

# Driver Experiences with Electric Vehicle Infrastructure in Ontario, Canada and the Implications for Future Policy Support

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On the 14th of February this year, Canada's Minister of Innovation, Science and Industry announced that the Canadian government was investing \$8 million to construct 160 fast chargers for electric vehicles at 73 locations in the Province of Ontario. The federal policy on energy and the environment has included the goal of encouraging the purchase of electric vehicles (EV) by Canadians as part of a strategy to reduce greenhouse gas (GHG) emissions.<sup>1</sup> From 1990 to 2017, emissions from the transportation sector in Canada grew by over 40% accounting for approximately 24% of total national GHG emissions (174 megatonnes of CO<sub>2</sub>eq) and second only to emissions from the oil and gas industry.<sup>2</sup> The Greater Toronto and Hamilton area (GTHA) is both Ontario's and Canada's densest urban corridor and as such is faced with significant transportation-related challenges such as traffic congestion and local pollution. With increasing national environmental consciousness, federal government policies have re-focused their attention on urban reform and GHG emission reduction goals. Electrification of transportation is considered important to meeting those goals and as part of that strategy, government policy has specifically targeted the expansion of EV-charging infrastructure. Provincial policies in British Columbia and Quebec have provided purchase rebates for EVs since 2011-2012 and when the Ontario government cancelled its rebate program in 2018, the federal government introduced its sales rebate program in early 2019. These policies have combined to encourage the adoption of both battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEVs) in Canada (Figure 1).

The government's technology push strategy can contribute to assisting in the diffusion of EVs in the

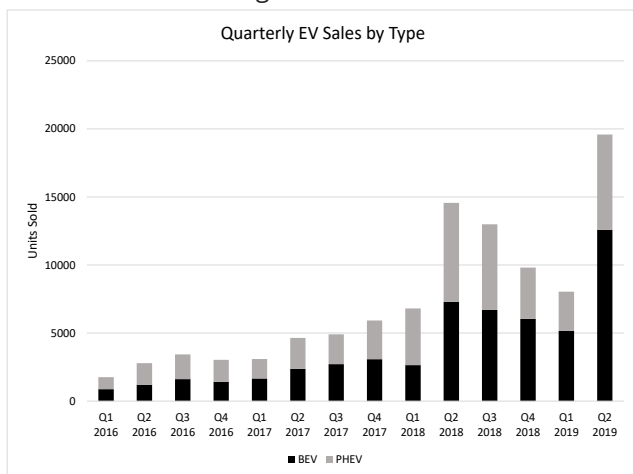


Figure 1 – EV Sales by Type (Source: Electric Mobility Canada)

marketplace but a certain level of technology pull is also required. Consumer acceptance of EVs is essential and recent studies in North America have shown that in addition to the common dissatisfaction with the higher initial pricing of EVs, consumers remain concerned about EV performance and access to charging facilities.<sup>3</sup> These concerns are driven to some extent by widespread misinformation and misunderstandings about the technology and, regardless of government policy to provide financial incentives to purchase, there remains anxiety on the consumer's part about the distance that EVs can cover per charge and the availability of charging infrastructure. Accordingly, this "range anxiety" persists as a major barrier to EV adoption in Ontario and the user-grid interaction has clearly become a priority for government, as reflected by their policy at improving and optimizing access to EV charging infrastructure.

In examining if the Canadian government's policy of investing in expanding EV charging infrastructure would be beneficial to the future adoption of EVs it helps to understand what current EV owners are experiencing in regards to range and availability of charging infrastructure. The justification of focusing on current EV owners instead of the broader car owner population is two-fold: first, technology adoption models consider ease of use and relative cost advantages as significant predictors of successful market diffusion and second, actual experience is preferred over perceptions. In 2017, a survey conducted by Plug'n'Drive, a Toronto-based non-profit organization that promotes EV use, asked 192 EV owners who live in the GTHA a series of questions pertaining to their experiences post-EV purchase. Access to that data was provided to us for further study and review. The outcomes of that study provided some interesting observations. Range anxiety turned out to be a relatively minor issue in contrast to non-EV owner perceptions with only 14% of EV drivers expressing dissatisfaction with the distance that can be travelled on a fully-charged battery. When it came to driving distances greater than 100 kilometers, approximately three-quarters of respondents used their EVs to do so entirely (~54%) or sometimes (~20%). In terms of charging infrastructure, more than two thirds felt that electric charging systems were not complicated. This latter observation is likely due to the fact that over eighty percent of the EV owners surveyed had purchased vehicles that were plugged

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into regular 110V-120V electric wall outlets and most relied on overnight charging all of the time or some of the time (~83%). It also appears that their home or office charging experiences have eased their concerns about the complexity of faster AC Level II charging systems and DC Fast Charging systems. In regards to the time it took to charge their EVs at home or work, a significant level of satisfaction (Figure 2) was found with only a smaller number of owners having been dissatisfied with the time it took to charge their EV while at home (~5%) or at work (~15%). However, EV owner satisfaction with charging away from the home or work tells a different story, with nearly half of those who were on the road being dissatisfied with the time

it took to charge their EV. This was especially true when travelling longer distances along highways and in need of charging quickly (Figure 3) with only a minority of surveyed EV owners being satisfied with the availability of AC Level 2 charging stations (~27%) and a slightly better satisfaction result for highway DC Fast charging stations (~41%). From the ease of use perspective, this dissatisfaction with charging time and availability of charging infrastructure when away from the home or work can present itself as a potential barrier to adoption. An examination of the data in terms of the relative cost advantages of the EV when compared to a conventional internal combustion engine (ICE) vehicle found that a significant percentage of EV drivers were saving money on fuel (~85%) and maintenance (~79%) and most were satisfied with the associated cost of installing their charging system (~59%). The data gathered was subjected to correlation analysis to identify any statistically significant relationships between the EV drivers' current experiences and their willingness to consider purchasing an EV again. Generally, the EV drivers who were surveyed would likely do so (~88%) again supporting the importance of user experience with the technology as a significant driver for adoption. Of all the experience variables

