

Formalizing EV Infrastructure and Management on Dalhousie Campuses

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1. Executive Summary

This report provides some highlights and examples of Electric Vehicle (EV) infrastructure and management programs at eight different universities throughout Canada and the United States. Methods of analysis include interviews with important administrative positions that have a detailed understanding of their respective university's EV programs. This includes matters of usage, policy, management, and support of EV related issues on campus. The report finds that many EV programs on campus' throughout North America are in their early stages, and that there is no set EV management policy solution that can be implemented universally. The report also finds that the most successful and efficient EV programs are ones that connect important stakeholders including the municipality, community, dealerships, manufacturers, and the universities themselves. When these stakeholders work together, it creates a support network that makes it easier for EV owners to navigate, and encourages non-EV owners to consider this emerging market. Recommendations discussed include; better signage and policing of current EV stalls on campus, more education for students on EV and associated technologies, and a standardization of technology when it comes to the charging stations chosen. The schools parking policy should be updated to include matters related to EV. Finally the report recognizes the limitations of time, scope, and the infancy of campus EV programs at the respective universities. Future research should follow up with these universities in three to five years to give these programs time to learn from mistakes and perfect strengths.

2. Introduction

Fossil fuels and the methods used to acquire them are leading contributors to the global climate dilemma. The transportation sector plays a large role in emitting greenhouse gases into the atmosphere and in 2015 alone, this sector was responsible for releasing 173 megatonnes of carbon dioxide equivalent into the atmosphere (Government of Canada, 2017). In an attempt to combat some of the negative effects of climate change, industries and large institutions such as universities, are looking for sustainable alternatives that can be used to lessen their global carbon footprint. One proposed alternative that has gathered some traction in recent years is the use and

implementation of Electric Vehicles. EV's receive power through non-fossil-fuel sources, such as nuclear or other alternative energies, which is significant as it reduces the dependence on oil and the negative effects this non-renewable resource has on the environment (Larminie & Lowry, 2012). What is yet to be determined is the most efficient and effective means of managing and directing EV usage on campus. In order to best take advantage of emerging green technologies, policies and guidelines need to be set in place that allow ease of use and potential for growth. Currently, Dalhousie has no official EV management program, but is looking to take advantage of the opportunity presented through this green technology. Other universities in North America have begun to incorporate EV's onto their campus' with varying degrees of success. It is our goal to achieve a better understanding of other campus' and their relationships with EV in order to determine the best management practices that could potentially be implemented at Dalhousie. Our objective is to check the feasibility of implementation regarding management and usage policies of EV in the hopes Dalhousie University can become not only a participant, but a leader in the incorporation of EV technologies. The purpose of this project is to understand what successful EV implementation might look like, and then based on our observations of the data, we will make recommendations to Dalhousie administrators.

3. Methods

3.1 - Description of study design

For this specific study, which focuses more on the input of administrative bodies at various schools across North America, the group felt that an interactive method was required. However, we wanted to avoid methods such as surveys and questionnaires as the greater majority of the questions could not be answered by simply anyone, as they were directed towards those who are familiar with the EV management systems on their respective campuses. As such, we felt the interactive method of interviewing to be a more appropriate way of conducting our first-hand research. In class, the interviewing method was discussed in some detail, and a few of the highlights of this method include; the interviewer has a chance of receiving a higher response rate from interviewees, and there is a better opportunity to clarify any questions the interviewee may have or to ask for clarification for any of the answers (Mui, 2018). These advantages are based on the fact that interviewing is a more direct and personal way of making contact with an

individual and thus interviewees will feel more inclined to respond and more comfortable and willing to ask questions for clarification. As the research we conducted looked at schools across North America, face-to-face interviews were therefore impossible, and so the telephone interview method was alternatively chosen.

