

Preliminary Economic Evaluation Electric Vehicles in Manitoba



Electric Vehicle Technology and Education Centre (EVTEC), Red River College, in collaboration with the Centre for Emerging Renewable Energy Inc.

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Summary

An evaluation of the economics of a generic electric vehicle relative to a conventional vehicle was undertaken, using reasonable assumptions based on experience to date with various electric vehicles in Manitoba. An electric vehicle was found to have a lower overall cost (i.e., purchase and operating) than a conventional vehicle within 9 to 10 years of operation. As such, an electric vehicle eventually will be more economical in Manitoba than a conventional vehicle, but the payback period may be too long yet to be realistic for many consumers. These relative economics are most sensitive to changes in the purchase price of the electric vehicle, followed by changes in the price of gasoline. One additional finding is that the economics of an electric vehicle are not sensitive to changes in the price of electricity.



Introduction

It is well known that when people buy a motor vehicle of any kind, their purchase decision is partly based on economics. The same is also true if considering an electric vehicle, even if the technology involved might be quite different. Electric vehicles are defined as obtaining at least some or all of their energy for motive operation from the electrical grid. These include battery electric vehicles (BEV), such as the Nissan LEAF or Mitsubishi iMiEV, that are all-electric, and plug-in hybrid electric vehicles (PHEV), such as the Chevrolet Volt or Toyota Plug-In Prius, that can use a combination of grid-based electricity or conventional fuels.

It is important to understand realistically how economical electric vehicles are relative to comparable conventional vehicles. The purpose of this short report is to help demystify electric vehicles and help consumers make more informed choices. Many different manufacturers now offer electric vehicles for sale. As such, this evaluation reflects a “generic” or average electric vehicle, rather than any specific manufacturer’s model.

Cost Assumptions

Vehicle Prices

- Electric vehicles currently are more expensive than conventional vehicles, this due primarily to the cost of batteries, but also because of the still relatively small numbers that are manufactured.
- Electric vehicle purchase price assumed as \$42,000.00.
- Conventional vehicle purchase price assumed as \$26,000.00, which is the approximate average price paid for a passenger car in Manitoba, according to Statistics Canada.
- Price difference is \$16,000.00, with the current range of price differences between electric vehicles and comparable conventional vehicles ranging from about \$14,000.00 to \$18,000.00.
- No taxes or incentives are included. Similarly, no value associated with resale is considered for either the electric or conventional vehicle.

Recharging Station Cost

- Electric vehicles so far within Manitoba have been able to rely on Level 1 charging. This involves a conventional 110 Volt, 15 Amp plug-in circuit, which is readily available throughout Manitoba.
- Although not absolutely necessary, installation of a Level 2 charging system is assumed, with approximate total cost of \$2,000.00. This involves a 220 Volt, 20 to 30 Amp circuit, similar to an electric clothes dryer, and requires roughly half the time to fully charge the vehicle compared to a Level 1 system.

Annual Travel Distance

- Both the conventional vehicle and the electric vehicle are assumed to travel 16,000 km annually. This represents on a long-term basis, the average annual travel distance for light duty vehicles within Manitoba, according to Statistics Canada’s Canadian Vehicle Survey.

Gasoline Price and Vehicle Energy Consumption

- Gasoline consumption of 12.5 Litres per 100 km is assumed for the conventional vehicle. Manitobans have relatively high fuel consumption compared to the rest of the country, being an average of 15 Litres per 100 km. This is due in part to colder temperatures, but also due to a preference to somewhat larger vehicles.
- The average price of gasoline into the near- to medium-term future is assumed as \$1.35 per Litre. The expected range of gasoline prices is from roughly \$1.00 to \$1.70 per Litre.

Electricity Price and Vehicle Energy Consumption

- One key advantage of electric vehicles is their much lower energy operating cost than conventional vehicles. Manitoba's low-cost electricity means that electrical operating costs are reduced here.
- Electrical recharging is assumed to be undertaken primarily at home, which is the case for electric vehicles here today, with an average price into the near- to medium-term future assumed to be 9 ¢ per kWh. The ratio of gasoline price per Litre (above), to electricity price per kWh is thus 15 to 1.
- Electricity consumption of 25 kWh per 100 km is assumed for the electric vehicle over the course of a yearly cycle. This is higher than suggested for some electric vehicles, but is based on experience to date, reflecting higher consumption through the winter for vehicle heating.

