Consumer lifestyle and response to low-carbon technologies: Semi-structured interviews with plug-in electric vehicle owners in British Columbia, Canada

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Ethics Statement

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Abstract

Lifestyles can play an important role in shaping consumer behaviour in regard to novel low-carbon technologies. In this study, I utilize a conceptual framework from lifestyle theory, which defines lifestyle as engagement in several related practices that inform and convey self-identity. I apply this theory to the case of plug-in electric vehicle (PEV) technologies by conducting 17 interviews with PEV-owning households in Greater Vancouver, British Columbia (Canada). I use content analysis to characterize the 17 participants based on engagement in technology-oriented or pro-environmental lifestyles, and group them into four segments: Tech Enthusiasts, Low-tech Greens, High-tech Greens, and Other. The six participants in the Other segment did not engage in either lifestyle and were thus driven primarily by other motives. Some patterns of behaviour with the technologies are fairly consistent across the sample and across lifestyle segments, as most participants: express greater interest in battery electric vehicles (8 of 17) than plug-in hybrids (1 of 17), report driving more after purchasing a PEV (12 of 17), and express high levels of interest in utility controlled charging programs (13 of 17). A range of motivations appeared to influence participants' behaviours, including "practicality", "embracing technology", "environmental protection", and "supporting innovative companies". Such motivations tended to correspond with participants' lifestyle engagement: participants in pro-environmental segments (Low-tech Greens and High-tech Greens) emphasized environmental attributes, participants in pro-technology segments (Tech Enthusiasts and High-tech Greens) emphasized technology and innovation, while "Other" participants emphasized more tangible functional attributes, such as affordability and practicality. Together, these findings suggest that policymakers and researchers should consider the variety of motivations that may influence consumer interest in, purchase, and use of low-carbon technologies, which may relate to a variety of benefits such as cost, environment and technology.

Keywords: Plug-in electric vehicles; Pro-environmental technology; Motivations; Behaviour; Lifestyle; Interviews

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BEV	Battery Electric Vehicle
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
UCC	Utility Controlled Charging

Chapter 1.

Introduction

Low-carbon technologies such as plug-in electric vehicles (PEVs) offer the potential to substantially reduce greenhouse gas emissions (Williams et al., 2012). PEVs include plug-in hybrids that can be powered by gasoline or electricity and battery electric vehicles that can be powered only by electricity. Within Canada, PEVs are capable of reducing well-to-wheel greenhouse gas emissions by as much as 79% to 98% in British Columbia, 58% to 70% in Ontario, and 44% in Alberta with current electricity generation sources (Axsen, et al., 2015). The emission reduction potential of PEVs can be further improved if the adoption of PEVs is integrated with increased deployment of renewable energy sources such as solar, wind, or hydro (Hart & Jacobson, 2012; Lund & Kempton, 2008; Williams et al., 2012).

Despite the potential of new PEV technology to reduce greenhouse gas emissions in the passenger vehicle sector, their success ultimately depends on consumer behaviour. In this study, I explore what motivates consumer interest in, purchase, and use of PEV technologies (i.e. what I refer to as “PEV-related behaviours). I utilize a conceptual framework from lifestyle theory to examine how motivations and PEV-related behaviours vary by lifestyle.

Lifestyle theory draws from the work of Giddens (1991), which states that individual identify is reflexively linked with engagement in various lifestyle (Giddens, 1991; Axsen, TyreeHageman, & Lentz, 2012). A lifestyle consists of sets of related practices; for example, a consumer engaged in a pro-environmental lifestyle might frequently compost, recycle, and purchase used products—and in turn they may see themselves as being pro-environmental. This same consumer might express interest in PEVs due to a desire to own a pro-environmental technology that is consistent with their

pro-environmental lifestyle (Axsen et al., 2012). Similarly, a consumer engaged in a technology-oriented lifestyle might be motivated to purchase a PEV because they want to own an innovative technology that is consistent with that lifestyle (as opposed to pro-environmental lifestyle). The influence of lifestyles on consumer behaviour may also lead a consumer to reject PEVs if they perceive the vehicle as inconsistent with their current or desired lifestyle. For example, a consumer engaged in a recreation-oriented lifestyle that enjoys accessing remote locations may perceive limited range battery electric vehicles as inconvenient; as a result, they may lack interest in PEVs altogether. In other words, they might reject the technology if they perceive it as threatening their dominant lifestyle.

As part of the larger Canadian Plug-in Electric Vehicle Study (CPEVS, explained further in Axsen et al., 2015), I conducted 17 interviews with PEV owners ("Pioneers") in Greater Vancouver, British Columbia in 2015. I define Pioneers as the first buyers of PEVs, i.e. current PEV owners at the time of this study, when PEVs made up less than one percent of new vehicle sales in British Columbia. Thus, Pioneers are a relatively small and distinct group of consumers. In contrast, "Mainstream" buyers owned conventional gasoline vehicles at that time. Research has shown that PEV Pioneers are more likely to be of higher income and education, and have greater engagement in pro-environmental or technology-oriented lifestyles than Mainstream buyers (Axsen et al., 2015; Langman, 2015). Despite these unique characteristics, research on Pioneers can provide valuable insights into how future PEV buyers may respond to PEV technologies.

In the remainder of this chapter, I will provide further context for the present study. I provide an overview of the case technologies in Section 1.1; summarize the relevant literature on PEV-related behaviours in Section 1.2; review how lifestyle can shape PEV-related behaviours in Section 1.3; and conclude with my research objectives in Section 1.4.

1.1. The case technologies

In this study, I consider three emerging low-carbon technologies: plug-in electric vehicles (PEVs), public charging infrastructure, and utility controlled charging (UCC). I

collectively refer to the three case technologies as PEV technologies, since both charging infrastructure and UCC are designed to facilitate and interact with PEVs. In this section, I provide a brief overview of the three PEV technologies.

PEVs are motor vehicles that operate on electricity stored in rechargeable battery packs. There are two types of PEVs: battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). PHEVs, such as the Chevrolet Volt, have both an internal combustion engine and a small rechargeable battery back, and can be propelled by electricity or gasoline. BEVs, such as the Tesla Model S or Nissan Leaf, are powered exclusively by electricity from a rechargeable battery pack that is often larger in size than those utilized by the PHEV. Both BEVs and PHEVs can significantly reduce greenhouse gas emissions if they are operated using electricity that is generated from renewable sources, such as solar, wind, or run-of-river hydro. In British Columbia, where hydropower is the dominant source of electricity generation, PEVs are capable of reducing well-to-wheel greenhouse gas emissions by as much as 98% relative to conventional vehicles (Axsen et al., 2015).

PEVs can be recharged from an external source of electricity by plugging in to one of three different levels of electrical service. Level 1 charging relies on standard 110 V outlets and is best suited for long-term parking or PHEVs that have smaller batteries. Level 2 charging infrastructure is 240 V and offers faster recharging than Level 1. Level 3 charging (also known as DC fast charging) uses 480 V and can fully recharge a BEV in less than 40 minutes. PEV owners that recharge their vehicle at home often use either Level 1 or Level 2 charging infrastructure, but the latter typically involves the installation of a specialized outlet or charging unit. By comparison, public charging infrastructure is predominantly Level 2 and, to a lesser extent, Level 3. In British Columbia, between 2011 and 2014, more than 550 Level 2 public charging stations were installed compared to eight Level 3 public charging stations; by 2018, another 200 Level 2 and twenty Level 3 public charging stations plan to be installed (Eagland, 2016; Plug in BC, 2015).

The rechargeable battery packs of PEVs present electric utilities with a new opportunity to manage the electrical grid. Utility-controlled charging (UCC) is a general term for systems that would allow electric utilities to control the charging of PEVs by

managing charging rates, charging times, or the direction of electrical flow (Bailey & Axsen, 2015), which can include the concept of vehicle-to-grid (V2G) systems (Kempton & Tomić, 2005). Controlling the charging of PEVs can allow utilities to improve load management by matching electricity supply and demand (Druitt & Früh, 2012). In addition, UCC can help electric utilities to more efficiently incorporate greater levels of intermittent, renewable electricity into the grid by matching the timing of PEV charging to the availability of sources such as wind, solar, and run-of-river hydroelectricity (Parsons, Hidrue, Kempton, & Gardner, 2014; Weis, Jaramillo, & Michalek, 2014). A UCC program could offer cost savings to utilities that could be transferred to PEV owners to incentivize enrolment in the program (Fernandes, Frías, & Latorre, 2012; Kempton & Tomić, 2005).

1.2. Consumer response to PEV technologies

Consumer interest in PEVs and other low-carbon technologies can be motivated by number of factors. To aid analysis, some PEV consumer researchers categorize a technology's attributes as either functional, symbolic, or societal (Axsen & Kurani, 2012; Axsen, Orlebar, & Skippon, 2013). I provide an overview of this categorization in Table 1 below.

Table 1: Categorization and examples of a plug-in electric vehicle's attributes

Functional attributes	Symbolic attributes	Societal attributes
High performance (e.g. fast acceleration) Affordable (e.g. low operating costs)	Expression of self identity Communication of lifestyle engagement	Reduce air pollution and greenhouse gas emissions Increase energy security

Note: Table adapted from Axsen & Kurani (2012).

Functional attributes are those pertaining to a technology's use and operation, such as how a vehicle performs or how much it costs to own (Axsen & Kurani, 2012; Axsen, Orlebar, & Skippon, 2013). In addition, a technology can offer symbolic attributes that carry unique social or emotional meaning. For example, a PEV may allow an individual to express an aspect of their self-identity (Axsen et al., 2013; Heffner, Kurani, & Turrentine, 2007; Steg, 2005). PEVs also have attributes with "societal" impacts that extend beyond the user. For example, PEVs are capable of reducing air pollution and

greenhouse gas emissions (Axsen, Goldberg, et al., 2015; Williams et al., 2012). Consumer assessments of the functional, symbolic, and societal attributes often change and develop as consumers gain experience with the technology (Axsen & Kurani, 2012).

Market and economics-based research has typically focused on how PEV-related behaviours can be motivated by the functional attributes of PEV technologies, such as driving range, recharge time, as well as the capital and operating costs (e.g. Hackbarth & Madlener, 2013; Hidrue, Parsons, Kempton, & Gardner, 2011; Krause, Carley, Lane, & Graham, 2013). However, because these studies focus on functional attributes, their conclusions tend to focus on potential functional limitations of PEVs compared to conventional vehicles. The focus on functional attributes may ignore the influence that symbolic and societal attributes can have in motivating PEV-related behaviours – an influence that has been demonstrated by some recent analyses (e.g. Axsen, Goldberg, et al., 2015).

PEV-related behaviours can also be motivated by symbolic attributes that express meaning or identity (Heffner et al., 2007; Noppers, Keizer, Bolderdijk, & Steg, 2014; Steg, 2005). Products such as PEVs can provide access to symbolic meanings that help consumers express who they are or who they want to be (Skippon & Garwood, 2011). For example, consumers may be motivated to purchase a hybrid electric vehicle to express themselves as ethical, intelligent, or caring (Heffner, 2007). Similarly, they might express interest in PEVs if they perceive the vehicle as an environmental or technological symbol (Axsen et al., 2012), and they may be motivated to drive a PEV to express themselves as an environmentalist, someone who cares for others, or someone open to new ideas (Steg, 2005; Skippon & Garwood, 2011).

The societal attributes of PEV technologies can also play an important role in motivating PEV-related behaviour. For example, the ability of technologies to reduce greenhouse gas emissions have been found to influence consumer interest in, and decisions pertaining to, various vehicle types (Gallagher & Muehlegger, 2011; Lieven, Mühlmeier, Henkel, & Waller, 2011) as well as utility-controlled charging programs (Bailey & Axsen, 2015; Bergmann, Hanley, & Wright, 2006; Langman, 2015; Noppers et al., 2014). Similarly, other studies have found that interest in PEVs can be motivated by

a consumer's desire to send a message to car companies to channel their innovation into more environmentally-friendly vehicles (Axsen et al., 2013; Heffner et al., 2007).

Although consumers can be motivated by a technology's functional, symbolic, and societal attributes, the most commonly used theoretical frameworks in alternative fuel consumer research focus on only one or two attribute types. For example, rational choice theory has been the paradigmatic approach to understanding PEV-related behaviours (e.g. Brownstone, Bunch, & Train, 2000; Ewing, 2000; Hidrue et al., 2011; Potoglou & Kanaroglou, 2007). The theory explains consumers as being autonomous decision-makers with static preferences, motivated by a desire to maximize their utility. Although studies that employ a rational choice theory framework can include functional, symbolic, and societal attributes, results often focus on functional attributes, such as consumers' willingness to pay for increased acceleration, added driving range, or decreased recharging time (e.g. Potoglou & Kanaroglou, 2007; Hidrue et al., 2011).

