-Acid batteries as an add-on battery. Ni-MH battery was maintained. ALL-EV mode is possible under 55 km/h.
Start and end date	September 2009 – Now
Project description	Obtain performance data on fuel consumption and test Pb-Acid battery performance over time and in low temperature conditions.
Studied parameters and monitored data	Speed, Fuel consumption, Distance driven for each run, Battery state of charge, Battery Current, Battery Voltage, External Temperature.
Data collection equipment used	None
Issues	Technical
Budget and funding sources	Université Laval

Project Outcome if available	Publications in conferences

11.1.7 PHEV St-Jérôme

Project name	Plug-In Hybrid Electric Vehicle Demonstration Project
Status	Current
Location	Province of Quebec
Sponsors	N/A
	
Vehicle type and number	7x Toyota Prius (second generation): 2x standard mode Hybrid, 5x Plug-In Hybrid
Start and end date	February 2010, February 2011
Project description	Evaluation of the overall performance of plug-in hybrid electric vehicle in the Province of Quebec and in different duty-cycle
Studied parameters and monitored data	Duty cycle; speed; fuel and electricity consumption; external, engine, coolant and battery temperature; battery state of charge
Data collection equipment used	ISAAC Instrument
Issues	Electrical outlet availability, discipline of the users when using their plug-in vehicle,
Budget and funding sources	Agence de l'Efficacité Énergétique du Québec, Hymotion, Ville de Saint-Jérôme, Centre National du Transport Avancé (CNTA), All participants contributed for the financing of their conversion and provided vehicles; these participants were both individuals and public entities, such as the Centre de gestion de l'équipement roulant (CGER) and Ville de St-Jérôme.
Project outcome if available	Final Report in March 2011

11.1.8 Toyota Canada – Toyota Prius PHEV

Project name	Toyota Prius Plug-In Hybrid Vehicle Demonstration Project
Status	Current
Location	Canada
Sponsors	Toyota Canada
	
Vehicle type and number	13x Toyota Prius Plug-in Hybrid OEM
Start and end date	March 2010 to N/A
Project description	Toyota Canada Inc. (TCI) is working with 13 partners on the first phase of this national trial, including academics, provincial government departments, municipalities and provincial power authorities. **British Columbia:** BC Institute of Technology BC Hydro City of Vancouver Ministry of Energy, Mines and Petroleum Resources University of Victoria's Institute for Integrated Energy Systems **Manitoba:** Manitoba Hydro Manitoba Innovation, Energy and Mines University of Manitoba **Ontario:** AUTO21 Network of Centres of Excellence City of Toronto **Québec:** Université Laval Ministère des ressources naturelles et de la faune Hydro-Québec
Studied parameters and monitored data	Trials will begin shortly and continue through next winter to assess Prius PHV performance under a range of driving and climate conditions.
Data collection equipment used	Each test vehicle will be fitted with a telematics device to capture performance data, and partners are encouraged to drive their Prius PHV in as many road, traffic and weather conditions as possible.
Issues	N/A
Budget and funding sources	N/A
Project outcome if available	N/A

11.1.9 PHEV Manitoba Hydro

Project name	Research the Impact, Reliability, and Operation of a Plug-in Hybrid Electric Vehicle (PHEV) in Manitoba
Status	Current. Project was initiated in June 2005.
Location	Winnipeg
Sponsors	Manitoba Hydro, University of Manitoba, CEATI, and Province of Manitoba.
	
Vehicle type and number	• Manitoba Hydro converted a Toyota Prius to a PHEV with an EnergyCS system in August 2006. • University of Manitoba converted a Toyota Prius to a PHEV with a Hymotion system in April 2007. • EnergyCS system failed, and Manitoba Hydro replaced it with a Hymotion system in November 2007. Province of Manitoba initiated a PHEV demonstration project in April 2008 and converted 10 Toyota Prius vehicles with Hymotion systems from Provincial fleets that included Manitoba Hydro, City of Winnipeg, Red River College, Manitoba Public Insurance, and Manitoba Government. Total – 12x Toyota Prius converted with Hymotion (A123 Systems)
Start and end date	Project started in June 2005 and does not have a mandated end date. With the two Hymotion conversions in 2007, there is an obligation to the US DOE to provide PHEV monitoring data from these two vehicles for a three year period.
Project description	To research the operating characteristics of a Plug-In Hybrid Vehicle (PHEV) as well as the impact of a PHEV on the Manitoba Hydro system. Data will be collected from the PHEV driving in both winter and summer conditions. Analysis of the data collected such as ambient conditions, distance, kWh consumption, gasoline consumption, charge/discharge data, and harmonics generated during charging will evaluate the performance of the PHEV, as well as the impact of a PHEV on the Manitoba Hydro system. From this data future projections will be made of the impact of a large number of PHEVs on the Manitoba Hydro system load.
Studied parameters and monitored data	Monitored data includes all OBDII channels, GPS data, and AEMC Power Quality logger parameters. Studied parameters include duty cycles, performance over varying driving conditions and weather conditions, and calculated vehicle emissions.
Data collection equipment used	OttoLink and Otto-Driving Companion record all OBDII channels and GPS data at a one second resolution. 140 channels are being logged. 84 are unknown, and the raw HEX

	values are being recorded. Monitoring equipment was designed and built by Persentech. AEMC PQL 100 loggers are used at the vehicle plug-in for voltage, current, power, harmonics, etc. The two vehicles with US DOE monitoring equipment also have a Kvaser data logger on the OBDII, which logs 27 channels.
Issues	12V lead acid battery is known to be undersized for the Toyota Prius, especially under winter conditions. The stock 12V batteries were replaced. Data loggers are also known to drain the 12V battery, so trickle chargers have been installed on the vehicles. Vehicles used as general pool vehicles in fleets tend to provide poor data, as they may not be driven on a regular basis and do not have a dedicated driver ensuring vehicle is regularly plugged in and functioning properly.
Budget and funding sources	Vehicles costs covered by fleet, while conversions and monitoring equipment were covered by sponsors listed above.
Project outcome if available	Internal reports are currently under draft and may not be made publicly available. Monthly and annual performance reports generated by Idaho National Labs Part of US DOE – Idaho National Laboratory study

11.1.10 PHEV B.C. Hydro

Project name	PHEV demonstration project
Status	Current
Location	Vancouver
Sponsors	B.C. Hydro, Province of B.C, City of Vancouver, Penticton, Kelowna and Dawson Creek
	
Vehicle type and number	13x PHEV – Converted Toyota Prius (Hymotion)
Start and end date	November 2008; data collection began in April 2009
Project description	Pilot plug-in electric vehicle technologies: to assess vehicle performance and operability, and to study system impacts (load profile for different user patterns and power quality).
Studied parameters and monitored data	• Gasoline fuel economy (mpg) • AC electrical energy consumption (AC Wh/mi) • DC electrical energy consumption (DC Wh/mi) • Distance travelled (mi) • Number of trips (and city/highway %) • Type of battery discharge (Charge depleting, charge sustaining or combined) • Plug-in charging events (number, duration, date, energy transferred)
Data collection equipment used	GridPoint (formely V2Green)
Issues	Lack of charging infrastructure with a couple of the cars.
Budget and funding sources	$400,000 – Funded by Provincial Government and BC Hydro.
Project outcome if available	Monthly and annual performance reports generated by Idaho National Labs

