ISSUES IN UNDERSTANDING THE SPATIAL DEMAND FOR CONSUMER ELECTRIC MOBILITY ACROSS CANADA

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Introduction

Few would argue that the automobile had a profound impact on the development of society in the 20th century. In an environment of high oil prices, sprawled cities, and negative implications of transportation emissions, there is the potential for electric vehicles (EVs) to have a very positive and comparable impact as they are adopted, particularly in jurisdictions with a "clean" electrical generation profile.

While electric vehicles have been briefly prominent at various times in the past, they have never caught on. There are some reasons to believe this time may be different. For one, consumers have more experience with clean automobile options through the prominence of hybrid electric vehicles which are viewed by many as a bridge to full EV adoption. Other telling factors are that battery technologies have improved and are improving dramatically and there is much more concern with the environment and greenhouse gas emissions than was the case in the past. According to researchers at the University of Waterloo, by 2030 the size of battery packs could decrease by almost half and their cost could be reduced by 75%. It is also possible that technologies other than lithium-ion will emerge.

Sales of plug-in EVs are at their early stages but forecasters are predicting up to 107,000 per year in Canada by 2020 (Pike Research, 2012) compared to the less than 2000 that were sold in 2012. Achieving that level of sales would still leave penetration levels at a small percentage of annual vehicle sales but would represent the largest toehold that EVs have ever attained. New models are being introduced more frequently. Recent examples are the Nissan Leaf, a

"pure" EV that runs only on an electric battery, and the Chevy Volt which can run in an extended range mode powered by gasoline if need be. Other auto manufacturers are seeing the EV market as a high priority.

A large share of existing EV research focuses on the engineering aspects of improving the performance of electric vehicles through better battery technologies and on electric grid infrastructure for adequate electricity supply and flexible refueling of electric vehicles. However, EV adoption will be associated with significant economic, social and environmental costs and benefits relative to the status quo of gasoline powered vehicles.

A central tenet of our work in this area is that the most credible cost-benefit scenarios will be based on work that is down to the level of the individual actors involved, be they individual consumers or particular firms and governmental entities. It is only through understanding the perceptions, motivations and attitudes of these individual players that the response to prevailing scenario circumstances can be accurately measured. Accordingly, the purpose of this brief paper is to consider some of the issues that are relevant in designing a survey instrument to best represent the consumer preferences of Canadians towards EVs.

Since the market for electric vehicles is largely an undeveloped one, the survey will be designed to accommodate stated preferences. In more fully developed markets, revealed preference techniques are appropriate as there is adequate evidence of the observed choices that people make. This is not the case for the EV market. There is a possibility that we will ultimately be able to construct discrete choice models that utilize revealed preferences to the extent that they are available along with the more voluminous stated preference results.

Development of the survey instrument will rely heavily on an extensive literature review to learn from experiences elsewhere and to use state-of-practice approaches in developing the survey. From a government policy perspective, it will be of value to learn about the types and values of incentives that have been used in other

jurisdictions and their current as well as projected EV uptake. Such policy questions are often addressed through stated preference approaches.

Recent examples of EV stated preference studies have included a an important national EV study for the U.S. (Hidrue et al., 2011) and a Carnegie Mellon study that has contrasted preferences toward EV technology in the U.S. versus China (Helveston et al., 2014) The former U.S. study is based on a representative national sample of about 3000 where respondents were asked to choose between their preferred gasoline vehicle and two EV options that differed from the respondents preferred gasoline vehicle only in select attributes. In Canada, to the best of our knowledge, a national-scale EV stated preference study has of yet not been carried out.

Methodology

The stated choice experiment will be based on a range of scenarios that respondents will need to evaluate. Each scenario will present 3-4 vehicle alternatives, one of which will need to be chosen. To make the choice, a respondent will estimate their expected utility for each option based on the attributes associated with each hypothetical vehicle.

The best way to describe the stated preference approach is to consider the illustration shown in Figure 1, which was developed to compare a gasoline, hybrid and alternative fuel vehicle. During the survey, the respondent will be presented with a series of screens similar to this one. For each screen they will evaluate the vehicles provided in terms of the associated attributes and choose one of the options. In Figure 1, the more expensive hybrid vehicle is shown to have fast acceleration and lower maintenance and fuel costs. The respondent needs to evaluate the trade-offs between vehicles and make the choice that makes sense for them. Another screen will collect information about the respondent such as postal code and various demographic measures to provide all the ingredients necessary for a subsequent statistical modelling exercise.

