

Direct Economic Benefits of Electric Vehicles to the Province of Ontario

Introduction

Numerous sources extol the benefits of Electric Vehicles (EV's) to their owners and society. For example, www.drawdown.org estimates significant operating cost savings for owners, albeit with higher purchase cost. Others, for example, www.bbc.com/news/uk-41011008 (1) conclude that the grid can handle the additional load, with some reinforcement at the distribution level. But I have yet to find any that connect the dots between higher utilization of generation and transmission (the grid) and economic benefits to shareholders (in the US) or Hydro ratepayers in Canada (where Hydro is mostly publicly owned, not for profit). The only mention of this I have seen was brief, in a sidebar in the Environment Commissioner of Ontario's 2018 Greenhouse Gas Progress (ECO Report) (2). In this paper, I have elaborated the points in that sidebar to roughly quantify the direct economic benefits of EV's to the Province of Ontario.

EV's provide *indirect*, hard to quantify economic benefits from reduction of health and climate change impacts. The climate change impact is of special concern in Ontario. Transportation represented 35% of our greenhouse gas emissions in 2016 as compared with just 30% from Industry (2, Table 1.1).

Currently, Industry appears to be the only, or at least the main, sector addressed by Ontario's climate change plan. That is in the proposed Emission Performance Standards (3) that aim for only a possible (not a sure) marginal reduction in only the non-process emissions, which are about half of industrial emissions (i.e. an uncertain, marginal impact on a fraction of a fraction of the problem). Clearly, Transportation must also be addressed to meet our reduction target of 30% by 2030. Policies to hasten adoption of EV's would serve that purpose. After shutting down coal-fired power stations, this is (in my opinion) now the lowest hanging fruit of significance relative to the emission reduction goals.

The reasons I say it is the lowest hanging fruit are: (1) electricity is a lower cost fuel for mobility than gasoline or diesel, whereas it costs more than natural gas for building heating, which is, therefore, going to be harder to decarbonize and (2) there are quantifiable and significant *direct* economic benefits, as described in this paper, which would also serve the government's promise to protect jobs and make life easier for ordinary, hard-working tax-payers. The Progressive (?) Conservative government of Ontario could enact policies to promote EV's that would be OK with its tribe of closet deniers and couldn't-care-lessers because they would ostensibly be for economic reasons. The federal Liberal government, in trouble because of carbon pricing, could point to how carbon pricing supports EV's and develop some complementary EV friendly policies to answer the critics that it is obsessed with carbon pricing and can't think of anything else to do.

Summary

The following are some high-level numbers that I either calculated myself, rather quickly, more or less on the back of an envelope, or took from specific references, but I believe they illustrate fairly the significant potential:

- Savings estimated over 10 billion \$ (+) per year from reduced imports of petroleum products
- Savings to individual motorists of \$700 to \$2,200/year in fuel, plus reduced maintenance
- Potential cut in Hydro Rates of up to about a third (seems incredible, but see work-up below under *How much would EV's save Ratepayers?*)

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➤ Net Impacts of EV Manufacturing, by 2025

- Total income increases by over \$2 billion/year
- Over 19,000 additional person years of employment
- \$241 million additional tax revenue for provincial government

Policies to boost EV sales to complement the Federal carbon pricing could include all of the following: quotas (essentially) for auto-makers (similar to the CAFE standards), government procurement, feebates (rebates for EV purchases paid for by fees on non-EV purchases), facilitating/ requiring more rapid installation of charging stations (suggested through local Hydro utilities, as a related business) and zero emission zones.

The ECO Report

The ECO Report contained this side-bar, on page 158.

Economic opportunities

An Ontario zero-emission vehicle standard could support clean energy jobs. More zero emission vehicles could:

- use made-in-Ontario electricity, either directly (in batteries) or indirectly (as hydrogen)
- reduce costs in Ontario's electricity grid by providing a market for surplus electricity generated overnight, and
- increase opportunities for Ontario's cleantech industry, including hydrogen technology companies.

A zero-emission vehicle standard in Ontario could increase the value for automakers of manufacturing these vehicles in Ontario. Numerous electric vehicle companies have begun production in California, where demand is high. China's New Energy Vehicle policy is similar to California's Zero Emission Vehicle standard. In June 2018, Aurora, Ontario based Magna International announced plans to build consumer electric vehicles - not here - but in China, where electric car sales are booming. As the president of DesRosiers Automotive Consultants describes the situation, "being in a market that accepts them is a critical element to manufacturing." Eleven other North American jurisdictions with a combined market of over 100 million people already have a zero emission vehicle standard.