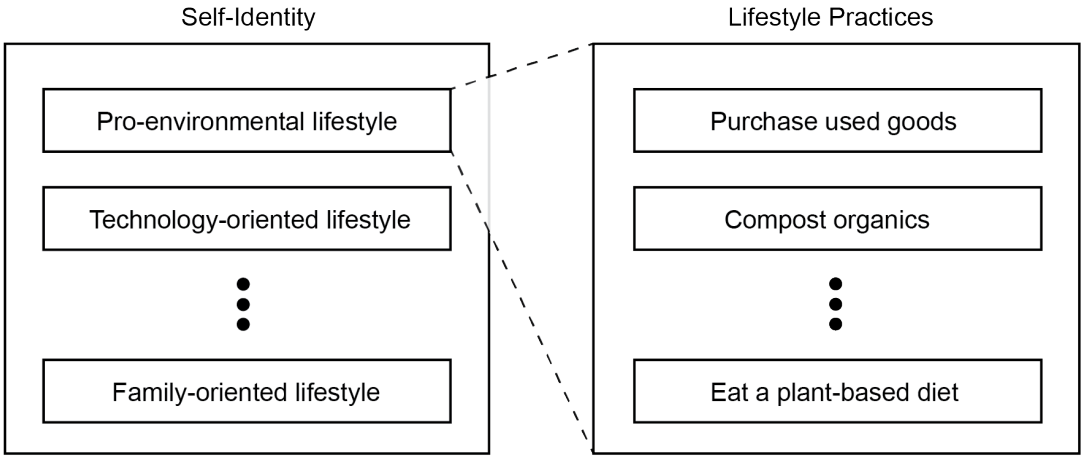
In the present study, I employ a framework constructed from lifestyle theory that is capable of addressing all three attribute types. Lifestyle theory explains consumer behaviour as being motivated in part by the need to engage in coherent patterns of lifestyle that represent an individual's self-identity (Axsen et al., 2012; Giddens, 1991). Accordingly, PEV-related behaviours can be viewed within the context of lifestyle engagement and identity construction (Heffner et al., 2007; Axsen et al., 2012; Axsen, Bailey, & Castro, 2015). I expand on this theoretical framework in the next section.

1.3. Lifestyle and PEV-related behaviours

Lifestyle theory explains consumer behaviour in the context of identity construction, theorizing that self-identity is informed and expressed by engagement in lifestyles. This approach is based on the theory presented by Giddens (1991), which was adapted and later applied to the study of consumer demand for pro-environmental technologies by Axsen et al. (2012). Building from these sources, I define lifestyle as engagement in several related practices that construct and express self-identity. For example, individuals that consider themselves to be pro-environmental might frequently engage in activities that relate to this lifestyle, such as purchasing used goods,

composting organic materials, and eating a plant-based diet. By engaging in these practices, other people may perceive the individual as someone who cares for the environment – or engages in a "pro-environmental" lifestyle (Axsen et al., 2012; Moulé, 2015). The same individual may concurrently engage in other lifestyles that contribute to other aspects of their self-identity (Giddens, 1991). For example, they may engage in a "technology-oriented lifestyle" and spend time repairing electronics, participating in online technology forums, and building their own computers. I provide a visual overview of this framework in Figure 1, and highlight how an individual's self-identity may be composed of engagement in distinct lifestyles (left-hand side of figure) that each consist of several related practices (right-hand side of figure).

Figure 1: Conceptual framework of lifestyle theory



Note: Adapted from Axsen et al. (2012)

Of course, consumers are not limited to engagement in pro-environmental and technology-oriented lifestyles. Researchers have identified several lifestyles consumers engage in, including spirituality-, recreation-, family- and career-oriented lifestyles (Axsen et al., 2012; Moulé, 2015). However, consumer research has found that early buyers of low carbon technologies are more likely than Mainstream buyers to be engaged in pro-environmental and technology-oriented lifestyles (e.g. Axsen et al., 2012; Axsen, Bailey, et al., 2015; Evans & Abrahamse, 2009; Whitmarsh & O'Neill, 2010). For example, Axsen et al. (2015) surveyed 1,754 new vehicle-buying households in Canada and found that the respondents that expressed interest in PEVs were significantly more

likely to be engaged in pro-environmental or technology-oriented lifestyles than those that were interested in hybrids or conventional vehicles.

Due to the prevalence of pro-environmental and technology-oriented lifestyles among Pioneers and potential early buyers of low carbon technologies, some researchers have segmented consumers based on their level of engagement in these two lifestyles (e.g. Axsen et al., 2012; Bailey & Axsen, 2015; Axsen, Bailey, & Castro; 2015). Axsen, TyreeHageman, and Lentz (2012) surveyed 711 new-vehicle buying households in San Diego and identified five distinct lifestyle segments using cluster analysis: engaged greens, aspiring greens, low-tech greens, traditionalists, and techies. More recently, Axsen et al. (2015) applied cluster analysis to survey data of 634 potential PEV buyers in Canada and identified six similar segments: strong pro-environmental, tech-enviro, concerned, techie, open, and unengaged. I provide an overview of these lifestyle-based segments in Table 2 below, illustrating that there is some overlap in the findings of these two studies—where several consumer segments can be defined by engagement in these two lifestyle types.

Table 2: Comparison of lifestyle segments identified in the two studies

Study	**Pro-environmental**			**Non-environmental**			
Axsen, TyreeHageman, & Lentz (2012)	Low-tech	Aspiring	Engaged	Techies	n/a	Traditional	n/a
Axsen et al. (2015)	Strong pro-environment	Concerned	Tech-enviro	Techie	Open	n/a	Unengaged

Although lifestyle theory can be used for understanding consumer behaviour in a variety of contexts, it is a particularly useful theoretical framework for understanding PEV-related behaviours. In most regions, practices associated with PEVs are novel and highly visible. For example, the practice of plugging a PEV into a public charging station in front of a restaurant is a rather new practice that may be witnessed by many members of the public. Conspicuous practices, such as vehicle usage, are more likely to invoke conscious consideration of lifestyle and self-identity compared to more routinized daily practices, such as watering a household's plants (Shove & Warde, 2002). As a result, the decisions a consumer makes in regards to expressing interest in, purchasing, or

using a PEV technology may be based on whether they perceive the technology's attributes to align or conflict with their lifestyles.

In conclusion, lifestyle theory explains consumer behaviour in the context of identity construction. Conspicuous practices, such as PEV-related behaviours, are likely to invoke conscious consideration of lifestyle and self-identity. In this study, I investigate whether motivations – and the resulting PEV-related behaviours – are influenced by a consumer's lifestyle engagement. I do this by conducting interviews with a sample of Pioneers and examining whether participants' interest in, purchase, and use of PEV technologies are associated with their engagement in pro-environmental and technology-oriented lifestyles. Based on the above discussion, I expect to find that participants' motivations and PEV-related behaviours will vary according to their engagement in these two lifestyles.

1.4. Research Objectives

In this study, I segment Pioneers (i.e. current PEV owners) into distinct consumer groups based on engagement in pro-environmental and technology-oriented lifestyles. I examine participants' PEV-related behaviours and motivations, and compare their prevalence across the consumer groups.

My sample consists of Pioneers drawn from the larger Canadian Plug-in Electric Vehicle Study (Axsen et al., 2015). As previously mentioned, Pioneers are expected to be of higher income and education than Mainstream buyers, and more likely to be engaged in a pro-environmental or technology-oriented lifestyle (Axsen et al., 2015; Langman, 2015). I sampled Pioneers in the province of British Columbia – a jurisdiction with a number of PEV policies, including purchase incentives for vehicle purchases, financial support for research and development, outreach campaigns to increase awareness, and rebates for charging infrastructure (Axsen et al., 2015).

I use qualitative data collected from the interviews to fulfill the following four research objectives:

1. Segment Pioneers according to lifestyle engagement;

2. Identify participants' stated interest in, purchase, and use of PEV technologies ("PEV-related behaviours");
3. Identify the motivations underlying these PEV-related behaviours;
4. Examine how the motivations and PEV-related behaviours relate to lifestyle engagement.

Chapter 2.

Methods

This study is one part of the larger Canadian Plug-in Electric Vehicle Study (CPEVS). CPEVS explores the potential market for plug-in electric vehicles (PEVs) in Canada and examines how consumer interest in PEVs may guide shifts in social and technical systems as the technology becomes more widely adopted. CPEVS addressed these questions by employing mixed-method surveys to a sample of 1,754 Canadian "Mainstream" new vehicle buyers (owners of conventional vehicles) and to a sample of 157 "Pioneers" (current PEV owners) in British Columbia. The surveys were administered between June 2014 and February 2015. Interviews were conducted with a subset of both the Mainstream buyers (see Langman, 2015) and Pioneers following completion of the surveys. The present study uses data collected from the interviews with PEV Pioneers. The full CPEVS can be found in Axsen et al. (2015).

2.1. Semi-structured interviews

I employed a qualitative interview methodology for data collection. Qualitative interviews are in-person interviews that allow participants to provide responses and data in their own words that they believe are relevant, without being limited to predetermined categories (McCracken, 1988). Participants are also able to carefully think through and develop their responses, and researchers are able to pick up on non-verbal cues including facial expressions, pauses and emphases in speech. The qualitative interview protocol I employed in this study was semi-structured. Semi-structured interviews use an interview guide to help structure the conversations, but researchers ask open-ended questions and allow conversation to progress in a natural manner. The semi-structured design enables researchers to identify and explore novel themes by allowing space for unanticipated answers. These characteristics make semi-structured interviews a useful

tool for exploratory research that aims to further develop theory that can later be tested via quantitative methods (McCracken, 1988). Accordingly, the semi-structured interview methodology I employed is well suited for identifying motivations (the perceptions that influence PEV-related behaviour).

2.2. Interview procedure

I conducted semi-structured interviews with 17 participants. I followed a purposeful sampling approach that identifies and selects a sample that is diverse and information-rich (Palinkas et al., 2013). In this study, I selected participants that had a range of demographics, vehicle models (i.e. Chevrolet Volt, Nissan Leaf, and Tesla Model S) and vehicle types (i.e. both BEV and PHEV). This diversity allowed me to explore motivations for PEV-related behaviours across a diverse group of consumers and examine whether patterns that emerged seem to be associated with demographic or vehicle characteristics rather than lifestyle engagement. I explain the sample further in Section 3.1.

I conducted the semi-structured interviews with a second researcher between December 2014 and April 2015. The interviews took place in participants' homes and were 1 to 2 hours in duration. The interview guide contained an outline of topics and prompts, but questions were open-ended and the conversations were allowed to flow in a natural manner. The full interview guide is provided in Appendix A and is summarized below into five parts:

1. Opening: We began the interview with a review of the participants' rights, an outline of the interview, and the consent form.
2. PEV purchase: The participants provided a narrative of their PEV purchase. This section explored the process and decisions made by the participant that led to the purchase of their PEV and involved prompts that encouraged the participants to explain their motivations as well as considerations between different vehicle types.
3. Vehicle charging and driving patterns: We asked a series of questions and prompts designed to facilitate discussion about participants' use of their PEV.
4. Charging design game: Participants completed a charging design game with two scenarios: (1) acceptance of a utility controlled charging program to support

green electricity development; and (2) acceptance of a utility controlled charging program for a discount on their electricity bill. The design game can be found in Appendix B.

5. Lifestyle: In the closing section, we prompted the participants to discuss their typical practices, hobbies, and interests in order to elicit, identify, and understand their lifestyle engagement.

In parts 2 and 3, I solicited PEV-related behaviours by first asking participants to explain how they came to purchase their PEV, whether they are more interest in purchasing a BEV or PHEV as their next vehicle, how they are currently using the vehicle, and how they recharge it. I then followed up with prompts as necessary. For example, I initially asked participants the following question: “Can you tell me about how you recharge the vehicle?” This question was followed up by a variety of prompts to encourage participants to share their usage, such as “where do you recharge it?” and “how does this process compare to refuelling a conventional vehicle?” In part 4 of the interviews, I solicited interest in utility controlled charging by having participants complete a charging design game (Appendix B). The game asked participants to opt in to a UCC program and select the amount of guaranteed charge they would sacrifice under two scenarios: the first scenario offered increased deployment of green electricity, and the second scenario offered a discount on electricity bills. I use participants’ PEV-related behaviours as a means to identify and examine their underlying motivations.

Motivations were elicited throughout the interview by asking questions that attempted to understand the influences behind participants’ PEV-related behaviours. For example, after participants explained how they are charging their vehicle, I would ask probing questions such as “what do you think of these charging locations?” and “why do you like (or dislike) the process of charging your vehicle?” Motivations were identified with statements such as “[public charging stations] are pretty convenient […] a lot of places that we go and do activities, there’s a place to charge”.

Participants’ lifestyle engagement was based on statements about their practices, interests, and identity. These statements would often emerge throughout the interview, but were also elicited through responses to specific questions in part 5 of the interview guide (e.g. “Can you tell us a bit more about how you spend your time?” and

"Are there any activities you take part in?"). I provide an overview of how this information was collected in Table 3.

