A SPECIAL REPORT FROM THE PUBLISHER OF ELECTRICAL BUSINESS MAGAZINE AND ENERGY MANAGER

EV CROSSROAD

fall 2012

Electric car TOPS GREENEST VEHICLE LIST FOR FIRST TIME IN 12 YEARS

DID YOU KNOW CANADA HAS AN EV TECHNOLOGY ROADMAP?

PREMIERE ISSUE

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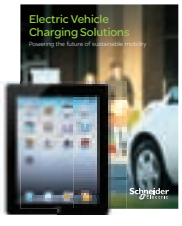

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EV CROSSROAD

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A special report from *Electrical Business* and *Energy Manager* magazines, *EV Crossroad* provides objective information on electric vehicles and electrifying Canada's homes, businesses and roadways.

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We're at an electric vehicle crossroad

Is there any substance to all the hype surrounding the return of the electric vehicle? We think so, which is why the publisher of Electrical Business (www.ebmag.com) and Energy Manager (www.energy-manager.ca) felt it important to publish this special report.

Governments, OEMs, inspection and safety authorities, and standards bodies are taking EVs seriously, ensuring both they and EVSE meet global standards, and laying policy roadmaps for the future.

EVs make sense for a lot of people. They unquestionably reduce noise and air pollution, and it's really only cost, unfamiliarity and sparse infrastructure that keep EVs from penetrating more homes.

But, as more pilot projects unfold successfully, and more businesses install charging equipment on their premises for employees, and batteries provide greater range, increasing numbers of urban dwellers will make their next vehicle a plug-in hybrid, if not fully electric—especially as the cost of technology comes down.

As Level III (quick-charge) EVSE becomes more prevalent, and infrastructure gets built up to the point where one could drive from, say, Toronto to Montreal, without fear of having nowhere to charge, increasing numbers of suburbanites will also start making the switch... slowly, at first, then in greater numbers, especially when early adopters start selling their used EVs and PHEVs.

The electric vehicle is here. And you may look out your window as you read this and not see a single one pass by, but they are here and their numbers are growing. Rather than a time of complaint and doubt, this should be seen as a time of excitement and opportunity. Embrace the future.

Contents

Photo A. Capkun

Did you know Canada has an EV technology roadmap?

Published in 2012, the evTRM (electric vehicle technology roadmap) is an industry-led, federal government-coordinated document focused on the development and adoption of EVs in Canada, while building a robust industry. The roadmap provides the perspective of numerous stakeholders—mainly industry—as to how EVs for highway use should evolve in Canada in the future, and what should be done to secure this evolution.

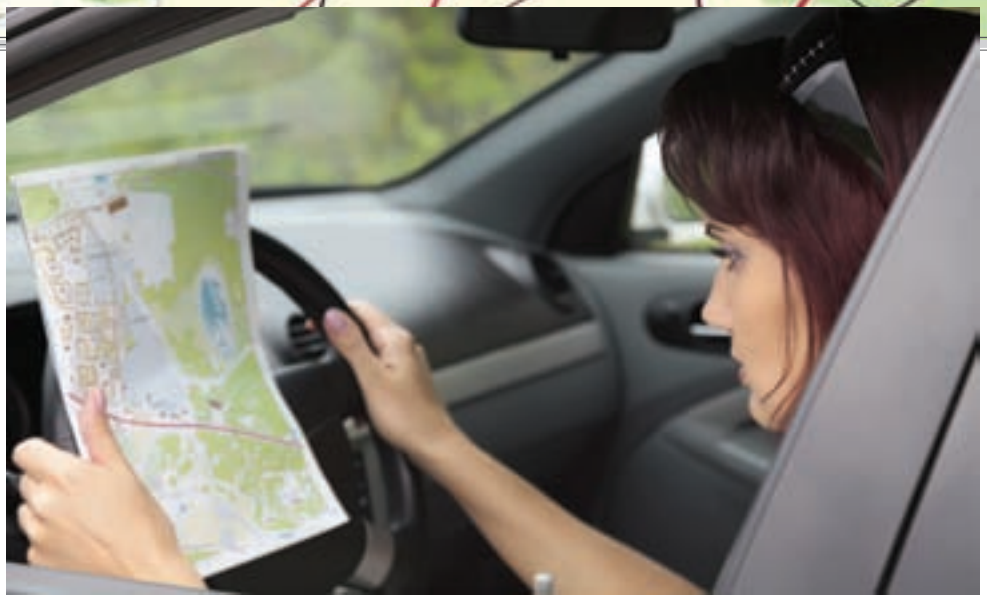
It covers a range of topics related to the vision of 500,000 or more EVs in Canada by 2018. The topics include energy storage, components for EVs, vehicle integration, business models and opportunities for EVs, government policies, regulatory and human resource issues, as well public awareness and education. The document is quite long, so here we present a slightly edited version of the Executive Summary.

