INTERNATIONAL BUSINESS DEVELOPMENT STRATEGY
CANADIAN ELECTRIC TRANSPORT SECTOR
YEARS 2014 - 2017

Approved March 2014
Updated January 2016

CONTEXT

An update of a three-year International Business Strategy (IBD) is an effective exercise to bring together the Canadian companies that are looking into international opportunities in a more structured way. Its submission is a mandatory requirement for the Global Opportunities for Associations (GOA) program. GOA provides assistance on a cost-shared basis to Canadian associations that have a national mandate. The selection process is conducted on an annual basis.

The IBD was approved by the Board of directors of Electric Mobility Canada in March 2014. The current update is aimed at reviewing the Canadian market progress and list of companies involved in the Canadian market. EMC invites its members and non members to be part of EVS29 in Montreal, June 19-22, 2016, as exhibitors. It is clearly a learning process to better understand the advantages of the products and services of Canadian companies, and their competitiveness in target markets, and the marketing and partnership possibilities and approaches on a longer term basis.

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EXECUTIVE SUMMARY

A first strategy document was prepared with the participation of Electric Mobility Canada industry members involved in EV technologies and services. The document was approved by the Electric Mobility Canada Board of Directors at its meeting of 2014 03 19. It describes the EV industry in Canada, their current focus and the export opportunities the industry wishes to pursue.

1. SECTOR ANALYSIS

1.1 Sector Overview

1.1.1 What is Electric Mobility Canada?

Electric Mobility Canada is a national membership-based not-for-profit association dedicated exclusively to the electrification of all modes of transportation in Canada.

*Our Vision***:** Working together to move Canada's transportation systems to electric traction.

*Our Mission***:** To support the efforts of our members in driving the adoption of electric mobility technologies by Canadians as a key means of achieving sustainability in transportation and to position Canada as a global leader in developing and implementing electric mobility in all modes of transport.

Our Goals: Electric Mobility Canada supports the activities of our members by:

- Communicating legislative, policy, technical and operational matters of key interest pertaining to electric mobility to our membership. This includes identifying the actions required to meet the needs of our members and proactively communicating these needs to policy makers and other stakeholders.

- Establishing partnerships to accelerate the adoption of electric mobility through research, demonstration projects, policies, programs and strategies to increase market penetration.

- Acting as a resource centre for relevant and contemporary information on electric mobility from across Canada and around the globe.

1.1.2 Description of the industry and its importance to Canada

Electric mobility can be defined as all surface transportation, including off-road vehicles, using electric drive technology operated through batteries, grid connectors, hybrids or fuel cells. In the past 10 to 20 years, Canada and Canadian companies have been engaging in R & D applicable to electric vehicle components in many strategic domains such as batteries, fuel cells, chargers, electric motors, power electronics, smart grids, management and monitoring software and information services. These technologies have been used in on-road, off-road, recreational and marine applications.

Appendix 'A' contains a list of terms and their definition as used in this report or in the electric vehicle industry.

Many of these technologies have reached a level of maturity and scale appropriate to supply the production of electric vehicles, but the domestic marketplace does not yet produce the volumes necessary to allow these companies to go into meaningful production volumes. Therefore, export strategies have to be vigorously pursued.

The transportation supply sector is a strong contributor to Canada's economy both in terms of vehicle assembly, supply of components and the maintenance and support activities needed to keep the transportation supply sector operating at peak efficiency. Canada's wide geography is particularly dependent on an efficient transportation network to link its markets and suppliers.

Canada has a strong supply of renewable energy sources – clean electric power and a relatively coordinated electric grid - to supply the adoption of electric vehicles as a reliable mode of transportation. This clean energy is also important to manufacturing companies using large amounts of electricity in their plants. Most of the companies involved in electric transportation in Canada are small to medium size and need professional support in their export activities.

