THE GAP BETWEEN ELECTRIC AND CONVENTIONAL VEHICLES: ELECTRIC VEHICLE CHARGING INFRASTRUCTURE AND SMART CITY PARKING SOLUTIONS

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ABSTRACT

With the recent incentives to practice sustainability in transportation, many government bodies are spending money on advancing Canada's charging infrastructure network to encourage Electric Vehicle (EV) consumerism (Natural Resources Canada, 2017).

This paper will bring attention to the large infrastructure gap between electric and conventional vehicles, and to discuss strategies that help bridge this gap. The first portion of the paper will be to first discuss ways to effectively manage parking space in urban areas for both conventional and EVs. Then, the latter half of the paper will focus on developing EV charging infrastructure to establish long-term consumer confidence in EVs.

INTRODUCTION

Throughout the past decade, the public transportation sector has motivated industry leaders and public officials to encourage sustainability practice in the transportation sector; this strong force has been the root cause for EV developments by some of the world's largest car manufacturing companies (Marowits, 2018). Despite these efforts, not much success has been obtained in EV consumerism. The issue of compatibility for EVs within the existing road infrastructure has been a major issue in the full deployment of EVs, and a central topic in providing integrated smart parking solutions. This paper will look at solutions to solve this issue, and will elaborate on considerations that can be made in

planning and policy-decision-making in consumer EV adoption.

SMART CITY PARKING STRATEGY

Effective parking management is the key to developing a structure that is prone to mitigating traffic congestion by reducing unnecessary delays in drive time. With that, the three visualizing factors can be formed:

1. The ability for parking infrastructure to visualize a parking lot.
2. Visualizing parking lots' statuses
3. Visualize routes to parking lots

The first stage is in a way collecting information about all of the parking lots in a city, on parking capacity, rates, parking functionalities (such as EV charging). Then, the goal is to manage this data in an organized fashion, giving the public accessibility to users via the apps. If our parking lots can visualize multiple designated parking lots that are in close proximity to one another (within 2 km apart), then there is room for expansion of our technology driven transportation sector to determine our EV charging infrastructure needs. This principle is rooted to how accurate we can manage data. Big data management, short range communication devices, real-time data availability are required to help develop this stage. The extents of our innovations is also contingent upon how effectively we can integrate our ideas in a realistic and cost-effective manner. With collaboration between the Internet of Things (IofT) and software industry leaders, we can develop a new sub-sector predominate to EV charging infrastructure that may achieve the 'never before seen' in a Canadian context.

The next step is to give our infrastructure the capability to visualize the status of a parking lot at a requested, given time. This is essentially code for detection. If our infrastructure can easily detect vehicle occupancy, then there is hope for smart parking lot implementations in EV context. This stage is visualizing parking lots' statuses. If our infrastructure has the capability to maintain accurate information on various parking locations throughout the city, then giving customized updates to drivers during a given time

of the day is possible. The benefits to such a system are endless. For example, EV users could easily be updated on the status of a parking lot with charging amenities, without having to drive in near proximity to the parking lot to obtain this information. More importantly, these benefits would be available during any time of the day, even during peak hours – in real-time.

With the ability to have smart parking infrastructure that contains information of parking lot features, and the accessibility to give real-time updates to driver's regarding parking lots' availability statuses, advanced route planning becomes achievable. In downtown areas, on Wednesdays, cities such as Edmonton and Calgary constantly deal with parking lots operating at full capacities (Ferreras, 2017). Occasionally, there are a few parking spots available, and for drivers to identify these parking lots from the thousands of occupying parking stalls is time-consuming. In fact, drivers spend minutes looking for these available spots. These additional delays in driving time heavily contributes to the transportation carbon footprint, and is in fact one of the targets for reducing global emissions.

