POLLUTION PROBE

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Electric Mobility Adoption and Prediction (EMAP) Tool

Developing a strategic approach to enabling electric vehicle technology in Canada

Public Final Report

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ABOUT POLLUTION PROBE

Pollution Probe is a national, not-for-profit, charitable organization that exists to improve the health and well-being of Canadians by advancing policy that achieves positive, tangible environmental change. Pollution Probe has a proven track record of working in successful partnership with industry and government to develop practical solutions for shared environmental challenges.

ACKNOWLEDGEMENTS

The development of the EMAP Tool was made possible through support from:

Natural Resources Canada
Electric Mobility Canada
ENMAX Corporation
Horizon Utilities
Hydro Ottawa
London Hydro
PowerStream

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Project Summary

Planning for the integration of an emerging technology is never an easy challenge. The purpose of Pollution Probe's Electric Mobility Adoption and Prediction (EMAP) Tool was to compile and analyze information that could be used by local utility companies to develop successful strategies for the deployment of electric vehicle (EV) technology in Canada.

The project saw Pollution Probe partner with five local utility companies servicing nine participating municipalities across Canada. These utilities primarily wanted to ensure that they were fully grid-prepared to integrate a significant number of EVs within their service areas, but were also interested in EV adoption due to the environmental and social benefits associated with EVs. Further, partnering utilities wanted to be responsive to customers' needs, proactive in encouraging EV charging patterns that benefit all customers, and progressive in promoting public awareness of EVs.

The EMAP Tool was developed and used to integrate sophisticated demand analysis research methodologies with detailed electricity system impact analyses in regard to EV usage. This integration led to the generation of the empirical information that is required by electricity distribution system operators to ensure that the demand for power associated with anticipated patterns of EV charging, which differ between urban centres and within communities, is safely, efficiently and reliably accommodated. As a tool of predictive analysis, EMAP was designed to improve the efficiency of capital investments in grid system assets and EV charging infrastructure, by ensuring that they align with the needs of early adopter markets.

What makes the EMAP Tool so unique and innovative is that it combines rigorous demand analysis research revealing statistically significant, neighbourhood-specific anticipated EV adoption levels with neighbourhood-scale grid integration and impact analysis. In short, EMAP identifies neighbourhoods within a municipality in which EV adoption is likely to occur and assesses the preparedness of the electricity distribution system to accommodate additional loading associated with anticipated charging patterns. It is this idea of EV clustering, or uneven demand patterns across the system, that presents a potential challenge if not adequately managed.

The EMAP project was made possible by funding from Natural Resources Canada's ecoENERGY Innovation Initiative, Electric Mobility Canada, and the five partnering utility companies, who not only offered financial support, but contributed their time and expertise throughout the project.

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Background

As outlined in the ecoENERGY Innovation Initiative program, the electrification of transportation may be the most effective strategy towards achieving a sustainable future for Canada's transportation sector. A lack of research on the preparedness of local electricity grids to accommodate increasing numbers of EVs, and the need to build collaborations between the varied stakeholders involved in the electrification of transportation, are unique challenges that must be addressed to achieve the successful planning, integration and adoption of EVs. Recognizing those challenges, and the pressing need to address them, Pollution Probe developed the concept of the EMAP Tool, which it saw as being uniformly applicable to municipalities across the country.

Pollution Probe's Electric Mobility Adoption and Prediction (EMAP) project arose out of the recognized need for a tool of predictive analysis capable of improving the efficiency of capital investments in electricity distribution system assets and electric vehicle (EV) charging infrastructure by ensuring that they align with the needs of early adopter markets. It combined the use of rigorous demand analysis research methodologies to identify neighbourhoods likely to contain relatively high levels of early adopters of EVs, with detailed electricity grid integration and impact analysis. The overarching goal of the project was to identify whether or not local utility grids were capable of providing charging for a significant number of EVs without exceeding the capacity of neighbourhood-level transformers in areas expected to see relatively high rates of EV usage in the coming years, and, based on the results of these investigations, to help utilities develop strategies for enabling EV use.