	Part of US DOE – Idaho National Laboratory study

11.1.11 PHEV Veridian Connections

Project name	Veridian PHEV demonstration project
Status	Current
Location	Oshawa
Sponsors	Veridian Connections
	
Vehicle type and number	1x Toyota Prius PHEV conversion with a solar panel on the roof
Start and end date	Sept 2006
Project description	Personal car
Studied parameters	N/A
Data collection equipment used	N/A
Issues	N/A
Budget and funding sources	N/A
Project outcome if available	N/A

11.1.12 PHEV ERMS

Project name	ERMS Environment Canada Electric Mobility
Status	Current
Location	Ottawa
Sponsors	NRCAN's PERD Program, Environment Canada
Vehicle type and number	Model: 1x 2009 PHEV Prius (converted by Hymotion – A123Systems)
Start and end date	December 2009 to March 2012
Project description	This vehicle was converted to PHEV configuration for testing of emissions, fuel consumption, and electrical consumption performance at the ERMS chassis dynamometer test facility in Ottawa. Goals of this testing include evaluating PHEV technology in Canadian climate (dynamometer testing at sub freezing temperatures), and contributing to the development of new test procedures and reporting protocols for fair comparison and regulation of this advanced technology. In addition, this vehicle will be used as a fleet vehicle when not being tested.
Studied parameters and monitored data	OBDII channels as monitored by the Kvaser Memorator data logger provided by A123Systems'. Additional data will be recorded during chassis dynamometer testing, however this data is probably not suitable for demonstration of on-road performance
Data collection equipment used	Kvaser Memorator data logger.

Issues	12V lead acid battery frequently requires trickle charging. Also, this vehicle is not driven regularly as it is often needed for dynamometer testing. Although it is not driven regularly, useful data may be acquired over the length of the project.
Budget and funding sources	N/A
Project outcome if available	N/A Monthly and annual performance reports generated by Idaho National Labs Part of US DOE – Idaho National Laboratory study

11.1.13 PHEV Environment Canada

Project name	PHEV Program
Status	Currently on hold due to technical issues
Location	Gatineau
Sponsors	NRCAN's PERD Program, Environment Canada
Vehicle type and number	Model: 1x 2004 PHEV Prius (converted by Hymotion – A123Systems)
Start and end date	April 2008 to January 2010 (potential re-start mid-2010)
Project description	Vehicle was converted to a PHEV to assist in the development of an emissions testing protocol being developed by Environment Canada. Vehicle is a pooled fleet vehicle, for use by staff at the 1040 facility.
Studied parameters and monitored data	Data collected through OBDII port
Data collection equipment used	Kvaser Memorator data logger.
Issues	12V lead-acid battery requires frequent charging and replacement. Power drains being investigated.
Budget and funding sources	Vehicle was purchased in 2004 as a fleet vehicle. Costs for fuel and maintenance come from program's operating budget.
Project outcome if available	N/A Monthly and annual performance reports generated by Idaho National Labs Part of US DOE – Idaho National Laboratory study

11.1.14 PHEV Biosphère – Environment Canada

Project name	Projet Prius/Biosphère
Status	Current
Location	Montréal
Sponsors	NRCAN's PERD Program, Environment Canada
Vehicle type and number	Model: 1x 2004 PHEV Prius (converted by Hymotion – A123Systems)
Start and end date	October 2008 to March 2012
Project description	This vehicle was converted to PHEV configuration for use as a fleet vehicle.
Studied parameters and monitored data	OBDII channels as monitored by the Kvaser Memorator data logger provided by A123Systems.
Data collection equipment used	Kvaser Memorator data logger.
Issues	Use is not frequent. The vehicle is parked off site and the battery charging is not optimally done. Data logger is not always used as it needs to be plugged back before every use as it drains the 12V battery if left plugged in.
Budget and funding sources	$20K – funded by PERD program

Project outcome if available	Li-Ion gives same performance as at the beginning of the project. Monthly and annual performance reports generated by Idaho National Labs Part of US DOE – Idaho National Laboratory study

11.1.15 PHEV FleetWise project from the Toronto Atmospheric Fund

Project name	PHEV pilot project Part of the FleetWise initiative – Toronto Atmospheric Fund
Status	Finished
Location	Toronto
Sponsors	Sponsors: Toronto Atmospheric Fund, A123 Systems Participants: AutoShare, Bullfrog Power, City of Toronto, Ministry of Transportation Ontario, Ministry of Environment Ontario, Toronto and Region Conservation Authority, Toronto Hydro, University of Toronto, York University.
 *Photo courtesy of Ben Marans*	
Vehicle type and number	Model: PHEV Prius (converted by Hymotion – A123Systems) Total of 9 vehicles: 1 vehicle for each partner (City of Toronto had 2)
Start and end date	August 2007 to December 2008
Project description	The pilot project was designed to evaluate the performance of PHEV technology in real on road testing for private and public fleets. Given that transportation is one of the largest sources of greenhouse gas emissions in the City of Toronto — and one of the fastest growing sources nationwide — the primary objective of the study was to see if PHEVs could reduce the greenhouse gas emissions and air pollutants associated with fleet vehicle use.
Studied parameters and monitored data	Driving Operation • Distance traveled [km] (HEV, PHEV, Combined, Overall) • Vehicle mean speed [km/hr] (PHEV, Overall) • Fuel economy [L/100km] (PHEV, HEV, Overall) • Fuel Volume [L] (PHEV, HEV, Overall) • EV mode travel [%] • Ambient temperature [°C] • Electrical energy consumed [Watt-hour] • PCM discharge rate [Wh/km] • Aggressiveness factor [%] Battery Operation • Recharging time [hr] • Electrical energy consumed [kWh]

	• State of charge at beginning & end of trip [%]
Data collection equipment used	Kvaser Memorator data logger. Data collected from each driving events.
Issues	N/A
Budget and funding sources	• Around $100K for the conversions, data loggers and software. Does not include staff time for TAF and A123Systems nor in-kind support from University of Toronto for data analysis and reporting. • Conversions costs and data logger and software: 50% by A123Systems and 50% by TAF. • Base vehicles were provided by the fleet partners.
Project outcome if available	Overall, the vehicles produced only a marginal increase in fuel efficiency (10%), which resulted in greenhouse gas emissions being reduced by 6%. However, when the vehicles were actually in a position to use the PHEV system (e.g., there was sufficient charge in the PHEV battery pack to run the electric motor), the vehicles delivered excellent fuel efficiency improvements of 36% with a 20% reduction in greenhouse gas emissions. Type of trip: • PHEV mode is best suited to shorter, lower speed trips or short highway trips with steady speeds where the ability of the PHEV unit to assist the ICE even at highway speeds can be useful. Driving style: • A smoother, less aggressive driving style maximizes the potential use of the PHEV unit. Charging: • More frequent plug-in charging of the PHEV unit ensures maximum availability. Temperature: • The vehicles achieved the best fuel economy during warm weather. Parking the vehicles indoors in winter if possible could improve winter performance. Total distance traveled by the 9 vehicles: 122 165 km Number of driving operations: 6861 Number of recharge: 1615 Total energy drawn from the grid: 3.4 DC MWh Final report is available at: http://www.toronto.ca/taf/pdf/fleetwise-phev-july2009.pdf

