ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS

January 1, 2017

Attention: Valentin Kostadinov
Ministry of the Environment and Climate Change
11th Floor, Ferguson Block
77 Wellesley Street West
Toronto, Ontario M7A 2T5

To Whom This May Concern:

The Ontario Society of Professional Engineers (OSPE) is pleased to offer expert recommendations that will support the success of Ontario Electric and Hydrogen Vehicle Advancement Program (EHVAP) in partial fulfillment of our consultative involvement with Ontario's Ministry of the Environment and Climate Change.

This submission is the product of hours of volunteer effort by OSPE's Energy Task Force, a membership committee that brings together a broad range of disciplines and experiences necessary to evolve a balanced view to any future policy involving the intersection of energy, infrastructure, and the environment.

The EHVAP is an important piece of the Climate Change Action Plan (CCAP) puzzle that Ontario has set in motion, a complex framework involving incentives for consumers, cutting-edge standards, markets and allowances, compliance tools, and timeframes and technology. In this effort the engineering community is a natural ally that is accustomed to total lifecycle costing, complex analysis, and fully developed simulation studies to achieve desired outcomes.

To enable the realization of EHVAP objectives and the broader success of the CCAP, **OSPE is available to develop and deliver an engineering fact-based education program that would satisfy the needs of two (2) identified and critical audiences:**

1. **Ontario's business community needs to understand how the CCAP (EHVAP, but also cap-and-trade) will function** and how they can maximize their involvement and take advantage of available incentives. OSPE has conducted literature reviews and collected survey data that indicate that a) few plain-language informative guides exist to instruct stakeholders, and b) that plain-language guiding documents would encourage program participation.

2. **Public awareness campaign targeted at consumers** to overcome misconceptions about EVs (and FCEVs) that threaten to undermine the purchasing decision for the full spectrum of potential participants.

Engineers understand that the way to forecast and realize outcomes is to conduct detailed technical and economic analyses combined with appropriate simulation studies. Whether the province is planning to achieve increased electric vehicle (EV) market share or operate a cap-and-trade program, it makes sense to collect data, develop models, run trials or simulation studies, and

consult with experts to establish a plan and oversee its execution. Given the overall importance of the CCAP for Ontario's future, of which the EHVAP is a critical part, it is pivotal that government engage engineering specialists in their existing organizations (i.e. Ministries and Agencies) and as third-party advisors and reviewers to ensure proposed policies are robust, optimized, and affordable.

Matters of complex science, functionality, and design are areas that demand the expertise of engineers to inform public policy decision-making. There is an absolute need for engineers to be at the table within virtually every division and at every stage of the CCAP, and the EHVAP is no exception. Engineers hold a variety of senior management positions in government and across industry, and in the recent past the province has underutilized their expertise with respect to climate change initiatives.

Ontario is home to more than 250,000 engineering graduates and this community is a tremendous potential resource for government to leverage to ensure the success of its bold plan. Ontario's CCAP would be best served by including not only Professional Engineers, but also engineering degree holders from a wide variety of disciplines: medicine, computer design, arts, and social fields, for example. Ontario's engineering graduates have expertise in pertinent areas of transportation, smart grids, electronics and information technologies, power generation, distribution and consumption modeling, economic modeling, and the social factors that govern consumer behaviour, adoption, and sustained behaviours.

These experts stand ready to help the government achieve its environmental goals at the lowest practical cost, each bringing a unique and valued lens to engineering problem solving. At OSPE, we too stand as a willing partner. We are an organization that understands how to mobilize and leverage Ontario's engineering talent, and it is critical that the province realize the potential of these partnerships.

Regarding electric vehicles, Ontario is well positioned to be a world leader given the confluence of engineering schools, graduates, professional engineers, and related small, medium, and large manufacturing entities that would participate in an evolving clean energy transportation manufacturing complex. Also, Ontario will have a continuing and significant amount of surplus zero-emission electricity that can be leveraged by the EHVAP. OSPE looks forward to working with government to help it meet its climate change objectives.