Work on the project was initiated in April of 2013, and wrapped up in June of 2015. It saw Pollution Probe, working in collaboration with Electric Mobility Canada, partner with five local utility companies servicing nine major Canadian municipalities who agreed to participate in the project. These utilities, and their respective service areas were:

1. Hydro Ottawa – Ottawa, Ontario
2. Horizon Utilities – Hamilton and St. Catharines, Ontario
3. London Hydro – London, Ontario
4. PowerStream – Markham, Richmond Hill and Vaughan, Ontario
5. ENMAX Corporation – Calgary and Edmonton, Alberta

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Objectives

The objectives of the EMAP project were threefold:

1. Research and generate localized information on anticipated EV usage;
2. Assess grid capacity in early EV adopter neighbourhoods; and
3. Foster the collaborations that will assist utilities and other stakeholders in strategically planning for the successful deployment of EVs in Canada.

1. Research and generate localized information on anticipated EV usage

Through its delivery of telephone surveys to 750 vehicle purchase decision-makers in each utility's service area, the demand analysis research component of the EMAP project succeeded at gaining insights into the following areas:

1. The profiling of potential early EV adopters
2. The determination of vehicle usage patterns
3. The determination of interest levels in EVs, as well as purchase motivations and barriers
4. The acquisition of range and charging needs and preferences
5. The identification of key group differences

The data acquired through the demand analysis research objective will prove useful to all EV and electricity system stakeholders when assessing infrastructural capacity to support growing levels of EV use, and to plan for a future in which EVs are increasingly integrated into Canadian society. All five partnering utilities gained crucial intelligence on which neighbourhoods within their service areas are expected to lead the way in terms of EV uptake—intelligence they would have been unlikely to free-up the resources to acquire barring their participation in the EMAP project.

2. Assess grid capacity in early EV adopter neighbourhoods

An ongoing consideration on the part of grid managers and EV stakeholders is the capacity of local distribution systems to deliver power to EV end-users while maintaining grid stability. The demand analysis research component of the project provided a better understanding of the nature of the charging services required to support EV deployment (i.e., when and where vehicles would be plugged in, for how long, and the importance of fast charging to EV users). Understanding how EVs are likely to change the profile of power demand at the neighbourhood level is critical to making informed, strategic and effective investments in technology and infrastructure to maintain and improve quality of service.

To better understand the implications of the anticipated uptake of EVs in the context of electricity demand, scenario development and simulation were undertaken to assess the electricity distribution system's capacity to support additional loading resulting from EV charging. The process involved two separate but related investigations, spearheaded by the project's utility partners:

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1. A neighbourhood-level assessment of the distribution system, beginning with the pole- or pad-mounted transformer and ending with the secondary cables responsible for running electrical power to individual households. The impacts of EV charging on the distribution system were simulated using relevant feeder and transformer data provided by partnering utilities.

2. A system-wide examination of the potential impact of EVs on the distribution systems of participating municipalities were conducted, with a focus on neighbourhoods identified through the market research work as being early adopter hot-spots.

The key variables examined by these investigations were: prospective EV penetration rates, EV on-board charger capacity (which determines the rate at which EVs can draw power from the grid), ambient temperature (due to the added stress that extreme temperatures place on grids), and time of charging (to help utilities plan for best—e.g., 100% off-peak charging—and worst case scenarios—e.g., 100% on-peak charging).

Knowing where their grids were potentially vulnerable in the face of rapid EV uptake allowed partnering utilities to accurately and efficiently establish which neighbourhoods require careful capacity monitoring in the near term, and which neighbourhoods have sufficient capacity to support the adoption of a significant number of EVs.

3. Foster the collaborations that will assist utilities and other stakeholders in strategically planning for the successful deployment of EVs in Canada

A key objective of the EMAP project was simply raising the importance of the trend of increased EV uptake with grid managers, and starting focussed dialogues between previously disparate stakeholders in the fields of transportation planning, the auto sector, and energy. All stakeholders engaged over the duration of the EMAP project were made aware of all the players that need to be engaged in the creation and delivery of successful EV implementation strategies. Partnering utilities were provided with the tools and knowledge they need to develop and refine such strategies, and when they are approached by government, industry or citizens' groups on the topic of EV implementation, they will have a wealth of information and expert contacts on which to draw due to their involvement in the EMAP project.

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Research Methods

Representatives of stakeholder organizations integral to the future of electrified transportation in the nine municipalities met regularly as Advisory Groups to the study, contributing to the overall project scope, sharing technical expertise and providing guidance on all milestones and deliverables. The participation of Advisory Group members helped to ensure that local perspectives informed the project, thus providing further credibility and enhancing the value and relevance of the recommendations and proposed strategic objectives for utilities outlined in the project reports.