Table 3: Methodology for identifying PEV-related behaviours, motivations, and lifestyle engagement

Concept	Definition	Method	Examples
PEV-related behaviours	Participants' stated interest in, purchase, and use of PEV technologies. Includes decision to purchase a PEV, interest in BEVs versus PHEVs, interest utility controlled charging, and use of PEVs and public charging infrastructure.	Parts 2 and 3: Questions about participants' interest in, purchase, and usage of PEVs and public charging infrastructure.	Participant explained they would be more interested in purchasing a BEV, rather than a PHEV, as their next vehicle.
		Part 4: Charging Design Game to identify interest in UCC.	Participant decided to enroll in a utility controlled (UCC) charging program.
Motivation	The perception(s) that influenced participants' PEV-related behaviours. Motivations can pertain to the functional, symbolic, or societal attributes of a technology.	Parts 2 to 4: Questions probing the underlying motivations behind participants' stated interest, purchase, and use of PEV technologies.	"[I wanted a PEV because] there's a lot less maintenance to do on an electric car than there is on a conventional gas car."
Lifestyle	Engagement in several related practices that construct and express self-identity. Consumers are likely to engage in multiple lifestyles, which can influence behaviour.	Parts 1 to 4: Statements about lifestyle practices and interests often emerged throughout the interviews without being prompted.	"I'm working on a couple of things now for the car, but this is from the perspective of me as a software developer and product developer […] I downloaded [a cupholder template] and I 3D printed a console unit for the car."
		Part 5: Questions about how participants spend their time, what practices they engage in, and what their interests and hobbies are.	"I tend to a do a lot of my own hobby stuff […] anything from soldering circuit boards to changing appliances or whatever in the house."

2.3. Data analysis

A third party transcribed audio recordings of the interviews. Data analysis consisted of three general stages. First, I analyzed the interview transcripts to identify themes using NVivo software. Second, I identified and rated the lifestyle engagement of each participant based on the lifestyle practices they described in the interviews. Third, I explored how the prevalence of the themes varied according to participants' lifestyle engagement. I provide a more comprehensive summary of these three stages below.

In the first stage, I used content analysis to analyze the interview transcripts. Content analysis is a useful analytical tool for identifying important themes in exploratory studies without initially constraining the full suite of themes that may be discovered (Hsieh & Shannon, 2005). Through this process, I identified themes in the interview transcripts by grouping participants' quotes into codes that highlighted distinct commonalities within the dataset (Hsieh & Shannon, 2005; Potter & Levine-Donnerstein, 1999). For example, a quote regarding a participant's vehicle purchase might initially be coded as "purchase motivation". The quote may later be grouped into more detailed codes as themes begin to emerge from the data, such as the technology's attribute (e.g. "functional") followed by the motivation itself (e.g. "practicality"). If other purchase motivations are later identified that do not fit under these codes, then new codes are created to capture the data. The motivations for PEV-related behaviours I review in the Results chapter are those I identified through this method.

In the second stage, I rated participants' lifestyle engagement on a 5-point scale based on my subjective analysis of each interview transcript—particularly based on statements participants made throughout the interviews about their practices, interests, and identity. I rated participants' engagement in pro-environmental and technology-oriented lifestyles, as these lifestyles have been identified in other low carbon technology research (e.g. Axsen et al., 2012). For example, one participant explained that he takes part in several practices related to technology, including reading technology blogs and repairing electronics. Michael also revealed that his profession is in the technology business; conversely, he did not communicate involvement in any pro-environmental activities. As a result, I rated Michael as a "4" for technology-oriented and a "0" for pro-

environmental lifestyle engagement. After the lifestyle engagement of all participants was rated, I compared the ratings to identify a grouping solution that would consist of participants' with relatively homogenous lifestyle engagement. I used a four grouping solution and subsequently assigned each participant into one of the segments.

In the final stage of data analysis, I compared the themes mentioned by participants in each of the four lifestyle-based segments. I did this by comparing each lifestyle-based segment by the number of participants that mentioned a theme at least once as well as how many times the theme was mentioned across all participants in that segment. This process revealed how the themes varied across the lifestyle-based segments and whether or not they were associated with lifestyle engagement.

Although I identify and explain three stages of analysis, the research was not conducted in discrete, sequential steps; instead, it was an integrated process where the transcription and analysis of an interview would identify and inform new ideas and themes to be explored further in subsequent interviews. This process improved the identification of themes and the amount of detail that could be captured.

Qualitative analysis relies on the interpretation of text-based data (Madill, Jordan, & Shirley, 2000); as a result, I used two verification methods to minimize bias and improve the validity of the data. First, I used the constant comparison method to improve reliability (Glaser, 1964). Using constant comparison, I identified themes in the qualitative data by grouping them into codes, gave each code a definition, and compared each new example of the code against previous examples and the definition. From this process I created an understanding of the properties of each concept and ensured codes were refined and accurate. Second, I used a verification process to reduce researcher bias in the analysis. I provided a second researcher with the codes, their definitions, and the quotes contained within them. The second researcher read through the transcripts, verified my codes, and identified any potential errors; this included omissions of any potential codes, disagreement with interpretation, or insufficient definitions. Potential errors were discussed and either re-coded or removed altogether depending on the quote's clarity.

Chapter 3.

Results

In this chapter, I present the results of my analysis. I begin with an overview of the study sample (Section 3.1) and the segments I constructed based on participants' engagement in pro-environmental and technology-oriented lifestyles (Section 3.2). I then present the motivations I identified for participants' PEV-related behaviours (Sections 3.3 to 3.7), including a brief summary of how the motivations vary by lifestyle segment. Specifically, these sections detail: participants' PEV purchase (Section 3.3); interest in PEV type (Section 3.4); use of PEVs (Section 3.5) and public charging infrastructure (Section 3.6); and interest in utility controlled charging (Section 3.7).

3.1. Interview participants

Table 4 provides an overview of the 17 participants, the larger CPEVS Pioneer (current PEV owners) and Mainstream (conventional car buyers) samples, and the B.C. population according to census data. Compared to both the CPEVS Mainstream sample and B.C. census population, my sample is: older; more likely to be male; of higher income; more likely to have a higher education; more likely to own a home; and more likely to live in a detached house. However, the characteristics of the present sample seem to be representative of PEV Pioneers in particular, as evidenced by the surveyed CPEVS Pioneers sample.

Table 4: Overview of the present study sample ('Interviews'), CPEVs Pioneer and Mainstream samples, and B.C. population.

	Interviews (Pioneers)	**CPEVS** (Pioneers)	**CPEVS** (Mainstream)	**Census** (BC)
Sample Size	17	157	538	4,400,057
Household Size				
1-2	35%	47%	57%	63%
3	29%	19%	19%	15%
4+	35%	34%	24%	22%
Sex (of person filling out the survey)				
Female	12%	18%	61%	51%
Age (of person filling out the survey)				
Under 35	18%	11%	26%	30%
35-44	18%	24%	19%	18%
45-54	24%	26%	20%	20%
55+	41%	39%	35%	32%
Highest level of education completed (of person filling out survey)				
Other	24%	20%	29%	59%
College, CEGEP, some university or other non univ. diploma	12%	22%	34%	22%
University, graduate, or professional degree	65%	58%	38%	19%
Household income (pre-tax)				
Less than $40,000	0%	17%	17%	26%
$40,000 to $59,999	0%	5%	22%	19%
$60,000 to $89,999	12%	11%	29%	24%
$90,000 to $124,999	41%	24%	24%	17%
Greater than $125,000	47%	43%	9%	14%
Residence ownership				
Own	88%	92%	76%	--
Rent	12%	8%	24%	--
Residence type				
Detached House	76%	79%	62%	54%
Attached House (e.g. townhouse, duplex, triplex, etc.)	18%	12%	15%	23%
Apartment	6%	8%	21%	21%
Mobile Home	0%	1%	2%	2%
Vehicle model				
Chevrolet Volt	39%	24%	0%	--
Nissan Leaf	39%	47%	0%	--
Tesla Model S	22%	10%	0%	--
Other	0%	18%	0%	--

3.2. Constructing lifestyle-based segments

I constructed lifestyle-based segments by rating participants' engagement in pro-environmental and technology-oriented lifestyles on a 5-point scale and subsequently comparing their ratings to identify a grouping solution. Of the 17 participants in the present study, I found 11 were engaged in pro-environmental or technology-oriented lifestyles, and 6 participants did not consistently engage in activities relating to either lifestyle. I subsequently grouped the 17 participants into four segments to explore their motivations for PEV-related behaviours (Figure 2). Table 5 provides an overview of the participants in each of the segments, which I refer to as "Tech Enthusiasts", "Low-tech Greens", "High-tech Greens", and "Other".

Figure 2: Visual overview of lifestyle segments

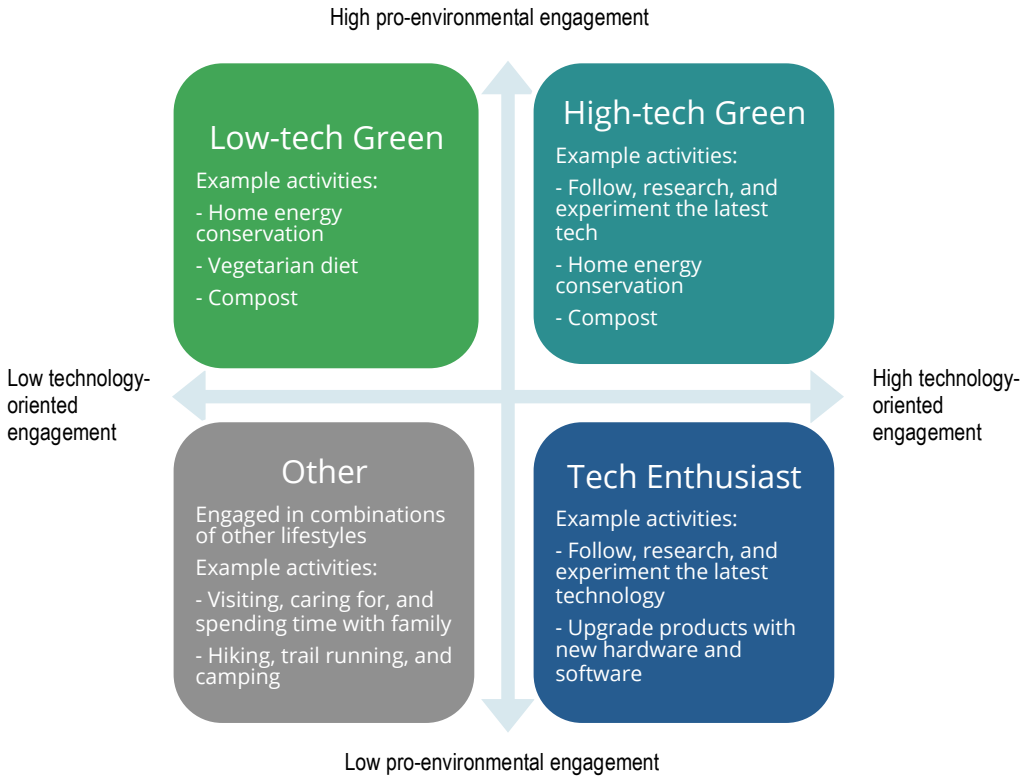


Table 5: Characteristics of 17 participants by lifestyle segment. Names are pseudonyms.

Surname	First Name	Age	Household Size	Household Income ($ thousand)	Vehicle Type	Vehicle Model
Tech Enthusiast						
Burns	Harold	55-64	5	100-124	BEV	Tesla Model S
Smith	Brian	55-64	2	> 150	BEV	Tesla Model S
Fisher	Mark	45-54	4	70-79	BEV	Nissan Leaf
Anderson	Michael	45-54	4	100-124	PHEV	Chevrolet Volt
Hall	Aaron	25-34	3	80-89	PHEV	Chevrolet Volt
Low-tech Green						
Cheung	Rachel	25-34	2	125-149	BEV	Nissan Leaf
Williams	Ron	55-64	3	> 150	BEV	Nissan Leaf
Moore	George	65+	2	100-124	PHEV & BEV	Volt & Leaf
High-tech Green						
McDonagh	Kevin	45-54	3	> 150	BEV	Tesla Model S
Morris	Arnold	25-34	6	> 150	PHEV	Chevrolet Volt
Green	Daniel	35-44	3	> 150	BEV	Tesla Model S
Other						
Hansen	John	55-64	2	100-124	BEV	Nissan Leaf
West	David	35-44	3	90-99	PHEV	Chevrolet Volt
Kelly	Sharon	55-64	2	90-99	PHEV	Chevrolet Volt
MacDonald	Robert	45-54	4	100-124	BEV	Nissan Leaf
Campbell	Chris	35-44	5	125-149	BEV	Nissan Leaf
Stewart	Tom	55-64	2	> 150	PHEV	Chevrolet Volt

The Tech Enthusiast segment includes five participants that demonstrated high levels of engagement in a technology-oriented lifestyle, including regular engagement in activities such as repairing electronics and purchasing the latest gadgets. These participants expressed little to no engagement in pro-environmental practices. Michael Anderson, for example, described himself as having “always been someone who likes to have the latest technology”. Michael reads various technology blogs and magazines to “follow the development of the Volt”. In his spare time, he makes YouTube videos that teach others “how to troubleshoot and how to maintain their old electronics”.

Participants in the Low-tech Green segment (n=3) have high levels of engagement in a pro-environmental lifestyle and expressed little to no engagement in technology-oriented practices. Participants in this segment report regular engagement in a variety of activities such as donating to environmental charities, eating a plant-based diet, or buying locally grown food. One example of a Low-tech Green is Ron Williams – a participant that works in medicine and describes himself as “biology-focused [and interested in the relationships between] natural things”. Ron voluntarily composts organic materials, has fruit trees on his property to produce local food, collects rainwater to reduce water consumption, and recently became vegetarian for “humanitarian and environmental [reasons]– it’s all tied together”.