The following quantifies the points made in that side-bar.

Keeping Energy dollars in the Province

The first bullet refers to the benefit to the local economy of recycling energy dollars within the Province ending the current hemorrhage of a huge flow of money out of Province to pay for imports of petroleum products.

According to Statistics Canada, Ontario uses 22 billion litres of petroleum products annually for road motor vehicles (4). A first order estimate of the non-tax value approximates \$1/litre. None of this is extracted or upgraded in Ontario. About three-quarters is refined in Ontario. Therefore, a guesstimate of the resulting drain of cash from the Province would be well above \$10 billion/year.

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Increased market penetration of EV's would avoid corresponding portions of this money leaving the Province, increasing the circulation of money within the Province, which would make us all richer. More immediately, savings would go partly to local motorists (including commercial carriers), from a lower energy cost, with the balance being additional revenue to local Hydro companies (which means ultimately to rate-payers in our cost-based Hydro systems, perhaps with some profits going to the owners - the municipalities, to the benefit of tax-payers).

Lower Costs for Vehicle Owners

How much money any particular motorist would save will depend on which particular EV model they drive, what would have been their alternative, how much they drive and when and where they charge. As an illustration, a Toronto Hydro website (Electric Vehicles, Toronto Hydro Corporation) quotes Ontario Ministry of Transportation estimates of \$300 per year for charging at night versus a comparable of \$1000 - \$2,500 per year to fuel gas vehicles. As it says, that's a saving of 8 times less spent each day. This truly represents significant savings for hard-working tax-payers.

Reducing Hydro Rates

That brings us to the second bullet; about Hydro Rates. A useful feature of electricity used for road transportation is that it is used via batteries (not rail, to-date, although there is potential even there). With proper management, these would not be charged during periods that would increase the peak load on the system.

[Technical note: the peak is defined as the highest load on the system, which occurs at just one instant of time each year. There are hours in the year when load is sufficiently close to the peak to limit additional load without increasing the peak, possibly leading to more investment in generation and/or transmission. Nevertheless, in any business day, whatever the season, the load in many hours is nowhere close to the peak (5). At weekends and holidays, the load is nowhere close to the peak. Therefore, with proper management, all or most of the charging of batteries should not increase the peak and not increase costs. This is because the cost of Hydro is mostly fixed, with little variable costs, especially in the provinces of Ontario, Quebec, Manitoba, British Columbia and Newfoundland. The same will gradually become true everywhere as fossil fuels are phased out for power generation.

This is notwithstanding yet to be fully resolved secondary technical issues about the voltages of chargers and the voltages that can be used by particular models of EV's, which affects the charge time and influences optimal location of chargers and whether users can be influenced to not charge at peak by pricing or whether smart controls, including staging (e.g. where there are multiple chargers connected to the same distribution feeder), will be needed (6).

We can expect these secondary, technical issues to be ironed out in the not too distant future with the result that electricity used for transportation will be almost entirely not on-peak and therefore will not add materially to the total cost of Hydro.]

An increase in sales volume, with little increase in cost, will result in a lower unit cost, which should lower Hydro Rates (or relieve pressure on them, i.e. if they still increase, it will be by less). The large increases in Hydro Rates of recent years in Ontario have been due primarily to capital spent with a decrease in sales: 2005 sales = 157 Terawatt-hours (TWh), 2018 sales = 137 TWh (5).

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How much would EV's save Ratepayers?

It is interesting (and surprisingly easy) to estimate, at a high level, how much Hydro Rates could be moderated by these increased off-peak sales. First, it's quite easy to estimate, at a high level, how much electricity would be consumed if all road transport in Ontario ran on electricity. According to NRCAN (6), 720 Peta-Joules (PJ) of energy was used in Ontario in 2015 for road passenger and freight transportation. One PJ = 1/3.6 TWh, so 720 PJ = 200 TWh.