Potential areas for exploration is more transportation officials coordinating with the Google Maps Team to identify the needs to provide this service to drivers. Industry is equipped with this infrastructure at a preliminary stage: for instance, through Google Maps, drivers can plan their driving routes in advance, but they may lack information on parking spot availability for their destination. There have been several start-up companies that aim to synchronize these two capabilities by providing their own apps (distinct from Google Map), but these apps are generally restrictive to a handful of larger cities such as New York and Boston. No major success has yet been achieved to synchronize these two capabilities at a large global scale that would be user friendly for residents as well as tourists anywhere in North America. To deal with this idea, GPS systems can be extended by providing more local features, which would require more data storage capabilities and smart phone processors that can process apps with a much larger data than what is in the market today.

Although these features can be costly, and require major investments with the data companies and cooperation with transportation industry professionals, they would be beneficial in the long-run. These efforts help to ensure that parking is utilized efficiently at full capacity, and reduce drive time significantly. Effectively, proper management of our parking facilities helps us better manage our parking facilities, and helps us in understanding the infrastructure available for conventional vehicles.

AN EXPANSION ON PARKING INFRASTRUCTURE – EVs

If our society maintains a smart city parking strategy, then effective integration of EV infrastructure takes place more naturally. The process of visualizing a parking lot requires infrastructure that can extensively analyze amenities in various parking lots and provide the information to the right user. In a way, this is all about customization. The concept comes down to the fact that the economy is driven when revenue is generated. With the advancements in car manufacturing, industry shows that electrical vehicles will slowly and gradually populate our roads, and these vehicles like other vehicles will require charging infrastructure. To upgrade parking infrastructure, the option to provide electric vehicle charging on a selected number of parking spots is a starting point. Parking stalls equipped with charging functionalities can save drive-time to charging stations, and help lessen waiting time during charging period. Intuitively, charging integration in parking lots would generate revenue for the parking lots, save space, and establish reliability for EVs.

EV infrastructure in parking lots helps ensure that infrastructure is sufficient to meet demands. In recent initiatives – many provinces such as British Columbia have made promises to reduce CO2 emissions, and as a way to reduce the carbon footprint, attention has been geared towards EVs (Mertl, 2018). A new law that was passed on March 16, 2018 by Vancouver City Council requires that all parking stalls to provide electric car charging infrastructure for condos developed as of January 1st 2019 (Mertl, 2018). The provisioning of this charging station amenity will incur an added cost of $300 per parking stall for developers, which the city views as a cost-effective approach (Mertl, 2018). Efforts to

provide charging amenities in parking stalls for older buildings will cost more than $300, but will in the long-run help improve the lack of charging infrastructure for EVs, and push for sustainability in parking design (Mertl, 2018). In Alberta alone, there are parking stations dispersed in Edmonton, Calgary, and one in Red Deer (JWN Staff, 2017). The Southern Alberta Network project is currently in progress, with the goal of creating 15 to 20 EV fast-charging hubs for EV users (City of Calgary, 2017). Upon completion of this project, EV users will be able to drive through Southern Alberta, and drive through British Columbia and the United States (City of Calgary, 2017). Indeed, the existence of these charging stations will provide incentives for consumers to invest in EVs, and will steer the province towards sustainability.

All such provincial efforts will undoubtedly push for reducing the Canadian carbon footprint. However, the approach to sustainability is to maximize efficiency in every economic sector. That is to say that a sustainable future involves multi-faceted planning in transportation. As of today, there are only a handful of EV charging stations situated in Alberta, and governments are intending to establish the necessary EV charging infrastructure to encourage consumerism in EVs.

POLICY DECISION-MAKING SHAPING EV INFRASTRUCTURE

Like the policy adopted by Vancouver City Council, governmental jurisdictions may manage infrastructure spending on ways to optimize the performance and functionality of EV infrastructure. There are two streams to optimize infrastructure usage: 1) establishing a network of charging stations; 2) establishing a network for battery swap. To generate a successful model for an accessible network of charging infrastructure, a combination of the two methods could be implemented.