Sincerely,

Sandro Perruzza
Chief Executive Officer
Ontario Society of Professional Engineers

Michael Monette, P.Eng., MBA
President and Chair
Ontario Society of Professional Engineers

Recommendations

1. To enable the realization of EHVAP objectives and the broader success of the CCAP, **OSPE is available to develop and deliver an engineering fact-based education program** that would satisfy the needs of two identified and critical audiences:

    a. **Ontario's business community needs to understand how the CCAP (EHVAP, but also cap-and-trade) will function and how they can maximize their involvement and take advantage of available incentives.** OSPE has conducted literature reviews and collected survey data that indicate that few plain-language informative guides exist to instruct stakeholders.

    b. **Public awareness campaign targeted at consumers** to overcome misconceptions about EVs (and FCEVs) that threaten to undermine the purchasing decision for the full spectrum of potential participants.[1]

2. With only four years left until 2020 it may not be feasible for Ontario to develop requirements and standards that manufacturers must meet before their cars qualify for incentives. It is likely that by the time those standards are issued it will be too late to meet program sales targets. It is best to move forward with best practices now and develop requirements and standards in parallel.

How to Improve EV and FCEV Sales

Regarding Electric and Hydrogen Vehicles, five key questions exist for consumers:

a) How far can I go on a full charge (or tank of Hydrogen)?
b) How long will it take to fill up?
c) How long will the batteries (or fuel cells) last under normal driving patterns?
d) Where do I plug in (or buy hydrogen)?
e) How expensive is the car and associated home fuelling equipment including installation?

Questions a), b), and c) can be addressed effectively by public education and a) and b) are also resolved by selecting appropriate battery sizes or H2 tanks.

Questions c) and d) require infrastructure and subsidies for home owners and fleet owners. However, major legislative changes will be required for multi-residential buildings like condos and apartments. Consequently, homeowners and fleet owners are the preferred audience for the 2020 sales target.

EVs and FCEVs present dissimilar problem sets. EVs require a long charge time so they will likely be charged at work or at home. Even at the full retail price, electricity is 1/3 the cost of gasoline. As such, low electricity prices are an additional incentive for EVs, but are not essential for EHVAP success.

By comparison, FCEVs can be quickly fuelled so they will likely be fuelled at a local hydrogen fuelling station. The success of FCEVs will require low cost zero-emitting hydrogen source and convenient fuelling stations. That means electrolyzers powered by zero-emitting electricity at low wholesale market prices is critically important for FCEVs. Electrolyzers that are installed close to the demand are ideal from an environmental standpoint. At present hydrogen is produced in a

[1] OSPE members work for all the vehicle manufacturers so it does not present a conflict of interest.

central location using the steam methane reforming (SMR) process. This has two major environmental disadvantages. The SMR process discharges about 11.8 kilograms of carbon dioxide into the environment for each kilogram of hydrogen produced according to a US-NREL study, and the hydrogen must then be transported to consumers throughout Ontario—typically in diesel powered trucks.[2]

Further Considerations: Enabling Program Success

Knowing that Ontario has made a decision not to introduce a California-style ZEV mandate, it is important that Ontario's program design and structure encourages the adoption of EVs and hydrogen fuel-cell electric vehicles (FCEVs) to achieve and exceed sales targets.

Responding to the identified themes and questions set out by the ministry as part of the EHVAP consultation process, OSPE offers the following additional considerations to enable program success should they be of interest to the MOECC:

1. Vehicle Incentive Amounts Should Reflect Performance

The current value of the incentive is based on the vehicle's battery capacity, seating capacity, and manufacturer's suggested retail price (MSRP). Ontario's low emission power system has and will continue to have significant amounts of surplus zero-emission electricity. The program guide should include incentives for EVs that also feature user friendly charging systems that allow the vehicle to use surplus zero-emission electricity when it is available to maximize the environmental benefits of that energy. Creating a "user friendly" or "grid intelligent" certification creates a new competitive advantage for automotive manufacturers to sell vehicles equipped with such chargers.[3]

Understanding the unique characteristics of Ontario's electrical grid is important, but so is recognizing the EV accomplishments of other jurisdictions. Canada and Ontario are not alone in attempting to capitalize on the opportunities electric and hydrogen vehicles present. Within Canada, Quebec has experienced the most success. British Columbia has only recently introduced an incentive plan, but it shows promise as well. The United States has incentives that have encouraged more EV sales per capita than Canada. Norway is far-and-above a global leader in EV penetration.