By 2018, there will be at least 500,000 highway-capable plug-in electric-drive vehicles (PEVs) on Canadian roads, as well as what may be a larger number of hybrid-electric vehicles (HEVs). All these vehicles will have more Canadian content in parts and manufacture than vehicles on the road in Canada in 2008.

Electricity as an alternative to traditional transportation energy is becoming a near-term reality for many countries, including Canada. Electric vehicles (EVs) will contribute to promoting sustainable energy development while addressing air quality and climate change.

The market for EVs in Canada is growing as Canadians look for cleaner, more efficient vehicles. Research confirms that consumers in North America are willing to pay more for an EV when the environmental benefits are significant. In Canada, it is expected these benefits can be achieved because the majority of our electricity is generated from renewable and low-emission sources.

With our significant amounts of energy and a growing EV industry, Canada is well-positioned to capitalize on this form of clean transportation. Our industry is well-placed to be a major supplier of EV components and vehicles, not only in Canada but also internationally. Canada has the opportunity to link our efforts with those of the United States because of the integrated North American automotive industry.



To achieve the timely and effective commercialization of EVs, governments and industry must work together on ensuring that the necessary steps are taken, which include activities such as the development of advanced batteries, a charging infrastructure, electricity storage devices, codes and standards, and policies, as well as public education and consumer acceptance.

The most important of these activities is energy storage. Progress toward widespread use of the vehicles covered by the Electric Vehicle Technology Roadmap for Canada depends above all on one factor: increasing the amount of electrical energy that can be stored in a given volume or weight on board a vehicle, thereby extending electric traction's range.

Included in the roadmap are two types of personal and commercial vehicles that rely exclusively or primarily on electric traction:

- Battery EVs that have only electric traction and are almost always charged from the electricity grid.
- EVs that have an internal combustion engine (ICE) in addition to an electric traction motor. The ICE can charge the vehicle's battery by powering a generator while the vehicle is in motion, and may also provide traction.

Other EVs that are not considered in the roadmap include fuel-cell-based vehicles, vehicles with two or three wheels, low-speed and off-road vehicles, military vehicles, and vehicles such as trolley buses that are powered from the grid while in motion.

There is a call for a reduction in carbon emissions by focusing on EVs that rely exclusively or heavily on connection to the electricity grid for recharging their batteries. Part of Canada's potential strength as a focus for EV production and use is the sophistication of the electricity grid and the electrical generation that feeds it.

In Canada, a higher share of this electrical generation is from renewable sources than in almost any other country, which means that conversion of the Canadian on-road fleet to EVs would result in large reductions in the fleet's carbon emissions. Moreover, several of the provincially, territorially and locally owned utilities that provide electrical energy in Canada have a strong interest in electric traction.

The roadmap includes three recommendations for securing the vision for EVs in 2018. It also identifies numerous matters that require action: strategic initiatives that complement the recommendations. Should the recommendations be adopted and the strategic initiatives implemented, Canada will retain its vibrant and growing EV industry and play a role in the transition toward a more sustainable energy mix.

The recommendations, addressed to governments, industry and other stakeholders, are these:

- Make timely and substantial investments in Canadian development and manufacture of EVs and in energy storage devices to build on Canada's already strong presence in these industries.
- Consider supplementing federal, provincial and territorial mechanisms to promote the development, public acceptance and procurement of personal and commercial EVs, and the installation of the charging infrastructure.
- Reconstitute the Steering Committee as a Roadmap Implementation Committee mandated to ensure that the strategic initiatives identified in the Roadmap are addressed.

Strategic initiatives

The strategic initiatives identified by stakeholders are summarized below in four categories. All are important, and all should have the timely attention of the Roadmap Implementation Committee.

Technology

- Improve energy storage through basic and applied research, including improvements in:
  - manufacturing techniques, with the goals of adding scale, improving efficiency and reducing costs
  - energy density, to reduce costs, increase range and achieve smaller, lighter systems
  - management and control electronics, for more efficient use of available energy storage
  - system packaging, to optimize thermal, electrical, mechanical and safety elements
- Reduce the cost of EV components by a factor of two to three so they can be competitive with equivalent ICE components.
- Reduce the weight of the components.
- Test options for the charging infrastructure in each major region of Canada, including smart charging and vehicle-to-home and vehicle-to-grid arrangements. Recommend changes and improvements, noting impacts of multiple chargers on power quality.
- Demonstrate vehicle use in real-world operation to assess the reliability and durability of energy storage and other components.

Codes, standards, regulations and infrastructure readiness

- Review national, provincial/territorial and municipal regulations that impact the manufacture and use of EVs in Canada. Ensure that the regulations support EV development without compromising safety and other concerns.
- Harmonize North American standards and practices concerning the integration of EV components, including charger interfaces.
- Develop harmonized standards for the conversion of used vehicles to electric traction.
- Amend building codes and other regulations to require that at least the rough-in for outlets for charging EVs is included in all new buildings. Provide model codes and regulations.
- Develop action plans for infrastructure readiness.