The academic book titled, *Research Decisions - Quantitative, Qualitative, and Mixed Methods Approaches*, considers the different methods of sampling, and this is where we have drawn our sampling method from. The sampling tool that fits our study is the non-probabilistic sampling procedure of purposive sampling, since we have identified that our technique is one that identifies a target population, which inevitably expresses our interests and objectives for the study (Palys & Atchison, 2014). Furthermore, within this procedure, our method can be narrowed down as an example of the intensity sampling strategy. The book states that this sampling strategy employs “sampling people whose interests or vocation makes them ‘experiential experts’ because of their frequent or ongoing exposure to a phenomenon” (Palys & Atchison, 2014). Thus, this method, procedure, and strategy is most pertinent to our specific case study, as the method we have chosen targets an audience of specific individuals at certain university institutions who are very familiar or to an extent “experiential experts” of the EV programs on their campuses.

3.2 - Procedures

After receiving feedback on our two potential research topics and deciding on the EV case study, we were told to contact Rochelle Owens. Rochelle is the Executive Director at the Office of Sustainability, and as she is currently in the process of developing a project regarding EV's, it was recommended that we receive input from her on an area of the study that would be beneficial to the study, for us to focus on. We first contacted Rochelle on Tuesday, the 13th of February, and after some trouble getting a response as she was away, we were finally given a more refined research topic through email on February 22nd. Rochelle told us to focus in on an important aspect of the EV program at Dalhousie University, creating a more fulsome EV charging station management approach for each of the campuses.

After receiving a response on a more refined research topic, we began work on our research proposal. As we chose the interview method for our report, we needed to develop research questions to fit with the themes of the information we were hoping to find out.

Furthermore, we considered an ethics review, but determined that the topic of study and the questions we were asking did not require one. An face-to-face meeting with Rochelle was made to inquire about further mentorship in terms of directions for the project. The meeting took place on March 5th, and the information that came out of the meeting was incredibly useful. We were thus able to formulate a more complete research topic and refine the research questions we were going to use for the interviews. We were further given recommendations of potential universities to contact for our research, based on their involvement with EV management programs at their respective schools.

After submitting our proposal and meeting with Rochelle, the weeks ahead were mostly dedicated to contacting the various schools and interviewing the correct person. The universities were divided up amongst group members, with each member being given 2 schools to contact. Furthermore, we came up with an introduction for each group member to use when calling that explained to study, our reasons for calling and to make it clear that we would be recording answers from the interviewees. In an article on the propriety of telephone interviews, there is discussion on the importance of having an introductory script at the beginning of the phone call to establish the credentials of the research and the identity of the interviewer (Glogowska, Young & Lockyer, 2011). Reflecting on this now, for these reasons and the added benefit of making sure the interviews followed ethical guidelines of keeping the participants informed, it was a beneficial decision to include an introduction.

The group decided to meet again about a week before the Pecha Kucha slides were due to discuss the information we had collected up to that point. By this time, we had complete answers from five universities regarding their EV management systems. We decided to go ahead with our Pecha Kucha presentation with the answers from these schools, as we wanted to leave enough time to create a well-rounded presentation. A sixth response was received after the first meeting, which we then added in a few days before the presentation, during a second meeting. We also delegated sections of the final report to each group member during this meeting so as to leave a sufficient amount of time to work on the assignment before the due date. We met as a group one last time on Monday the 9th to go over the report as a group, make any edits or changes and add in any final information before submitting the final report.

3.3 - Limitations

There were a few limitations to this project that in turn impacted the results of our study. To begin, one of the most difficult challenges was during the information/data collection stage of the study, and the challenge pertained to simply getting in contact with the correct person to interview. Much of our time during this stage was spent either talking to the wrong person, who did not know about the EV program, or finding it extremely difficult to get in contact with the right person who did know the information we needed. In the article discussing propriety of telephone interviews, the authors consider this as a limitation of the telephone interview method, as finding proper times to make the calls and record the answers can be challenging (Glogowska, Young & Lockyer, 2011). As a result, it was somewhat difficult to collect data from all of the schools that were initially recommended to us, and thus a few of the schools we used were backup options.