11.1.16 Transport Canada - ecoTECHNOLOGY for Vehicles (eTV) Program

Project name	Transport Canada - ecoTECHNOLOGY for Vehicles (eTV) Program
Status	In progress
Location	Across Canada
Sponsors	Transport Canada
Vehicle type and number	1x PHEV – Toyota Prius converted (A123) 1x HEV – Toyota Prius (2010) 4x EV – PT Cruiser converted, Tesla Roadster, Mitsubishi i-MiEV (2x)
Start and end date	February 2007 to March 2011
Project description	The ecoTECHNOLOGY for Vehicles (eTV) Program (www.tc.gc.ca/eTV) is Transport Canada's national initiative aimed at encouraging the introduction of advanced vehicle technologies across Canada. eTV works with industry associations, manufacturers, other government departments and stakeholders to coordinate the national testing and evaluation of emerging vehicle technologies across Canada, in accordance with test procedures and best practices established by the Code of Federal Regulations, the Society of Automotive Engineers and the Electric Drive Transportation Association, among others. The eTV program acts as a key link between industry and government, working to identify and address potential market barriers to the introduction of promising new passenger vehicle technologies in Canada. eTV achieves these objectives in relation to battery electric, PHEV and hybrid vehicles by: 1. Acquiring a range of emerging environmental light-duty advanced vehicles from a number of vehicle manufacturers, in order to test and evaluate their performance in Canada; 2. Working in collaboration with industry to demonstrate vehicle use in real-world operating conditions, in order to assess the reliability and durability of these technologies in Canada; 3. Identifying and addressing gaps, amendments and new requirements for codes, standards and regulations, to encourage the introduction of these technologies in Canada; 4. Working to increase Canadians' awareness of these technologies through outreach events, technology articles, newsletters, 5. our interactive website, a technical glossary, educational curricula and other demonstration and development activities; 6. Conducting studies and assessments to determine the environmental impacts and benefits of these technologies in Canada.
Studied parameters and monitored data	eTV tests and evaluates vehicles according to test procedures and best practices established by the Federal Code of Regulations, the SAE and the Electric Drive Transportation Association Tests and evaluations aim to determine: energy consumption per unit distance, charging efficiency, regenerative braking efficiency, vehicle range at various states of charge and temperatures, consumer perception of EV performance, potential market barriers, and specific aspects of vehicle dynamic performance.
Data collection equipment used	N/A
Issues	N/A

Budget and funding sources	Transport Canada
Project outcome if available	eTV's test results help inform the development of regulations, codes and standards for the next generation of advanced vehicles, including electric, fuel cell and plug-in electric hybrid vehicles, among others. Results help Canadians to better understand the benefits of new technologies -- highlighting their environmental performance and accelerating their acceptance in Canada.

11.1.17 EV Hydro-Québec, Boucherville and Mitsubishi i-MiEV

Project name	EV demonstration project with Mitsubishi i-MiEV
Status	Current
Location	Boucherville
Sponsors	Hydro-Québec
	
Vehicle type and number	EV – Mitsubishi i-MiEV Up to 50 vehicles
Start and end date	2010 to 2013
Project description	Integrate, test, and evaluate all-electric vehicles on urban streets under real-world conditions. The project is designed to study the vehicles' charging behaviour, driving experience as well as overall driver satisfaction. It will also allow Hydro-Québec to evaluate the challenges involved in integrating electric vehicles into its grid.
Studied parameters and monitored data	• Tests to be conducted under real-life circumstances ○ Vehicle performance under winter conditions ○ Driving experience and overall driver satisfaction ○ Vehicle charging behavior ○ Impact on electrical power grids • Implementation of charging infrastructure • Evaluation of CO2 emission reduction • Project aims to encourage larger-scale adoption of electric vehicles in Québec
Data collection equipment used	Currently under evaluation
Issues	Right-hand drive for the first unit. Other units will be left-hand drive.
Budget and funding sources	$4.5 million, funded by Hydro-Québec
Project outcome if available	N/A

11.1.18 EV B.C. Hydro, Vancouver and the Mitsubishi iMiEV

Project name	EV demonstration project with Mitsubishi Motors
Status	Current
Location	Vancouver
Sponsors	B.C. Hydro, Province of BC, City of Vancouver and Mitsubishi
	
Vehicle type and number	EV – Mitsubishi iMiEV – 2x BC Hydro and 1x City of Vancouver
Start and end date	Fall 2009
Project description	N/A
Studied parameters and monitored data	N/A
Data collection equipment used	GridPoint (formely V2Green)
Issues	N/A
Budget and funding sources	N/A
Project outcome if available	N/A

11.1.19 EV BC Hydro, Vancouver and the Nissan LEAF

Project name	EV demonstration project with Nissan
Status	Not started
Location	Vancouver
Sponsors	BC Hydro, Province of BC, City of Vancouver and Nissan
	
Vehicle type and number	EV – Nissan LEAF
Start and end date	N/A
Project description	N/A
Studied parameters and monitored data	N/A
Data collection equipment used	N/A
Issues	N/A – Project not started
Budget and funding sources	N/A

Project outcome if available	N/A – Project not started

11.1.20 EV300 Initiative by Toronto Atmospheric Fund

Project name	EV 300 Initiative
Status	Not started
Location	Toronto (GTA)
Sponsors	Toronto Atmospheric Fund
Vehicle type and number	300x EV – any model
Start and end date	N/A
Project description	EV procurement project for both the private and public managers. The goal is to acquire at least 300 EVs and monitor, maintenance and assess them in a coordinated manner. Private and public fleet participating in the initiative will access EV vehicles, get technical support, establish infrastructure tariffs, and get support understanding and assessing the grid integration of EVs. The purpose is to have a common approach and economies of scale.
Studied parameters and monitored data	N/A
Data collection equipment used	N/A
Issues	N/A – Project not started
Budget and funding sources	N/A
Project outcome if available	N/A – Project not started

11.1.21 BEV bus Écolobus

*Please note that this project does not fully comply with the project's scope, because the vehicle is a bus with no highway capability. It is listed here for information purposes.

Project name	Écolobus
Status	Demonstration project completed – the vehicles are now under regular use
Location	Québec city (Vieux-Québec)
Sponsors	Federal (UTDP) & Québec Governments; Ville de Québec; Réseau de Transport de la Capitale (RTC);
	
Vehicle type and number	8x Tecnobus Gulliver Electric urban minibus
Start and end date	Start : 2008-06 End : Not specified, endless
Project description	Free stop on demand ecological run through the Vieux-Québec
Studied parameters and monitored data	No parameter monitored anymore (data was only used to validate the feasibility in 2007) Total distance (odometer); vehicle cost to operate;
Data collection equipment used	None (2007 used ISAAC Instruments)
Issues	Project considered a success, manufacturer is from Italy : brought several issues, buses are just about to receive complete CMVSS certification, DC motor was an issue with the cold weather, vehicle limited speed of 32 km/h is still an issue.
Budget and funding sources	12.4 M$ (33% each sponsor)
Project outcome if available	Get on the bus in the street, for further information : http://www.rtcquebec.ca/%C3%89colobus/tabid/151/language/fr-FR/Default.aspx

11.1.22 Unicell Quicksider BEV

*Please note that this project does not fully comply with the project's scope, because the vehicle is an urban package-delivery vehicle, with no highway capability. It is listed here for information purposes.