Studies and assessments

- Assess the merits of, and develop a mandate for, an Electric Transportation Institute as a Canadian focus of applied EV research and development and other activities required to accelerate widespread use of EVs.
- Assess the potential impacts of incentive programs for the purchase of EVs on EV penetration and the impacts of battery warranty and lease programs.
- Estimate how much EVs will increase the demand for national and regional electrical energy and power over several periods and at several levels of market penetration. Take into account the reduced block heater loads and the additional battery conditioning loads. Assess the current and expected future ability to handle these demands, noting additions that would be required to the generation and distribution infrastructure.
- Estimate the lifetime savings that will result from the shift to EVs from ICE-based vehicles, anticipating changes in electricity rates and fossil fuel prices.
- Identify the effects on government revenue from the shift to EVs from ICE-based vehicles.
- Assess whether renewable sources of electricity will be able to support use of the proposed 500 000 or more EVs by 2018.
- Assess the prospects for battery leasing models and the viability of battery "repurposing."
- Compare the social benefits and costs of electric traction with ICE-based traction that uses fossil fuels.
- Identify the feasibility, costs and benefits of creating a Canadian brand of highway-capable EVs.
- Identify new business opportunities for Canadian electrical utilities that could arise from growth in the EV industry.
- Identify and assess the challenges and opportunities for Canada's EV industry posed by the American Recovery and Reinvestment Act of 2009 and other such measures.
- Identify potential early adopters of EVs, particularly fleets, and how they may be encouraged to become early adopters.

Education and outreach

- Assess the resource requirements for training, education and certification in skills related to the emerging EV industry. Provide this information to organizations that can develop:
  - technical courses on EV repair, service and maintenance and on the conversion of ICE-based vehicles to EVs
  - courses to help graduates of universities and colleges secure employment in high-paying jobs in the emerging EV industry in areas such as battery engineering, power systems engineering, power electronics, manufacturing processes and development of new business models
- Develop educational and public relations programs that increase awareness across Canada of the benefits of EVs and associated technologies.

An additional task for the Roadmap Implementation Committee could be to review the limited scope of the current Roadmap and, after appropriate consultation, seek to initiate roadmaps in other areas of electric traction.

We live in extraordinary times, from a transportation and energy perspective as well as many others. Our times are fraught with challenge but also brimming with opportunity.

The basic message of the Roadmap is clear: early action, mainly by governments and industry, will sustain Canada's strong position in electric transportation and enhance it for the benefit of all Canadians.

Photo courtesy SMART

Electric car tops greenest vehicle list for first time in 12 years

With the auto industry back on its feet and fuel economy standards shifting into high gear, automakers provided consumers with an array of vehicles and technologies from which to choose in 2012. Recently, the American Council for an Energy-Efficient Economy (ACEEE) released its 14th annual vehicle environmental rankings, which shows how these offerings stack up.

Congratulations to the Mitsubishi i-MIEV battery electric vehicle for shaking up the list and claiming top honours from the natural gas Honda Civic (which held First Place for eight years in a row). Making its model year 2012 debut on the American market, the i-MIEV earns a score of 58: the highest Green Score awarded since the rankings began in 1998. With a combined city and highway fuel economy of 112 mpg (equivalent), the i-MIEV outpaces all other vehicles currently sold in United States.

"Even taking into account the emissions generated from the electricity used to power the i-MIEV, it still handily outscores other vehicles on the market today," said ACEEE lead vehicle analyst Shruti Vaidyanathan.

In second place, tied with the Honda Civic Natural Gas, is the all-electric Nissan Leaf. Rounding out the top six are the Toyota Prius, the Honda Insight, and the Smart ForTwo. This year, hybrids dominate the list, occupying half of all spots.

Vehicles are analyzed on the basis of a Green Score, a singular measure that incorporates unhealthy tailpipe emissions, fuel consumption and emissions of gases that contribute to climate change.

This year, a number of updates were made to the Green Book methodology to more accurately estimate vehicles environmental impacts. These include improved emissions estimates for the vehicle manufacturing process, changes reflecting current natural gas extraction practices, and consideration of upcoming shifts in the generation mix for the electricity used to power electric cars. ■

Photo courtesy Mitsubishi

Photo A. Capkun

How is your province charging ahead?

Hydro-Québec and its partners—Rona, les Rôtisseries St-Hubert, Metro and the Agence métropolitaine de transport (AMT)—have teamed up to create "The Electric Circuit", which they say is Canada's first public charging network for plug-in electric vehicles (PEVs).

Alyssa Dalton

Canada is often referred to as a 'mosaic'—a mosaic of cultures, of races, of international music... but a mosaic of various programs supporting electric vehicles (EVs)? Hey, it may not roll off the tongue quite as smoothly but it seems applicable here.

"What we're seeing is the convergence of 200-year-old industries—the automotive and the power generation and utility industries, and they've never really crossed paths before," says Chris Hill, president and CEO of Electric Mobility Canada (EMC, www.emc-mec.ca), a not-for-profit organization founded in 2006 with the goal of promoting EVs across the country. "It's different from what anybody is used to, so it's a question of finding out how to do it."