Another issue the group found with the data we collected was the simple fact that most of the EV management programs at these universities are relatively new as well. There were only one or two schools that we made contact with that have established EV management programs on their campuses. Otherwise, most of the schools have one or two EV chargers currently on the campuses, with plans for the establishment of more in the near future. This affected our results significantly, as it has made it very complicated to try and develop a management plan for our school, based off the lack of useful data we were able to collect from other the programs at other universities.

4. Results

The results from our research were based on the responses from the individual universities that we contacted. There are a few considerations to keep in mind regarding the data we collected, one being that York University's only public EV charging station was donated for research purposes. Therefore, the university did not undergo a full preliminary decision making process when installing the station. For instance, York was unable to choose the model or level of the station, whether it went in before or after construction, or how payment was set up. Additionally, the University of Toronto's EV program is exclusively private, thus it will be excluded from results pertaining to public participation. We found the most crucial responses to consider towards improving Dalhousie's EV management was implementation of EV stations as

they relate to building construction, department(s) responsible for management, cost of charging, local support for EVs, campus policy, and motivations for establishing an EV program on campus.

Primarily, we found that implementing EV charging stations during construction of with a new building as opposed to post construction, is the most effective time for implementation. We found the predominant reason for this was cost efficiency. The cost estimates for implementation of a charging station post construction ranges between \$32 000- 50 000, which is far more expensive than estimates for station implementation during construction (Gary Cremeens, 2018, *Personal Communication*). It further poses difficult for new EV charging infrastructure to adapt to existing buildings that were not designed to accommodate it.

Department specific responsibilities towards EV infrastructure varied among the Universities we studied (as outlined in table 2). The focus of this research was to identify who was accountable for general management, and especially maintenance of EV stations. Largely, it was the parking services department who took on the bulk of the management responsibility, due to the considerable role of parking and signage within EV infrastructure. Facilities, transportation, and maintenance services were also common departments across the Universities to assume responsibility. Alternatively, both Cornell University and the University of Guelph have contracts with their EV charging stations' manufacturers who attend to the maintenance of the stations.

The cost of charging and the method of payment varied across the universities (see figure 3). York University was the only school studied that intends to charge payment via credit card or a student card for payment at stations. The single station currently on campus has no charge, due to its purpose of research, however there is plan in place to install EV charging stations during construction at the new campus in Markham. These stations will require credit or student card, with prices determined based on location. Western University used an external payment method whereby charging station users must load a card through the company Chargepoint. This decision was largely based on accessibility for users, as Chargepoint provides a social and technical network for EV users that makes tasks such as finding charging stations, automakers and businesses more efficient. Apart from these two universities, the remainder of universities we studied all did not require payment for their charging, however they did require a valid parking pass and the fees for these passes varied across the universities. Cornell University was

the only school that offered truly free charging, with no direct payment at the station or parking pass required.

The policies concerning the EV charging stations were also a main focus of research. Most of the universities do not have firm policies in place due to the fact that they are only in the beginning stages of their programs. While there are different charging stations and signage between fleet and public EV stations among the campuses, public EV's tended to fall under the same campus guidelines as gasoline vehicles. We found that the University of Guelph, Queen's University, and Western University had varying ways of approaching policies and associated penalties. The only requirement of EV users at campus charging stations at the University of Guelph is that once their vehicle has fully charged, the vehicle must be removed from the designated charging spot. Queen's University plans to allocate a number of spaces near their parking lot charging stations that will be clearly identified, and the spaces will have a 4 hour limit for EV users, which will be enforced by parking services. Western University plans to have four parking spaces for their two new EV charging stations designated for EV users. The intent is so that two users can be charging while two users wait in cue, which will encourage high turnover rate if users can see other vehicles waiting to charge.