According to the US Department of Energy's Office of Energy Efficiency, the median efficiency of internal combustion vehicles (ICV's) is 19% versus 61% for EV's (allowing for charging and discharging and, in some cases, converting from AC to DC and back) (7). Adjusting for the efficiency of ICV's being only 31% (19/61) of EV's, the electricity required for EV's would be 31% of 200 TWh, or 63 TWh. In perspective, this is only 29% of the total energy the existing Ontario Grid could produce after the Pickering shutdown in 2023 (my estimate 216 TWh, assuming all units running at typical capacity factors for each technology). That's an interesting result in itself - the existing Grid has plenty of spare power to electrify all the road vehicles in the Province.

The actual consumption in 2018 was 137 TWh, which represents a utilization of just 63%, based on the post-Pickering capacity, which is typical for grids like Ontario's, due to daily and seasonal load variation. The additional 63 TWh of additional sales would take the utilization to 92%. Some utility types might view this utilization as high, just in relation to what they have been used to. But it would take many years to reach 100% market penetration of EV's. In the meantime, Grid capacity is likely to be expanded in response to other load growth (which impacts the peak) and also become smarter and more efficient, thus providing more off-peak capacity.

These numbers allow a first order estimate of the impact on Hydro Rates. If the Grid sold an additional 63 TWh, that would create a new total of 200 TWh (using the 2018 sales of 137 TWh as a base). The unit cost per TWh would be the total cost (which is largely fixed) divided then by 200 TWh instead of 137 TWh as at present, which would be 31% less (=1 - 137/200). (The cost per kilowatt-hour (kWh) is the cost per TWh divided by a billion.)

More discussion re Hydro Rates

There may be a difference between the overall average price and the average price paid for charging. On one hand, it might be less if mostly off-peak, so the % savings would be less. On the other hand, it should be possible to have increased prices for charging vehicle batteries because it is so competitive with liquid fuel, (i.e. market based rates, rather than cost-based).

The above analysis ignores any incremental costs that may be needed for distribution upgrades, "the last-mile problem" (6) and the charging stations themselves. However, these would most appropriately be included in special rates for charging batteries, not applied to the rate base for general customers.

The above analysis gives no credit for all these batteries making the grid more robust if battery to grid technology is deployed, as is likely, (6) which would reduce the need to add more generation and transmission, thereby further helping to keep Hydro rates from rising.

It is a very rough estimate, but spectacularly more than any reduction achieved by any government initiative in the past, or envisioned, and specifically more than the 12% reduction that was one of the present government's election promises. Of course, the 31% saving estimated is for 100% penetration,

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which may seem like an impossible dream at present, but, logically, to achieve Canada's goal of zero emissions by 2050, it must go to 100% or near 100% (recognizing that the only other zero emission vehicle technologies we know use hydrogen, which is essentially bottled electricity, or methanol made from hydrogen and recycled carbon dioxide).

By simple arithmetic, it can be derived from the above that the government's 12% Hydro rate reduction promise could thus be met with 38% EV's, which is not that far above the 2040 global fleet forecast by Bloomberg New Energy Finance of 33% (9). Why couldn't Ontario be ahead of the global average? The UK certainly has that intention. In July, its government announced that all sales of new petrol and diesel cars in the UK would cease by 2040 (1). Norway has more than intent. Nearly 60% of drivers who went shopping for a new car in Norway in March (2019) drove home an electric vehicle, leaving the fossil-fuelled models to gather dust. With a parliamentary mandate that all new cars sold must be electric by 2025, Norway is doing a great deal to boost consumer interest, waiving "hefty vehicle import duties and registration and sales taxes of electric cars to boost sales," Associated Press states. EV owners are also exempt from road tolls, and are permitted to use bus lanes in congested city centres (11).

A Norwegian-Canadian friend who visited his dad recently told me the government there put charging stations all over the place (12).

The government might boast that it'll achieve a 12% cut sooner than that by other means, but that boast looks very hollow to anyone familiar with how very fixed Hydro costs are in reality. Cutting energy efficiency programs certainly won't do it, nor will firing a CEO.

Who should install the Charging Stations and Where?

It would make sense to mandate local Hydro utilities to locate, install, maintain and collect the revenue from charging stations (paid via credit or debit cards, not added to normal Hydro bills). To incent them, this revenue (from a "related business") should be over and above their regulated return on investment. (This would also be important for US utilities).

They should be granted "eminent domain" to locate the charging stations as they chose to maximize revenue and minimize cost (which makes sense because they have the relevant marketing and distribution planning expertise). They could be located in (private or municipal) parking lots, shopping malls, places of employment, hotels and even (fast chargers) in gas stations, with the utilities granted authority to over-ride objections of the land owner, whether public or private.