While Hill predicts 2015 as the magic year EVs gain nationwide support, our utilities have been hearing chatter of the "imminent arrival" of EVs over the past decade. So what are they doing about it?

Seeking the cluster

EV adoption across Canada's provinces and territories is progressing slightly slower than expected, according to Tom Odell, manager, capital projects and EVs at Toronto Hydro (www.torontohydro.com). Leading the way, in his opinion, is Ontario.

"Ontario is the largest market for vehicles in general. As well, EVs are very much an urban phenomena and Ontario has a concentration of population in urban areas," he says.

Potential and current EV owners living in the Toronto area can participate in the Toronto Hydro EV Connections program, where the utility helps connect them with electric vehicle supply equipment (EVSE). Depending on the specific case, Toronto Hydro installs metering to monitor electricity consumption through its AMI (advanced metering infrastructure) system, while collecting load data, home load data and data from transformer smart meters to analyze grid impacts. Through the program, participants are entered into a five-year EV lease agreement from the date of connection.

"We have had considerable success with our pilot program. It has evolved since inception (last year) and is now very effective in enabling us to understand the real-world impact of EV owner behaviour and grid impact," he notes.

The program strives to gather diverse data—various EV models, long commutes, short commutes—but more importantly, says Odell, it seeks a cluster of EV connections on one transformer. "This way, you can find a way to break the system or determine some of the larger impacts rather than doing simulations," he says.

"We saw that, with clustering, there could be an impact on the local distribution transformer," says Odell. "Generally, utilities outside of urban centres can react much differently to increased loads than those in an urban centre. They don't have the interdependencies at the different levels of distribution."

"It's about [managing] unanticipated load in unanticipated areas."

The Electric Circuit

Having rebuilt its system after the infamous 1998 ice storm knocked out part of its electricity supply for up to five weeks, Hydro-Québec (www.hydroquebec.com) now arguably has one of the strongest power grids in Canada. In 2009, the utility broadened its EV research to include real-life testing through its Boucherville-Mitsubishi EV pilot project. The objective was to study the participants' charging behaviour and driving experience in various real-life conditions, primarily in snowy winter weather.

"We had a series of specific criteria,

such as the number of km the applicant drove each day, whether they used highways or secondary roads, whether they used their vehicle during the day or not, if they had a garage, etc.," says Mathieu Rouy, Hydro-Québec spokesperson.

Thirty drivers living or working in Boucherville, Que., were selected for the pilot project, each receiving the use of a Mitsubishi i-MiEV and a 240V charging station installed at home and at work. Mid-term results show participants are "extremely satisfied" with their overall EV experience. "Users have confidence in their vehicle. They told us they had to shift their way of thinking in that now they're planning their trips in terms of distance or km rather than in terms of time," says Rouy. Furthermore, after two winters of real-life testing, Hydro-Québec has proudly confirmed EVs are fit for the province's rigorous winter climate.

Hydro-Québec's active preparation and testing for electric transportation over the years is partly due to the provincial government's 2011-2020 Action Plan for Electric Vehicles, which mandates the utility to plan and implement the rollout of the necessary charging infrastructure to accommodate plug-in EVs (PEVs).

In April 2012, Electrical Business learned Hydro-Québec, along with Les Rotisseries St-Hubert, Rona, Metro and the Agence metropolitaine de transport (AMT), had officially launched the country's self-proclaimed first public charging network for PEVs. About 80, 240V Electric Circuit plug-in stations are now available in parking lots of Rona and Metro stores and Rotisseries St-Hubert restaurants in the greater Montreal and Quebec areas.

According to the partners, the circuit will allow PEV operators to drive worry-free, knowing that a public network of charging stations is available to meet their needs. More than 150 charging stations are slated to be available in the province by the end of 2012.

A load by any other name

At a time when some utilities appear concerned with whether their electric grid can support EV deployment, Daniel Yurkiw, strategic review analyst at Manitoba Hydro (www.hydro.mb.ca), says he sees an individual EV load as similar to that of a stove, a clothes dryer, or an electric furnace. In his eyes, the EV is simply a type of large appliance that needs to be plugged into the grid.

"Load growth is fairly consistent," explains Yurkiw. "We don't do public campaigns for hot tubs, even though they're electrically-powered. Although this is a special, mobile load, we're trying not to treat [EVs] any differently than any other load when it goes on the grid."

"Every year our load is growing and this is just one more load on the grid," he says. He likens EV adoption to the electronics movement, citing a spike in electricity consumption when plasma TVs first hit the marketplace as an example.

Manitoba Hydro first dedicated resources to researching and understanding the EV in anticipation for last year's launch of the Chevy Volt and Nissan Leaf. Through two separate pilot projects, one for each EV model, the utility tracked the response of its electric grid throughout its distribution systems, making sure different components could be upgraded if they started to reach their maximum capability.