1.1.3 State of the Sector – Key Trends and Market Outlook

On a global scale, transportation is evolving to electrification wherever possible to minimize the use of petroleum products and resulting emissions caused by transportation as well as to reduce dependence on the importation of petroleum products and the resulting financial impacts on the importing countries. Clearly, Canada's transportation supply chain has to move in steps with other countries adapting to electric mobility and this means supporting and strengthening our EV supply sector so that the supply chain can continue to be an important contributor to Canada' economy. Market penetrations by EVs are forecasted to reach significant numbers in the coming years.

1.1.4 General description of association members and their key capabilities

The Canadian EV supply chain includes companies involved in:

- Batteries
- Chargers
- Charging Infrastructure
- Enabling technologies
- Motors and controllers
- EV assemblers
- EV researchers

Our member companies have highly qualified personnel in all of these areas.

Appendix 'B' contains a profile of companies and organizations in each of the above categories for further reference.

1.1.5 Competitive position

Canadian companies possess some advantages when compared to their international counterpart, especially in the following clusters:

- Chargers
- Software
- Gear boxes
- Electric motors and controllers
- Transit buses
- Rail transport
- Electric and charging infrastructure
- Lightweight materials
- Off-road vehicles
- Electronics

These advantages are particularly noticeable because of the following:

- Technology research and development in universities, colleges, government departments and private consulting firms. National Resources Canada, Transport Canada and the National research Council are actively involved in supporting EV research and development projects. Some provinces (i.e. British Columbia, Manitoba, Ontario, and Quebec have financial support programs supporting industry and academia.
- A wide range of federal and provincial financial support programs aimed at R & D, demonstration and export that can be used to support EV technologies and services.
- Clean electricity supply with 60% hydro power and additional nuclear, wind and solar power sources. This is an attractive feature for manufacturing plants.

- Canada is the world's largest exporter of minerals and metals and has natural resources used in batteries and motors and vehicles. Growth in the electric vehicle industry will help the Canadian mining sector.
- Canada's EV industry players have strengths that are beyond the early phases of product development in skills, innovation, design, prototyping and demonstration. These companies have agility, flexibility and are easy to do business with.
- Established testing facilities and a strong understanding of a wide variety of temperature / climate conditions in which electric vehicles and technology needs to operate in.
- With more than 17,000 EVs on the road, a strong growth is expected supported by the recommendation included in the National roadmap in discussion with NRCan.
- Standards for integrating EVs with the electric grid are in place and in harmony with US standards.

Notwithstanding the above-noted advantages, there are important factors that are considered challenges to the growth of the EV industry in Canada. In summary, these are:

- Short production runs on batteries and accessories can be produced more cheaply elsewhere, such as China, Korea and the United States where production cost are lower, domestic markets are larger and where investment opportunities are more easily accessed.
- Traditional Canadian OEMs are branch plants of companies based in the US, Europe or the Asia-pacific region and do little EV research in Canada.
- Not yet a large domestic market for EV sales which is needed as an export base.
- 'Buy America' regulations require a strong percentage of components and final assembly in the USA of vehicles purchased with public funds. As a result, Canadian companies assembling vehicles such as buses are required to have branch plants in the USA thus exporting accompanying jobs.

The recognized global leaders in the EV industry come from China, United Kingdom, Europe, US, Japan and Korea where their national governments have made EVs a priority and developed a wide variety of programs to support their EV industry.

1.2 Sub Sectors that will be focused on and reasons for their selection

This report focuses on Canadian companies involved in EV technologies in buses, on road and off-road vehicles as well as marine applications. EMC members consulted agree that the companies operating in the sectors outlined in the following sectors should be the target of association led export activities:

- Batteries
- Chargers
- ~~S~~oftware
- Gear boxes
- Electric motors and controllers
- Transit buses
- Recreational vehicles
- Electric boats
- Two and three wheel vehicles
- Off Road Industrial vehicles (i.e. mining)
- Car-sharing applications
- Autonomous Vehicle technology

1.3 Target Markets

The following countries are some identified export targets Canadian EV companies would like to pursue:

- EU
- USA
- India
- China
- Korea
- Japan
- Brazil
- Mexico
- South East Asia
- Turkey

All foreign OEMs although accessing them through their existing supply chain might be easier. All system integrators and /or electric vehicle programs are priority targets are also targets. The stability of our country's finances, our skilled labour force, strong R & D facilities, proximity to the US market and our clean energy sources for manufacturing might cause foreign companies to choose Canada for investments.