The support of the community regarding campus EV infrastructure was somewhat substantial across all the universities studied, considering that most of them were still in the beginning phase of development. However this support did not extend as broadly to local dealerships and maintenance, with the exception of the University of Calgary and Cornell University, who both reported good dealership support. Many of the universities claimed that while there are sufficient retailers of EV's and EV stations for purchase, there is not enough support for when the stations need repair. The manufacturer of the electric engines for one of the EV fleets at the University of Toronto, for instance, has gone out of business, and thus the school has experienced an end to the maintenance support for this vehicle. It has also become difficult to repair the other brands of EV's they have in their fleet due the fact that only specific dealerships have the expertise to provide maintenance, however there are none in the area that the university is aware of. The University of Guelph mitigates this threat to their EV program by having trained their mechanical shop employees to be able to fix charging stations in house.

Finally, the motivations for campuses entering the EV program were considered. We found reasoning to be largely focused on environmental consciousness and EV research. Most of

the universities expressed their interest in taking part in green technology. Cornell University admitted that supporting EV infrastructure on campus was a step towards lessening dependence on foreign non renewables such as oil.

5. Discussion

5.1 Purpose of Our Research

This research was conducted to understand the various usage and management procedures of electric vehicle charging stations at designated universities across Canada and in the United States. Questions asked during the interview stage were subdivided into subcategories of infrastructure, usage/operational cost, maintenance and dealership/community support. In doing so, we were able to determine some significant findings, such as; the number of charging stations available on campus, and the make and model of the installed charging stations. We were further able to determine if the EV charging stations were constructed prior or post construction of surrounding buildings and the impacts of construction either way, as well as determining the department responsible for maintaining this infrastructure.

5.2 Overview of significant findings

The initial goal of our study was to find beneficial policies and management practices across various universities, and to then deduce a structured policy for Dalhousie's own EV management program. However, each of the eight schools that we were able to contact gave varying answers to the questions posed. A similar trend we observed was the lack of an established EV management programs at each university. Furthermore, there were few specialized EV parking permit passes or parking spots for EV vehicles to ensure their proximity to the charging spots at most of the schools. Dealership support was fairly poor across the board, resulting in some universities opting for internal management and repairs from on-campus maintenance departments.

In the majority of the contacted schools, there were no policies on the usage and maintenance of the EV station. When considering many of the schools contacted, this may be the case because for the most part there is still only a very small community of EV users, with a total of between two to ten frequent users in some cases. We found that the policies regarding the usage of the EV charging stations were very similar to regular parking policies , this should not

be the case. Designated EV charging stations do not serve the same purpose as regular parking spots and as such, they should not have similar usage guidelines. Moreover, EV charging spaces often serve a dual purpose as a charging spot and parking in many of the contacted schools with no regulatory guidelines. This is problematic as it prevents other EV users from using the chargers even after the current parked car has been fully charged. Prior to conducting these interviews, we found that the study of EV management processes was lacking a substantial literature review. That is, there is a significantly low amount of research done towards EV management processes, making it difficult to develop a best practices method.

5.3 Recommendations

We examined the findings and although we were unable to determine a complete set of best practices that the university can employ, we were able to highlight some important recommendations to be considered for EV management programs in general. First and foremost, we recommend the involvement of various stakeholders as it was a common occurrence that the schools with the most multi-stakeholder involvement, also had the most established EV programs. Some of the ways other schools have sought to increase community support and awareness is through events like the drive share day at Cornell University and the Waterloo High School Electric Vehicle challenge. Stakeholder involvement from the different school departments is also essential and multiple school departments should work hand in hand to ensure a smooth operation of EV management on campuses. For example, the sustainability department can work with the parking department to enforce rules regarding things like the charging and parking time limit. We also found that support from local governments can prove to improve community support for EV's and by installing proper signage at EV stations. For example, the local government in the New York State has been pushing for a conversion to EV across the area, so as to decrease dependence on foreign oils and as such, places like Cornell University have received massive support from the government towards installation and increased use of EV charging stations. Finally, drawing from the recommendations from University of Calgary, a way to increase public awareness and usage of EV station is by constructing these station in University 'hot-spot zones' or high traffic areas and creating EV carpool priority parking spots. Putting EV charging station in central University locations will serve as an incentive to get an EV because, charging stations are centrally accessible.