High-tech Greens (n=3) are very engaged in both technology-oriented and pro-environmental lifestyles, and are often involved in a number of practices related to both lifestyles. High-tech Greens engage in pro-environmental practices that are often more technology-oriented than those of the Low-tech Greens. For example, Kevin McDonagh (High-tech Green segment) installed his own home automation system to monitor and reduce energy consumption, and is considering installing “a dozen solar panels on the roof” within the next two years as the “price comes down and energy density starts to go up”. In his spare time, Kevin explained that he enjoys several hobbies involving technology, including “anything from soldering circuit boards to changing appliances”.

In contrast to the three aforementioned segments, participants in the “Other” (n=6) segment expressed little or no engagement in pro-environmental or technology-oriented lifestyles. Robert MacDonald (Other segment) was instead engaged in a family-

oriented lifestyle, and explained “the kids keep us busy … Family is first and foremost … [and we] like to see our family often”. Participants in the Other segment typically expressed some level of engagement in either a family-oriented, recreation, or social lifestyle – or any combination of the three. I segmented these six participants into “Other” because their PEV-related behaviours and motivations did not appear associated with their engagement in these three lifestyles.

3.3. Plug-in electric vehicle purchase

The second section of the interviews examined participants’ PEV purchase. I used prompting questions as needed to encourage the participants to explain their motivations that led to their decision to purchase their vehicles (Appendix A).

Using the methods explained in Section 2.2, I identified six distinct motivations for participants’ purchase decisions. Participants stated that they wanted to own a PEV because they perceive them as practical, offer a positive driving experience, provide access to the symbolism of embracing technology and supporting innovative companies, or can help protect the environment and reduce society’s dependence on oil. I present these six motivations in Table 6 and group them according to the three attribute types explained in Section 1.2. I also provide a count of the number of mentions (to convey relative emphasis) and the number of participants who explicitly mentioned the motivation (to convey prevalence across the sample). For example, “practicality” was mentioned 80 times in the interviews, and 16 of 17 participants mentioned it at least once.

Table 6: Purchase influences: Total number of mentions and number of participants with at least 1 mention of each motivation

Attribute type	Motivation	Total number of mentions	Number of participants with at least 1 mention
Functional	Practicality	80	16
	Improved driving experience	20	13
Symbolic	Embracing technology	62	12
	Support innovative companies	23	7
Societal	Environmental protection	76	13
	Reduce oil dependence	16	8

Numerous participants (n=16) stated that their purchase was motivated by the perceived practicality of PEVs (functional), which was based on a low operating cost, limited maintenance requirements, sufficient electric range, or accommodating vehicle designs. Chris Campbell (Other segment) described that he needed a family car and was "surprised that the trunk space [of his Nissan Leaf] was so big" and that "it was a five-seater [and we could] fit the two car seats in there comfortably." David (Other segment) perceived PEVs as practical because he "could own a vehicle and not have to worry about the variable cost [of gasoline], right? Because [gasoline is] not only expensive, it's also highly variable".

Thirteen participants mentioned the motivation that PEVs offer a superior driving experience to conventional vehicles (functional). All thirteen participants explained the superior driving experience as the result of the vehicles' torque, silent operation, or lack of gears. Participants varied in their assessment of the relative importance of each benefit. Michael Anderson (Tech Enthusiast segment) emphasized the torque: "I was sold on [the Chevrolet Volt] as soon as I put my foot into it and thought, 'Wow, this thing's got a lot of power'… the get up and go right off the line is incredible, as all electric [cars] are." Tom Stewart (Other segment) emphasized the lack of noise and gears instead: "[The Volt] is very quiet … When a motorcycle goes by me, I go '(sigh), I'm so glad I have this car' … There's [also] no transmission, so … it just kind of glides."

Twelve participants stated they were motivated by the symbolism of embracing new technology, which was connected to expressing a self-identity of being adventurous, innovative, or tech-oriented. Michael Anderson (Tech Enthusiast segment), for example, felt "the Volt is the most high-tech vehicle that's been ever produced … and I like the high-tech stuff". Similarly, Chris Campbell (Other segment) explained how "[buying the Leaf is like] 'Taking the road unknown', you know, go for an adventure" and "among our friend group, we are the pioneers [and] the only ones that have an electric car." David West (Other segment) connected their vehicle's design to the idea of being different: "both [my wife] and I liked the idea that the Volt looked different enough, but it wasn't trying to be so different that it was like, 'Whoa.'"

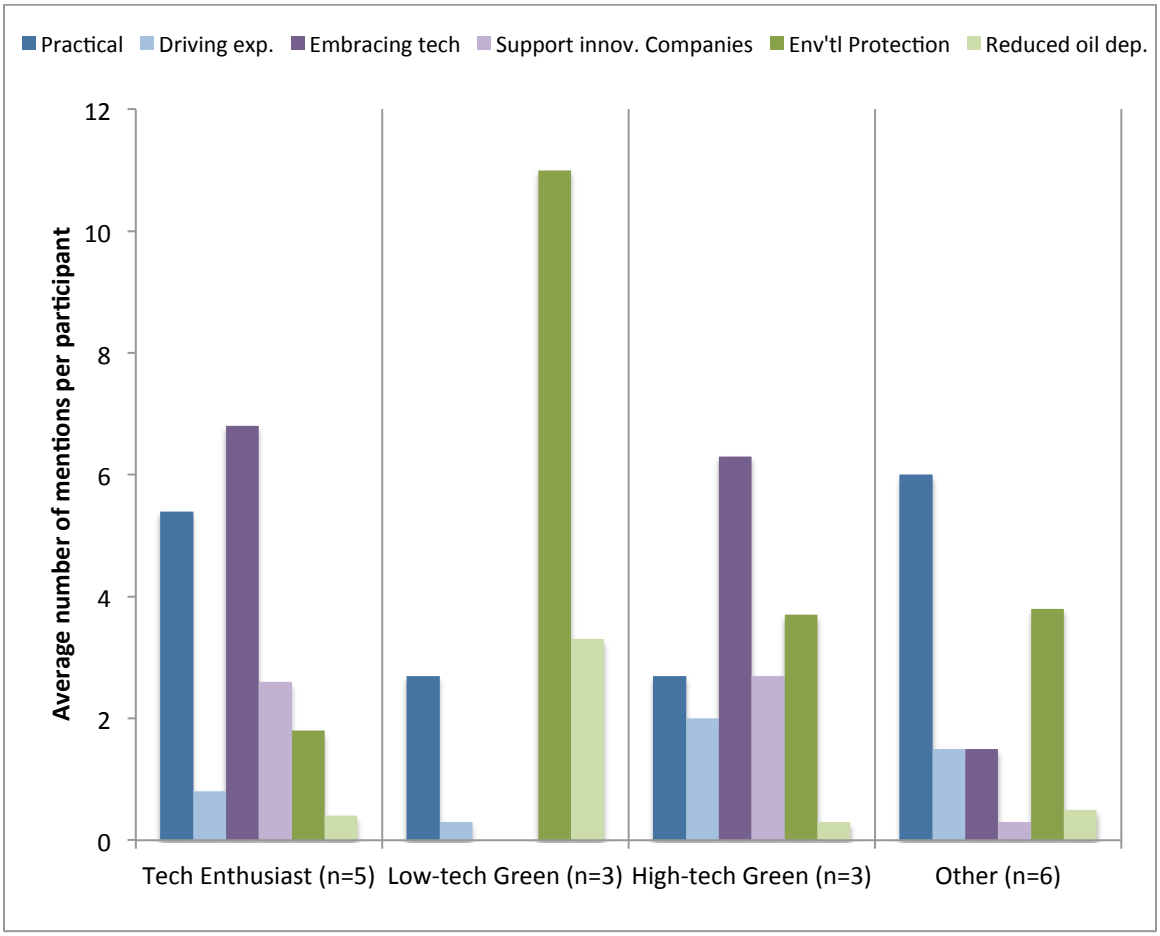
Participants' were also motivated by two societal attributes. Thirteen Pioneers stated that they were motivated by the desire to help protect the environment. John Hansen (Other segment) explained how he "didn't need to analyze things to death when I know that [buying a PEV] seems to be the right thing to do [for the environment]."

Eight participants wanted to help society reduce its dependence on oil companies. This motivation was often abstract and not directly connected to protecting the environment. For John Hansen (Other segment), oil independence was about national security: "[Current oil prices] are just … a manufactured thing by the Middle Eastern oil [producers]. They're just causing this whole thing to disrupt the scale of oil in the world." For others, oil independence was about transitioning society to decentralized power production. For example, Ron Williams (Low-tech Green segment) thinks that "the whole idea of decentralized power production is only a rational choice" and "it would be nice if [we would] produce the power [we] use."

Seven participants mentioned that they wanted to support innovative companies (symbolic). Daniel Green (High-tech Green segment) saw the purchase of his Tesla as helping "[push] the world in the right direction towards fully sustainable energy" and felt that even if he had to pay more, the transition to sustainable energy is "going to take people like us to do that and to help [companies] generate revenue so that they can do the [research and development] necessary."

Figure 3 compares participants' motivations across the four lifestyle segments. Because the lifestyle segments vary in size, I use the average number of mentions of each purchase influence per participant. As Figure 3 reveals, frequency of mentions of these six motivations varied by lifestyle segment. Participants in the Tech Enthusiast and High-tech Green segments emphasized the symbolism of embracing new technology with an average of 6.8 and 6.3 mentions, respectively. Participants in the Low-tech Green segment instead emphasized the motivation of environmental protection (average 11 mentions) and reduced oil dependence (average 3.3 mentions). By comparison, participants in the Other segment emphasized being motivated by the perceived practicality of PEVs (average 6 mentions). Accordingly, the relative emphasis of the six motivations appears consistent with lifestyle engagement.

Figure 3: Average number of mentions of purchase motivations per participant, broken down by lifestyle segment



3.4. Interest in plug-in electric vehicle type (PHEV and BEV)

In the interviews, I explored participants' interest in PHEVs and BEVs using a series of prompts to foster discussion. Specifically, I asked participants to consider their next vehicle purchase and to explain what vehicle type they would be interested in buying and why.

From this process, I found that both plug-in hybrid (PHEV) and battery electric vehicle (BEV) vehicle owners were more interested in BEVs. Eight of the 17 participants explained they would only consider a BEV as their next vehicle, compared to just one participant that would only consider purchasing a PHEV (eight participants would consider either). Looking at the lifestyle segments, 2 of 5 Tech Enthusiasts, 2 of 3 Low-tech Greens, 2 of 3 High-tech Greens, and 2 of 6 Other participants reported greater interest in BEVs than PHEVs.

I identified three motivations behind participants' interest in BEVs (over PHEVs): a desire to protect the environment, to reduce society's dependence on oil, or to own what they perceived to be a superior technology to PHEVs. Table 7 below provides a summary of the prevalence of each motivation.

Table 7: Interest in BEV over PHEV: Total number of mentions and number of participants with at least 1 mention of each motivation (where 8 of the 17 participants stated greater interest in BEVs)

Attribute type	Motivation	Total number of mentions	Number of participants with at least 1 mention
Functional	Superior technology	16	5
Societal	Environmental protection	20	6
	Reduced oil dependence	9	5