Project name	Purolator Unicell Quicksider EV The vehicle is manufactured by Unicell and was demonstrated by Purolator.
Status	Current
Location	Toronto
Sponsors	Transportation Development Centre of Transport Canada Sustainable Development Technology Canada ArvinMeritor Unicell
	
Vehicle type and number	EV urban package delivery vehicles 1 vehicle
Start and end date	Prototype project started by Unicell in 2000, Purolator joined in 2003, ArvinMeritor in 2004. Demonstration project started in September 2007
Project description	Demonstration project meant to assess the performance of Unicell's Quicksider courier truck prototype.
Studied parameters and monitored data	Energy use and the efficiency and safety of delivery operations.
Data collection equipment used	N/A
Issues	N/A
Budget and funding sources	N/A
Project Outcome if available	Commercialization and development work is ongoing.

11.1.23 BEV bus demonstration – University of Ontario Institute of Technology (UOIT) Oshawa

*Please note that this project does not fully comply with the project's scope, because the vehicle is a bus with no highway capability. It is listed here for information purposes.

Project name	UOIT EcoCAR team EV Bus – University of Ontario
Status	Current
Location	Oshawa
Sponsors	University of Ontario Institute of Technology Ontario Power Generation Veridian Connections DSEA

Vehicle type and number	2 EV buses (converted)
Start and end date	Phase I: Aug 2008 to Mar 2010 Phase II: April 2010 to March 2011
Project description	EV bus, environmental impact and energy use study
Studied parameters and monitored data	Distance, Speed, Velocity, GPS position, Altitude, Temperature, Battery voltage, Battery Current, Ah, KW and KWh, Charging energy KHh
Data collection equipment used	DART energy monitor http://sbeti.org/ Custom Microsoft Visual Project Data logging Application with GPS receiver
Issues	Administrative: none, excellent support from University Political: none Technical: bus is underpowered for urban speeds, batteries need upgrade Regulatory: Imported on Schedule VII, now elapsed. We need an extension to continue.
Budget and funding sources	Initial budget (Source OPG): $68k, purchase, transport, licensing and commissioning. Phase II is under negotiations.
Project outcome if available	No final report yet – will be available March 2010.

11.2 Projects in Other Jurisdictions

Demonstration projects done outside Canada can provide very useful lessons for Canadian projects. The following list is non-exhaustive and is targeted at providing an order of magnitude of demonstration projects outside our borders. It is worth noting that the U.S. Idaho National Laboratory reports currently include most Canadian and American demonstration projects in one aggregated database and study.

11.2.1 U.S. – The EV Project

Project name	The EV Project
Status	Current
Location	US
Sponsors	U.S. Department of Energy Partners: ECOtality, eTec, Nissan North America, Idaho National Engineering and Environmental Laboratory, Zero Emission
Vehicle type and number	EV Nissan LEAF Total – 4700 vehicles and 11 210 charging systems
Start and end date	Start : 2009 – 36 months
Project description	The EV Project will collect and analyze data to characterize vehicle use in diverse topographic and climatic conditions, evaluate the effectiveness of charge infrastructure, and conduct trials of various revenue systems for commercial and public charge infrastructure. The ultimate goal of The EV Project is to take the lessons learned from the deployment of these first 4,700 EVs, and the charging infrastructure supporting them, to enable the streamlined deployment of the next 5,000,000 EVs. In the summer of 2010, charging infrastructure will be deployed in the following major population areas: Phoenix (AZ), Tucson (AZ), San Diego (CA), Portland (OR), Eugene (OR), Corvallis (OR), Seattle (WA), Nashville (TN), Knoxville (TN) and Chattanooga (TN). The Nissan LEAF will be available in those same areas in the fall of 2010 to consumers and fleets.
Studied parameters and monitored data	N/A
Data collection equipment used	Gridpoint
Issues	N/A
Budget and funding sources	$99.8 million
Project outcome if available	N/A

11.2.2 US Idaho National Laboratory BEV America study

Project name	EV America
Status	Finished
Location	US

Sponsors	• U.S. Department of Energy – Office of Technology Utilization
	• Idaho National Engineering and Environmental Laboratory
	  o U.S. Department of Energy – Idaho Operations Office
	  o Lockheed Martin Idaho Technologies Co.
	• Qualified Vehicle Testers: Southern California Edison, Electric Transportation Applications (Arizona Public Service, Potomac Electric Power Co., Salt River Project)

Vehicle type and number	EV from manufacturers and conversions • NiMH batteries: Chrysler Epic, Ford Ranger, GM EV1, Chevrolet S-10, Toyota RAV4 • PbA batteries: Ford Ranger, GM EV1, Chevrolet S-10, Toyota RAV4, Solectria Force, Solectria E10 Pickup, Baker EV100 Pickup Total – more than 250 vehicles
Start and end date	Start : 1994 End : 1999
Project description	The project is not an actual demonstration project but an aggregator of data for different projects across United States. The goal was to demonstrate the validity of operating electric vehicles in commercial fleet applications by documenting the performance, the costs and the support requirements

Studied parameters and monitored data	• Baseline Performance Testing (EV America)
	  o Initial performance
	  o Periodic checks
	  o Testing parameters such as driving cycle range (SAE J1634), constant speed range, Maximum speed, Acceleration, Charge time, Charge efficiency, Vehicle specifications, Braking, Handling
	• Fleet testing
	  o Viability as fleet vehicle
	  o User acceptance issues
	  o Data monitoring of parameters such as kWh meter onboard, for onboard conductive chargers, kWh meter offboard, for inductive chargers, kWh data stored in 15 minute segments, Odometer readings, Location, vehicle identification, time/date
	• Accelerated reliability testing
	  o High mileage
	  o Performance over life-cycle
	  o Infrastructure support

Data collection equipment used	N/A
Issues	N/A
Budget and funding sources	N/A
Project outcome if available	• Leaving vehicles charging over weekends/nights results in low miles/AC kWh efficiencies • Early vehicles often failed to meet performance goals • Average annual performance results are improving • New vehicles are OEM manufactured and include warranties • Performance test results suggests that vehicle quality is significantly increasing as OEMs provide vehicles

11.2.3 U.S. Idaho National Laboratory - Plug-in Hybrid Electric Vehicles (PHEV)

Project name	INL Plug-in Hybrid Electric Vehicles (PHEV)
Status	Current
Location	US
Sponsors	75+ Testing partners in the U.S. and Canada, including: • 40 Electric utilities and 2 clean air agencies • 10 City, county, state, and province governments • 7 Private companies and advocacy organizations • 8 Universities and colleges • 2 PHEV conversion companies • 1 sea port and 1 DOD facility Operating in: • 22 U.S. states • 4 Canadian provinces
Vehicle type and number	PHEV from manufacturers and conversions • Hymotion PHEV Escape conversion • Hymotion PHEV Prius conversion • Electrovaya Escape PHEV conversion • Hybrids Plus Escape PHEV conversion • EnergyCS PHEV Prius conversion • Renault Kangoo PHEV Total – 227
Start and end date	Start : 2006 - current
Project description	The project is not an actual demonstration project but an aggregator of data for different projects across United States and Canada. Development of the PHEV Integrated Test Plan and Evaluation Program, which is used to conduct accelerated onroad and baseline performance (dynamometer and test track) testing
Studied parameters and monitored data	Perform independent testing of PHEVs, using: • Baseline performance testing: closed test tracks and dynamometers • Accelerated testing: dedicated drivers operating on defined onroad loops • Fleet testing: everyday unstructured \ non-directed fleet and public use, with onboard data loggers • Laboratory testing of PHEV batteries Testing used to document: • Battery life, charging patterns and profiles • Vehicle operations, fuel use (electricity and gasoline) and infrastructure requirements • Driver influences on fuel use • Individual PHEV models and PHEV concepts
Data collection equipment used	V2Green and Kvaser data logger
Issues	N/A
Budget and funding sources	N/A
Project outcome if available	• Summary reports posted monthly on web • Individual vehicle reports only go to the respective fleets each month, 950+ reports to date (July 1, 2009) • 150 Hymotion Prius PHEVs, 710,000 miles, 76,000 trips, 18,000 charging events, 43,000 kWh used.