Figure 1: Sample Stated Preference Scenario

	VEHICLE A	VEHICLE B	VEHICLE C
Fuel Type	GASOLINE	HYBRID ELECTRIC	ALTERNATIVE FUEL
Vehicle Class	MIDSIZE CAR	LARGE CAR	COMPACT CAR
Acceleration (0 to 100 kph)	9 SEC	6 SEC	6 SEC
Maintenance Cost per Year	$1400	$700	$700
Fuel Cost per Year	$2100	$1680	$420
Pollution Level	85% OF PRESENT DAY AVERAGE CAR	75% OF PRESENT DAY AVERAGE CAR	75% OF PRESENT DAY AVERAGE CAR
Fuel Availability	AVAILABLE AT ALL STATIONS	AVAILABLE AT ALL STATIONS	1 OUT OF 10 STATIONS
Incentive	NOT APPLICABLE	NONE	NO PURCHASE TAXES
Purchase Price	$35000	$38500	$28000
Choose One Vehicle	○	○	○

Source: Potoglou and Kanaroglou, 2007

In the case of a complete stated preference experimental design, there might be well over 100 distinct scenarios of the type that are shown in Figure 1 in order to thoroughly test the response to different attribute values such as price point, vehicle range, or generosity of incentive. No single respondent to the survey will be subjected to such a large number of scenarios and most will be expected to deal with no more than ten; however, over many respondents, all scenarios would be dealt with adequately.

Overview of Survey Issues

This brief overview paper concludes now with a point form list of some the key issues that will need to be taken into account in developing the survey:

- A necessary element of a successful stated preference experiment will be the development of a representative sample of people to

respond to the survey. There are several private firms that specialize in the collection of survey data through survey panels that they have assembled. Some of the largest firms have panels composed of hundreds of thousands of potential respondents throughout the country. Individual potential respondents within survey panels are willing participants in surveys and are incentivized to participate in surveys. Use of a survey panel essentially does away with concerns about low response rates and achieving a representative sample.

- The main consumer survey will be administered in 2014 but we also plan to insert a longitudinal element by revisiting the consumer panel in 2017 to track how preferences will have evolved in that time frame. The latter survey will be of a smaller scale.

- To permit the most in-depth comparisons between different provinces/regions and to provide interesting results specific for each province/region, we will employ a stratified approach. For example, a straight forward national sample might not produce enough observations from Atlantic Canada to permit significant statistical conclusions. A stratification process across regions, on the other hand, would permit the collection of more observations from Atlantic Canada than its population would suggest.

- It will be important that the sample conform well to the population across variables such as age and income distribution, education, type of residence and other variables of importance. At this point the most likely sample count we would aim for is 20,000 across Canada.

- Consideration will need to be given to the types of questions that will be posed to respondents in terms of identifying who they are. This may involve questions about their age, household income levels, type of dwelling, do they have a garage to assist with charging, and where they live (i.e. postal code) among other factors.

- The definition of the vehicle attributes will be an important element in the development of the experiment as these, ideally, should be the attributes that people use in reality when evaluating a vehicle choice. Moreover, the chosen attributes will need to be specified in a way that respondents can relate to them. Likely vehicle attribute themes that we will need to focus on include: the range of the vehicle and how it can be less in winter, presence of recharging/refueling infrastructure, purchase price of the vehicle, annual fuel/electricity costs to operate the vehicle, and the annual expected maintenance costs. Other themes might include the presence/effectiveness of government incentives and the performance of the associated vehicle as measured by a criterion such as acceleration. Along with the questions of which themes/attributes to cover there is the question of how optimally to express same to respondents.

- To provide the best statistical properties for subsequent model estimation, an appropriate experimental design matrix (D. Potoglou & Kanaroglou, 2007) will be developed. For each attribute of a vehicle, a range of "levels" or values will be explored. It will not be practical to develop scenarios for every combination of values and every type of vehicle. An appropriate experimental design will limit the required number of scenarios while preserving the required statistical properties of the experiment.

- The need for "warm-up" questions and educational material prior to responding to scenarios

- The possible need for a mechanism for people to express their support for the concept of EVs while not necessarily being willing to "purchase one" in the set of scenarios (see Hidrue, 2011)

References

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