Plug-in Hybrid Electric

Chevrolet Volt in Manitoba

Summary of Operational Experience: First Year Report

Prepared by the Electric Vehicle Technology & Education Centre,
Red River College, in cooperation with the Energy Division,
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Objectives and Reporting

In 2011 the Government of Manitoba began the testing of commercially-available electric vehicles.[1] The overall objectives for testing have been to understand the practicality and public perception of using electric vehicles in our climate conditions, and to publicize and demonstrate the benefits of these vehicles. The primary intent of this and other reports prepared on electric vehicles is to be able to address a variety of practical questions that potential users may have in considering the purchase of these vehicles. As such, this report is deliberately organized according to a series of questions clustered into four areas, regarding: operation; maintenance; economics; and overall suitability. Information in this and other reports is also being shared with respective automobile manufacturers to hopefully help them make their vehicles better in the future.

Introduction

Acquisition of Volt

The Government of Manitoba, through its Vehicle and Equipment Management Agency (VEMA), purchased a 2012 model year Chevrolet Volt that was delivered in July 2012. This vehicle is being used within the Energy Division, Department of Municipal Government, with monitoring of vehicle performance for a three-year period up to July 2015. Annual reports of experience with this vehicle are being prepared for each individual year. As such, this first year report covers from July 2012 through July 2013.

Volt characteristics and specifications

The Chevrolet Volt is a highly novel vehicle within the category of those capable of using electricity. Rather than being an electric-only battery electric vehicle (BEV), like the Nissan Leaf or Mitsubishi i-MiEV, the Volt is technically classified as a plug-in hybrid electric vehicle (PHEV). It has an electric motor with batteries and the capability of being powered-up from the electrical grid, but also incorporates a gasoline engine that is used as a back-up generator. Uniquely in the case of the Volt, there is no direct connection between the engine and drive wheels. Given these characteristics, General Motors has tended to eschew the term PHEV for the Volt.

Most other PHEV models now available, such as the Toyota Prius Plug-in or Ford Fusion Hybrid Energi have tended to involve relatively smaller battery capacity, i.e., some grid-based battery electric operation in a vehicle primarily operated using liquid fuel. General Motors has tended instead to use the term extended range electric vehicle (EREV) to describe the Volt, i.e., vehicle operating primarily using electricity from the grid, with a conventional fuel engine as a backup generator intended to be used only to a limited extent. These distinctions are relatively subtle, and sometimes can be a bit confusing.

Chevrolet Volt Technical Specifications

Dimensions	4.5 m long x 1.8 m wide x 1.4 m high
Curb Weight	1.7 tonnes (3,800 lb)
Electric Motor	Permanent magnet, 111 kW output primary motor; with 55 kW output secondary motor
Battery	Lithium-ion chemistry, with 16 kWh total capacity, and 10.4 kWh usable
Back-up Engine Generator	1.4 L EcoFLEX, with output of 63 kW at 4,800 rpm
Liquid Fuel Tank Capacity	35 Litres
Speed	190 km per hour (limited duration)
Range (all-electric)	Target all-electric range of more than 70 km, with practical expected range of 56 km, based on U.S. EPA testing protocol
Additional Range (using back-up engine)	Up to range of 610 km with full liquid fuel tank

1 http://news.gov.mb.ca/news/?item=11605

IPLC-PM2 device

The Volt was commercially introduced to the world market initially in 2010, becoming available in selected locations within Canada in late 2011, and more broadly available in 2012, including Manitoba. The first Volt in Manitoba arrived in 2011, but this unit was brought in from outside. Since its introduction, the Volt has also proven to be the single-most popular modern commercial electric vehicle in Canada, and this is also true for Manitoba. Aggregated registration data from Manitoba Public Insurance (MPI) confirmed that the Volt is the most popular vehicle within Manitoba, having the capability to be plugged into the grid.

The Volt is intended as a family vehicle, able to seat up to four adult passengers, and able to drive both within urban environments and on highway. Key technical specifications for the Volt are provided in the table on page 2, with photographs throughout this document.