Yurkiw and his colleagues, along with 13 other utilities and three municipalities, have also teamed up with EMC to develop a set of guidelines to help utilities and communities better understand and prepare for the impact of EVs on the grid and on the road. Scheduled to be completed January 2013, the guideline will cover topics such as: the installation of home and public charging stations; rules and regulations; the ability to sell electricity; and road taxes.

Park easy, charge easy

Over on the West Coast, BC Hydro (www.bchydro.com) has partnered with several auto manufacturers, including Mitsubishi, Nissan, Toyota and GM/Chevy, for pilot programs and early commercial deployments to better understand the implications to its customers and distribution system, and build awareness of the environmental benefits of the cars, it says.

In one of its earlier EV demonstrations, two extended-range electric Volts were highlighted as part of BC Hydro's Power Smart Village during the Vancouver 2010 Olympic and Paralympic Winter Games. The cars, which plugged into the Home of the Future, gave visitors a sneak peek of one of the new transportation options to come. Following the showcase, BC Hydro and Chevrolet placed 15 Volts into various fleets of B.C.-based organizations, two of which were recently added to the utility's own fleet.

"In preparation for electric vehicles entering the B.C. marketplace, our focus at BC Hydro is to ensure the best possible customer experience and that means a solid understanding of both our customers' needs and the impact on the grid, so that we can be ready to support the vehicles," says Bev Van Ruyven, deputy CEO at BC Hydro.

This led to BC Hydro and the City of Vancouver's EasyPark Easy Charge Pilot Project, a program that saw the installation of up to 15 public charging stations at EasyPark lots throughout the city, beginning June 2011. According to BC Hydro, the project is intentionally small in scope to focus attention on how stations will be installed, supported, used and how they can be integrated into the city's electrical grid.

One of the first steps in the project was to test a range of Level II 240V EVSE units: "These Level II units provide motorists with faster charging options than currently exist and will enhance the local EV charging network," explains BC Hydro.

All public EV charging stations in the city can be found through a live location map (bit.ly/V1hBYw), various smartphone apps (including PlugShare, ChargePoint and Recargo), as well as Google Maps in the future (search for EVSE Vancouver, Canada).

While EVs may appear to be largely an urban development, Hill encourages all Canadian utilities to be aware of the discussions surrounding EV deployment, regardless of whether they decide to implement a pilot program themselves. Interestingly enough, Hill spotted two Toyota Prius hybrid vehicles in the two days he was in Whitehorse, Yukon, two months ago. He's told there are 10-15 hybrid vehicles there.

Looks like 2015 will be here sooner than we think.

2012 forecasts for

Many bumps on the road ahead

Dr. Peter Harrop

One year ago, it was widely believed there were three key enabling technologies for hybrid and pure electric vehicles: batteries, motors and circuitry (electrics, electronics, telematics), but *the battery is the car* when it comes to controlling cost and performance, so success revolves mainly around getting battery costs down and performance up—particularly improving energy density for pure electric vehicles.

However, it is now clear that we are not only in the decade of the hybrid in terms of money spent, but plug-in hybrids (PHEVs) are key, and the most aggressive manufacturers will be selling more plug-ins than traditional hybrids by the end of the decade. For that to happen, the price premium must be small or non-existent, and the all-electric range be useful rather than a token gesture. That means battery energy density is now key for hybrids as well.

Electric vehicle components

Traction motors did not matter as much in determining price or performance of the vehicle. No longer. The rocketing price of dysprosium and neodymium now means that prices of most of the motors used have become painful and threatening for the future. All serious suppliers are racing to make magnet-free motors, particularly asynchronous and switched-reluctance synchronous versions. Some hope they can get away with motors with fewer magnets or with magnets that do not employ rare metals. Unfortunately, a surprising number of traction motor manufacturers persist with motors heavily employing conventional magnets and many even stick with motors that have brushes. They will be blown out of the business.

In-wheel motors are only making slow progress because they tend to incur huge expenditure to create new vehicle platforms, and you need to buy several motors where one sufficed—a cost escalation not always offset by the many gains from eliminating other parts. Nevertheless, the robust move to *born electric* vehicles is in their favour—eventually.

It was amazing that, just one year ago, few realized the emerging importance of three new key enabling technologies: energy harvesting, supercapacitors/ultracapacitors and range extenders. Yet kinetic energy recovery systems (KERS) are now being trialled on Volvo family cars; motors that inherently regenerate braking energy are becoming the norm, shock absorbers generating energy are soon to be very important and photovoltaics with much wider area—and, therefore, power—are being trialled in many forms, including conformal, transparent and unfolding versions.

Heat harvesting (thermoelectrics) is creeping toward adoption too. We see multiple energy harvesting as a key part of working around the battery problems, as are improved circuitry and fast-charging stations.

Key enabling technology

For 2012, the most important of the new key enabling technologies is range extenders. It is quite wrong to think that the current practice of slightly modifying conventional piston engines and fitting them in hybrids will be acceptable for much longer. It is equivalent to teaching a tortoise to fly. Conventional engines must cope with huge load and torque variations—range extenders with almost none.