Additional Vehicle Maintenance Costs

- Both conventional vehicles and electric vehicles require periodic servicing, and this is an area of potential advantage for the electric vehicle.
- Conventional vehicle servicing is tied primarily to oil changes, and is assumed to be approximately \$400.00 per year.
- Electric vehicle servicing is tied primarily to battery diagnostic checking, and is assumed to be approximately \$100.00 per year.
- Although effective battery life is unknown at this time, no battery replacement costs are assumed in this analysis. There is little experience yet with lithium ion batteries over long periods of time. The longest operating vehicles within Manitoba having lithium ion batteries are roughly four to five years old, but continue to operate. These vehicles were part of the Manitoba PHEV demonstration.
- Batteries in hybrid electric vehicles, like the Toyota Prius, have been in operation for more than a decade, although these are not lithium ion.

Cost of Money

- The value of money changes with time, and there is always a cost for money. This is obvious in the case of loans from a lending institution, but is also the case when a person uses their own money, i.e., people have choices when they decide what to spend their own money on.
- The cost of money is assumed uniformly to be 6% annually.
- The Present Value Interest Factor Annuity or PVIFA (see explanation at end) is calculated

using the assumed cost of money and the number of periods (i.e., years) assumed. The PVIFA multiplied by the annual operating costs represents today's value of all future operating expenses for the respective vehicle.

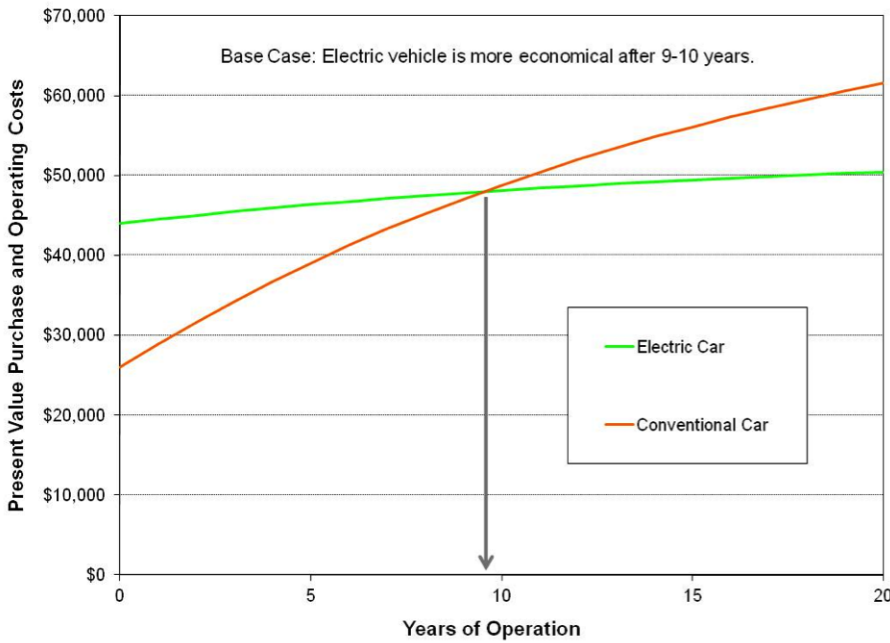
Time Frame

- The comparative costs of an electric vehicle versus a conventional vehicle depend on the number of years that the vehicle is operated by the owner.
- For the purpose of comparison to show how relative costs change, the vehicle is assumed to be operated for a minimum of 0 years up to a maximum of 20 years.
- Realistically a vehicle would be typically operated somewhere between about 5 to 15 years.

Results

The present values of cost (i.e., purchase and operating) for an electric vehicle versus a conventional vehicle are summarized here. If the number of years of operation is zero, which is not realistic, only the purchase costs are considered. As the number of years of operation increases, the total present value of cost for each of vehicles continues to increase, reflecting operating costs. The two curves are not straight because of the time value of money.

As seen in the figure at the top of page 4, the present value cost for the electric vehicle becomes lower than the conventional car sometime between 9 and 10 years. As such, within Manitoba an electric vehicle could be expected to eventually pay off, and be more economical, if ownership is maintained to that point. The long retention time required, however, may be undesirable or unrealistic for many consumers.



50%. This is illustrated in the first sensitivity plot on page 4 (Case 1). If, as illustrated in the second sensitivity plot on page 4 (Case 2), the electric vehicle purchase price is reduced by 60%, then it is more economical within less than one year of operation. Clearly, change in purchase price is the most sensitive factor for the economics of the electric vehicle. The purchase price of electric vehicles is anticipated to continue dropping into the future as battery technology improves.