Licensing and insurance

The Volt was registered for operation in Manitoba with MPI and covered under a standard automobile insurance policy. Registration was undertaken by VEMA, as the formal owner of the vehicle, and as one of their regular vehicle-related functions. There were no concerns identified or special requirements for registration or insurance as compared to a conventional vehicle. Interestingly, MPI classifies the Volt as a hybrid vehicle, i.e., like the more conventional Toyota Prius hybrid.

Data-logging

No on-board data-logging device was directly installed on the Volt during its first year. It had been considered to install a more modern version of Manitoba-based Persentech's Otto data logger system, but this was deferred until later on in the three-year testing. This device had been used earlier on other vehicles primarily to determine two parameters to characterize the nature of vehicle-use: (i) number of trips per day; and (ii) daily travel distance. At the same, daily odometer values were quite rigorously recorded manually for the Volt, providing data on daily travel distance.

Owners of the Volt vehicle are eligible to access General Motors' internet-based telematics On-Star service. Although this system is significantly oriented to remote operations (i.e., via smart phones), it also maintains vehicle information relating to energy performance.

A separate meter, the IPLC-PM2 manufactured by Manitoba-based Vantera Inc., was used for interactive monitoring of electricity consumption of the vehicle when plugged into the grid for Level 1 (i.e., 110 V, 15 A) charging. This device, which is illustrated in the photograph above, was carried with the vehicle and externally installed between the vehicle cord-set and a Level 1 plug-point during recharging. Data was recorded and stored on a memory stick.

Although vehicle electric-range is ultimately most important for drivers to understand in the operation of an electric vehicle, range estimates can sometimes be vague. In order to objectively address vehicle range, precise measurements of vehicle electricity consumption were taken at the wall plug under different conditions using the IPLC-PM2 device. The range of any all-electric vehicle depends directly on the available battery capacity, and on electricity consumption under the conditions of operation. As such, expected range is inversely related to any change in energy consumption, i.e., higher energy consumption means lower expected range.

Operation

What is it like to drive this vehicle?

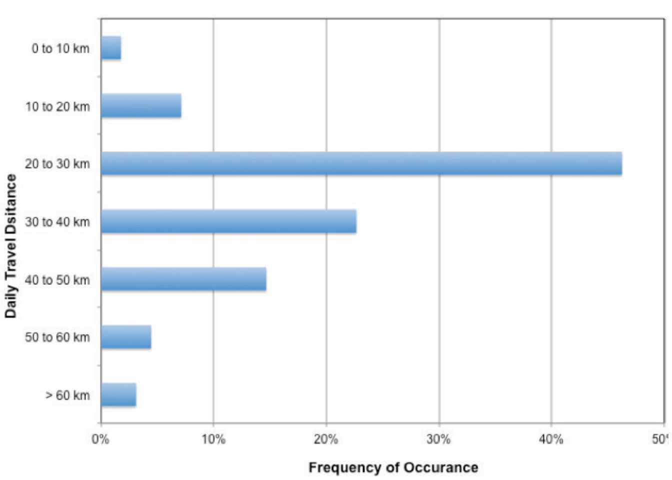
The Volt is a sophisticated vehicle designed to act and to feel no different than a conventional all-liquid fuel vehicle. Based on feedback, this goal was achieved. During the first year of operation, the Volt was primarily driven by one individual from the Government of Manitoba, with two others also driving the vehicle intensively for short periods. The vehicle was also primarily driven in the vicinity of Winnipeg.

The overwhelming impression of the Volt was positive, with certain drivers indeed expressing a strong desire to personally acquire a Volt. Noted by drivers as particularly seamless was the transition between using batteries and using the on-board engine for electricity to power the vehicle. As such, the Volt is able to provide all of the advantages associated with electric operation, but with none of the disadvantages associated with range limitation or range anxiety. This aspect is explored further in the next section.

How is this vehicle typically used?