Ontario needs to interact with other jurisdictions to better understand global best practices for EV incentives with an eye to like-jurisdictions that best align with Ontario's consumer demographics, geography, electrical grid, and other key features.

Norway may be of special comparative interest to Ontario because they also have a very low emission power system and they are working to overcome unexpected issues that are linked to rapid EV deployment/expansion. The Government of Ontario should liaise with Norwegian officials to understand the challenges of scaling up and how to incentivize sustainable EV deployment.

[2] Pamela L. Spath and Margaret K. Mann, National Renewable Energy Laboratory Technical Report NREL/TP-570-27637, "Life Cycle Assessment of Hydrogen Production via Natural Gas Reforming, February 2001.

[3] Note: in cooperation with the federal government, Ontario might consider removing HST on the purchase of EV cars for a defined period of time. Removing sales tax will assist OEMs and consumers to develop and acquire larger batteries.

2. Fund and Establish Standards Development for EV Smart Charging

Rather than pay generators to stop producing zero-emission electricity, surplus zero-emission electricity should be used to power Ontario's economy by displacing fossil fuels in other sectors. The CCAP plan will allow for free nighttime charging for EVs and this is a positive step toward optimizing our grid since nighttime demand tends to be low. The key challenge to the success of the night charging program is that most of the existing car charging timers are not user friendly and will discourage consumer involvement in charging when generation is available and potentially sales of EVs.[4]

The government should encourage better charging management software with better user interfaces. It is reasonable in the longer term to require the software on each model to pass a usability test before being eligible for the vehicle subsidy. The importance of this issue should not be underestimated, because suboptimal software and interfaces will result in undesirable costs on the electric grid and for consumers.

If Ontario incentivizes continuous improvements to charge timing systems, there are opportunities to do much better than just time-of-day. It is feasible to allow charging when zero-emitting generation capacity is in surplus regardless of the time of day. An intelligent system could use real-time market pricing data (already available at the IESO) to opportunistically fill up the battery when surplus zero-emitting electricity is actually available.[5] Then it would really make economic sense to offer this electricity for the wholesale market price or even for free, because Ontario would otherwise be paying to curtail it. This strategy is more forward thinking than the MOECC's baseline plan to offer free overnight charging regardless of grid condition, because this is not an optimum strategy as Ontario's renewable generation capacity and EV sales increase.[6]

From a manufacturer and consumer standpoint, a new level of incentives for even smarter chargers or further discounted pricing on electricity would make sense. Companies will compete to have the smartest charging software. This would encourage "level 4 smart charging software" and manufacturers will develop it so as to claim the best software to minimize charging costs and maximize environmental performance.

All told, ratings and certifications are useful tools to encourage program success. As an analogy, we have seen what various ratings have done for consumer safety with traditional autos, homes, and equipment, and how third-party ratings have become marketing tools. Similar to how automotive companies have fought to claim the title of the safest car, the ratings grew in complexity and comprehensiveness. Electric cars could be certified based on a number of factors, including environmental benefit (including how the car charging system impacts power grid emissions) and car companies could develop their software to improve and market this rating to consumers.

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[4] In terms of best practices for intelligent charging systems, some manufacturers provide user friendly controls to allow charging at night when electricity rates are lowest.

[5] However, Ontario's low emission power system often has surplus zero-emission electricity during the day Establishing a data link by Internet to the IESO forecasting computers would allow chargers to activate when surplus zero-emission electricity is available. IESO forecasts are not perfect but they are sufficiently accurate for the EHVAP program.