A more cost effective approach should be taken in terms of adding an EV charging station post or pre construction of campus buildings (cost estimates for post construction range between 30,000-50,000). Adding an EV station to a building post construction, has more factors to consider such as; alterations to be made to existing building. More research should be done in choosing what technology/company to go with. An example is in the case of Cornell University - initially installed brand which went out of business two years after installment. there is currently no technical support from the manufacturers if the EV charger. Universities should exercise due diligence in Choosing a good company with a good history and promising future.

Finally, In terms of payment, we could not come to a unanimous recommendation. However, parking passes and daily passes proved effective as the form of payment. These payments were used to offset costs such as the electrical cost of the charging station.

6. Conclusion

6.1 - Recommendations for action at Dalhousie University

Overall, the results of this study were not what we expected, when keeping in mind the intended end goal. It was not feasible to formalize a complete plan of action for EV management at Dalhousie, as the various factors mentioned above limited the amount of valuable information we were able to gather. However, within this data we were able to determine a few important recommendations that Dalhousie can employ to aid in the creation of a more fulsome EV management approach on campuses.

More appropriate and effective signage concerning EV in general as well as the charging stations can prove to increase awareness and understanding regarding EV charging lots and how best to use them. Another recommendation we can offer is to develop a multi-management approach, which can help to alleviate pressure from just one department to oversee all components of the program. For example, parking facilities can manage things like ticketing, signage, enforcement and other policy related factors so that the Office of Sustainability can take on a broader role that is not responsible for the finer details of the program. Moreover, although it is not currently reasonable to consider creating a new position at Dalhousie dedicated to the EV management program that is still so small, when the program has time to grow and develop, this may be a recommendation to consider. Creating a specialized position can prove to further

alleviate pressure from other departments as well as concentrate efforts towards EV in that direction. When looking at current parking policies at Dalhousie, we took notice that there are proper rules and regulations in place for gasoline vehicles, however EV is not mentioned under these guidelines or in its own section. As mentioned, some schools have specific rules and regulations regarding EV charging stations, and as this infrastructure has unique needs, a separate section for EV policy and guidelines can prove to enhance consumer consideration and accountability.

6.2 - Recommendations for further research

As EV's are still a relatively new concept, most EV management programs at universities are currently still in their infancy. As a result, there is not yet a set of best practices to follow from any school as most are just starting to develop programs. Thus, it is important to consider what further research needs to be conducted in order to one day reach a conclusion on EV management system best practices.

It will be incredibly important to consider not only the various current technologies, but also what new and upcoming technologies are being introduced onto the market. This will help determine what technologies are best to implement and which to avoid, based on factors relating specifically to Dalhousie's EV program. Furthermore, research dedicated to community, dealership and local government support can prove to determine how to improve factors such as efficiency, demand and infrastructure. It would be interesting to study which kind of EV presence can incite substantial local support; whether community and EV users give rise to improved dealership and maintenance presence, or alternatively if existing dealership and maintenance support is evidence for more EV usage. As a final thought, it would be incredibly useful to follow up with the schools we have interviewed in three to five years to see what progress has been made. As mentioned, since most of the EV programs are only in their infancy, to see what new ideas, techniques and technologies have been employed can help to formulate a more complete management approach for the future.