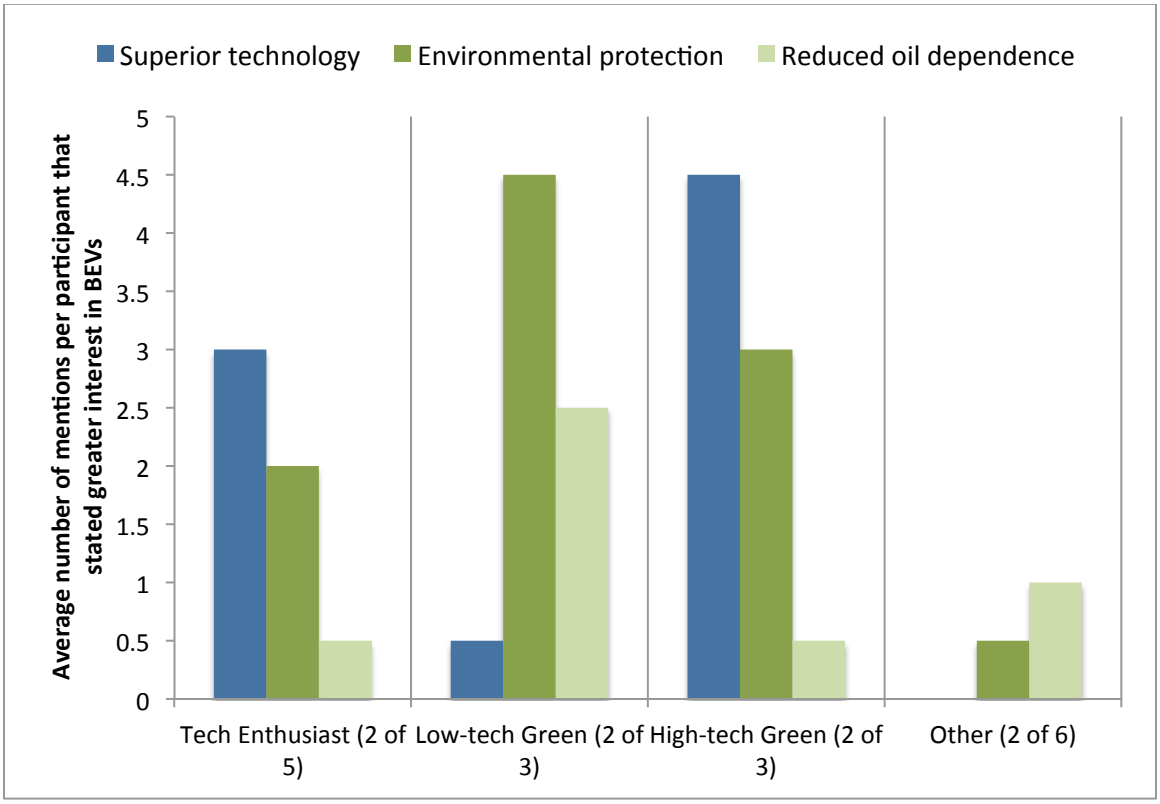
Five of the eight participants that stated greater interest in BEVs mentioned they were motivated by the perceived technological advantages of BEVs that result from having only an electric motor. Kevin McDonagh (High-tech Green segment) explained that PHEVs have an internal combustion engine, which means "wasted energy … noise, heat, dealing with fuel that doesn't burn efficiently and goes out the tailpipe…it's all this waste, so it seems pointless". Daniel Green (High-tech Green segment) also believed

that “the efficiency of the electric motor and the energy storage and the whole design of the [BEV] from an engineering standpoint just seemed so much better”. Five participants were very explicit about the perceived technological inferiority of PHEVs. For example, Daniel Green (High-tech Green segment) stated: “[with a PHEV] you don’t get the benefit of a more simplistic system”. Similarly, Ron (Low-tech Green segment) felt the “mechanical complexity [of PHEVs] kind of just seems silly.”

Environmental protection was the most prominent motivation behind interest in BEVs (n=6). Robert MacDonald (Other segment) explained that he “didn’t like the concept of the hybrid because you’ve got two engines … so even though you’re buying half the gas, you’re still buying gas. So obviously it’s not going to be zero emission”. John Hansen (Other segment) shared similar sentiments, as he described PHEVs as ”sort of halfway there to where we need to get to” in terms of protecting the environment. The motivation of reducing oil dependence was again distinct from environmental protection. Five participants believed that BEVs provide an opportunity to gain greater energy independence relative to PHEVs and conventional vehicles.

As Figure 4 reveals, motivations behind BEV interest vary by lifestyle segment and again appear consistent with lifestyle engagement. Participants in the Tech-Enthusiast segment emphasized that BEVs are a superior technology with an average of 3 mentions per participant. Similar to the purchase influences, participants in the Low-tech Green segment again emphasized environmental protection (average 4.5 mentions) and reduced oil dependence (average 2.5 mentions). Participants in the High-tech Green segment emphasized the motivations of superior technology (average 4.5 mentions) and environmental protection (average 3 mentions). By comparison, participants in the “Other” segment did not strongly emphasize any of the motivations and may have been influenced by other considerations that I did not identify in this study. In summary, participants’ interest in BEVs was the result of motivations that appear consistent with lifestyle engagement, while overall levels of interest were the same.

Figure 4: Average number of mentions per participant that stated greater interest in BEVs relative to PHEVs, broken down by lifestyle segment



3.5. Use of plug-in electric vehicles

As explained in Section 2.2, the third section of the interviews explored participants' PEV use. Because PEVs operate differently than conventional vehicles, it is important to understand how and why consumers may change their driving patterns after purchasing a PEV. I asked participants to explain how they are using their vehicle and I used prompts as needed to elicit more detailed information (e.g. "where are you driving the vehicle", and "have you changed any routines or the way you use a vehicle?"). Participants' comments were then categorized to identify patterns in PEV use and motivations using the content analysis method explained in Section 2.2.

Twelve participants reported they have increased the frequency of vehicle trips or, more broadly, "drive more" since purchasing a PEV. The specific change in average

vehicle kilometres travelled for the household is unknown, as I relied on participants' statements and did not collect detailed driving diary information pre- and post-purchase of the PEV. The reported increased frequency of trips was prevalent across the lifestyle segments (3 of 5 Tech Enthusiasts, 2 of 3 Low-tech Greens, 3 of 3 High-tech Greens, and 4 of 6 Other). Participants explained the increased frequency of trips as resulting from either the low operating costs (functional), improved driving experience (functional), or reduced environmental impact of PEVs (societal) relative to conventional vehicles. Table 8 provides an overview of these motivations.

All twelve participants cited reduced operating costs. One participant, for example, explained that with their PEV they will "not think twice" about driving to the grocery store, whereas with their conventional vehicle they would have postponed a trip until necessary to reduce fuel expenses. Eight participants mentioned the improved driving experience that PEVs offer relative to conventional vehicles: "If you're in a traffic jam, nothing is running, and it's just as happy as punch [so] around the city it's a lot nicer [to drive than a conventional vehicle] … [So] I do drive quite a bit more" (Arnold Morris, High-tech Green segment). Three participants mentioned the reduced environmental impact of PEVs as a motivation for increased driving frequency: "I'm looking for guilt-free driving … I love [being able to] go where I want to go when I want to go … without feeling like I'm wrecking the environment. And I've driven much more for these sorts of reasons" (Brian Smith, Tech Enthusiast segment). Interestingly, I did not identify any symbolic motivations that pertain to changes in driving patterns.

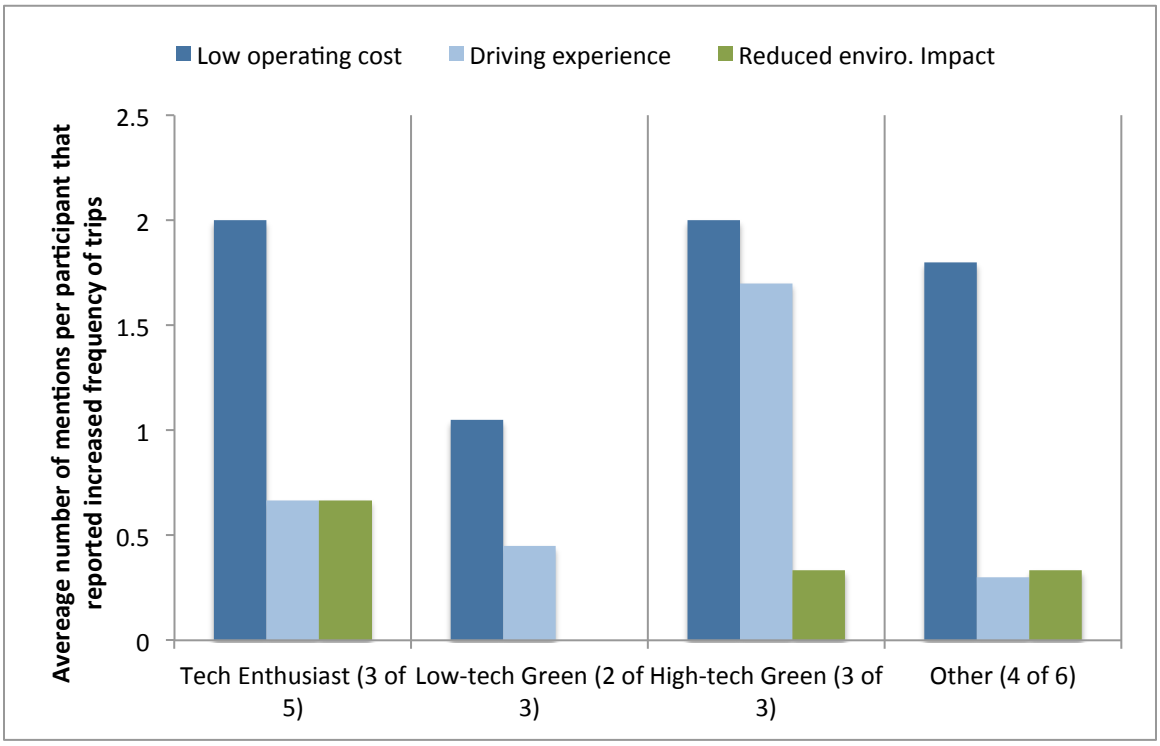
Table 8: Increased frequency of vehicle trips: Total number of mentions and number of participants with at least 1 mention of each motivation (where 12 of 17 participants stated increased frequency of trips)

Attribute type	Motivation	Total number of mentions	Number of participants with at least 1 mention
Functional	Low operating cost	21	12
	Driving experience	10	8
Societal	Reduced environmental impact	5	3

In contrast to participants' purchase decisions and interest in PEV types, the relative emphasis of motivations behind PEV use did not vary substantially by lifestyle

segment (Figure 5). The motivations of low operating cost and an improved driving experience were present in all lifestyle segments. Further, all four lifestyle segments placed greater emphasis on low operating cost relative to the pleasurable driving experience. Interestingly, participants in the Low-tech Green segment did not mention the motivation of reduced environmental impact; however, only three participants mentioned this motivation across the entire sample.

Figure 5: Average number of mentions per participant that reported increased frequency of trips, broken down by lifestyle segment



3.6. Use of public charging infrastructure

In addition to driving behaviour, the third section of the interviews explored participants' use of public charging infrastructure. I asked participants a general question to initiate discussion (e.g. "can you tell me a bit about how you recharge the vehicle?"), and subsequently asked a series of prompts to elicit greater detail and identify motivations (e.g. "where do you recharge your vehicle?" and "how does it compare to refuelling a conventional vehicle?"). In this section, I review the four motivations I

identified using content analysis that appear to influence the use of public charging infrastructure.

The overall use of public charging infrastructure was high across the sample. All participants stated that they have used public charging infrastructure at least once and identified specific chargers they have used on multiple occasions. Participants' mentioned motivations of convenience (functional), cost savings (functional), and opportunities to be ambassadors of PEV technology (symbolic). Interestingly, 13 of 17 participants also stated that public charging infrastructure is somewhat unnecessary for their charging needs. Table 9 provides an overview of the four motivations.

Table 9: Public charging use: Total number of mentions and number of participants with at least 1 mention of each motivation

Attribute type	Motivation	Total number of mentions	Number of participants with at least 1 mention
Functional	Convenience	37	15
	Cost savings	6	6
	Unnecessary	31	13
Symbolic	Be an ambassador	37	13

Convenience was the most prevalent motivation across the sample (n=15). For Chris Campbell (Other segment), public charging infrastructure is convenient because it reduces the need to plan trips: "[Public charging] is a safety net for when things are unplanned … There's been a couple times where, let's say, I know I need to charge at the end of the day, but something might come up where I'm meeting somebody … and knowing there's a charger close by, I don't have to worry. But if that wasn't the case, would I have to go home and charge for a while or just cancel it because I couldn't make it [there]?" Many participants stated that the greatest convenience was the parking locations that public charging stations provided. As Chris Campbell (Other segment) bluntly stated, "We like the rock star parking". Aaron Hall (Tech Enthusiast segment) now goes to busy locations in the city on weekends knowing, because of public charging infrastructure, that "even on a Saturday, we usually get good parking." In addition to convenience, six participants mentioned the cost savings that public charging infrastructure provides.