	Conclusions • Extreme ambient temperatures significantly impact PHEV fuel economy – Engine operating time increases – Accessories utilization increases Prius battery control system (calibrated for NiMH) is not able to take full advantage of possible benefits of Li-Ion technology at extreme temperatures • Battery capabilities show a slight decrease at low temperatures – Reduced energy capacity – Increased internal resistance – Increased cell imbalance which could lead to further reduction in capacity

11.2.4 France

Project name	La Rochelle PSA
Status	Finished
Location	La Rochelle, France
Sponsors	PSA (Peugeot-Citroën), Ville de La Rochelle, Électricité de France (EDF)
Vehicle type and number	EVs - Peugeot 106 and Partner, Citroën AX, Saxo and Berlingo
Start and end date	1992 to 1994 – Since 1995, the fleet has been converted for self-service vehicles for a project now called Liselec, maintained by Véolia Transport
Project description	Fleets
Studied parameters and monitored data	N/A
Data collection equipment used	N/A
Issues	N/A
Budget and funding sources	N/A
Project outcome if available	The fleet is still available as self-service vehicles. The 50 cars are spread in 7 stations around La Rochelle and available for a monthly membership of 7 Euros and a per-use fee based on time and mileage.

11.2.5 U.S. – TH!NK City

Project name	TH!NK city – Electric vehicle demonstration program
Status	Finished
Location	US – California, New York, Georgia and Michigan
Sponsors	Ford, Idaho National Engineering and Environmental Laboratory, US Department of Energy (DOE)
Vehicle type and number	EVs – 340 TH!NK city in California (185), New York (100), Georgia (15) and Michigan (40)
Start and end date	2001 - 2002
Project description	• Enhancing public awareness of Urban EVs • Defining the unique Urban EV market and niche applications • Enhancing EV infrastructure

	• Investigating economic sustainability of Urban EVs The project included station and shared car, targeting first-time users and a wide scope of customer applications.
Studied parameters and monitored data	N/A
Data collection equipment used	Ford data logging systems and dedicated surveys done by Electric Transportation Applications
Issues	N/A
Budget and funding sources	N/A – Vehicles subsidy by states' incentives programs, 10% federal tax incentive program, DOE grant and locally available grants.
Project outcome if available	Final report available. Market difficult to target; cost and timing of installing the required residential charging units; economic sustainability not fully realized.

11.2.6 Netherlands, Sweden, France, Germany, Italy and Norway

Project name	Elcidis – Electric vehicle city distribution systems
Status	Finished
Location	La Rochelle, Rotterdam, Stockolm, Milan, Stavenger, Erlangen
Sponsors	European Commission – Directorate-General for Energy and Transport
Vehicle type and number	39 EVs and 16 hybrids vans and trucks (Mercedes Sprint, Citroën Berlingo and Saxo, Peugeot Partner)
Start and end date	March 1998 till August 2002
Project description	Overall objective was proving the viability of hybrid and electric vans and trucks for urban distribution, preferably in combination with the use of urban distribution centres (UDC), showing the environmental benefits of such an application and promoting incentives for the use of those vehicles.
Studied parameters and monitored data	• Energy consumption of vehicles, environmental and energy benefits • Information on charging facilities and battery performance • Measurement of logistic data: Distance covered, number of stops, payload factor, goods transported • Investments in vehicles, charging facilities, logistics system • Evaluation of market, driver and public acceptance • Various questionnaires among all parties involved
Data collection equipment used	N/A
Issues	Some sites took a great deal of time to get the desired application 'on the road'.
Budget and funding sources	N/A
Project outcome if available	Urban distribution concepts using electric vehicles are not utopian, but still far away, so substantial barriers have to be taken, before they can be applied generally. Both vehicle manufacturers and public authorities can provide the key-elements for cleaner urban distribution in future. The manufacturers have to provide mature products where the price performance ratio and reliability as well as after sales servicing and maintenance meets the high standard that has been reached with ICE vehicles. • Obstacles were cost of EV vs ICE vehicles and unfavorable product diversity. • Benefits were clean and silent use as well as extensions of delivery hours and possibilities to enter areas, which are, or should be closed for ICE vehicles, like pedestrian areas and public transport lanes. Final report is available here: http://www.elcidis.org/elcidisfinal.pdf

11.2.7 Monaco

Project name	Smart ED
Status	Current
Location	Monaco – similar projects in cities across Europe, Canada and USA
Sponsors	Daimler
Vehicle type and number	10x Smart ED with lithium-ion batteries (1000 worldwide)
Start and end date	2010
Project description	This study follows the previous study with Coventry City Council (UK) which tested 100 electric drive equipped Smart car started in 2008. This study is part of a major study done by Daimler and has for goal to evaluate Smart ED cars in real world conditions.
Studied parameters and monitored data	N/A
Data collection equipment used	N/A
Issues	N/A
Budget and funding sources	N/A
Project Outcome if available	N/A

11.2.8 Strasbourg, France – Toyota Prius PHEV

Project name	Toyota PHEV
Status	Current
Location	Strasbourg (project for Toyota will also expand to UK, Germany, Netherlands and Japan)
Sponsors	Électricité de France (EDF), Toyota
Vehicle type and number	100 Toyota Prius PHEV – from OEM, not converted models
Start and end date	Start 2009
Project description	Toyota leases PHEV Prius for three years to local companies and partners. EDF will install charging points in private homes and at participating partner locations, as well as in parking lots and along the roads. The goal is to broaden consumers' understanding and acceptance, in preparation for broad commercialization in the future.
Studied parameters and monitored data	• Return real-world driving information • Perform critical tests on the battery-charging infrastructure. • Test innovative charging system that ensures safe charging, communication between the plug and the vehicle, identification of the vehicle and automatic invoicing of electricity.
Data collection equipment used	N/A
Issues	N/A
Budget and funding sources	N/A
Project Outcome if available	N/A

11.2.9 France – Réunion

Project name	Renault projet VERT (Véhicules Electriques pour une Réunion Technologique)
Status	Current
Location	Réunion (island), France
Sponsors	France, Renault, EDF, GBH (Groupe Bernard Hayot), Total Réunion, GE Money and GERRI agency
Vehicle type and number	50 Renault EV
Start and end date	Start 2009
Project description	Test a private and public fleet of EVs and evaluate the deployment of a charging infrastructure network in a small territory (island), in association with renewable energy production.
Studied parameters and monitored data	N/A
Data collection equipment used	N/A
Issues	N/A
Budget and funding sources	N/A
Project Outcome if available	N/A