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9. Appendix

	Number of Stations Currently Operating on Campus	Number of Stations With Construction Underway Aimed at 2018 Completion
Western University	0	2
University of Toronto	3	0
York University	1	0
Queen's University	2	62
University of Guelph	6	0
Cornell University	18	0
University of Calgary	1	1
University of Victoria	5	4

Figure 1- An Account of EV Charging Stations on University Campuses

University	Department(s)
Western University	Parking Services
University of Toronto	Facilities and Services
York University	Maintenance Parking Services
Queen's University	Parking Services Facilities
University of Guelph	Physical Resources within Sustainable Transportation and Parking Services Manufacturing company of stations (responsible solely for maintenance)
Cornell University	Transportation and Delivery Services Manufacturing company of stations (responsible solely for maintenance)
University of Calgary	Fleet Department & Electrical Shop
University of Victoria	Facilities Contractors if required

Figure 2- University Department Responsible for EV Management and Infrastructure Maintenance

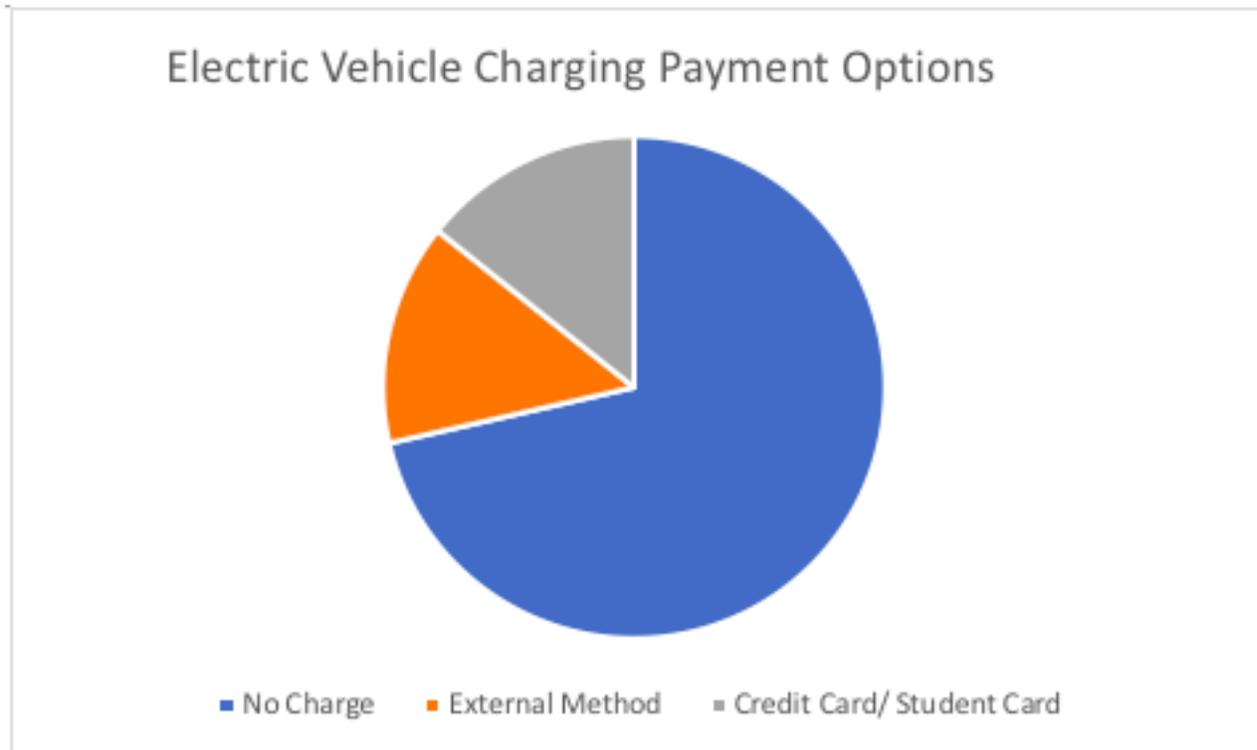


Figure 3: Payment Options at University Campuses' EV Charging Stations

*Note that the University of Toronto is not included among this data considering it is a private system that does not require payment at each station