Electric Mobility Canada / Mobilité électrique Canada

Electric Vehicles and the Grid

Can we produce enough electricity for all those electric cars?

Yes, and with far less impact than many people think.

"At GM, we believe that electrically driven vehicles are the best long-term solution we have for addressing society's energy and environmental concerns"

– Rick Wagoner, CEO of General Motors, May 2008.

Full electric vehicles (EV) and plug-in hybrid vehicles are available today that can meet the needs of most commuters, especially those in urban areas. Studies show that the average vehicle commute in Canada is 8 kilometres (km) one way[1]. Allowing for occasional errands, there is a sizable market segment for an EV that will travel an average of approximately 20 km per day. While their available range of the EV will be greater than 20 km, it is the actual distance travelled that will determine the amount of electricity that will be consumed.

To determine the amount of electricity needed for widespread adoption of electric vehicles we'll assume that the average EV will travel 5 km/kilowatt-hour (kWh). (This figure is obtained today by hobbyists converting small gasoline cars to electric power; presumably manufacturers will do at least as well.). This results in a daily power consumption of 4 kWh to travel 20 km. Charging of this magnitude can be easily done over the off-peak period. It is likely that the smallest chargers that will be used by EVs are 1 kW chargers, thus in the above charging scenario the increase in off-peak demand will be 1 kW.

Consumers are interested in electric and plug-in hybrid electric vehicles, but their adoption will be limited until manufacturers introduce and increase their production capacity for new models based on electric drive technology. For example, Toyota sold just over 11,000 Prius hybrids in the first eight years they were offered in Canada – an average of less than 1,400 per year. Let us be optimistic and assume EVs and PHEVs are adopted at more than 10 times the rate of the Prius, at 15,000 units per year. If we multiply the 1000 watts consumption per vehicle by 15,000 vehicles, if all EVs were charging at the same time then neglecting time zone difference, the maximum total increase in electrical power demand is 15 MW per day during the off-peak period.

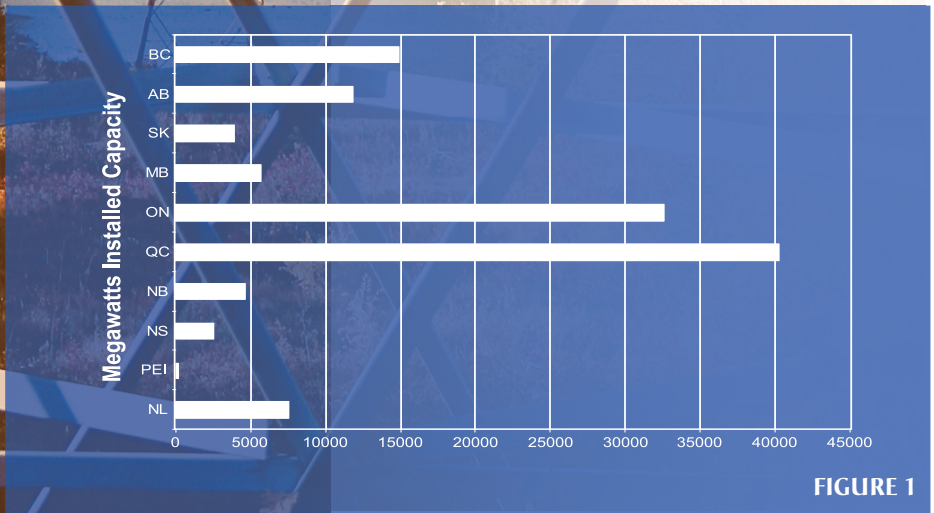

FIGURE 1

Electricity available

Now that we have a sense of how much electricity a fleet of EVs is likely to consume, we need to examine how much electricity is actually available.

In Canada, there is no federal authority regarding the production of electricity; it is a provincial jurisdiction. Therefore, answering the question regarding generating capacity can only be answered by aggregating the figures from the provinces. Figure 1 shows the installed capacity by province.[2] The total for Canada is 123,793 megawatts (MW).

Having viewed daily load profiles for several North American jurisdictions, it is normal to see a peak demand around the dinner hour, a lesser peak around the breakfast period, and a significant trough in demand at night which is around 60 to 80% of the peak demand. As utilities size their supply capacity to be larger than the peak demand (a 20% reserve is typical), and the daily peak demand is lower than the generation capacity, and there is a considerable difference between the peak and off-peak demands, this gap is available to charge a sizable number of EVs without any need for additional generating capacity.

This curve for Ontario is representative.[3] Ontario represents about 25% of the total electrical demand for Canada. Ontario actually has over 32,000 MW of installed capacity. Ontario can supply over 27 MW of domestic load (as it did in 2006). The Ontario IESO states: "Demand in the middle of the night can be as low as 12,000 – 13,000 MW and can rise by as much as 10,000 MW later the same day." [4]

Canada's peak load in 2006 was about 100 GW, with a maximum possible generation of 110GW. Canada's minimum load in 2006 was about 80 GW, leaves a margin of about 20 GW for EV charging

While Ontario has had specific electrical supply issues on the hottest of summer afternoons in some recent years, it is expected that most electric cars will be charged overnight because this is when they are parked for the longest period each day, and because this is when electricity will be cheapest under time-of-use pricing plans. Even if we only consider the 10,000 MW fluctuation between peak and off-peak daily demand, at 1 kW charging per vehicle during the off-peak period, Ontario alone could accommodate 10,000,000 EVs recharging overnight with no additional generating capacity required. That's roughly 1.5 times the total number of vehicles licensed for on-road use in Ontario today.