1.4 Target Customers

As noted in 1.3 above, efforts will be focused on getting through the auto industry supply chain.

2. STRATEGIC PRIORITIES

Strategic priorities will be given to sales in the USA, Europe and South East Asia.

2.1 Strategic Objectives and Desired Outcomes

As a first important presence in the exhibit of EVS29, EMC and the GOA participating companies will evaluate its outcome, and adjust for EVS30, in the fall of 2017.

2.2 Suggested Tactical Actions

For the moment, the following tactical actions are proposed for the next three years.

- Support attendance at key transportation related exhibits and conferences dealing with cars, trucks, buses, consumer recreational vehicles, battery shows, smart/sustainable mobility.
- *Canada has secured EVS29 to take place in Montreal in 2016. This will create an excellent forum for Canadian companies to showcase their electrification technologies, products and services to the world.*
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2.3 Measurement of Results

We will measure our performance by the number of exhibitors in trade shows at EVs, the quality of relationships developed with a certain number of potential partners and enquiries received by Canadian EV companies.

Appendix A - Glossary of Terms and their Abbreviations

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 other on-bard energy storage system.
Charging Station	Equipment that transfers electricity from the grid to the vehicle with standard connectors and current management software.
Electric Mobility	Can be defined as all surface transportation including off-road vehicles using electric drive technology operated through batteries, grid connectors, hybrids or fuel cells.
Electric Vehicle (EV)	A vehicle that depends on one or more electric motors for some or all of its traction.
Fuel Cell	A electromechanical cell in which the energy of a reaction between a fuel, such as liquid hydrogen, and an oxidant, such as liquid oxygen, is converted directly and continuously into electrical energy.
Hybrid Electric Vehicle (HEV)	An EV for which an on-board internal combustion engine is the only source of electrical power.
Internal Combustion Engine (ICE)	An Otto-cycle or similar engine fuelled by either gasoline, diesel fuel, natural gas, bio fuel or other combustible liquid or gas.
Plug-In Hybrid Electric Vehicle (PHEV)	An EV that can be refuelled from an off-board source of electricity and that has an on-board ICE to recharge the battery or provide traction or both.
Plug-In Electric Vehicle (PEV)	An EV that can be refuelled with an off-board source of electricity, it includes both BEV and PHEV.
Renewable Energy	An energy that can be naturally replenished or renewed within a human lifespan.
Smart Grid	A distribution network that allows two-way, digital communication between producers and consumers of electricity as well as its basic function of transmitting power in one or both directions.

Appendix B – List of Canadian companies in the EV sector

Canadian EV Industries per Sectorial Activities				
Activity Sector	**Corporations Active in Canada**			
	QC	**ON**	**BC**	**Other provinces**
1. Vehicle Manufacturers	**Bombardier Aerospace** - *Produces electrified tracks and trains*	**Fiat Chrysler** - *OEM*	**Vossloh Kiepe Corporation** - *manufacturer of electrical traction equipment for trams, trolleybuses and other transport vehicles*	**New Flyer** - *Manufactures electric, and other alternative fuel type buses.*
	Bombardier Recreational Sports - *Produces electric recreational vehicles*	**Ford Motor** - *Flexible engine assembly plant/Global manufacturing platform development to reduce overall energy consumption*	**Form Flex** - *Hanging basket systems, internal transport systems, lifting devices and various types of cultivation and harvesting systems.*	**Canadian Electric Vehicles** - *Electric vehicles used in non-road applications*
	Institut du véhicule innovant - *e-school bus; e-powertrain etc.*	**General Motor** - *OEM*		**Cresline Coach** - *Produces a hybrid bus.*
	Nova Bus / Volvo - *Manufactures electric buses.*	**Toyota** - *Support for production of Lexus RX350 and RX 450h*		**Papa Bravo Innovations** - *Underground electric vehicles*
	FP Innovations / PIT - *off-road small electric vehicle*	**Honda** - *OEM*		**MCI Coaches** - *hybrid coaches*
	LionBus - *Manufactures electric buses.*	**Bombardier Transportation** - *Produces electrified tracks and trains*		
	Services Précicad - *Manufactures industrial electric vehicles.*	**Spur Innovations** - *development of innovative controls solutions for transportation*		
	Technologies Lanka - *Electronic systems in a variety of passenger rail and locomotive operations.*	**Metrolinx** - *Electrification of the GO rail transit network*		
	Paccar of Canada - *Designs and manufactures light, medium and heavy-duty hybrid trucks.*	**AGT Electric Cars** - *Produces electric vehicles used in non-road applications (golf carts, utility and industrial vehicles).*		