Conventional engines are in use all the time; increasingly, hybrid engines are used only occasionally and, increasingly, they only need to supply electricity—they do not need to rotate and they certainly do not have to employ a shaft to a separate generator in the clunky old *box-on-box* approach of yesteryear.

Consider what has recently happened: a German hybrid electric aircraft has flown with a Wankel range extender, and an Italian one with a fuel cell range extender. The Lotus Engineering designed-to-purpose tiny piston-engined range extender appeared in Proton, Jaguar and other concepts and prototypes and, a less imminent prospect, a mini-turbine range extender in a Jaguar concept. The Polaris Industries Swisscom single piston range extender—without even an oil pump—staggered observers with its silence

when fitted into a German electric van.

Those hybrid vehicle manufacturers that think it is simply a matter of waiting for fuel cell range extenders to become affordable and acceptable are wide of the mark. We have waited 140 years for fuel cells to become volume products and we are in the third decade of extensive testing of fuel cells on buses alone. They will come, but mainly in the second wave of *fuel generators*—elegant range extenders that inherently produce electricity, competing with the free piston engine, the Clarian Wankel engine swathed in coils and other options being developed.

The battery shakeup we and others predicted has begun as expected with the troubles at Ener1, the refocusing of ASDL after acquisition and so on. It will be even more vicious than we predicted because huge companies continue to enter the business. Certainly third generation lithium-ion batteries are appearing sooner than some expected and more of the battery requirement is being made by the vehicle manufacturers themselves. Yet what is really wanted still fails to reach the production line.

Despite the bumps, up and at 'em

We are constantly amazed how a little in-depth research can reveal that a situation is the opposite of that portrayed. Toyota has pulled ahead in sales of electric vehicles and in the in-house development and patenting of their key components, yet all that is reported is its former quality problem and the effect of the tsunami. Electric vehicles (EVs) are portrayed as a one-day-maybe business yet 25% of cars sold in Japan are electric, with Toyota making 60% of them (nearly all hybrid).

Look at what has happened with golf cars and indoor fork lifts to autonomous underwater vehicles (AUVs), and you get the point: EVs are a very large business—now and key to the future. Huge potential acquisitions await such as KION profitably in forklifts but with no chance of becoming leader in EVs as a whole as that becomes the economically meaningful market.

We forecast huge new markets opening up such as those for outdoor hybrid forklifts and military EVs. The predicted demise of vehicles dangerous to pedestrians on the sidewalk and to drivers on the road continues but there is always another one being designed by the romantics. The big picture reveals huge opportunities for business both in the vehicles and their components, yet most participants are suicidally pursuing the obvious.

The reading of success and failure must be taken with a pinch of salt too. We simply do not know whether the Nissan Leaf and GM Volt will be a success because they have been production limited. Selling showroom models smells of desperation but not failure. Only this year will we see where they and their derivatives are headed. Even then it is worth remembering that the Toyota Prius—winner by far—was in the wilderness for six years. It was laughed at.

We have had to recognize that the hybrid and pure electric car business has lost a year due to delayed rollouts and other factors, and it alone is highly vulnerable to the whims of government support for the next few years. All other sectors are largely on track, but the mix is changing within sectors. For example, hybrid buses are set to be a huge business, particularly in China, guaranteed by state and local government support and largely recession proof.

There is a real possibility we shall have to revise our forecasts upward for the industrial and commercial sector a year from now. By contrast, the military is adopting EVs fast but facing budget cutbacks, which makes forecasting rather difficult. We keep a watching brief on the excellent new hybrid electric powertrains in seagoing leisure boats. Certainly, the percentage of the electric vehicles business that is beyond cars continues to rise beyond 50%.

Dr. Peter Harrop is the chair of IDTechEx, a provider of independent market research and advice in selected emerging technologies to companies across the value chain to support them in making strategic business decisions. Visit www.idtechex.com.

EV charging systems and the code

The old reliable internal combustion engine is being supplemented (and may even be supplanted) by electric drive motors that provide the driving force in electric vehicles (EVs). There are many different models of electric vehicles, such as fuel-cell-powered or plug-in hybrid, etc. The move to EVs is driven by the ever-increasing cost of gasoline and the associated negative impacts on the environment of car engine emissions.

But before the EV is driven off the dealer's lot, consideration needs to be given as to how the vehicle will be maintained in operating condition. One concept includes an onboard rechargeable electricity storage system using batteries. This system requires a connection to a receptacle for the purpose of charging the batteries at regular intervals. These EVs need to be plug in to charge the batteries whether at home or on the road. The Canadian Electrical Code (CEC) Section 86 contains rules for the installation of electrical conductors and equipment (EVSE) that connect an electric vehicle to a source of electric current by conductive or inductive means to accomplish the necessary charging.

The electric vehicle batteries are charged through an electric vehicle inlet connector. Rule 86-100 defines the special terminology used, such as the definitions for electric vehicle, charging equipment (EVSE), EV connector and inlet. Rule 86-104 limits the alternating current system voltage used to supply charging equipment to 750 volts maximum.