[6] In theory surplus electricity should be priced at its marginal cost of production to ensure costs are not transferred from electric car owners to electrical grid customers. The marginal cost of production for zero-emission electricity is very low so it is not a major concern.

3. Determine Charging Infrastructure Capacity & Needs

The Ontario government must be careful when making assumptions about the cost of upgrades to the distribution system with higher penetrations of EVs. Initiatives should be developed in close consultation with electrical engineers who are experts in distribution system design and local distribution companies.

Overall, the distribution system has more spare capacity than transmission or generation, but capacity is not unlimited. Furthermore, how the electric cars are distributed relative to the distribution of local residential transformers and subdivision buses plays an important role in determining the cost at different levels of EV penetration. A 240 VAC fast charger is double the size of a residential air conditioner. However, unlike an air conditioner, the fast charger has a relatively heavy-duty cycle because it does not cycle on and off every several minutes. As such, these fast chargers could place sustained demand on transformers and subdivision bus capacity that is beyond double the air conditioning load stated above.

Super chargers present an even greater challenge to distribution grids. Super chargers run on 550 VAC which is commercial/industrial grade power and will require extensive changes to transformers and existing wiring to residential premises. Further, commercial sites that use 550 VAC could face significant costs if required to install a large fleet of super chargers at sites like shopping centers, movie theatres, etc.

Fleet adoption of EVs will almost certainly pose challenges to existing distribution systems and will require further engineering analysis to determine if some local storage or generating capability is more cost effective than distribution system redesign.

4. Ontario's Unique Situation Demands EV R&D and Policy Leadership

Ontario is unique in starting with a very inflexible grid with significant amounts of base load nuclear and run-of-the-river hydroelectric plants. These challenges will eventually be faced by other jurisdictions as they move to cleaner and more intermittent generation in the future. That is both a challenge and an opportunity to lead the design of solutions. OSPE cautions the MOECC that emulating or importing policies from other jurisdictions or waiting for others to do EV R&D will result in missed opportunities to develop new markets for Ontario's clean energy businesses. Regarding the EVHAP, Ontario's unique grid means that it could encourage the development and manufacture of intelligent car charging systems in Ontario that can respond to the availability of surplus zero-emitting electricity.

Ontario has one of the lowest emitting mixed generation electric grids in the world. This is both an asset and a challenge. Ontario is one of the fortunate places where electric cars dramatically reduce environmental emissions. However very low emission power grids have significant amounts of surplus zero-emission electricity. It makes sense that Ontario would take the lead in developing intelligent EV charging infrastructure. If Ontario does act on this opportunity, it would then be in a position to lead in establishing national and international standards and export this technology worldwide to EV manufacturers. Other jurisdictions will eventually begin to experience significant amounts of surplus zero-emission electricity as they clean up their power grids. Using that surplus productively to lower emissions in the transportation and other sectors will become an environmental priority.

5. Fund Independent Public Awareness Campaigns

The greatest barrier to EV sales at the moment is not cost but range and charging time anxiety. For most consumers in Ontario, lower priced EVs are not viewed as being viable as primary vehicles. Major misconceptions by consumers of how much time they will need each day to charge their cars for typical use and how far they can reliably travel on a partial charge if they fail to charge their EV batteries the night before will continue to limit sales. People with range anxiety generally fail to recognize that you have the equivalent of a gas station at home and can leave every morning with a full tank if they use the automatic charging features.

Addressing this problem with factual, real road data and compelling stories by EV owners can help eliminate that perception barrier.

Public awareness is unlikely to be championed by automotive dealerships as their entire business model (built on service intensive ICE vehicles) is threatened by EVs. Ontario will need fewer gas stations, car dealers, and repair shops. Because of this, Ontario must engage with EV owners and impartial scientific authorities as the best sources of information.