By the end of the first full year of operation, the Volt had travelled approximately 8,500 km. The Volt was operated as a government vehicle, and the annual travel distance was not significantly different from two types of BEV also under test in the same type of operation, i.e., the Nissan Leaf and the Mitsubishi i-MiEV. Although reflecting operation as a government vehicle, this travel distance corresponds to what would be expected from a vehicle involved in daily commuting (i.e., 150 km to 200 km per week x 50 weeks). For comparison, an average vehicle within Manitoba travels approximately 16,000 km annually, based on data from Statistics Canada's Canadian Vehicle Survey.[1]

A histogram of travel-distance frequency for the Volt is presented in the figure below but considering only the actual operational days. Statistical characteristics for these operational days are summarized in the table on page 5, including mean, median, mode and standard deviation values. As part of the Manitoba PHEV Demonstration, unpublished results were provided from the University of Winnipeg regarding work they had done earlier to summarize travel characteristics for a total of approximately 76 different volunteer-vehicles within Winnipeg using the Otto Driving-Companion data-logger from Persentech.[2] Comparable statistical data from their work are also included in the table on page 5.



It is obvious that the driving characteristic data for the Volt, when operated, were very similar to the average driving characteristic data found for Winnipeg drivers by the University of Winnipeg. This is an important finding, suggesting that the manner in which the vehicle was driven matched closely what an average driver of a typical vehicle in Winnipeg would undertake. At the same time, data for the all-electric BEVs under test, even when considering only operational days, were all quite different from that of the University of Winnipeg. The obvious interpretation is that the way in which BEVs were driven was affected by range limitations and other vehicle characteristics, but with the Volt, the driver was freed from any consideration of range limitation, and the way in which the vehicle was driven was not different from a typical vehicle in the same city.

Although the total travel distance for the Volt was only about 8,500 km, highway driving was undertaken, including a total travel distance on one day of roughly 200 km. Highway travel was not a concern. The total travel distance for the Volt appeared to be limited by fleet vehicle-like driving characteristics, not by any technical constraints of the vehicle itself. As such, the Volt easily could have been driven 16,000 km or even more during the first year of operation, if desired.

How does recharging work on this vehicle, how long does it take, and how frequently do I need to charge?

The charging-point access for the Volt is located on the driver side front quarter. Interestingly, a location generally on the driver side is consistent with other North American-built electric vehicles, and contrasts to vehicles from Europe or Japan, where the charging-point access tends to be on the front or on the passenger side. This appears to reflect an orientation to garage or driveway parking for North American vehicles versus street parking for the others.

The circular hatch cover is released at the driver's position using a button on the door. The Volt only has a single charging port, this being SAE J1772-compliant for charging at Level 1 (i.e., 110 V AC; 15 A), or at Level 2 (i.e., 220 V AC; 20 A). The Volt also includes one cord-set for recharging, this suitable for Level 1, i.e., it plugs into standard 110 V electrical receptacles, which are broadly available within Manitoba and not different from receptacles already used for plugging in conventional vehicle block heaters or in-car warmers.

[1] **Brief summary presentation of Manitoba PHEV Demonstration results at the Electric Vehicle 2011 Conference in Vancouver: http://www.emc-mec.ca/ev2011ve/proceedings/EV2011VE27-T4s4-4_Robert%20Parsons.pdf**

[2] **Blair, D., and R. Smith. University of Winnipeg. Unpublished results from analysis of Otto Driving Companion data. For more information visit the site: http://auto21.uwinnipeg.ca**

General Motors has indicated that when using Level 1, the Volt requires 10 to 11 hours to recharge, while using Level 2 it requires 4 to 5 hours. Normally, the vehicle would not be fully depleted by the end of the day, such that recharge times would be even shorter. The relatively short charging time required for the Volt at Level 1 means that under normal circumstances the vehicle can be readily charged overnight to full (i.e., within 12-hour window from 6 pm to 6 am), no matter how low the state of charge (SOC). This is also consistent with General Motors' overall orientation to the importance of home-based charging over other charging locations. During the reporting period, the Volt was charged exclusively using Level 1, and overwhelmingly at home locations. Level 2 charging was never used, and was not found to be necessary.