Rule 86-306 requires each receptacle used for the purpose of EV charging to be labelled in a permanent manner identifying it as an EV charging receptacle. Also, the receptacle must be a single receptacle of CSA configuration 5-20R supplied from a 125V branch circuit rated not less than 20A and be protected with a ground fault circuit interrupter (GFCI) of the Class A type when the receptacle is installed outdoors and within 2.5 metres of finished grade. This voltage and amperage level is generally available in residential homes and commercial buildings.

Rule 86-300 requires EVSE to be supplied by a separate branch circuit that supplies no other loads. The only exception to the rule is that the circuit can be used to connect the ventilation equipment intended for use with EVSE.

Rule 86-302 requires the total connected load of a branch circuit supplying EVSE and the ventilation equipment to be considered continuous for the purposes of Rule 8-104. Therefore, the maximum continuous load on this circuit cannot exceed 16 amperes.

Rule 86-306(1)(b) presents another acceptable option of using a receptacle of the appropriate CSA configuration in accordance with Diagram 1 or 2 when supplied from a branch circuit rated at more than 125V or more than 20A: for example, a non-locking type receptacle of CSA configuration 6-30R or a locking type receptacle L6-30R. These receptacles would allow for higher voltages and currents that would be beneficial because they provide much faster battery charge restoration and, thus, quicker vehicle availability.

Rule 86-400 (2) requires adequate ventilation to be provided in each indoor charging site as specified in Rule 26-546. The EVSE must be electrically interlocked with the ventilation equipment so that the latter operates with the EVSE and, should the supply to the ventilation equipment be interrupted, then the EVSE must also be made inoperable.

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Opportunities in electric vehicles surge

Photo courtesy Tesla Motors.

Gerry Malloy

The auto industry, worldwide, is charging full speed ahead toward the electrification of the automobile. Draconian fuel-economy regulations that will keep tightening from now until at least 2025 all but ensure that electrically driven vehicles will become a significant part of the product mix in Canada and the United States, as well as overseas.

Some of those vehicles will be conventional hybrids, with which we have become familiar over the past decade. But, increasingly, they will be plug-in hybrids (PHEVs) or battery-electric vehicles (BEVs). And what makes those vehicles different from anything we've seen before, in any significant volume, is that they'll all need charging from the electrical grid. A lot of charging.

Which means there's going to be a real surge in the need for the installation of dedicated chargers or, at the very least, high-voltage circuits. And that need means new opportunities for electrical suppliers and contractors at all levels, and to a multiplicity of customers.

Volt and Leaf are the vanguard

Two highly publicized new vehicles arriving on the Canadian scene this fall are at the cutting-edge of this change in direction. And they preview the type of infrastructure expansion that will become necessary over the next decade.

General Motors calls its Chevrolet Volt an "extended range electric vehicle" (EREV). In pure technical terms, it is a series hybrid, in which a small gasoline engine is used to drive a generator to keep its batteries charged and power its electric motor, until the gas tank runs dry—just like a normal car.

But the batteries can also be charged by plugging into the grid. Enough so that the Volt can be driven up to 56 km, depending on operating conditions, on battery power alone, before the gasoline engine ever kicks in. It is possible, then, that someone commuting less than 56 km/day, round-trip, would never use any gasoline. But the gasoline engine provides a backup to ensure the driver isn't stranded should the battery become discharged.

Nissan's Leaf is a pure BEV. It has no engine; just batteries. Its nominal driving range is about 117 km, which means it's capable of longer commutes than the

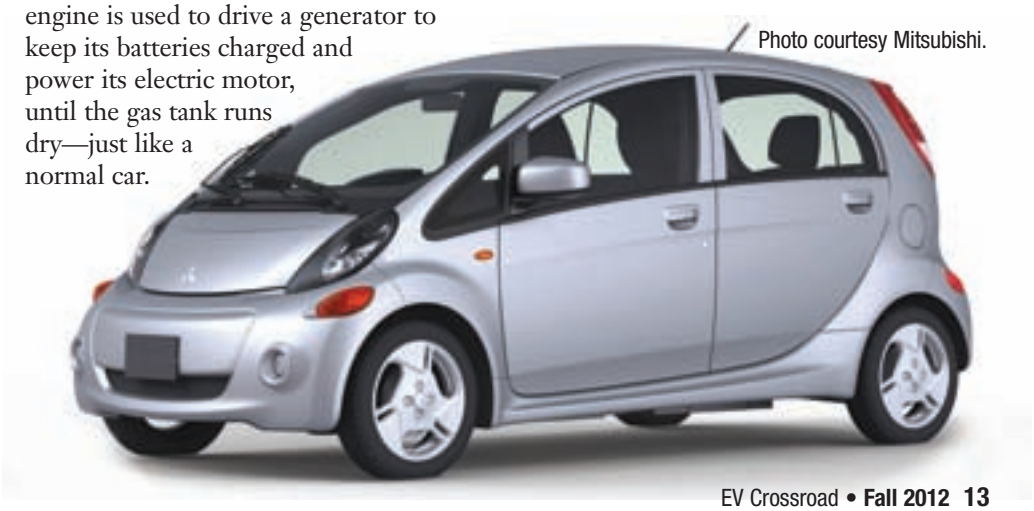

Photo courtesy Mitsubishi.