In addition to a comprehensive final report for each partnering utility, which outlined early EV adopter neighbourhoods in their jurisdictions and assessed the readiness of the local grids to support high levels of adoption, the project also led to the production of a number of complementary reports for each jurisdiction. These complementary reports included detailed, municipality-specific market research reports produced by Environics Research Group, based on robust telephone surveys of statistical significance, as well as electricity distribution system assessment reports produced by the partnering utilities. Hydro Ottawa and PowerStream produced grid assessment reports with the assistance of students and faculty members from Carleton University's Department of Electronics and Georgian College's School of Engineering Technology and Environmental Studies, respectively.

The demand analysis research component of the project was accomplished through the delivery of 750 (the number determined by Environics to ensure statistical significance) detailed telephone surveys to consumers in each of the five partnering utilities' service areas. The surveys for each service area were unique—although several groups of questions were consistent across all surveys—reflecting the utility-specific needs and interests as determined in consultation with the Advisory Groups. The surveys were only given to licensed drivers of the age of 18 or older who were the vehicle purchase decision-makers for their households, and who had either purchased/leased a new vehicle between 2011 and 2014, or were intending to purchase/lease a new vehicle between 2014 and 2017. Existing Environics data, derived from their PRIZM C2 segmentation system, was used to establish postal codes in each participating municipality that had demographic profiles indicating a likelihood of early EV adoption. Residents living within these postal code-defined neighbourhoods were targeted for direct research via telephone surveys.

Survey respondents were asked about the main factors influencing their vehicle purchasing decisions, as well as a broad range of questions relating to their thoughts and knowledge regarding EVs. Respondents were also asked about their mobility patterns, level of household income, and level of education. It was interesting to note that prospective early EV adopters tended to be people over the age of 45 who were relatively affluent and had above-average levels of education.

Taken together, these resources provided a comprehensive examination of the grid implications of trends towards increasing EV usage that are already evident in most Canadian cities.

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Benefits to Stakeholders

At this time, local utilities do not have the ability to forecast where and when EVs will access their distribution systems. The EMAP project assisted utilities in preparing for the increase in power supply required to service the anticipated numbers of EVs in their respective jurisdictions.

It is essential for utility companies, auto manufacturers and the government to act in a coordinated and proactive manner to ensure the successful introduction of EVs among consumers and businesses in Canada. Establishing and strengthening these collaborations is important to the strategic and successful deployment of EV technology throughout Canada. Towards this end, the EMAP project brought together an informed group of multi-sector stakeholders capable of advancing the dialogue necessary for the successful introduction of EVs beyond the nine participating municipalities. Pollution Probe expects that the expert networks it assembled will not only to continue to work together in the future, but will grow and eventually take root in all sectors of Canadian society.

Benefits to Canada

In short, the EMAP project was intended to enhance the successful adoption of EVs in Canada. As the project has only recently come to a close, it is too soon to say to what degree this benefit was realized, as many of the lessons learned will take time to be disseminated and integrated into municipal policies, local business practices, and consumer preferences. It is clear, however, that the project will remain relevant for decades to come, as municipal grids are modified and upgraded to accommodate the accelerating growth of the EV market. The methodology developed over the course of the EMAP project can be utilized repeatedly by any utility preparing to adopt new grid management practices to serve the growing demand for EV charging.

The primary benefit of EV adoption is the reduction of greenhouse gas emissions and criteria air contaminants. Increasing the number of EVs on Canada's roads will reduce fossil fuel usage and emissions through the displacement of conventional vehicles in the transportation sector. EVs offer the added benefits of: noise reduction from traffic, creating opportunities for new areas of business that can result in local economic development, reducing anthropogenic drivers of the urban heat island effect, raising environmental awareness among the general public, and reducing the total cost of ownership of vehicles.

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Lessons Learned

The dominant barrier that was faced throughout the execution of the EMAP project was the skepticism on the part of many stakeholders regarding the ability of EVs to supplant conventional vehicles, as opposed to other alternative forms of personal transport. While there is no guarantee that EVs will become the dominant mode of personal transport in the coming decades, they currently offer the most viable alternative to fossil fuel-based modes of transport, and the rate of technological innovation surrounding batteries and overall vehicle efficiency is accelerating. A crucial mitigation measure for EV skepticism was found to be education, not only surrounding the rapidly improving technical aspects of EVs, but also on their level of uptake in international jurisdictions.