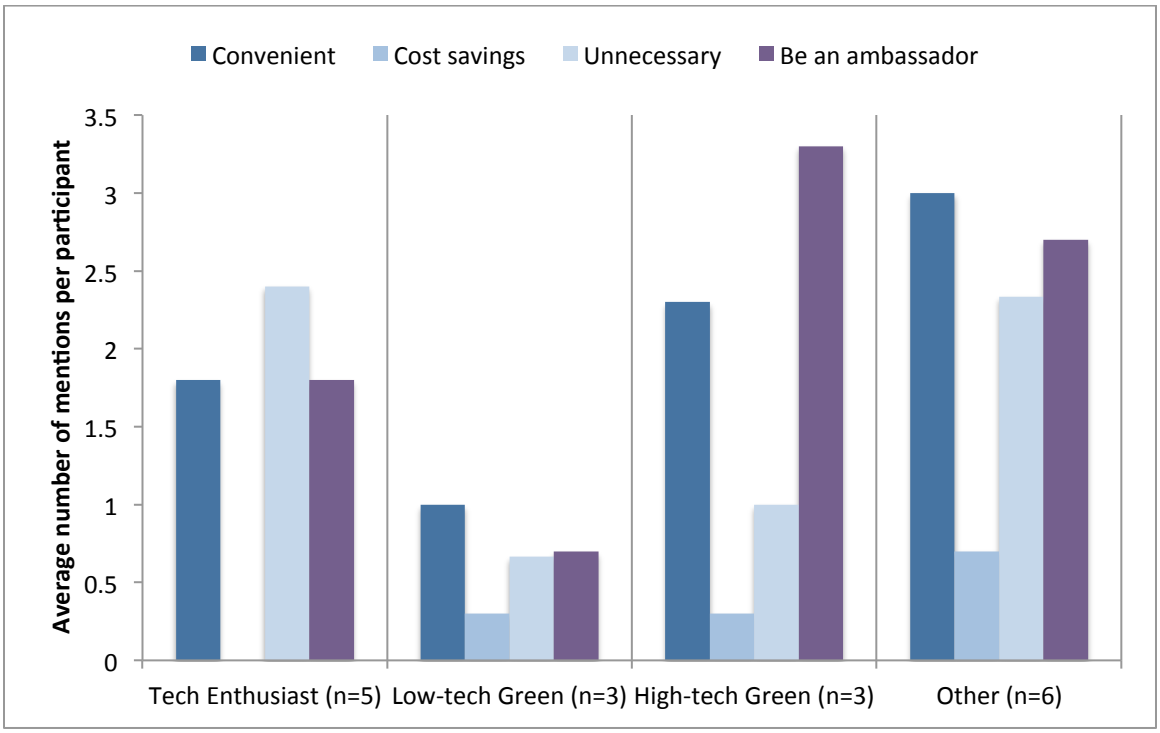
Despite the potential benefits of public charging infrastructure, thirteen participants described the infrastructure as somewhat unnecessary (functional) after a period of familiarization of PEV ownership. Chris Campbell (Other segment) explained: "I think public charging stations are important, because … it was the impetus for me to consider the electric car. After driving it for a while, I realize, 'Hey, with the routine that I have, I can just plug it in at home most of the time. I don't have to worry about charging.'" The importance of charging infrastructure at home was emphasized across the sample. As Daniel Green (High-tech Green segment) explained: "One of the complaints you hear from people who don't own electric cars is … 'the charging, it takes so long and it's so inconvenient'. But it's not. Standing at the gas station … in the middle of your commute is really annoying and inconvenient, and it costs you money. With an electric car, you just come home and plug it in. It takes all of 10 seconds."

The visibility of public charging infrastructure provided some participants with opportunities to interact with and educate potential buyers about PEVs. Thirteen participants explained how public charging infrastructure enables them to be ambassadors of the technology and encourage others to adopt PEVs (symbolic). For example, John Hansen (Other segment) recalled one night he and his wife went to see a play: "We came out at about 10:30 pm and I have an audience … They're looking at the car, they're going 'What is this?' … It's happened almost everywhere I go [and] I have the time to chat … I think it's important to get the message out [about PEVs] and I'm playing a small role in doing that." Brian Smith (Tech Enthusiast segment) also embraced the opportunity that public charging infrastructure provides to be an ambassador and has gone as far as taking strangers for test drives: "I've made some new friends because I've got this car … It's amazing, it opens some doors. Not only just other PEV owners … I've given rides to [people] I probably wouldn't have had the chance to meet otherwise."

As Figure 6 shows, use of public charging infrastructure was driven by motivations that were relatively consistent across the sample. However, minor variations do exist between the lifestyle segments and appear somewhat associated with lifestyle engagement. For example, the High-tech Green segment was the only segment that mentioned the motivation of being an ambassador more than any other motivation. This

result is somewhat expected as PEVs are an innovative low-carbon technology that may align with pro-environmental and technology-oriented lifestyle engagement. Interestingly, participants in the Other also frequently mentioned the motivation of being an ambassador.

Figure 6: Average number of mentions per participant of motivations for public charging use, broken down by lifestyle segment



3.7. Stated interest in utility controlled charging

As explained in Section 1.1, utility controlled charging (UCC) is a general term for systems that would allow electric utilities to control the charging of PEVs by managing charging rates, charging times, or the direction of electrical flow (Bailey & Axsen, 2015). To explore interest in UCC, participants completed a design game during their interview (Appendix B). The design game asked participants to opt in to a UCC program and select the amount of guaranteed charge they would sacrifice under two scenarios: the first scenario offered increased deployment of green electricity, and the second scenario offered a discount on electricity bills. I used guaranteed charge as a measure of support

for UCC, where accepting a lower guaranteed charge in their PEVs' batteries indicated a greater willingness to support UCC (by potentially undergoing some inconvenience due to an incomplete battery charge). I provide the results of the two scenarios in Table 10 below, and categorize participants according to their interest in UCC.

Table 10: Participant interest in utility controlled charging

UCC interest	Guaranteed minimum charge	Scenario Benefits	
		Support green electricity deployment	Discount on electricity bill
High interest	50%	3	4
	65%	3	3
Medium interest	80%	5	4
	90%	2	0
Opposed	100%	4	6

Participants were generally interested in supporting a UCC program. A majority of participants were willing to opt-in to a UCC program in both scenarios. In the first scenario, 13 of 17 participants opted in to UCC for the increased deployment of green electricity. Six participants were willing to accept a high level of UCC (50% to 65% guaranteed minimum charge), seven were willing to accept a moderate level of UCC (80% to 90% guaranteed minimum charge), and four would not accept any level of UCC. In the second scenario, 11 of 17 participants opted in to UCC to receive a discount on their electricity bill. Interestingly, seven participants were willing to accept a high level of UCC (an increase of one participant in comparison to the first scenario), but only four were willing to accept a moderate level of UCC and six would not accept any level of UCC (an increase of two participants in comparison to the first scenario).

Interest in UCC was associated with two motivations: that by opting in to a UCC program they would help protect the environment (societal) and be embracing technology (symbolic). Mark Fisher (Tech Enthusiast segment), for example, emphasized the potential environmental benefits of UCC and perceived opting in to such a program as "doing the right thing [by] contributing to the hydro grid for clean power". Arnold Morris (High-tech Green segment), by comparison, stated that he was motivated by the notion of embracing technology, and saw opting in to UCC as a way to transition to a future where "all your heaters, appliances, and things talk to some kind of

centralized unit in your house … [Right now] it's not like a centralized, fully organized efficient system".

Despite the high level of interest in UCC, there were three motivations that constrained overall interest: loss of control, battery degradation, and invasion of privacy. Nine participants explained that they were concerned about the loss of control over charging, and some desired an option to opt out on occasion: "The only thing I would be concerned about was if you needed a full charge – there would have to be some way to say 'I need the full charge [tomorrow]'" (Aaron Hall, Tech Enthusiast segment). Four participants stated that they were concerned of the potential battery degradation that may result from UCC and would want "a guarantee that it's not damaging to the vehicle in any way or degrading the battery" (Daniel, High-tech Green segment). Two participants perceived UCC as a potential invasion of privacy because the PEV would have to communicate with the utility. Aaron Hall (Tech Enthusiast segment), for example, explained "it's a little … Big Brother-ish … [I have the same concerns] with the smart meter, too".

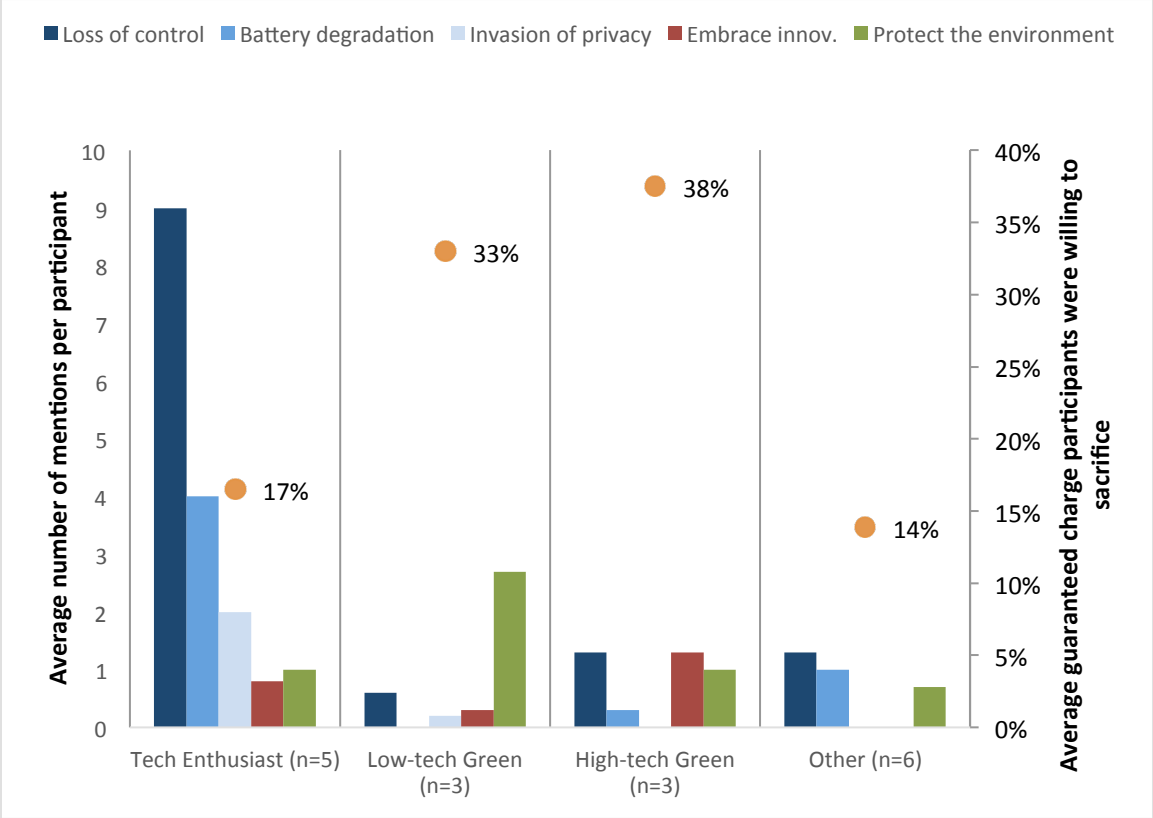
Table 11: Utility controlled charging: Total number of mentions and number of participants with at least 1 mention of each motivation

Attribute type	Motivation	Total number of mentions	Number of participants with at least 1 mention
Functional	Loss of control	15	9
	Battery degradation	5	4
	Invasion of privacy	3	2
Symbolic	Embrace innovation	9	5
Societal	Protect the environment	20	10

Figure 7 compares participants' motivations and interest in utility controlled charging (i.e. average guaranteed charge participants were willing to sacrifice in the two UCC scenarios) across the four lifestyle segments. Participants in the Tech Enthusiast segment mentioned the functional attributes of UCC more than any other segment. Participants in the Tech Enthusiast segment frequently mentioned that UCC would result in a loss of control (average 9 mentions), battery degradation (average 4 mentions), and be an invasion of privacy (average 2 mentions). By comparison, no other segment had more than 1.3 mentions on average for any of the three functional motivations.

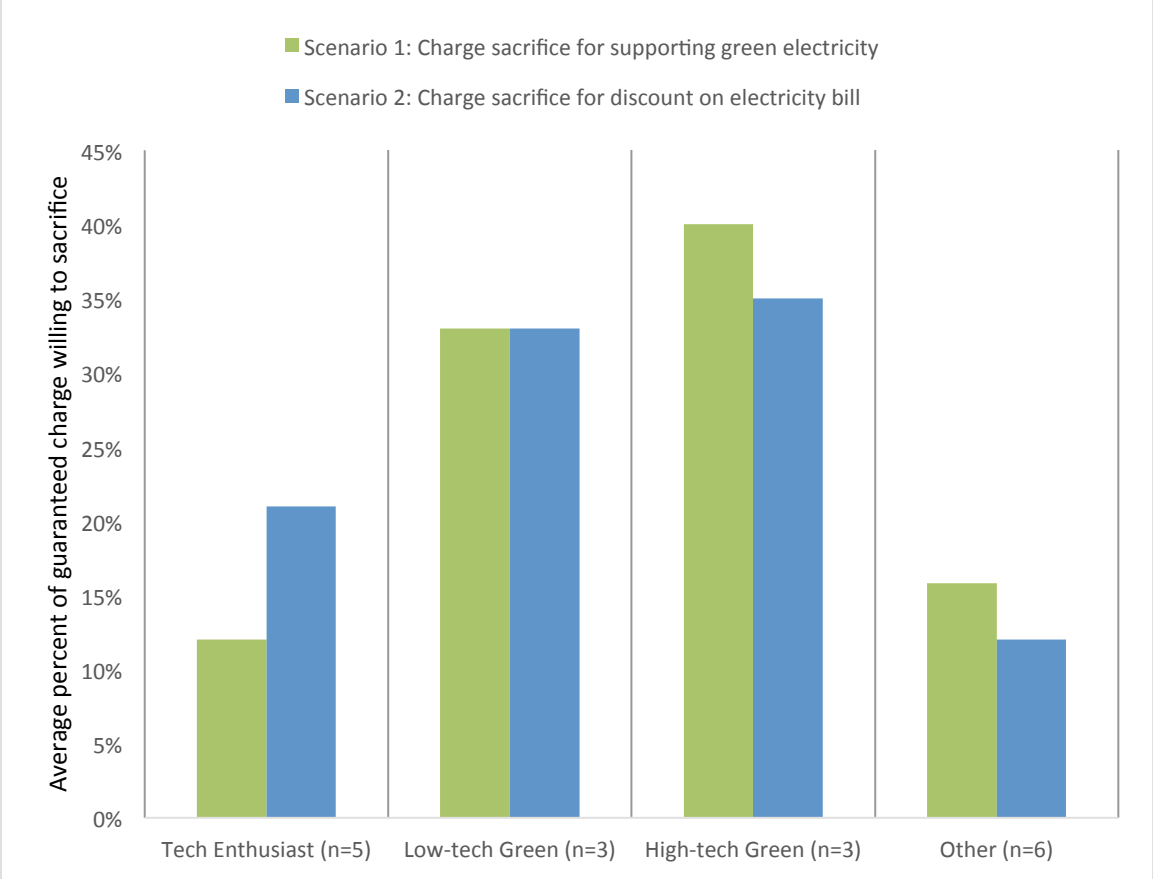
Participants in the Low-tech Green segment instead emphasized the functional motivation of protecting the environment (average 2.7 mentions). Participants in the High-tech Green and Other segments did not place substantially greater emphasis on any single motivation.