	QC	ON	BC	Other Provinces
	Motrec - *Creates and manufactures industrial vehicles from electric tow tractor to specialty vehicle*	**Magna E-Cars** - *Produces a wide range of electric vehicle drivetrain and power storage components.*		
	Campagna Motors - *Produces three wheeled combustion engine vehicles and a three wheeled electric car*	**Linamar** - *Multinational producing and designing many different hybrid/electric vehicle components (drivetrain).*		
		Electric Tractor - *Developed a line of environmentally friendly lawn and garden tractors.*		
		Unicell - *Truck bodies for Ford and General Motors*		
2. Batteries & Energy Storage	IREQ/ Hydro-Québec - *battery research and development*	**Electrovaya** - *Designs, develops, and manufactures proprietary Lithium Ion SuperPolymer batteries, battery systems, and battery-related products*	**Powertech Labs** - *Electric vehicle testing and performance services, engineering consulting, electric vehicle smart grid integration, data monitoring and other services.*	**Silicon Batteries** - *Manufactures batteries that can be used in electric vehicles.*
	Clariant Canada - *EV Batteries*	**Crown Battery Manufacturing** - *Battery manufacturing*	**Ballard Power System** - *designs and manufactures clean energy hydrogen fuel cells*	**Springpower International Inc**. - *Development and commercialization of advanced lithium-ion battery materials and cell technologies*
	Bathium - *Research and development of lithium metal polymer batteries.*	**EV Fern Limited** - *systems integrator providing engineered products that meet your needs in potential energy at rest or in use over an extended period of time.*	**Discover Energy Corporation** - *robust power and energy storage for off-grid, grid-support, battery back-up and RE applications*	
	NRC (Boucherville)	**Fly Wheel Energy Systems** - *design, test, manufacture and distribute flywheel energy storage systems for hybrid vehicles and industrial applications.*	**All Power Battery** - *Manufacturer of sealed lead acid batteries for commercial applications*	
		E-Camion - *Produces car charging stations.*	NRC (Burnaby)	
		Battery Technologies - *Battery manufacturing*	**Alpha Technologies** - *The Center of Excellence for AC & DC Powering*	

	QC	ON	BC	Other Provinces
2. Batteries & Energy Storage		**EcoSol Solar Technologie**s - *Start to import and sell Polycrystalline Silicon from 2004 with self -developed Si/C Separate technology.*	**Carmanagh Technologies** - *FAA and ICAO-compliant solar LED runway batteries*	
		Energy Visions Inc. - *HYDRO CARBON CATALYTIC CONVERSION*	**Corvus Energy**- *Energy Storage Systems for Hybrid and Electric industrial systems*	
		Grid Grabber inc.	**EaglePicher Energy Products** - *battery systems, power storage*	
		MAHY E Cell - *developing battery packs*	**Excell Battery Company** - *certified custom battery pack manufacturer specializing in Lithium-Ion*	
		Prime Battery Products - *battery manufacturing*	**iQ Power Technologies** - *battery manufacturing*	
		Pure Energy Inc. - *solar batteries*	**General Hydrogen Corporation** - *develops and commercializes fuel cell systems and hydrogen batteries*	
		Pure Energy Visions - *rechargeable alkaline batteries*	**Advanced Lithium Power** - *latest developments in battery technology and energy management.*	
		Hydrogenics - *develops and manufactures integrated PEM fuel cell systems, Hydrogen Generators and Renewable Energy Solutions.*	**EAS Sustainable Power Solutions** - *EAS Sustainable Power Solutions*	
		Cantec - *Distributes power products but also builds custom designed batteries and power solutions*		
		Springpower International - *Advanced battery materials and battery technology development*		
		Retriev Management Ltd. - *Battery recycling – primarily lithium batteries*		
		Adventec - *Currently producing a range of components and sub-assemblies for EV batteries*		