For Level 2, General Motors does offer a dedicated home-based charger under its own brand, i.e., GM Voltec. However, any Level 2 system that is SAE J1772-compliant and satisfactory in terms of the Canadian Electric Code can be used. A dedicated home-based Level 2 charger represents an additional cost for the owner, likely in the range of $1,000 to $2,000, depending on circumstances.

Although Level 2 certainly allows faster recharging, the decision of an owner to implement Level 2 is not a matter of necessary, but rather convenience. Also important for Level 2 is that the on-board charging system of the 2012 model Volt is about 3.3 kW. This is satisfied by a Level 2 charger on a 20 A rated circuit (i.e., 16 A delivered). The Volt certainly can be plugged into a Level 2 charger having higher rated amperage (i.e. 30 A or more), but the vehicle will not charge any faster.

During the summer, it was not necessary to plug in the vehicle every night in order to maintain electrical operation. During colder months it was found to be prudent to recharge the vehicle every night, to ensure that maximum possible charge was available if required. Indeed, in the owners manual, General Motors recommends consistently plugging in the Volt at night for temperatures below 0°C. To further ensure vehicle electrical range during the coldest weather, the Volt under test was also plugged in at work in extreme cold.

Comparison of Daily Travel Data for Volt versus University of Winnipeg Earlier Study of Roughly 76 Volunteer-Vehicles within Winnipeg

Daily Travel Distance Data Parameter	Data for Volt during 2012-2013 Period *	Data from University of Winnipeg
Mean Value (km)	35.6	35.8
Median Value (km)	29.0	26.0
Mode Value (km)	24.0	
Standard Deviation (km)	40.0	42.4

*** Note: Volt data considers only days when vehicle was operated, i.e., excluding zero-travel days.**

What happens if the vehicle runs out of battery energy while driving?

Unlike all-electric BEVs, the full depletion of the battery pack on the Volt during operation is not a concern. This is, of course, due to seamless transition from the battery pack alone to the back-up liquid fuel engine. Nevertheless, the driver receives ample warning. In this regard, the display of the Volt was found to be particularly effective in informing the driver, with only necessary data presented.

How much electricity does this vehicle use?

Electricity use was measured for the Volt using the IPLC-PM2 meter for Level 1 charging, as described earlier. Combined with odometer changes over logged periods, this permitted calculating vehicle energy consumption in units of kWh per 100 km. This calculation method is consistent with that employed by Transport Canada as part of the ecoTechnology for Vehicles (ETV) program in evaluation of electric vehicle performance.[3]

Three different types of commercially-available electric vehicles have been evaluated for energy consumption in the same way during summer operation in the vicinity of Winnipeg, with no AC or heating employed. In addition to the Volt, these include the Nissan Leaf and the Mitsubishi iMiEV. Baseline energy consumption data for all three vehicles are provided in the table on page 6, with mean and standard deviation shown, based on actual monitor data with five replicate tests for each vehicle (n = 5). Official baseline energy consumption results for these same three vehicles have also been determined by Natural Resources Canada under conditions for city-