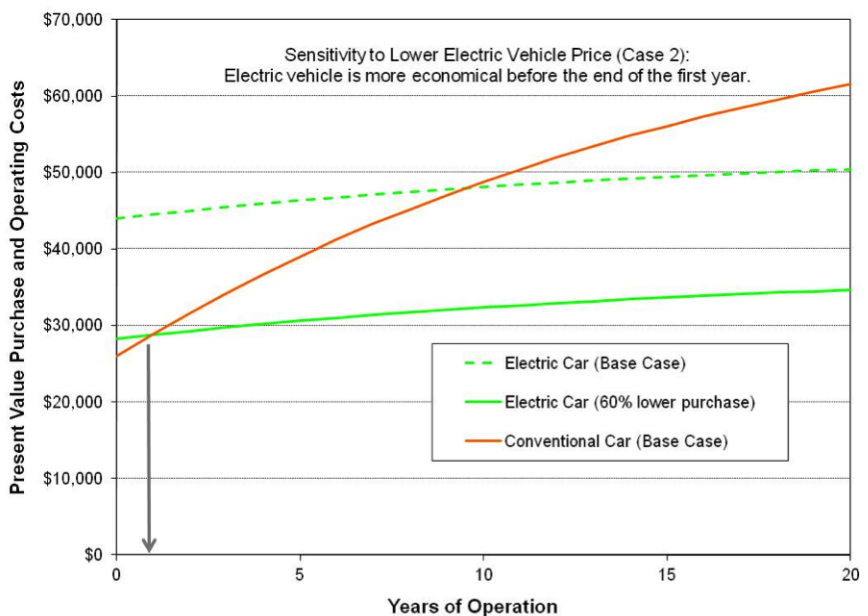
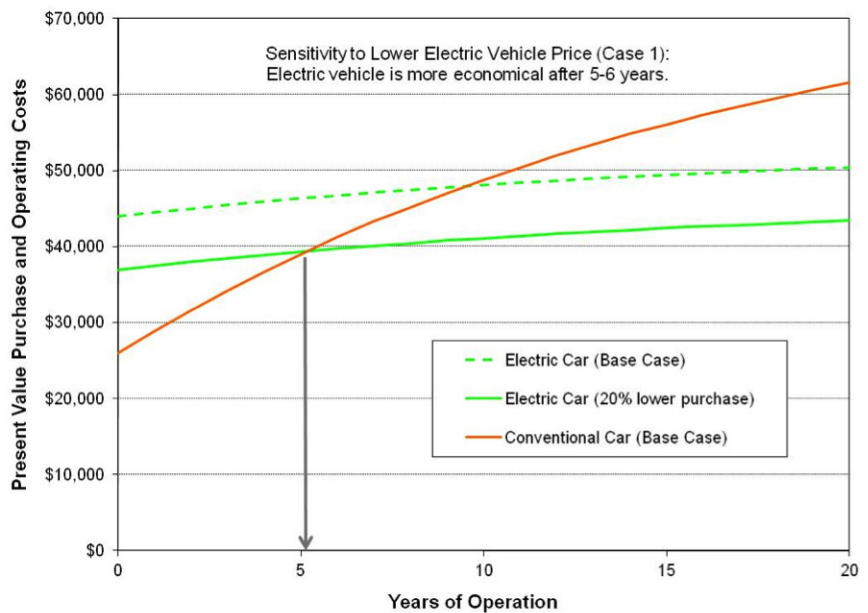
The curve, as presented, also illustrates a common misperception about conventional vehicles. People will often purchase a vehicle based primarily on the purchase cost, but without considering operating cost. For the conventional car, the initial purchase cost is relatively low, but operating cost per year is quite high. By around 11 years of use, the overall cost of the conventional car is more than double the initial purchase.

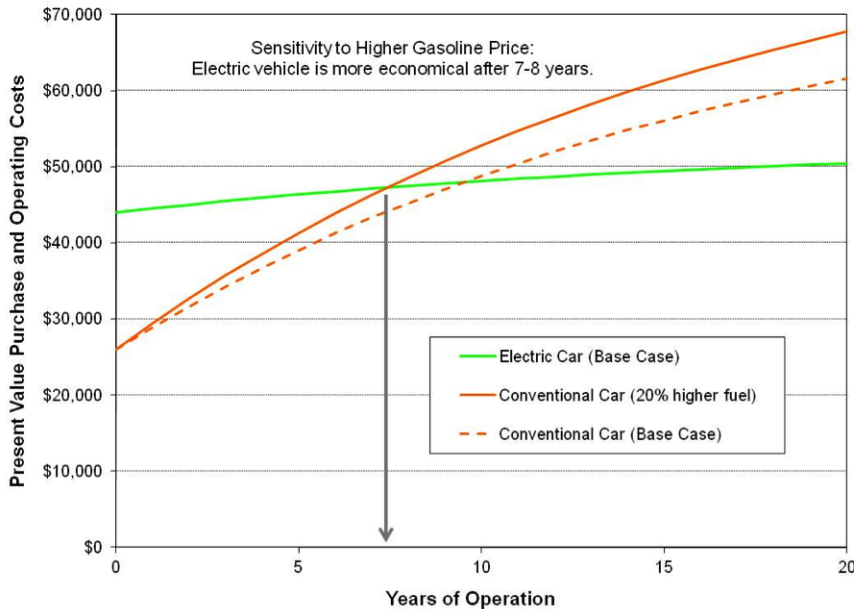
Sensitivity

Although an electric vehicle is likely to be economic within Manitoba over a longer period, it is also important to understand the sensitivity to price changes that may occur into the future. Changes in three main variables have been evaluated: (i) purchase price of the electric vehicle; (ii) price of gasoline; and (iii) price of electricity.