11.2.10 UK – Mini E

Project name	BMW Mini E
Status	Current
Location	UK (similar projects in USA and Germany)
Sponsors	BMW Group, UK government, Scottish and Southern Energy
Vehicle type and number	40x BMW Mini E
Start and end date	2010
Project description	Joint project to introduce emission free driving and the required infrastructure. The project is supported by the UK Technology Strategy Board, SEEDA (South East England Development Agency) and Oxford Brookes University.
Studied parameters and monitored data	N/A
Data collection equipment used	Data logging device, survey and logbook.
Issues	N/A
Budget and funding sources	Monthly rental payments for participants is £330 including maintenance and insurance
Project Outcome if available	N/A

11.2.11 UK – CABLED

Project name	CABLED – Coventry and Birmingham Low Emission Vehicle Demonstrators
Status	Current
Location	UK (West Midlands)
Sponsors	E-On
Vehicle type and number	25x Mitsubishi iMiEV, 40x Smart ED, 25x Tata Indica EV, 5x Land Rover Range_e (PHEV), 5x LTI taxis
Start and end date	2010
Project description	CABLED is a consortium of manufacturers of
Studied parameters and monitored data	N/A – Three universities will be associated in data collection and analysis
Data collection equipment used	Data logging device, survey and logbook.
Issues	N/A
Budget and funding sources	£15 million - The project has been part-funded by the Technology Strategy Board with support from Advantage West Midlands.
Project Outcome if available	N/A

11.2.12 US Google.org – RechargeIT

Project name	RechargeIT.org
Status	Current
Location	US – California
Sponsors	Google
Vehicle type and number	9x PHEV Prius (converted by Hymotion – A123Systems) & 2x conventional Toyota Prius
Start and end date	Start in 2007
Project description	RechargeIT is an effort within Google.org that aims to reduce CO_2 emissions, cut oil use, and stabilize the electrical grid by accelerating the adoption of plug-in electric vehicles. Demonstration fleet of PHEVs at headquarters in Mountain View and publicly available statistics on the performance of those cars.
Studied parameters and monitored data	All of these cars are outfitted with data recording devices that track technical and environmental performance, use patterns and charging history. • Electricity and gasoline consumption • Speed, distance driven, fuel use, and the vehicle's high voltage battery parameters. Information from the extended hybrid battery, such as voltage, current, charge state and battery temperature, is also accessed and archived for data analysis. During charging, the system monitors and records the AC charge power. GPS is used by the fleet manager to track the vehicle's location, and in the future may be used to plot vehicle data against altitude • Data compared to conventional Prius
Data collection equipment used	Embedded computer running Linux connected to CAN, a wireless data card, a GPS and an AC power monitoring device to monitor charge power. Also, a fleet fueling card.
Issues	N/A
Budget and funding sources	N/A
Project Outcome if available	Website with information on the energy consumption - www.google.org/recharge

12 Appendix 4 – Temperature Statistics from The Weather Network

The weather statistics displayed here represent the mean value of each meteorological parameter for each month of the year. The sampling period for this data covers 30 years, from 1961 to 1990.[xxv]

Statistics: Montréal/Aéroport P.-E.-Trudeau, Canada

Latitude: 45.28N **Longitude:** 073.45W **Altitude:** 31m

Temperature °C

	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	-5	-3	2	11	19	23	26	25	20	13	5	-2
Minimum	-14	-13	-6	1	7	13	15	14	9	4	-1	-10
Mean	-9	-8	-1	6	13	18	21	19	15	8	2	-6

Statistics: Vancouver Int´l, BC, Canada

Latitude: 49.11N **Longitude:** 123.10W **Altitude:** 3m

Temperature °C

	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	6	8	10	13	16	19	22	22	18	14	9	6
Minimum	0	1	3	5	8	11	13	13	10	6	3	1
Mean	3	5	6	9	12	15	17	17	14	10	6	4

Statistics: Toronto Pearson Int´l, ON, Canada

Latitude: 43.40N **Longitude:** 079.38W **Altitude:** 173m

Temperature °C

	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	-2	-1	4	12	18	24	27	26	21	14	7	0
Minimum	-10	-10	-4	1	6	11	14	13	9	4	0	-6
Mean	-6	-5	0	6	12	17	21	20	15	9	3	-3

13 Appendix 5 – EVs available in the near future and prototypes

13.1 PHEVs in the Near Future

A PHEV can be described as an electrically rechargeable vehicle equipped with an ICE. Manufacturers are using different approaches in combining mechanical and electrical power to move a vehicle, from a series hybrid to a parallel hybrid or a power-split configuration. For simplification purposes, we will not distinguish between them in the following vehicles. Additionally, manufacturers have different strategies for all-electric range, which can vary from 10 to 60 km, largely related to the amount of on-board batteries.

Bright IDEA

Vehicule Type	Van
Canadian Market Availability	N/A
Marketing Year	2013
www.brightautomotive.com	

Technical Specifications

Propulsion Type	Plug-In Hybrid
Range in EV mode	40 miles
Fuel Economy Hybrid	40 mpg
Battery Type	N/A
Battery Capacity	13 kW/h
Charging Voltage	220V/10A
Weight	3200 lbs
Top Speed	100 mph
Country of Origin	USA
Price (US$ Approx)	N/A

Chevrolet Volt

Vehicule Type	5 door
Canadian Market Availability	2011
Marketing Year	2010
www.gmvolt.com	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	40 miles
Fuel Economy Hybrid	320 Mpg
Battery Type	Lithium Ion
Battery Capacity	16 kW/h
Charging Voltage	120/240 VAC
Weight	3520 lbs
Top Speed	100 mph
Country of Origin	USA
Price (US$ Approx)	32 500

Fisker Karma

Vehicule Type	4 door
Canadian Market Availability	Yes
Marketing Year	2010
www.fiskerautomotive.com	

Technical Specifications

Propulsion Type	Plug-In Hybrid
Range in EV mode	50 miles
Fuel Economy Hybrid	100 mpg
Battery Type	Lithim Ion
Battery Capacity	22,6 kW/h
Charging Voltage	120/240 VAC
Weight	4650 lbs
Top Speed	125 Mph
Country of Origin	USA
Price (US$ Approx)	80 000

Toyota Prius Plug-In

Vehicule Type	5 door
Canadian Market Availability	2012
Marketing Year	2011
www.toyota.co.jp/en/tech/environment/conference09/index.html	

Technical Specifications

Propulsion Type	Plug-In Hybrid
Range in EV mode	12.5 miles
Fuel Economy Hybrid	50 mpg
Battery Type	NiMh/Lithium-Ion
Battery Capacity	5,2 kW/h
Charging Voltage	110/220 VAC
Weight	3285 lbs
Top Speed	60 mph (electric)
Country of Origin	Japan
Price (US$ Approx)	40 000

13.2 PHEV and BEV Conversions

Most of the current or past plug-in hybrid electric vehicle projects were done by converting hybrid cars into plug-in vehicles. In fact, there are a number of companies that offer conversion equipment, mainly for Toyota Prius models. Here is an overview of some companies that offer kits to convert vehicles into PHEVs or BEVs. This list is indicative only and not meant to be complete.