Electrification drive moves up to medium and heavy trucks

Hybrid-electric cars have been around for more than a decade and hybrid pickup trucks, plug-in hybrids and electric vehicles (EVs) are now making their mark as well.

Those technologies have been slower to infiltrate the medium and heavy truck markets, but they are also beginning to appear there in greater numbers. And that trend is expected to increase dramatically over the next five years.

A report by Colorado-based Pike Research, a market research and consulting firm specializing in clean technology markets, predicts that global sales of hybrid, plug-in hybrid and battery electric trucks will surpass 100,000 vehicles annually by 2017.

Truck manufacturers are looking for technologies that can help mitigate the rising cost of diesel fuel while meeting increasingly strict emissions requirements, the report says. And they got an additional incentive in September when American president Obama announced the first-ever fuel economy standards for medium- and heavy-duty vehicles.

The new rules are predicted to reduce fuel consumption by 10% to 15% between the 2014 and 2018 model years—a significant hurdle for truck-makers to overcome, but one that opens the door for greater electrification of those vehicles.

A broad range of hybrids are already offered in that market. Ford, via its originally Canadian partner, Azure Dynamics, offers a hybrid (E450) cargo van and chassis, as do Freightliner and Navistar. The latter has also developed a purpose-built battery-electric delivery van, for which Canada Post is a customer.

Mack and Volvo offer hybrids specifically for the refuse collection market and Smith Electric Vehicles provides battery-electric Class 5 and 6 units for such specialized applications as airport service.

Further up in Class 6 and 7 territory, Freightliner, Kenworth, Navistar and Peterbilt offer a variety of hybrids. Peterbilt even markets a hybrid long-haul tractor.

Hybrids and electric trucks are particularly well-suited to city delivery service, with frequent starts and stops as their electric motors provide maximum torque from start-up to aid acceleration and the use of regenerative braking when slowing down helps recharge their batteries.

Volt in EV mode but, when its battery is dead, it stops... until it's recharged, that is.

These two vehicles are the vanguard of a host of similar vehicles of both types that are now (or soon will be) in the pipeline, and they illustrate why there will be two different types of charging needs: private and public.

Home charging

Both the Leaf and Volt can be recharged by plugging into a common 120-volt household outlet. Nothing more is required, which will make it easy for them to be charged at home, if one's home includes a parking place with access to an electrical output (not always the case, particularly in cities).

There's another problem with that scenario. Recharging either vehicle at 120 volts takes a long time for a full charge: 10 hours for the Volt; 20 hours for the Leaf.

Which is why a market for Level 2 (240-volt) chargers is quickly developing for both home and commercial use. Within North America, SAE J-1772 has been adopted as a standard for charging connectors to enable the same chargers to be used for multiple vehicles.

General Motors is marketing a Level 2 charger supplied by SPX Service Solutions to its Volt customers. It plugs directly into a 240-volt outlet and reduces the Volt's recharge time to about four hours.

Nissan has partnered with AeroVironment to supply Leaf customers with hard-wired Level 2 chargers that cut its recharge time to somewhere around seven to eight hours.

Numerous other suppliers offer Level 2 EV chargers, including such well-known names as Schneider Electric, Eaton, Legrand, Leviton and General Electric, to name just a few, and their numbers continue to expand.

Beyond just home installations, a market is also developing among municipalities, government agencies, businesses—particularly those that want to demonstrate their environmental responsibility—and at auto dealerships that will be required to sell and service electric vehicles.

As an example of business involvement, Google in the United States has already installed over 220 charging stations, and is planning 250 more. The charging stations are used for staff-owned electric vehicles, as well as by GFleet, the company's employee car-sharing program.

Fast chargers

The limited range of BEVs, in particular, is also driving the installation of commercial charging stations in areas where EV populations are growing rapidly, such as California. For that purpose, several companies, including Schneider and Eaton, are developing and offering so-called fast chargers (480-volt) that can achieve almost full-charge in some vehicles in as little as one-half to three hours.

One of the problems with that approach is that there is as yet no single connector standard that has been adopted by all automakers. The Japanese are the furthest advanced in that regard, and agreement on a common standard is expected in the near future.

Looking a little further into that future, there is the real possibility of connector-free charging using wireless magnetic resonance devices. Delphi has demonstrated a system that comprises two metal plates about the size of a pizza box. One is attached to the floor, the other to the bottom of a vehicle and when the latter is driven over the former charging begins, at about the same rate as with a Level 2 connection.

It may be a while before EV charging stations are as common on street corners as gas stations are now. They'll probably even take a completely different format. But, rest assured, the day is coming when EVs of various types will no longer be a novelty but part of the mainstream. And, between now and then, there's a lot of electrical business to be done.

Photo courtesy Ford Motors.

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