	QC	ON	BC	Other Provinces
3. Hardware Solutions Providers	**FP Innovations** / PIT - *off-road small electric vehicle*	**Magna International** - *Produces a wide range of electric vehicle drivetrain and power storage components.*	**Powertech Labs** - *Electric vehicle testing and performance services, engineering consulting, electric vehicle smart grid integration, data monitoring and other services.*	**Tundra Solutions** - *electrical lifts*
	TM4 - *Develops electric powertrains and electric vehicle power/drivetrain management systems.*	**Linamar** - *Development of powertrain components related to fuel efficiency*		**nonaBlue Devices** - *developing next generation power conversion semiconductor devices that dramatically improve energy efficiency in power management systems.*
	Posi-Plus Technologies - *Aerial lifts, Cable Placers, Cable Handlers*	**Honeywell**		
	Robert Hydraulique - *aerial lifts*	**Eaton Canada** - *Electrical Power management*		
	IEC-HOLDEN- *Independent motor and generator manufacturer of electric mobility products*	**TestForce** - *the premier technical distributor and manufacturer of test and measurement equipment and integrated systems in Canada.*		
	Effenco- *Developing and have the intent to market hybrid technologies for the recuperation of energy from brakes*	**Chroma Systems** - *Automated test equipment (ATE) for power conversion and electrical safety (hipot) testing in power supply, battery, electric vehicle*		
		D&V Electronics - *North America's leading manufacturer of custom automotive testing equipment.*		
		Varmit Technologies - *Motor Technology*		
		GaNSystems - *power conversion and control applications*		
		Siemens Canada - *Electrification, automation and digitalization*		
		Safran - *aircraft engine, rocket engine, aerospace-component, and security company*		
		General Electric - *Electric Vehicle Solar Carport*		

3. Hardware Solutions Providers	QC	ON	BC	Other Provinces
		AVL Manufacturing - *Mechanical and Electrical Assembly*		
		ABB (National) - *Electrical and mechanical power transmission and conversion products, cables, control systems, electric vehicle charging infrastructure.*		
		ASI Accelerated Systems - *developing advanced drive systems for electric vehicles*		
		Dynacert		
		Denso North America - *develop innovative EV advanced products and technologies*		
		Bach-Simpson - *Designs, markets and manufactures electric and electronic measurement monitor*		
		Electrocraft Systems- *Electric vehicle chargers, controllers DC converters and engineering services*		
		Cummins Eastern Canada - *Design and manufacture diesel engines combined with electric motors and drives for hybrid transit buses.*		
		Allison Transmission - *Produces commercial duty automatic transmissions, hybrid propulsion and related parts*		
		Unico Canada Drives & Systems Inc. - *Manufacturing and specializing in AC/DC drives and control systems*		

	QC	ON	BC	Other Provinces
4. Software Solution Providers	NRC Boucherville	**CrossChasm/FleetCarma** - *Fleet monitoring technologies for conventional, hybrid and electric vehicles.*	**Quester Tangent Corporation** - *Designs and manufactures software products for electric rail transit*	
	Mogile Technologies - *Develops charge station information software.*	**IBM Canada** - *vehicle software*		
		LMS-Siemens - *testing solutions and simulation for performance engineering of system dynamics*		
		Maplesoft - *world leader in mathematical and analytical software*		
		Fleet Challenge Ontario - *Develops fleet monitoring and management technologies.*		
		Thumbprint Solutions Inc. - *Thumbprint Solutions provides mechanical engineering services and simulation software* solutions to a broad range of clients		
5. Connected and Autonomous Vehicle Networking, etc.		**Thales** - *Transportation solutions*		
		Ericsson - *communication technology and services*		
		TE Connectivity - *connectivity & sensor solutions across industries and harsh environments*		
		XPS Interactive		
		B.R.A.K.E.R.S. Early Warning Systems - *Automotive warning systems*		
		Alcohol Countermeasure Systems		