[3] http://www.tc.gc.ca/media/documents/programs/i-MiEV_testplan_ENG.pdf

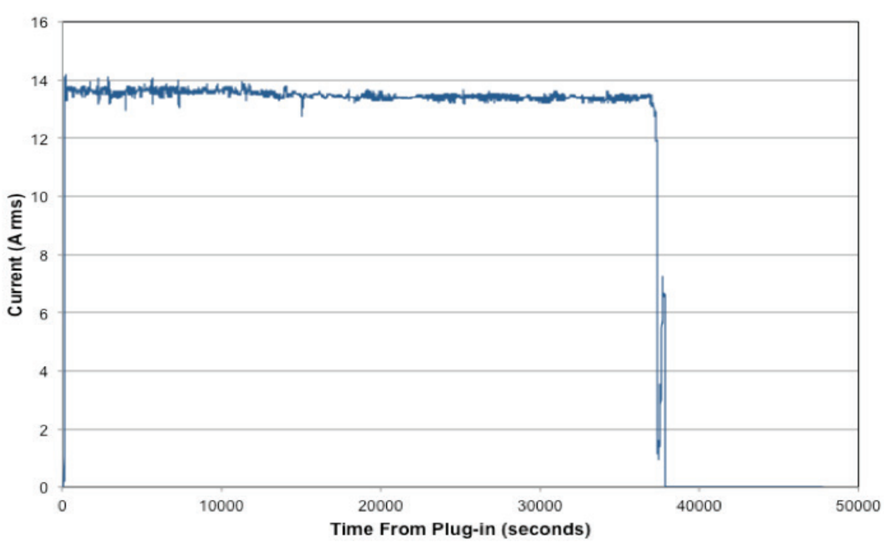
Baseline Energy Consumption for Electric Vehicles in Summer Operation with No Heating or Air Conditioning Involved		
Vehicle Model	Energy Consumption (kWh per 100 km)	
	Winnipeg Test Results	City-Based Official Value*
2012 Chevrolet Volt	19.9 ± 2.1 (n=5) (Testing in July 2012)	22.3
2012 Nissan Leaf	20.2 ± 1.6 (n=5) (Testing in June 2013)	19.6
2012 Mitsubishi iMiEV	16.3 ± 0.9 (n=10) (Testing in July 2013)	16.9
* Natural Resources Canada. Fuel Consumption Guide 2012. Available at: http://oee.nrcan.gc.ca/transportation/tools/fuelratings/fuel-consumption-guide-2012.pdf		
Conversion equation: Electricity use = Litre equivalent per 100 km x 8.9 kWh per Litre equivalent		

based driving with no AC or heating employed, albeit in this case based on specific dynamometer cycle operation. These results are also included in the same table above.

Baseline summer energy consumption for the Volt was found to be 19.9 ± 2.1 kWh per 100 km (n = 5). This was higher than the Mitsubishi iMiEV by roughly 22%, but not practically different from the Nissan Leaf. These results make sense given that the Leaf and Volt have relatively similar curb weights, and both are heavier than the iMiEV.

Testing with electric vehicles has shown that overall energy consumption is strongly affected by the use of climate controls, whether cabin air conditioning during the summer, or cabin heating during the winter. Climate impacts on the Volt were not investigated extensively during the first year and will be considered during further years.

A typical charging curve for the Volt using Level 1, i.e., current level over time, is presented in the figure below. This is based on data obtained from the IPLC-PM2 logging device.



Characteristic Level 1 Charging Curve for Volt

The data presented on energy consumption represent all-in alternating current (AC) electricity-use as measured at the wall plug. This is the electricity consumption that must be paid for by the owner to the utility in order to operate the vehicle. Vehicle users, however, can find that the values as presented here may not necessarily correspond to data presented on the vehicle display. This is to be expected, primarily given that vehicle displays involve direct current (DC) electricity use from the battery, rather than at the wall plug.

The energy consumption values as presented are entirely valid, but at the same they are unfamiliar, appear to be relatively high, and are difficult to tangibly relate to other quantities for comparison. This has led to the use of Litre equivalent comparisons for electric versus conventional vehicles (i.e., Litre equivalent = 8.9 kWh of energy). As such, electric vehicles in the range of 16 to 20 kWh per 100 km, as noted, translate to very low comparative values, in the range of 1.8 to 2.3 Litre equivalent per 100 km, roughly 2.2 Litre equivalent per 100 km in the case of the Volt. It is through this use of Litre equivalent measurements that electric vehicles show outstanding performance relative to conventional vehicles.

For an individual consumer, it is the power level (i.e., kW energy flow rate) rather than energy consumption that is most familiar. Plugging in an electric vehicle, like the Volt, to charge at Level 1 is no different than operating a variety of common consumer appliances. The power level in this case is similar to a hand-held hair-dryer, a microwave, or a dishwasher. For upgraded Level 2 charging, the power level is similar to an electric clothes dryer, but less than would be typical for an electric hot water heater.

How well does this vehicle operate in the winter?

Operation in Manitoba's winter conditions is a challenge for all vehicles, including those that are electric. During the first year of operation, the Volt operated satisfactorily during winter. More specific detailed evaluation of winter operation will be included in later years.