Within each partnering utility, it was found that local grids were currently capable of supporting significant volumes of EVs without encountering service disruptions or capacity issues. Several stakeholders took this fact as an indication that their local grids were essentially EV-ready in the short term, and that further proactive measures to plan for EV integration could wait until an unspecified future date. Pollution Probe feels that this stance fails to take into account how rapidly emerging technologies can enter the mainstream, and also how long system-level infrastructure upgrades take to implement. Further work with utilities and municipal governments is needed to create accurate EV uptake forecasts, and to plan for the electricity grids of the future. Smart grid components like vehicle-to-grid technologies need strategic roadmaps and proactive planning that lay out what forms they could take to garner optimal benefits in specific regions. Utilities and local governments need to work together to find a balance between emerging technology preparedness and the active promotion of technologies that offer clear environmental, social, and economic benefits to their constituencies. If utilities and governments fail to take a stance on emerging technologies with robust business cases, they will relegate themselves to a follower role in emerging technology development and will fail to reap the rewards that are inherent with taking some level of calculated, informed risk.

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Outcomes and Steps Forward

The five final EMAP reports—one for each partnering utility—were posted on Pollution Probe's website (http://www.pollutionprobe.org/transportation/emap-reports/), and were made openly available to the public free of charge. The methodology employed by the EMAP Tool showed great potential for replication in other jurisdictions and, going forward, Pollution Probe will use the final reports to promote the development of EV implementation strategies to municipalities and utilities across Canada. Detailed descriptions of the EMAP project in the form of process templates were prepared for each partnering utility, constituting the basis for an analytical and empirical tool to support and inform the ongoing development of EV support strategies as the market expands and evolves. The establishment and engagement of expert Advisory Groups within the service areas of each partnering utility also helped to create EV champions within participating municipalities, and provided them with the knowledge they needed to further advocate for EV deployment and preparedness efforts.

The participating stakeholders and academic institutions in the EMAP project gained an enhanced capacity to knowledgeably engage in policy development and building broad-based awareness of the challenges and solutions to EV adoption. Pollution Probe's partnership with Carleton University, for example, contributed to their ongoing research efforts related to the impacts of EVs on local grids. Engaging with Carleton University and Georgian College also helped to raise the profile of EV technologies at those schools, setting the stage for subsequent research.

The EMAP Tool produced valuable data on likely early EV adopter neighbourhoods and the readiness of local grids to integrate increasing levels of EVs from municipalities representing 13% of Canada's total population, and 16% of its urban population (where demand for EVs is the greatest). Knowing the mobility patterns and preferences, and general opinions surrounding EVs, from such a large segment of the Canadian population will give policy-makers and transportation stakeholders across the country much of the information they need to begin rolling out EV deployment efforts in earnest. Follow-up work to be undertaken by Pollution Probe as a result of the EMAP project consists both of working with municipal governments on EV deployment strategies and engaging other utilities on the potential of utilizing the EMAP Tool framework. Municipal governments possess several strengths relevant to EV deployment that utilities lack, namely, their ability to enact regulations surrounding EV infrastructure and preparedness, the potential for them to incentivize EV purchasing and usage, their ability to leverage public real estate for EV deployment, and their freedom to actively promote EVs and engage in related outreach and educational efforts.

Overall, the EMAP project was uniformly regarded by project partners and contributors as a complete success, with the value of the process exceeding expectations. Recommendations stemming from the project are already beginning to manifest themselves in the policies and practices of participating local electricity distribution companies. Powerstream, for example, decided in 2015 to move forward with the planning and installation of a network of Level 3 charging stations in the Markham area. This network will help to address the range anxiety of prospective EV users while maximizing the convenience of charging in high-traffic commuting corridors. All partnering utilities will undertake work in the coming years that will largely determine the ease with which their customers are able to

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make the switch from gasoline-powered to electric vehicles – work that will be founded on the outcomes of the EMAP project.

As EV uptake rates continue to accelerate around the world, exceeding market penetration estimates from only a few years ago, it is important that Canada's local electricity grid operators are ready for a paradigm shift in personal transportation. Positioning utilities to play a critical facilitating role in accelerating the adoption and use of EVs was the core ambition of the EMAP project, and will stand as its core achievement.