Company	Technology	Models	Type
AC Propulsion	Full conversion with Li-ion battery pack www.acpropulsion.com	Scion xB	EV
A123 Systems	Formerly known as Hymotion; Li-ion battery pack added to the Prius to transfer it in a PHEV. www.a123systems.com/hymotion	Toyota Prius 2nd generation	PHEV
Enginer	PHEV conversion kits suiting Toyota Prius Gens 1, 2 and 3. www.enginer.us	Toyota Prius 1st, 2nd and 3rd generation	PHEV
EnergyCS	Replaces the Ni-MH Prius battery with Li-ion battery. www.energycs.com	Toyota Prius 2nd generation	PHEV
PICC - Plugin Conversions Corp	Ni-MH conversion kits for Prius. www.pluginconversions.com	Toyota Prius 2nd generation	PHEV
REV Rapid electric vehicles	Converted Ford Escapes with electric motor and Li-ion battery pack www.rapidelectricvehicles.com	Ford Escape	EV

13.3 BEVs in the near Future

A number of electric vehicles will be available in the coming months. However, as noted here, most are not planned for Canada in the near term. The Canadian market is considered less attractive for manufacturers of electric vehicles because it is smaller compared to the American market, and the Canadian climate imposes additional constraints compared to a milder climate. There are other barriers for entry, such as Canadian-specific regulations such as bumpers and running lights.

BYD e6

Vehicule Type	Crossover
Canadian Market Availability	N/A
Marketing Year	2010 (US)
www.byd.com	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	250 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium Fe Phosphate
Battery Capacity	72 kw/h
Charging Voltage	220V/10A
Weight	3200 lbs
Top Speed	100 mph
Country of Origin	China
Price (US$ Approx)	40 000

Coda EV

Vehicule Type	4 door
Canadian Market Availability	N/A
Marketing Year	2011
www.codaautomotive.com	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	90-120 Miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium Fe Phosphate
Battery Capacity	33.8 kW/h
Charging Voltage	220V/30 Amp
Weight	3660 lbs
Top Speed	80 mph
Country of Origin	USA
Price (US$ Approx)	40 000

Ford Focus EV(Magna)

Vehicule Type	4 door
Canadian Market Availability	TBD
Marketing Year	2011
www.focusev.com	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	100 miles
Fuel Economy Hybrid	N/A
Battery Type	N/A
Battery Capacity	23 kW/h
Charging Voltage	120/240 VAC
Weight	N/A
Top Speed	N/A
Country of Origin	USA
Price (US$ Approx)	40 000

Ford Transit Connect (Azure Dynamics)

Vehicule Type	Van
Canadian Market Availability	Yes
Marketing Year	2010
http://www.azuredynamics.com/products/transit-connect-electric.htm	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	80 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium Ion
Battery Capacity	28 kW/h
Charging Voltage	120/240 VAC
Weight	N/A
Top Speed	75 mph
Country of Origin	USA/Canada
Price (US$ Approx)	N/A

Lightning GT

Technical Specifications

Propulsion Type	Electric
Range in EV mode	300 km
Fuel Economy Hybrid	N/A
Battery Type	Lithium Ion NanoSafe
Battery Capacity	36 kW/h
Charging Voltage	120/240 VAC
Weight	N/A
Top Speed	210 km/h
Country of Origin	UK
Price (US$ Approx)	188 000

Vehicule Type	2 door
Canadian Market Availability	N/A
Marketing Year	2010
www.lightningcarcompany.co.uk	

MINI Electric (AC Propulsion)

Technical Specifications

Propulsion Type	Electric
Range in EV mode	156 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	35 kW/h
Charging Voltage	120/240 VAC
Weight	3239 lbs
Top Speed	95 mph
Country of Origin	Germany
Price (US$ Approx)	N/A

Vehicule Type	3 door
Canadian Market Availability	N/A
Marketing Year	2009
www.miniusa.com/minie-usa/	

Mitsubishi i-Miev

Vehicule Type	5 door
Canadian Market Availability	2012
Marketing Year	2010
www.mitsubishi-motors.com/special/ev/	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	100 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	16 kW/h
Charging Voltage	120/240 VAC 200 VAC Triphasic
Weight	2380 lbs
Top Speed	130 km/h
Country of Origin	Japan
Price (US$ Approx)	47 500

Modec

Vehicule Type	Truck
Canadian Market Availability	N/A
Marketing Year	2007
www.modeczev.com	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	60-100 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion (Zytek)
Battery Capacity	85 kW/h
Charging Voltage	200 VAC Triphasic
Weight	6610 lbs
Top Speed	50 mph
Country of Origin	United Kingdom
Price (US$ Approx)	40 000

Nissan Leaf

Vehicule Type	5 door
Canadian Market Availability	2012
Marketing Year	2010
www.nissanusa.com/leaf-electric-car/	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	100 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	24 kW/h
Charging Voltage	200 VAC
Weight	2980 lb
Top Speed	90 mph
Country of Origin	Japan
Price (US$ Approx)	30 000

Scion IQ Electric

Vehicule Type	3 door
Canadian Market Availability	N/A
Marketing Year	2012
www.toyota.com/concept-vehicles/ftev.html	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	100 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	N/A
Charging Voltage	N/A
Weight	N/A
Top Speed	70 mph
Country of Origin	Japan
Price (US$ Approx)	N/A

Smart ED

Vehicule Type	3 door
Canadian Market Availability	2012
Marketing Year	2011
www.smart.com	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	72 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-ion
Battery Capacity	14 kW/h
Charging Voltage	220 VAC
Weight	1882 lbs
Top Speed	60 mph
Country of Origin	Germany
Price (US$ Approx)	N/A

Smith Edison Electric

Vehicule Type	Truck
Canadian Market Availability	N/A
Marketing Year	2010
www.smithelectricvehicles.com/	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	60-100 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion Iron Phosphate
Battery Capacity	40 kW/h
Charging Voltage	220 VAC
Weight	5000 lbs
Top Speed	50 mph
Country of Origin	United Kingdom
Price (US$ Approx)	40 000

Subaru R1e

Technical Specifications

Propulsion Type	Electric
Range in EV mode	50 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	N/A
Charging Voltage	220 VAC
Weight	N/A
Top Speed	65 mph
Country of Origin	Japan
Price (US$ Approx)	30 000

Vehicule Type	3 door
Canadian Market Availability	N/A
Marketing Year	2010
www.subaru-global.com/eco_ev.html	

Subaru Stella

Technical Specifications

Propulsion Type	Electric
Range in EV mode	55 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	9.2 kW/h
Charging Voltage	N/A
Weight	2340 lbs
Top Speed	60 mph
Country of Origin	Japan
Price (US$ Approx)	29 000

Vehicule Type	5 door
Canadian Market Availability	N/A
Marketing Year	2009
www.subaru-global.com/eco_ev.html	

Tata Indica Vista

Technical Specifications

Propulsion Type	Electric
Range in EV mode	120 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	N/A
Charging Voltage	N/A
Weight	N/A
Top Speed	65 mph
Country of Origin	India
Price (US$ Approx)	N/A

Vehicule Type	5 door
Canadian Market Availability	N/A
Marketing Year	2011
www.tatamotors.com/our_world/press_releases.php?ID=419&action=Pull	

Tesla Roadster

Technical Specifications

Propulsion Type	Electric
Range in EV mode	244 miles
Fuel Economy Hybrid	N/A
Battery Type	Lihium-Ion
Battery Capacity	53 kW/h
Charging Voltage	220 VAC
Weight	2723 lbs
Top Speed	125 mph
Country of Origin	USA
Price (US$ Approx)	129 000

Vehicule Type	2 door
Canadian Market Availability	Yes
Marketing Year	2008
www.teslamotors.com	

Tesla S

Technical Specifications

Propulsion Type	Electric
Range in EV mode	150 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	42 kW/h
Charging Voltage	220 VAC
Weight	3825 lbs
Top Speed	125 Mph
Country of Origin	USA
Price (US$ Approx)	57 400

Vehicule Type	4 door
Canadian Market Availability	2011
Marketing Year	2010

www.teslamotors.com

Think City

Technical Specifications

Propulsion Type	Electric
Range in EV mode	110 miles
Fuel Economy Hybrid	N/A
Battery Type	Sodium / Lithium
Battery Capacity	5,2 kW/h
Charging Voltage	220 VAC
Weight	2450 lbs
Top Speed	60 mph
Country of Origin	Norway
Price (US$ Approx)	15 000

Vehicule Type	3 door
Canadian Market Availability	N/A
Marketing Year	2008

www.thinkev.com

13.4 Concept Vehicles

Although some of the vehicles mentioned earlier are still not available, the following ones are at an even earlier phase in their development and are considered concept vehicles. This list is incomplete, since new prototypes are released every month. They are shown here to give an idea of the designs under consideration.