Educational campaigns to focus on the environment benefit of EVs as well as the health benefits, quiet operation, dramatically lower operating costs, and other major benefits should be executed. Further, Ontario should seek support from insurance associations and their membership companies to dispel myths that EVs are costly to insure. These campaigns will help to overcome American media that constantly tells viewers that EVs emit as much carbon dioxide as ICE vehicles on account of the coal generation in the grid. Ontario's grid has overall emissions less than 1/10th of that of the average USA power system. And intelligent charging systems can preferentially charge when there is surplus zero-emitting electricity available from Ontario's very low emission power system.

6. Monitoring & Fraud Prevention

Monitoring power is easy; doing it in a fraud-proof way is difficult.

One way or another, enforcing special rules for car electricity is going to be a complex process. An individual could charge their EV with free electricity at night, and suck power back out in the daytime to help power your home. There are already off-the-shelf systems that can do that, and it should not be our objective to discourage them because they have the potential to help grid efficiency through demand management.

Car charging is the easiest residential load to shift, so consumers would naturally be drawn to charge at night, or whatever surplus zero-emission electricity was available. If consumers find some other ways to shift load that makes the power system run more efficiently or at lower emissions, that should be encouraged as well.

However, for fair attribution of costs, it would make more sense to differentiate between non-interruptible and interruptible loads like adjoining power systems do when they trade electricity. Non-interruptible loads pay the full cost of production (essentially the retail price for Ontario consumers). Interruptible loads pay the marginal cost of production (essentially the wholesale market price for Ontario consumers). Interruptible loads enjoy the marginal cost of production because they do not impose additional peak capacity demands on the power system. When peak load exceeds available capacity the interruptible loads are disconnected. Since most EV charging can be done on an interruptible basis, that interruptible load should be able to receive the wholesale market rate without any additional markups provided it is subject to interruption by the IESO or LCD operators. The average wholesale market rate in 2014 during periods when surplus

zero-emission electricity was available was about 1.7 cents/kWh. To accomplish this however would require intelligent charging systems that can respond to IESO or LDC curtailment signals.

7. *Alternative Electricity Pricing Systems*

In the previous section we discussed pricing electricity based on whether the load was non-interruptible or interruptible. There are other alternatives that can be considered if the approach suggested in section 6 is not acceptable to the government. Various jurisdictions have proposed or implemented alternatives to monthly tiered pricing and time-of-use pricing. Each has strengths and weaknesses. None that OSPE is aware has resulted in a major change in consumer behavior and load demand profile.

The main reasons for the poor performance is that most of those plans do not provide sufficient cost reductions to pay for automated equipment to carry out the load shift. Manual load shifts by customers are not reliable over a longer period of time as the inconvenience factor outweighs the cost savings. However, OSPE has developed a voluntary price plan that should create about 50% savings in electricity bills for an average residential customer over a 1-year period. That should be a sufficient saving for consumers to invest in the incremental cost of automatic load shifting equipment such as intelligent EV chargers. More information is available on OSPE's Smart Grid Price Plan here.

Research is required to determine at what price point electricity can be sold that the consumer behavior is influenced (both high and low). Too, it should be determined at what price point does the consumer achieve optimal consumption for grid balance (i.e. if the consumer uses electricity equally as much when it is priced at two cents per kilowatt as they do when it is priced at zero cents per kilowatt, government should capture that revenue).

8. Green Parking Requirements & Incentives

Ontario should expand the availability of green car parking lots (with or without charging infrastructure) and consider flexible pricing for green parking spaces. In addition, Ontario should act to address the issue that no city bylaw or provincial act precludes ICE vehicles from occupying green parking spaces, which undermines current initiatives. Easier and more visible parking in congested urban centers will act as a constant reminder and powerful incentive for consumers.

9. *Expand Number of Green Express Lanes*

Ontario should expand the availability of green lanes (i.e. HOV/HOT lanes). In the congested Greater Toronto-Hamilton Area this will present a more valued incentive to commuters. It may also be possible to negotiate or legislate a differential rate for ICE versus EV/FCEV cars on toll highways such as 407ETR and its extension east of Toronto – Hwy 407.