The latter case is a cost-effective revenue generating stream, requiring less charging infrastructure spending but may require a more solidified management plan to meet the nationwide widespread demand. The tools required for exchanging batteries, managing storage, and administrating the process will further add to the level of planning required. At

a preliminary stage, batteries, plugs and charging amenities can be operationally compatible for all EVs if manufacturers agree to produce charging products that are compatible and interchangeable for all EV models (Wittenberg, 2016).

If charging tools are compatible, then bridging the gap between EVs and conventional vehicles is a matter of a balancing act between maintaining the right supply of infrastructure, and establishing a distributed network across North America. Determining the most ideal battery swapping stations will require careful examination on factors such as an EV battery swapping model that thrives on consumer subscriptions to ensure the permanency of battery swapping practice. Another way of economizing the increase in electric vehicle charging infrastructure may be to have it as a side project for charging stations, offering customers pre-charged batteries at a premium rate. To ensure success, decision makers should consider implementing it so that it provides a constant stream of revenue, and provide a sense of consumer confidence in the reliability of battery exchange. The benefit of battery swapping are also in grid power adjustments, allowing more flexibility for the time to charge the batteries.

ENGAGING THE RIGHT STAKEHOLDERS IN DECISION MAKING

To best serve the public interest, and to help close the gap between electric vehicle infrastructure and gasoline fueled cars, there is a clear need to involve stakeholders; stakeholders include electric utility service provides who will be directly involved. As primary stakeholders, their goal is twofold: 1) to extract revenue in the most efficient manner; and 2) to obtain a more precise sense of planning for future loads on the gridline. For an electric utility supplier, the effective management of resources is key to market survival. With the measures passed on, there is possibility for charging vehicles in each residence to double, or even triple the load during peak hours. Effective resource management may take form in offsetting the load away from peak hour periods, and providing solutions to more balanced load periods. However, it is unclear of how much of that load our power systems can handle. It just may be that a whole re-design and re-

calculation of our power systems maybe required – at least in core downtown areas. The answer to this question will require further investigation, and is contingent upon the power efficiencies of the manufactured EV models.

SUSTAINABILITY OF EVS AND INCENTIVIZING CONSUMERS

Sustainability is critical in building a successful network of EV charging infrastructure. In particular, considerations to involve all affiliates/third parties is required to ensure that EV remains a viable alternative to gasoline fueled vehicles. In a way, the focus of policy decision making should heavily focus on guaranteeing a sense of long-term obligation for consumers for using charging infrastructure. One approach is to implement preventative maintenance programs for charging infrastructure. These services should be feasible, and the length for each maintenance contract should at the bare minimum improve the reliability of the charging infrastructure for users – to gain consumer confidence.

FINANCIAL ROLE OF GOVERNMENTS

The role of governments can primarily be in the subsidization of charging infrastructure in facilities. In particular, governments may financially assist with the retrofitting of older facilities to develop electric vehicle charging infrastructure (Marotte, 2018). In return, governmental efforts will help to achieve the green house emission reduction targets.

CONCLUSION

Over the past decade, there have been many initiatives to lessen the transportation global footprint. In other words, to ensure that supply meets demands, industry leaders can design for infrastructure that comprehends the amenities available in a given parking lot. This can include information such as EV charging station inventory. With this data processed, technology can then be used to provide parking lot status availability to drivers from remote locations. Lastly, the need for providing advanced route plans to parking lots with available parking is a must in integrating a smart city parking system that efficiently reduces traffic congestion. All these outcomes can further drive consumer confidence such

that EVs can be compatibly operational within our existing infrastructure, with minor modifications – such as implementing charging stations in parking facilities.

Overall, efforts to provide charging station amenities in parking lots will solidify the grounds for EV consumerism, as it will improve consumer confidence. The practice will reduce the load on current charging stations, and will drastically improve the supply for charging infrastructure – which will ultimately bridge the gap between conventional and EVs. Furthermore, extensive time may be dedicated to examine the feasibility of each electric vehicle charging infrastructure implementation to ensure that the matter of equity is addressed - are all stakeholders incorporated into the business model being developed, or is the concept of majority rules dominating the policy decision making.

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