If 15 MW are needed each day to recharge 15,000 EV's during the off-peak period, that's less than 0.1% of the current idle off-peak capacity of 20,000 MW estimated to be available nationally, and considerably less than 0.01% of the total installed Canadian generating capacity of 123,793 MW in 2006. Even assuming that growth in EV use will accelerate over a period of years, the necessary amount of electricity can also be supplied incrementally. This adoption period gives us the opportunity to implement clean, sustainable generation sources, such as those supported by the Ontario Green Energy Act.

Displacing gasoline use will also reduce electrical demand somewhat through direct or convoluted pathways. Oil refining alone uses 0.5% of all electricity consumed in Canada.[5] That does not include the electricity used to move oil and gasoline through pipelines, or into tanker trucks, or pump it into vehicle fuel tanks. During hot weather in urban areas, removal of a significant number of heat-producing internal combustion engines will help reduce the heat island effect, reducing demand for electricity to power air conditioning. These reductions in electrical demand can be used to partially offset the power used to recharge the EVs.

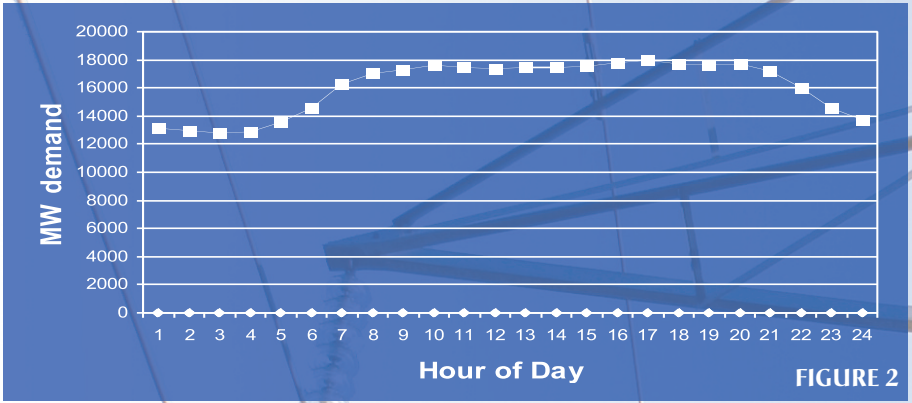

FIGURE 2

The mix of actual electric vehicles used may also reduce the anticipated electrical demand for EVs. The fastest growing segment of electric vehicles today, worldwide, is the electric-assist bicycle, which can travel over 100 km/kWh. Other fast-growing vehicle segments are the electric motorcycle/scooter and the Low Speed electric Vehicle (LSV), which also consume less electricity per km than full-size, highway-capable electric cars and trucks. While each electric car could increase electrical demand by 1000 watts during off-peak periods, an electric bicycle would require only 35 watts or less to refuel for the same distance over the same period. That is about 2kWh, or the same amount of energy as used by a vacuum cleaner in 10 minutes, or using a 100-watt light for 2 hours.

This analysis shows that the current grid capacity is not an obstacle to even an optimistic introduction of EVs in Canada. It is likely that most charging will occur overnight, and that most EVs will be used for short, urban trips. Thanks to the potential for use of small, efficient EVs, off-setting reductions in electrical demand related to fossil fuels, existing surplus capacity at off-peak periods, and the incremental increase of the use of EVs over time, the increase in electrical demand can be managed easily within current electrical utility planning frameworks. **Considering the benefits of reduced air, water, noise and thermal pollution and reduced greenhouse gas emissions, accommodating the modest increase in electrical demand is a challenge we should welcome.**

(The greenhouse gas emissions benefits of using more electric cars are addressed in the EMC backgrounder, *Electric Vehicles - Part of Canada's Climate Change Solution*.)

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

Our Mission
o establish electric mobility, in all its forms, as the primary solution to Canada's growing transportation energy issues and to assist its members in the fulfillment of their mandates.

Our Vision
A Canadian society that accepts electric mobility, in all its forms, as the first choice for the transport of persons and goods. This is being achieved through collaboration efforts between government al all levels and the private sector supported by an informed public faced with increasing energy costs and concerned about the impacts of burning fossil fuels on the environment and quality of life.

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Footnotes:
1. www12.statcan.ca/english/census06/analysis/pow/19_oshawa.cfm
2. www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/lctrcty/clfrdpwrgnrtn2008/clfrdpwrgnrtn-eng.html#a1
3. Figures for the load profile chart come from the Web site of the Independent Electricity System Operator for Ontario for a day picked at random from their 2008 data.
4. www.theimo.com/imoweb/media/md_demand.asp (accessed 2009.02.16)
5. www.tdds.ca/default.asp?lang=En&n=CB51D3B8-1&offset=4&toc=show