This business would bring in more revenue than from their usual regulated rate of return on investment (RROI). It should be used to lower rates while still earning the same RROI.

Economic Benefits of Manufacturing EV's

The third bullet of the ECO Report sidebar and discussion in its final paragraph refer to the economic development advantages of manufacturing EV's in the province and the dependence of the viability of such manufacturing on strong local demand, encouraged by government. Hence the decision of local firm Magna to go to China to manufacture EV's rather than doing it at home.

Numbers are shown in the Summary of the Net Impacts of EV Manufacturing as presented by Econometric Research Limited at the Big Ideas, Big Cities conference in Hamilton in 2016 (10). The

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results are based on just a 5% market share of EV's that might reasonably be achieved, with supportive policies, by 2025. Of course, even higher market shares could be achieved over the years.

This presentation noted that in 2014 the auto sector contributed over \$16 billion to Ontario's GDP and employed over 104,000 people directly. With the recent shutdown by GM in Oshawa, and planned elimination of the third shift at the Fiat Chrysler Plant in Windsor it is evident that Ontario's auto sector is in trouble. Why?

Surely, you would have to be a recent immigrant from another planet not to know that internal combustion engines are going the way of horses, soon to be replaced by recently developed technology that is cleaner, cheaper, quieter, safer, simpler, fewer moving parts, less maintenance, smoother running, smells better ... better in every way.

The Swedes know this. Volvo has said every vehicle it launches from this year (2019) will have an electric motor (1). Of course, Volvo is now owned by the Chinese ... hmmm!

As noted previously, Bloomberg New Energy Finance projects that, by 2040, 55% of all new car sales and 33% of the global fleet will be electric (9). The questions to ponder are (1) how many of these EV's will be made in Ontario? and (2) will any vehicles of any sort be built in Ontario?

Wake up, Progressive (?) Conservatives. There is no fossil fuel production in Ontario, no reason to be such fossil-philes, fighting the Backstop and having a sham climate plan. But there is a significant auto sector, which could be helped by policies to boost EV sales if temporarily needed support of existing operations were tied to re-tooling to make EV's.

Policies to Boost EV sales

Policies to encourage EV sales include not only a zero-emission standard (i.e. a type of quota for each auto-maker), but also: carbon pricing, government procurement (all government vehicles purchased could be EV), feebates, increased availability of charging stations and, even, low emission zones (i.e. you must be in a low emission vehicle to drive in it).

A lesson from history is that infrastructure was all important. For example, cars didn't surpass horses until sufficient suitable road surface was provided. Today's analogy would be publicly accessible charging stations because, e.g., in Toronto, half the population live in apartments or condos or houses without garages or driveways that preclude charging at home. And these tend to be the kind of folks who would buy EV's. Hence, the emphasis above under *Who should install the Charging Stations and Where?* to mandate local Hydro utilities to provide charging stations in publicly accessible places.

Again, wake up, Progressive (?) Conservatives and federal Liberals. "It doesn't serve the world (or my family) to play small" (from Nelson Mandela's inaugural speech). Let's get EV's rolling off the production lines in Windsor, Brampton, Oshawa, Oakville, Cambridge, Woodstock, Alliston and Ingersoll. Save jobs, reduce costs for motorists, cut Hydro rates and keep energy dollars at home in the Province. Oh, and leave a liveable world to our children and grandchildren.

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References:

- (1) <https://www.bbc.com/news/uk-41011008>
- (2) <https://docs.assets.eco.on.ca/reports/climate-change/2018/Climate-Action-in-Ontario.pdf>
- (3) <https://ero.ontario.ca/notice/013-4551>
- (4) <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2310006601>
- (5) <http://www.ieso.ca/power-data>
- (6) Google: Transportation Sector Ontario Table 9: Road Transportation
- (7) <https://cleantechnica.com/2018/03/10/electric-car-myth-buster-efficiency/>
- (8) <https://www.fleetcarma.com/impact-growing-electric-vehicle-adoption-electric-utility-grids/>
- (9) <https://about.bnef.com/electric-vehicle-outlook/>
- (10) <http://mitl.mcmaster.ca/blog/economic-impact-electric-vehicles-canada>
- (11) <https://theenergymix.com/2019/04/09/electric-cars-hit-nearly-60-of-new-vehicle-sales-in-norway/>
- (12) Personal communication

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