	QC	ON	BC	Other Provinces
6. Light-Weight Materials		**CanMET Materials** - *The largest research centre in Canada dedicated to the fabrication, processing and evaluation of metals and materials.*		**Composites Innovation Centre** - *not-for-profit engineering consulting group*
		NRC (London)		
		Blachford - *Chemicals for rubbers*		
		Dana - *Large, independent suppliers to vehicular, off-highway, and industrial manufacturers.*		
7. Electric Vehicle Supply Equipment (EVSE) & Energy Storage (vehicle to grid) & Charging Networks	**Schneider Canada** (QC) - *Produces car charging stations.*	**NRStor** - *Energy Storage Solutions*	**Schneider Canada** (BC) - *Produces car charging stations.*	**General Electric** Customer - *charging stations*
	AddEnergie - *Produces electric vehicle charging stations.*	**KSI** - *Canada's leader in Electric Vehicle (EV) Products, Services and Upstream Infrastructure to support the Build-Out of EV Charging.*	**Delta Q** - *Charging and power conversion products.*	Composites Innovation Centre - *not-for-profit engineering consulting group*
	Leviton - *Produces electric vehicle charging stations.*	**Precise Park Link** - *parking machines that revolutionized on and off-street parking*		
	MCM Structures - *Manufactures charging infrastructure for electric vehicles.*	**Autochargers.ca** - *charging stations*		
	Renewz Sustainable Solutions Inc. - *Solar power carports and electric vehicle charging hardware.*	**Composite Power Group** - *electrical manufacturers' representative firm*		
	Réseau Azra - *Electric car charging network and online app (allows online payment for car charging services and shows car charger locations).*	**Ascent Solutions** - *integrated electrical solutions*		
		ECOtagious - *smart meter disaggregation*		
		Grid Cure - *smart grid data*		
		Sun Country Highway - *Produces car charging stations.*		
		E-Camion - *turn-key solution provider for the community energy storage industry, specializing in integration of battery solutions with advanced grid control*		

	QC	ON	BC	Other Provinces
8. Electric Motors / Generators & Power Electronics / Controllers	**Construction Energie Renouvelable**	**ABB inc**. - *Electrical and mechanical power transmission and conversion products, cables, control systems, electric vehicle charging infrastructure.*		
	TM4 - *Develops electric powertrains and electric vehicle power/drivetrain management systems.*	**Baldor Electric Canada** - *electric motors*		
	B3CG Interconnect - *Production of cable assemblies and harnesses, including simple and complex harnesses, and electrical, electromechanical and electrical connectors.*	**Ballard Generation Systems** - *designs and manufactures clean energy hydrogen fuel cells*		
	Vicone High Peformance Rubber	**Cambridge Profab**		
		IEC Holden - *OEM Supplier of electrical coils and windings for large traction motors.*		
		Standard Motor Products - *electric motors*		
		Siemens Canada		
		Navitas - *Electric vehicle controllers.*		
		Bender Canada - *Produces electrical safety equipment, insulation monitoring to prevent electric shocks and minimize fire hazards.*		
9. Electric Vehicle & EVSE Testing and Certification	**PMG Technologies** - *Develops electric vehicle/battery testing and safety services, electric vehicle infrastructure testing and certification, other electric vehicle support services.*	**TUV SUD Canada** - *Develops electric vehicle/battery testing and safety services, electric vehicle infrastructure testing and certification.*	**Powertech Labs** - *Electric vehicle testing and performance services, engineering consulting, electric vehicle smart grid integration, data monitoring and other services.*	