Figure 7: Average number of mentions per participant of motivations for interest in utility controlled charging as well as the average guaranteed charge participants were willing to sacrifice, broken down by lifestyle segment



Interestingly, consumer interest in UCC was the only PEV-related behaviour I identified in the study that did vary by lifestyle segment. All participants in the High-tech Green segments opted-in to UCC in both scenarios; all other segments had a last one participant decline UCC in each scenario. Further, participants in the Low- and High-tech Green segments were willing, in both scenarios, to sacrifice considerably higher levels of guaranteed charge than participants in the Tech Enthusiast and Other segments (Figure 8).

Figure 8: Average percent of guaranteed charge each segment is willing to sacrifice under the two scenarios. Higher percentage indicates greater willingness to sacrifice guaranteed battery charge.



Chapter 4.

Discussion

Although low-carbon technologies such as plug-in electric vehicles (PEVs) are capable of significantly reducing greenhouse gas emissions, the success of these technologies ultimately depends on consumer behaviour. I drew from qualitative data collected through interviews with 17 participants in British Columbia, Canada, to explore motivations for PEV-related behaviours (i.e. consumer interest in, purchase, and use of PEV technologies). My sample consisted of the first group of consumers to purchase a PEV, which I refer to as "Pioneers". Pioneers tend to be of higher income and education than "Mainstream" vehicle buyers (who do not currently own PEVs), and have greater engagement in pro-environmental or technology-oriented lifestyles (Axsen et al., 2015; Langman, 2015). I employed a theoretical framework from lifestyle theory and explored how motivations and PEV-related behaviours are associated with lifestyle engagement. Within this context, my research objectives were to:

1. Segment Pioneers according to lifestyle engagement;
2. Identify participants' stated interest in, purchase, and use of PEV technologies ("PEV-related behaviours");
3. Identify the motivations underlying these PEV-related behaviours;
4. Examine how the motivations and PEV-related behaviours relate to lifestyle engagement.

4.1. Identifying lifestyle segments among PEV Pioneers

Lifestyle theory defines a lifestyle as engagement in several related practices that contribute to self-identity (Giddens, 1991). Following my theoretical framework, PEV-related behaviours are carried out in the context of lifestyle engagement. In this study, I explored the lifestyle engagement of 17 Pioneers using the qualitative methodology

explained in Sections 2.2 and 2.3. I used data collected from semi-structured interviews to identify lifestyle practices, rate participants' lifestyle engagement, and subsequently group participants into lifestyle-based segments.

Based on a review of literature, I expected to find high levels of engagement in pro-environmental and technology-oriented lifestyles. Indeed, a majority of participants (11 of 17) communicated engagement in a pro-environmental lifestyle, a technology-oriented lifestyle, or a combination of the two. The prevalence of these lifestyles in my study suggests that consumers engaged in pro-environmental or technology-oriented lifestyles are more likely to own PEVs. This finding builds off of Axsen et al. (2012) and Axsen et al. (2015), who noted that participants engaged in either of these lifestyles are more likely to be interested in PEVs.

Interestingly, despite the prevalence of pro-environmental and technology-oriented lifestyle engagement, I found that six of 17 participants were not engaged in either lifestyle. The qualitative methodology I used revealed that these participants were instead engaged in social-, recreation-, or family-oriented lifestyles. This finding supports those of Axsen et al. (2015) and Heffner et al. (2007), who found that some potential PEV buyers and current hybrid owners might lack engagement in pro-environmental or technology-oriented lifestyles. I provide two explanations for this – both of which may be true to some extent. First, as suggested by Axsen et al. (2015), PEVs may appeal to consumers engaged in other lifestyles with motives that differ from those identified in the present study. A second explanation could be that consumers seeking to engage in a pro-environmental or technology-oriented lifestyle may purchase a PEV to experiment engagement in either lifestyle. Axsen, TyreeHageman, & Lentz (2012), for example, found that respondents in a state of lifestyle openness and exploration reported the highest interest in low-carbon technologies such as PEVs.

I also grouped all 17 participants into four segments based on their rated engagement in pro-environmental and technology-oriented lifestyles: Tech Enthusiast (n=5), Low-tech Green (n=3), High-tech Green (n=3), and Other (n=6). These four lifestyle-based segments are similar to those identified by Axsen, TyreeHageman, and Lentz (2012) and Axsen et al. (2015). I reviewed the lifestyle-based segments of the

latter two studies in Section 1.3, but expand on the comparison in Table 12 below by adding the four segments I used in this study.

Table 12: Comparison of lifestyle segments identified in three studies

Study	Pro-environmental			Non-environmental			
Axsen, TyreeHageman, & Lentz (2012)	Low-tech	Aspiring	Engaged	Techies	n/a	Traditional	n/a
Axsen et al. (2015)	Strong pro-environment	Concerned	Tech-enviro	Techie	Open	n/a	Unengaged
Present study	Low-tech Green	n/a	High-tech Green	Tech Enthusiast	n/a	n/a	Other

The lifestyle-based segments in the three studies share commonalities. Specifically, my Low-tech Green segment closely corresponds with the other studies' Strong pro-environmental and Low-tech segments; my High-tech Green segment corresponds with the Tech-enviro and Engaged segments; my Tech Enthusiast segment aligns with the Techie and Techies segments; and my Other segment somewhat corresponds with the Unengaged segment. I do not have a segment that aligns with the other studies' Traditional, Open, Concerned and Aspiring segments; however, these four segments are classified according to either openness to lifestyle change or attitudes, which I did not measure in the present study.

4.2. PEV interest, purchase, and use

In this study, I examined participants' interest in, purchase, and use of PEV technologies ("PEV-related behaviours") using the two approaches explained in Section 2.2. First, I asked general questions in the interviews about how participants came to purchase and are using their PEVs. Second, I had participants complete a charging design game that provided them with opportunities to opt-in to a utility controlled charging program in exchange for environmental or financial benefits. Three patterns emerged in participants' PEV-related behaviours: participants were more interested in BEVs than PHEVs, had high levels of interest in participating in UCC programs, and reported increasing their vehicle kilometres traveled since purchasing a PEV.

The finding that participants were more interested in BEVs than PHEVs appears unique to Pioneers. In the present study, 8 of 17 participants stated they would only consider a BEV as their next vehicle (due to technological and environmental motivations), whereas 1 of 17 participants would only consider a PHEV. By contrast, studies of Mainstream buyers typically find the opposite. For example, Langman (2015) interviewed 22 Mainstream households in British Columbia, Canada, and found that 18 of the 22 households preferred PHEVs to BEVs. This general interest in PHEVs among Mainstream buyers has also been noted in larger quantitative studies in California (Axsen & Kurani, 2013) and multi-city studies in the United States (Krause et al., 2013). This difference may be the result of a lack of familiarity with the technology. One American study interviewed 15 PHEV-owning Pioneers in 2007, and found that their sample also reported interest in BEVs, as they perceived PHEVs as an intermediate technology in the transition from conventional cars toward BEVs (Kurani, Heffner, & Turrentine, 2008). Alternatively, the difference between Pioneers and Mainstream buyers' reported levels of interest in BEVs and PHEVs might be the result of different motivations. Both Canadian (Langman, 2015) and German studies of Mainstream buyers (Lieven et al., 2011) found that greater interest in PHEVs might be due to concerns that BEVs have insufficient range and long recharge times.

Utility-controlled charging (UCC) is a general term for systems that would allow electric utilities to control the charging of PEVs by managing charging rates, charging times, or the direction of electrical flow (Bailey & Axsen, 2015). Interest in UCC was high overall with a majority of participants having stated they were willing to opt in to a UCC program. Thirteen of 17 participants were willing to opt in to a UCC program to support the deployment of green electricity, while 11 of 17 participants were willing to opt in to receive a financial discount on their electricity bill. Interestingly, although fewer participants were willing to opt in to receive a financial discount compared to supporting the deployment of green electricity, the participants that opted in for a financial discount were willing to sacrifice more guaranteed charge than those that opted in for the deployment of green electricity. This finding suggests that although environmental benefits may increase interest in a UCC program, financial incentives may be more effective at encouraging consumers to sacrifice greater levels of guaranteed charge. Two recent studies applied a quantitative methodology and had similar results. Bailey

and Axsen (2015) sampled 1,470 Canadian Mainstream buyers using a stated choice experiment and found that although green electricity deployment increased support for UCC, financial savings were more a stronger motive for consumers. Axsen et al. (2015) applied the same methodology to a sample of 157 Pioneers and noted the similar results. Together, these findings suggest that electric utilities can increase consumer interest in and support for UCC by offering both financial and environmental benefits to consumers in exchange for opting-in to a UCC program.

Finally, participants stated they have adjusted their vehicle usage since purchasing a PEV. Specifically, 12 of 17 participants reported they have increased the frequency of their vehicle trips since purchasing their PEV. Participants often explained this shift in vehicle use as willing to make non-urgent trips, such as going to the store to grab a single item. Increases in driving have been observed in other research involving PEV Pioneers (e.g. Rolim, Goncalves, Farias & Rodrigues, 2012) as well as PEV trials (e.g. Graham-Rowe et al., 2012), suggesting that this shift in driving patterns may also occur when Mainstream buyers adopt PEVs. Increased driving following the purchase of PEVs could have implications for transportation planning; accordingly, future research could monitor shifts in household driving patterns before and after consumers adopt PEVs to better understand this PEV-related behaviour.

In addition to identifying certain patterns in PEV-related behaviours, I considered whether these patterns varied across the sample and found a surprising level of consistency. Interest in UCC was the only PEV-related behaviour that varied across the sample and was associated with lifestyle engagement. Participants engaged in a pro-environmental lifestyle (i.e. Low- and High-tech Green segments) were willing to sacrifice substantially higher levels of guaranteed charge in a UCC program than were participants in the Tech Enthusiast and Other segments. This finding aligns with Bailey and Axsen (2015), who found that potential early mainstream PEV buyers in Canada perceive that UCC will help the environment.

4.3. Motivations for PEV interest, purchase and use

In this study, I defined motivations as the perceptions that influenced participants' PEV-related behaviours. Motivations can be based on perceptions of the functional (pertaining to a technology's use and operation that impact the individual), symbolic (pertaining to social meanings and emotions), or societal (impact the wider society) attributes of a technology.

In accordance with my framework, I found that a diverse range of motivations pertaining to functional, symbolic, and societal attributes influenced participants' PEV-related behaviours (Table 13). Although motivations that pertained to functional attributes were common, I identified at least one motivation behind all PEV-related behaviours that pertained to symbolic or societal attributes. Looking at the entire study, the most frequently mentioned motivations pertained to cost minimization and practicality (functional), environmental protection (societal), as well as embracing new technology and being a PEV ambassador (symbolic).

Table 13: Compilation of participants' motivations for PEV interest and usage (number of participants that mentioned the motivation)

PEV-related behaviour	Functional	Symbolic	Societal
PEV purchase	Practicality (16) Driving experience (13)	Embracing technology (12) Supporting innovative companies (7)	Environmental protection (13) Reduce oil dependence (8)
Interest in PEV type (BEV vs. PHEV)	Superior technology (5)		Environmental protection (6) Reduced oil independence (5)
PEV use	Low operating cost (12) Driving experience (8)		Reduced environmental impact (3)
Public charging use	Convenient (15) Cost savings (6) Unnecessary (13)	Be an ambassador (13)	
Stated interest in utility controlled charging	Loss of control (9) Battery degradation (4) Privacy concerns (2)	Embracing new technology (5)	Environmental protection (10)

Motivations pertaining to cost minimization, environmental protection, and embracing new technology have been identified in other studies of both Pioneers and Mainstream buyers (e.g. Langman, 2015; Kurani et al., 2008; Heffner et al., 2007; Axsen et al., 2013; Pierre et al., 2011). However, the finding that participants' were interested in BEVs due to their perceived practicality has not been identified in the literature. In contrast, a recent study found that Mainstream buyers express greater interest in PHEVs, as they tend to perceive BEVs as inconvenient due to the practice of recharging the battery (Langman, 2015).

Looking at public charging use, the finding that participants were motivated by the symbolism of being ambassador has not been identified in previous research. This motivation suggests that the opportunity to use public charging infrastructure may offer important intangible, symbolic benefits that have not previously been considered and should be explored further. Surprisingly, I did not identify any symbolic motivations behind the reported increase in the frequency of trips. One possible explanation for this lack of symbolism is that driving a PEV is a more routinized and less novel practice than other PEV-related behaviours, such as purchasing a PEV. As a result, it might not invoke a strong consideration of a consumer's self-identity.