Aptera 2e

Vehicule Type	3 wheels / 2 seats
Canadian Market Availability	N/A
Marketing Year	2010
www.aptera.com/index.php	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	100 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium Iron Phosphate
Battery Capacity	10-13 kW/h
Charging Voltage	110 VAC
Weight	1500 lbs
Top Speed	N/A
Country of Origin	USA
Price (US$ Approx)	25 000 - 45 000

Future Vehicle Technology

Vehicule Type	3 wheels 1 seat
Canadian Market Availability	N/A
Marketing Year	N/A
www.futurevehicletechnologies.com/html/faq_s.html	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	125 miles
Fuel Economy Hybrid	275 mpg (city) 165 mpg (highway)
Battery Type	N/A
Battery Capacity	N/A
Charging Voltage	N/A
Weight	N/A
Top Speed	135 mph
Country of Origin	Canada
Price (US$ Approx)	N/A

Purolator Quicksider

Vehicule Type	Truck
Canadian Market Availability	Demo
Marketing Year	N/A
www.unicell.com/new/media.html	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	40 mile
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	N/A
Charging Voltage	N/A
Weight	N/A
Top Speed	65 mph
Country of Origin	Canada
Price (US$ Approx)	N/A

Persu Hybrid

Vehicule Type	ULV (Urban Life Vehicule) 3 wheels
Canadian Market Availability	N/A
Marketing Year	2010
www.persumobility.com	

Technical Specifications

Propulsion Type	Plug-In Hybrid
Range in EV mode	20 miles
Fuel Economy Hybrid	75 mpg
Battery Type	N/A
Battery Capacity	N/A
Charging Voltage	N/A
Weight	1500 lbs
Top Speed	100 mph
Country of Origin	USA
Price (US$ Approx)	N/A

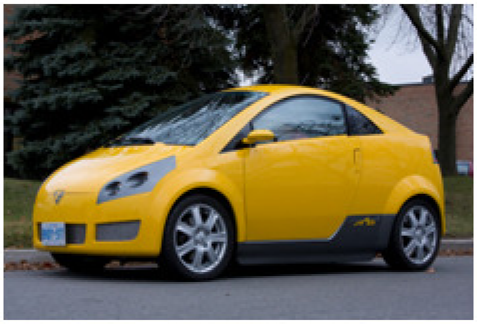
Renaulf Fluence (Better Place)

Vehicule Type	4 door
Canadian Market Availability	N/A
Marketing Year	2011
www.renault-ze.com	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	100 miles
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	24 kw/h
Charging Voltage	220 VAC
Weight	N/A
Top Speed	N/A
Country of Origin	France
Price (US$ Approx)	N/A

Toronto Electric



Vehicule Type	2 door
Canadian Market Availability	N/A
Marketing Year	N/A
www.futurevehicletechnologies.com/html/faq_s.html	

Technical Specifications

Propulsion Type	Electric
Range in EV mode	210 km
Fuel Economy Hybrid	N/A
Battery Type	Lithium-Ion
Battery Capacity	27 kWh
Charging Voltage	110-220 V
Weight	1160 kg
Top Speed	99 km/h
Country of Origin	Canada
Price (US$ Approx)	N/A

14 Appendix 6 – Idaho National Laboratory Report Sample

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

North American PHEV Demonstration

Vehicle Technologies Program

Fleet Summary Report - Hymotion Prius (Kvaser data logger)

Number of vehicles: 1

Reporting Period: Feb 09 - Dec 09

Date range of data received:

2/2/2009 to 12/21/2009

Number of days the vehicles were driven: 90

All Trips Combined

Overall gasoline fuel economy (mpg)	39
Overall DC electrical energy consumption (DC Wh/mi) [2]	56
Total number of trips	467
Total distance traveled (mi)	2704

Trips in Charge Depleting (CD) mode [3]

Gasoline fuel economy (mpg)	43
DC electrical energy consumption (DC Wh/mi) [4]	159
Number of trips	227
Percent of trips city / highway	93% / 7%
Distance traveled (mi)	741
Percent of total distance traveled	27%

Trips in both Charge Depleting and Charge Sustaining (CD/CS) modes [5]

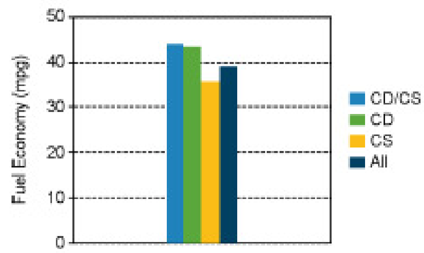
Gasoline fuel economy (mpg)	44
DC electrical energy consumption (DC Wh/mi) [6]	55
Number of trips	34
Percent of trips city / highway	65% / 35%
Distance traveled (mi)	593
Percent of total distance traveled	22%

Trips in Charge Sustaining (CS) mode [7]

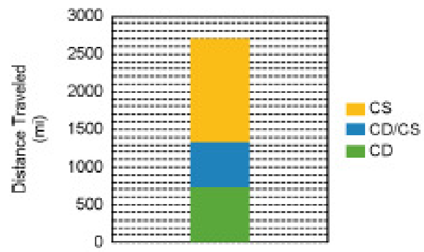
Gasoline fuel economy (mpg)	36
Number of trips	206
Percent of trips city / highway	82% / 18%
Distance traveled (mi)	1370
Percent of total distance traveled	51%

Number of trips when the plug-in battery pack was turned off by the vehicle operator [8]	25
Distance traveled with plug-in battery pack turned off by vehicle operator(mi) [9]	325

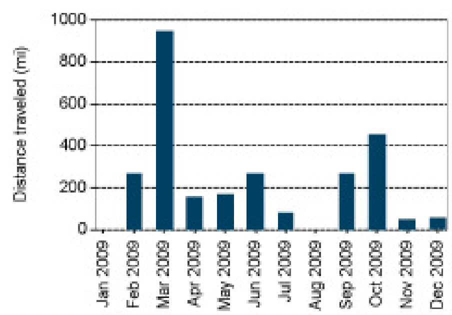
Gasoline Fuel Economy By Trip Type



Distance Traveled By Trip Type



Miles Logged by Month This Year



Notes: 1 - 9. Please see http://avt.inel.gov/phev/reportnotes for an explanation of all PHEV Fleet Testing Report notes.

MonthlyReportAllFleet Summary Report - Hymotion Prius (Kvaser 1 1/27/2010 4:36:27 PM

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