10. EV Licensing

Ontario should consider waiving or reducing license plate renewal fees for EVs and run public awareness messaging to emphasize that EVs are not subject to clean air testing costs unlike ICE vehicles.

Further Considerations: Alternative Business Models & Partnerships

It is important that the EHVAP encourage industry, academia, and NGOs to complement government initiatives and innovate their operations. OSPE believes that alternative business models and partnerships will play an important role in delivering this program. OSPE sees opportunities in the following actions:

1. ***Partner with Manufacturers to Mutually Support and Determine Customer and Government Needs***

Market profiling, market segmentation, and the product specs per segment need to be better understood. This process starts with consumer surveys. Engineers are currently being asked to design a new personal transportation system but do not have access to this critical information. Telling a world-class expert to design a bridge is not enough. How much weight will the bridge be expected to take? How long does it have to last? What are the environment factors it must be able to withstand? All good marketing begins with thoughtful buyer needs surveys.

Each question will define consumer groups of various sizes. A set of parameters can characterize a market segment. In traditional internal combustion engine (ICE) cars, the market is divided into appeals: the sports car, the workhorse, the long haul, and cars for various ages and demographics. Auto manufacturers will design cars to appeal to a market segment and then make the advertisements match their targets. Of course if a manufacturer gets their target segment wrong the product will fail. Knowing the product specifications (product differentiation) in each market segment means getting the facts that drive design decisions.

2. Automatic Control Systems & Opportunistic Charging

Automatic control systems would see vehicles receive low or no cost energy as it becomes available, as part of an intelligent charging system. If there is additional zero-carbon electricity on the grid, the automated system takes advantage by charging the EV battery. If the vehicle has a required or set threshold of charge it needs to meet regardless of pricing, it would time itself to meet that requirement by the designated time. The important point is that intelligent charging systems meet the needs of the consumer, power system and environment and makes trade-offs automatically based on consumer requirements and power system real time status.

3. *Partnerships with High-Density Residential and Commercial Developers*

Electric car charging in multi-unit residential commercial buildings will be in demand in the near future. Developers, as well as Condo boards and property management companies for existing properties, that are prepared will attract EV drivers as tenants, owners, and purchasers.

Ontario already offers **three LEED points** for the installation of EV chargers, and this incentive could be expanded to encourage these actors to achieve green/sustainable building standards by installing or expanding charging facilities.

OSPE acknowledges that the installation of charging in condos can present unique challenges, but planning and proper placement will eliminate risks and help keep costs down. Legislative changes will be required if EV enabled parking facilities in condominiums for EV owners do not align with parking spot ownership registration. In the case of multi-residential rental properties, legislative changes may be required to provide a minimum number (and charging level) for EV charging stations that should be adjusted upward with increasing demand by residents.

About the Ontario Society of Professional Engineers

The Ontario Society of Professional Engineers (OSPE) is the voice of the engineering profession in Ontario. We represent 250,000 members of the engineering community, including engineers, engineering professionals, graduates, and students who work or will work in several of the most strategic sectors of Ontario's economy.

OSPE elevates the profile of the profession by advocating with governments, offering valued member services, and providing opportunities for ongoing learning, networking, and community building.

OSPE was formed in 2000 after members of Professional Engineers Ontario (PEO) voted to separate regulatory and advocacy functions into two distinct organizations. PEO continues to conduct regulatory activities and OSPE focuses on advocating for issues that impact engineering.

Acknowledgements

OSPE would like to thank members of its Environment, Energy, and Infrastructure Task Forces and Subject Matter Experts for contributing to the development of the recommendations in this submission. It is OSPE's hope that the recommendations contained in this submission will assist government in creating a thoughtful, evidence-based strategy for the advancement and benefit of all Ontarians.

For further discussion, please contact Patrick Sackville (Lead, Policy & Government Relations) at (416) 223-9961 ext. 225 or patrick@ospe.on.ca.