How far will this vehicle travel (on a single charge), particularly in the winter? (i.e., range by season)

All-electric travel distance for the Volt is a bit more complex to determine than for BEVs, given the combination of batteries and a conventional engine. The maximum all-electric travel distance for the Volt is in the range of 70 km to 80 km, while during cold weather, the effective all-electric travel distance is in the range of 20 km to 30 km. More detailed evaluation of all-electric range will be included in later years.

Maintenance

What maintenance is required for this vehicle?

It is normally expected that electric vehicles require less maintenance than conventional internal combustion engine (ICE) vehicles. However, the case of the Volt is more complex because it combines both. During the first year, no maintenance was required for the Volt, including the ICE, i.e., oil changes. The vehicle includes extensive self-monitoring, and no requirement for engine maintenance was indicated by on-board systems.

Comparative Current Operating Costs

Vehicle	Fuel Consumption per 100 km	Operating Cost per 100 km	Annual Operating Cost
Volt	25 kWh + 1.4 Litre	$3.40	$550
Conventional average car	15 Litre	$18.00	$2,880
Conventional efficient car	8 Litre	$9.60	$1,540
Assumptions: liquid fuel price of $1.20 per Litre; electricity price of 7¢ per kWh; and annual travel of 16,000 km			

What battery degradation would be expected, both seasonal and long-term?

Over the first year of operation, there was no apparent degradation of the main battery on the Volt. Battery performance, including seasonal based impacts, will continue to be evaluated over future years.

How long will the batteries last, and will replacement be required?

The practical longevity of batteries is a key aspect for electric vehicle operation that still remains uncertain. Insufficient long-term experience exists yet to be able to predict battery life. This uncertainty has been reflected in the economic evaluation (next section) by including differences in the assumed resale value of an electric versus conventional vehicle. General Motors, like other vehicle manufacturers, offers an eight-year warranty on the Volt's batteries.

Economics

What does it cost to purchase an electric vehicle?

When initially available in 2012 within Manitoba, the purchase price for the Volt was relatively high, around $42,000. Since then, by mid-2013, the list purchase price was reduced by approximately $5,000, and is currently around $37,000. Such a price reduction reflects a general trend, primarily associated with decreasing battery costs and increasing battery performance.

What does it cost to operate an electric vehicle?

The use of electricity as the primary "fuel" for the Volt results in a significantly lower operating cost compared to a conventional vehicle. Representative operating costs are presented in the table above, comparing the Volt to both a conventional average vehicle and a conventional efficient vehicle. Values are presented both in term of "per 100 km" basis and "annual" basis, the latter assuming 16,000 km travel per year, which corresponds to that for an average Manitoba vehicle. The availability of the back-up engine generator means that the Volt can fully match such travel requirements.

Electricity consumption of 25 kWh per 100 km was estimated as an annual average based on actual experience so far. The Volt also does still require some liquid fuel, particularly during winter and for longer trips, with an overall average value of 1.4 Litre per 100 km, again based on experience so far. The current cost of electricity is about 7¢ per kWh, versus about $1.20 per Litre for liquid fuel. Based on

Economic Feasibility Assessment Assumptions	
Chevrolet Volt	**Conventional Cars**
Higher purchase price $42,000 Reduced purchase price $37,000	Average car purchase price: $26,000 Efficient car purchase price: $22,000
Annual maintenance cost $200	Annual maintenance cost $400
Electricity use: 25 kWh/100 km Liquid fuel: 1.4 Litre/100 km	Average car fuel use: 15 Litre/100 km Efficient car fuel use: 8 Litre/100km
Longer-term electricity price: 10¢/kWh	Longer term liquid fuel price: $1.60/Litre
Resale value after eight years: Volt: $4,000 (Matches average conventiional vehicle to be conser-vative)	Resale value after eight years: Average car: $4,000 Efficient car: $3,500
Assumed vehicle life of 8 years, annual travel of 16,000 km per year, and 6% cost of money.	

assumptions, as presented, the operating cost for the Volt is less than 1/5th that of a conventional average vehicle, and about 1/3rd that of a conventional efficient vehicle. This cost advantage makes a compelling case for electric vehicles within Manitoba.