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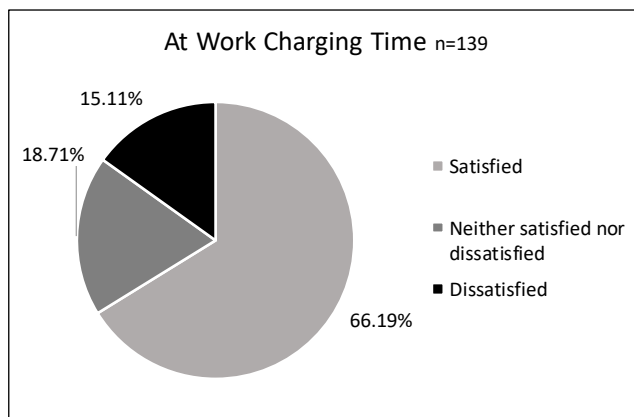
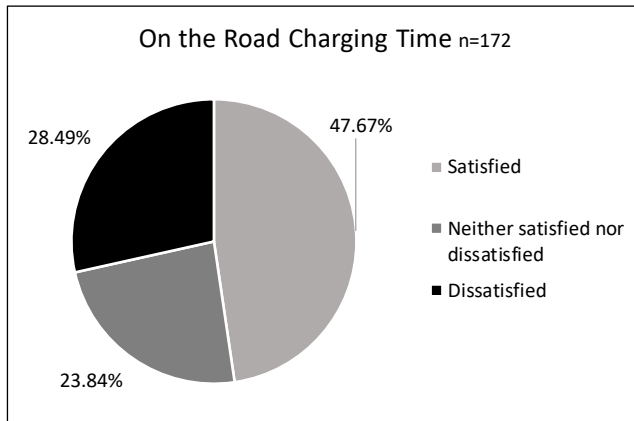
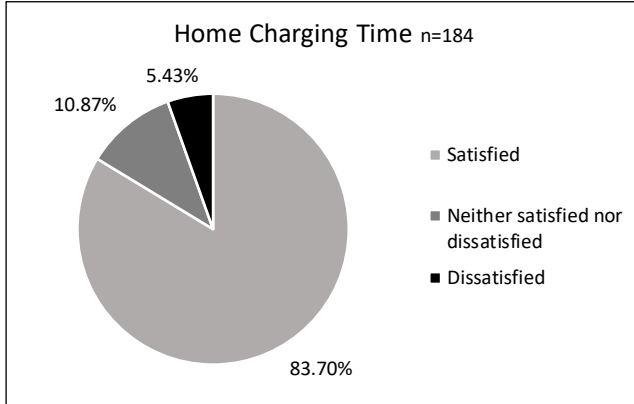


Figure 2. EV User Satisfaction - Charging Time at Various Locations

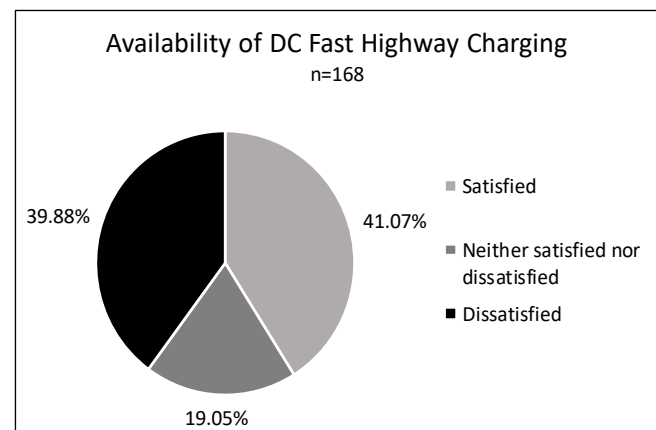
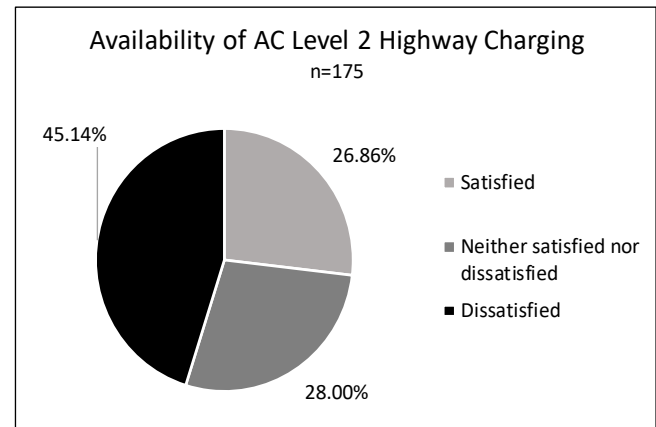


Figure 3. EV User Satisfaction - Highway Charging Availability