Electric vehicle purchase price

If the purchase price of the electric vehicle is reduced by 20%, i.e., from \$42,000 to \$35,000, the overall cost of the electric vehicle becomes lower than the conventional vehicle within 4 to 5 years, a reduction in the payback time of 5 years, or roughly





Price of gasoline

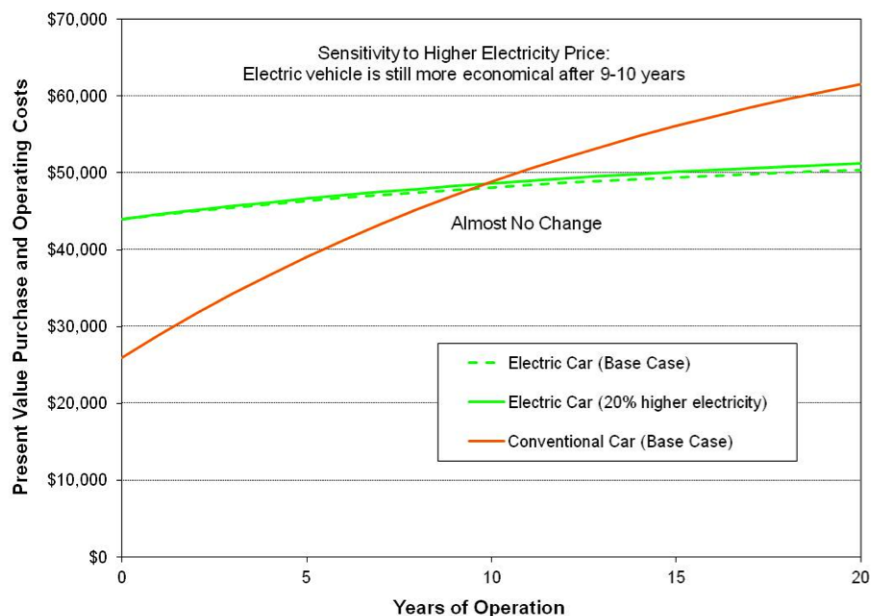
If the price of gasoline is increased by 20%, i.e., from \$1.35 to \$1.60 per Litre, the overall cost of the electric vehicle becomes lower than the conventional vehicle within 7 to 8 years, a reduction in payback time of 2 years, or roughly 20%. This is illustrated in the third sensitivity plot on page 5. The price of gasoline is the second most sensitive factor for the economics of the electric vehicle. Gasoline pricing continues to be highly volatile and difficult to predict, but prices generally continue to rise over time.

Price of electricity

If the price of electricity is increased by 20%, i.e., from 9¢ to 11¢ per kWh, there is almost no impact. The overall cost of the electric vehicle still becomes lower than the conventional vehicle within 9 to 10 years. This finding is illustrated in the fourth sensitivity plot on page 5, and seems counter-intuitive. Unlike conventional vehicles, the price of fuel for an electric vehicle (i.e., electricity) has relatively little effect on economics.

Follow-up and Additional Information

The economic evaluation undertaken was based on reasonable assumptions that reflect the situation in Manitoba as of the end of 2012. At the same time, the status and performance of the technologies involved, the prices of electric and conventional vehicles, the prices of energy inputs, and other costs all will change into the future. Further updates of this economic evaluation will be undertaken at reasonably regular intervals to reflect any significant changes.



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Additional information

Additional information about electric vehicles within Manitoba is available through the Government of Manitoba, and the EVTEC at Red River College, at the following Internet sites:

<http://www.manitoba.ca/iem/energy/transportation/index.html>

<http://www.rrc.mb.ca/index.php?pid=8312>

Present Value Interest Factor Annuity (PVIFA)

The PVIFA is used extensively in finance. Values for this parameter are calculated using the cost of money (r), which is expressed as a percentage rate, and the number of periods (n), in this case the number of years of operation. The PVIFA can be somewhat complicated to calculate, but values are readily available via the Internet. The calculation formula is as follows:

$$PVIFA = \frac{1 - (1 + r)^{-n}}{r}$$

Once calculated for appropriate conditions, the PVIFA value is very simple to use. The PVIFA multiplied by the annual operating cost for a typical year gives the value today (i.e., present value) of all future operating expenses for the number of years selected.