What is the payback compared to a conventional vehicle?

The overall economic feasibility of the Volt was considered based on a series of assumptions. These are summarized in the table above, with results outlined in the table below for four comparative cases. These are presented in terms of the present value (PV) of total vehicle costs (i.e., capital and operating) over an eight-year period, based on annual travel of 16,000 km per year. The Volt could be expected to operate for a longer period, but eight years was selected for analysis, given it corresponds to the typical battery warranty period, including that provided by General Motors.

There is also still uncertainty as to the life and costs of batteries for electric vehicles. As such, for this analysis the assumed resale value of the Volt is no more than that for a conventional average vehicle, even though the Volt has a higher purchase price. This is a highly conservative assumption. Fuel consumption for the Volt is as described in the last section, and translates on an annual basis to 4,000 kWh of grid-base electricity combined with approximately 220 Litres of liquid fuel. Greenhouse gas (GHG) emissions are directly and primarily related to liquid fuel consumption. This means the Volt, using only a small amount of fuel for back-up purposes, achieves roughly a 90% reduction in emissions compared to a conventional average vehicle, and even an 80% reduction compared to a conventional efficient vehicle.

The results for PV cost in the table below show that the Volt, irrespective of purchase price (i.e. whether higher or reduced), has a lower PV cost over eight years than a conventional average vehicle within Manitoba. For the case involving the more recent, reduced purchase price, the Volt has a significantly lower PV cost (i.e., more than $9,000 lower). This can be considered in terms of a simple payback comparing the annual operating savings versus the incremental higher purchase price for the Volt, which works out to within 3 years to 5 years. However, at the same time, even the Volt with reduced purchase price still has a higher overall PV cost than a conventional efficient vehicle (i.e., roughly $6,000 higher).

Continuing this analysis further to provide better insights, it was determined that economic feasibility for the Volt depends mostly on the fuel consumption of the vehicle it is replacing. Using an average conventional car price of $26,000, as long as fuel consumption for the car in question is 12 Litres per 100 km or greater under Manitoba conditions, the Volt will be more economical overall based on eight years of use. It is obvious that either further reductions in the purchase price of the Volt or increases in the pump-price of liquid fuel improve the economic attractiveness of the Volt. Less obvious, but equally important is clarifying the life and costs of batteries for this and other electric vehicles. As such,

Present Value Total Vehicle Cost Results, based on Assumptions	
Vehicle Case	**Present Value Cost**
Conventional average vehicle	$54,840
Volt - higher purchase price	$50,460
Volt - reduced purchase price	$45,460
Conventional efficient vehicle	$39,400

3 Refer to internet site: http://oee.nrcan.gc.ca/transportation/tools/fuelratings/fuel-consumption-guide-2012.pdf

the Volt shows significant promise to be an economically attractive vehicle for many consumers, and is worth considering for purchase. At the same time it is obviously not necessarily suitable for everyone.

Overall Suitability

What are the most suitable users for this type of vehicle?

The Volt is an all-round vehicle that offers complete flexibility to be used in virtually all uses. It is equally at home in urban areas or on the highway, and is capable of undertaking a large number of short commuter trips, as well as longer-distance trips. That said, given its obvious economic advantages when operated electrically, the Volt is best suited where it can operate entirely or primarily using electricity, which means a primary focus on commuting in urban environments.

The Volt can easily accommodate average Manitoba travel of 16,000 km, but it is best if most of that, i.e., desirably 12,000+ km, involves commuting. One example would be a commuter living in a suburban area near to the Perimeter travelling roughly 250 km per week, with additional long-distance travel of 3,500 km on weekends or holidays.

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Electric Vehicle Technology & Education Centre (EVTEC): EVTEC at Red River College is responsible for applied research and innovation projects concerning ground transportation electric and hybrid vehicles that utilize renewable fuels. EVTEC has a mission to: support electric vehicle (EV) innovation amongst Manitoba's transportation sector; enhance electric vehicle education at the College and in the region; and increase public awareness and understanding of electric vehicle technology.