I also examined how the prevalence of motivations varied across the consumer segments and found evidence that motivations are associated with lifestyle engagement – a finding that suggests consumer motivations may play a role in the communication of self-identity. I provide a summary of this association below, and provide a thorough breakdown of the motivations and how their emphasis varied by lifestyle segment in Table 14.

Table 14: Average number of mentions per participant relative to the entire sample

Attribute type	Motivation	Tech Enthusiast	Low-tech Green	High-tech Green	Other
Functional	Practicality	+1.2	-1.5	-1.5	+1.8
	Driving experience	-0.5	-1.2	+1.8	-0.1
	Superior technology	-0.3	-1.2	+3.0	-1.5
	Low operating cost	+0.3	-0.7	+0.3	+0.1
	Convenient	-0.2	-1.0	+0.3	+1.0
	Unnecessary	+0.8	-0.9	-0.6	+0.7
	Loss of control	+6.0	-2.5	-1.8	-1.8
	Battery degradation	+2.7	-1.3	-1.0	-0.3
	Privacy concerns	+1.5	-0.4	-0.6	-0.6
	Cost savings	-0.3	0.0	0.0	+0.4
Symbolic	Embracing technology	+3.4	-4.0	+3.4	-2.8
	Supporting innovative companies	+1.2	-1.4	+1.3	-1.1
	Be an ambassador	-0.3	-1.4	+1.2	+0.6
Societal	Environmental protection	-4.1	+9.3	-1.2	-3.9
	Reduced oil dependence	-1.4	+3.6	-1.5	-0.8
	Reduced environmental impact	+0.7	0.0	+0.3	+0.3

Compared to the entire sample, participants in the Tech Enthusiast segment emphasized motivations pertaining to the functional and symbolic attributes of the technologies. Tech Enthusiasts' interest in utility controlled charging appeared strongly motivated by functional concerns that such a program would result in a loss of control, risk battery degradation, and threaten their privacy. In regard to interest in PEVs and BEVs, Tech Enthusiasts' frequently mentioned motivations of owning a superior technology and embracing technology. It is also notable that compared to other participants, Tech Enthusiast participants infrequently mentioned any motivations that pertained to the environment. The patterns of motivations identified for Tech Enthusiast participants align with engagement in a technology-oriented lifestyle.

Similarly, participants in the Low-tech Green segment frequently mentioned motivations that align with engagement in a pro-environmental lifestyle. On average, participants in the Low-tech Green segment mentioned motivations pertaining to societal attributes, including protecting the environment and reducing society's dependence on oil, more than any other segment. Their lack of engagement in a technology-oriented lifestyle may also explain why participants in the Low-tech Green segment were the least likely to mention motivations pertaining to embracing technology and supporting innovative companies, as these motivations may conflict with their self-identity.

The motivations mentioned by participants in the High-tech Green segment also align closely with their lifestyle engagement. High-tech Greens mentioned, on average, the following motivations more frequently than participants that lacked engagement in a technology-oriented lifestyle: embracing technology (symbolic), supporting innovative companies (societal), and being an ambassador for the technology (symbolic). High-tech Greens also mentioned being motivated by a desire to protect the environment more frequently, on average, than participants that lacked engagement in a pro-environmental lifestyle. It is notable, however, that participants in the High-tech Green segment were the least likely to mention being motivated by the desire to reduce society's dependence on oil.

Participants in the "Other" segment, by comparison, did not frequently mention motivations pertaining to the environment (societal) or technology (symbolic). Instead, participants in the "Other" segment frequently mentioned being motivated by the more tangible functional benefits of PEV technologies, including the perceived practicality of PEVs and the convenience of public charging infrastructure.

Together, these findings contribute to the literature by suggesting that consumer interest, purchase, and use of PEV technologies can be influenced by a number of distinct motivations that correspond with lifestyle engagement. Although other researchers have highlighted the role of symbolic and societal attributes in influencing behaviour (e.g. Heffner et al., 2007; Langman, 2015; Axsen & Kurani, 2012; Axsen & Kurani, 2013), my findings suggest that the relative importance of these motivations may vary according to lifestyle engagement. In the present study, participants that engaged in

pro-environmental lifestyles (i.e. High- and Low-tech Green segments) emphasized motivations pertaining to the environment (societal), while participants that engaged in technology-oriented lifestyles (i.e. Tech Enthusiast and High-tech Green segments) emphasized technology and innovation (functional and symbolic). By comparison, participants that lacked engagement in either lifestyle (i.e. “Other” segment) did not strongly emphasize any specific set of motivations; however, they did frequently mention the more tangible functional attributes of PEV technologies. The apparent association between lifestyle engagement and motivations should be further explored using quantitative research methods.

4.4. Relevance of lifestyle theory

Lifestyle theory posits that self-identity is informed and expressed by engagement in lifestyles (Giddens, 1991). In this study, I explored the relevance of lifestyle theory in two ways. First, I identified the lifestyle engagement of 17 PEV Pioneers to see if PEV ownership is associated with lifestyle engagement. Second, I assigned the 17 Pioneers into four segments based on engagement in pro-environmental and technology-oriented lifestyles to examine whether motivations and PEV-related behaviours corresponded with lifestyle engagement.

My findings provide evidence for the association between PEV ownership and engagement in pro-environmental or technology-oriented lifestyles. Eleven of the 17 participants communicated engagement in either a pro-environmental or technology-oriented lifestyle, or a combination of the two. This finding supports the conclusions of recent quantitative studies that found interest in pro-environmental technologies (including PEVs) correlates with engagement in either of these two lifestyles (e.g. Axsen et al., 2012; Axsen, Bailey & Castro, 2015). It is noteworthy, however, that our findings also suggest that PEV technologies may appeal to consumers engaged in other lifestyles with other motivations, as evidenced by the 6 participants in the “Other” segment in the present study.

Another novel insight is the apparent association between lifestyle engagement and consumer motivations. Despite the overall consistency in PEV-related behaviours

across the sample, participants' motivations varied and generally aligned with their lifestyle engagement. For example, although 8 of 17 participants stated greater interest in purchasing a BEV rather than a PHEV as their next vehicle, participants that engaged in a technology-oriented lifestyle often established this interest based on a desire to own what they perceived to be a technology superior to PHEVs and conventional vehicles. By comparison, participants that engaged in a pro-environmental lifestyle were motivated by a desire to own a vehicle that was less harmful to the environment. This association between lifestyle engagement and motivations suggests that consumers evaluate technologies based, in part, on whether they perceive the technologies to conflict or align with their self-identity.

More broadly, my findings demonstrate the relevance of lifestyle theory as a useful framework for assessing and understanding consumer behaviour. Lifestyle theory can, and has been, applied using a variety of methods to improve our understanding of consumer interest in novel technologies (e.g. Axsen et al., 2012; Bailey & Axsen, 2015). This study further contributes to the existing body of literature by demonstrating that the motivations behind consumer behaviour can be partly explained according to a consumer's lifestyle engagement.

4.5. Limitations of study and future research

The present study had three limitations that can be addressed in future research. First, my sample was limited to Pioneers, a group of consumers that has been shown to be different from Mainstream buyers (Axsen et al., 2015; Langman, 2015). While my sample was appropriate for this study, I cannot conclude that my findings would hold for Mainstream buyers. Future studies should apply the methodology of this study to a sample of Mainstream buyers to explore the motivations and lifestyles of a different, and much larger, consumer group.

Second, although this study was exploratory and a small sample size was necessary, it is unknown how well these results can be generalized to different contexts and populations. Further research should explore the generalizability of these results by

conducting similar studies in different locations and by adapting my findings for use in surveys with larger samples.

Finally, my sample focused on three PEV models: the Chevrolet Volt, Nissan Leaf, and Tesla Model S. Some responses may have been specific to owners of these three vehicle models. I attempted to control for this by comparing participant s across vehicle models and did not find any strong associations. Future PEV studies could test the present results with a sample that includes other PEV models, such as the Mitsubishi i-MiEV, BMW i3, and Ford Focus Electric.

Despite the aforementioned limitations, this study provides valuable observations and insights from its in-depth interviews with current Pioneers – rather than potential buyers who less familiar with the technology.

4.6. Implications for policy and industry

Policymakers that seek to facilitate the adoption or use of PEV technologies will likely be more effective if they to better understand consumer motivations. This study reveals that consumers have a diverse range of motivations, and the prevalence of these motivations may vary across consumer segments. Policies that neglect this heterogeneity may be limited in their effectiveness. Accordingly, efforts to encourage consumer interest in PEV technologies should consider addressing some of the functional, symbolic, and societal motivations identified in this study. For example, financial incentives, such as purchase rebates, could be combined with labelling requirements that highlight environmental performance, and with information campaigns that communicate the novel features of the technology. The deployment of public charging infrastructure should also consider the symbolism of “being an ambassador” that is associated with its use; if such social interactions could possibly influence others to buy PEVs, then new charging stations could be installed in visible areas subject to high volumes of foot traffic in order to facilitate such opportunities. Electric utilities should also seek to address the range of consumer motivations by designing a UCC program that addresses functional and societal motivations. For example, a well-designed UCC

program might offer financial incentives, an option for consumers to temporarily opt-out, and provide users with information regarding potential environmental benefits.

Industry should also consider the heterogeneity of consumers when pursuing design and marketing efforts. Current marketing efforts focus on individuals assumed to be engaged in a pro-environmental lifestyle and motivated by societal attributes pertaining to the environment. Indeed, I find evidence that Pioneers are likely engaged in a pro-environmental lifestyle and motivated by a desire to protect the environment. However, I also find that not all Pioneers are engaged in a pro-environmental lifestyle, and not all Pioneer motivations are related to societal attributes. The manufacturing and marketing of PEVs and other low-carbon technologies should aim to appeal to consumers engaged in a variety of lifestyles – beyond those typically targeted (e.g. participants in my “Tech Enthusiast”, “High-tech Green”, and “Low-tech Green” segments). As a result, industry might consider emphasizing the more tangible, functional attributes of PEVs, such as practicality, convenience, and cost savings. Automotive manufacturers could also increase the number of PEV models available to ensure PEVs exist that align with the diverse motivations and lifestyles of consumers.

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Appendix A.

Interview outline

Overview

1. Opening	5 min
2. PEV Purchase	25 min
3. Vehicle Charging and Driving Patterns	40 min
4. Charging Design Game	25 min
5. Lifestyle	15 min

Note: This is only a guide and discussions may have varied.

1. Opening

- Thank you for participating in the study
- We want to learn about you and your household's experience with your electric vehicle
- Please go into as much detail as possible, and expand your answers to the best of your ability
- Do not hesitate to ask questions at any time
- You do not have to answer every question if you are not comfortable, and are able to withdraw from the conversation at any time
- All information you share will be anonymous and confidential, and will only be used for the purposes of this study
- *Consent form*
- *Turn recorder on; state names for transcribing*

2. PEV Purchase

- ☐ Can you tell us about the vehicles you own (make, model, year)?
  - ➲ *For non-PEV:* Can you tell me a bit about why you decided to buy that vehicle?
  - ➲ What did you like/dislike about it?
- ☐ Can you walk me through how you came to purchase your _____, thinking back to when you first considered one?
  - ➲ Was there an initial event that made you consider a PEV?
  - ➲ Did you do research? What sources did you use?
  - ➲ Did you have previous experience with a PEV?
  - ➲ Did you consult anyone during the purchase process? Did you talk to any friends or family? Are any of them interested in electric vehicles? Why?
  - ➲ What did your friends or family think about the purchase? Why do you think they felt that way?
  - ➲ Did you have any concerns about owning a PEV?

- ➲ Did you consider a conventional vehicle? PHEV/BEV? Why or why not?
    - i. Why did you purchase your ____ instead?
    - ii. Did buying an electric vehicle instead of a conventional vehicle make some sort of statement?
- ➲ Buying a new vehicle is a major purchase for many people. Was there anything else going on that might have encouraged you to purchase an electric vehicle?
    - i. Were you particularly open to trying something new?

☐ Did you consider where you would charge it? At home/work?
- • Did the availability of charging infrastructure influence your decision?

☐ Looking ahead to your next vehicle, do you have any thoughts about what vehicle you would like to buy?
- • BEV, PHEV, Conventional, Other?

3. Vehicle charging and driving patterns

☐ Now that you have owned your ____ for a while, can you tell us how you use your vehicle?
- ➲ Where are you driving it? Does it work well for you?
- ➲ *If two or more vehicles:* Is it your primary vehicle? When do you use your other vehicles? When do you use other modes? (Is this more or less than before the PEV purchase?)
- ➲ Are you driving more or less than before the electric vehicle? Why?
- ➲ Have you changed any routines or the way you use a vehicle? For example, are you going to certain places more or less with the vehicle?
- ➲ Do you use the electronic information that the car provides?

☐ Can you tell me a bit about how you recharge the vehicle?
- ➲ Where do you recharge it? How often? What do you think of these locations?
- ➲ How do you find charging opportunities?
- ➲ How do you compare it to refuelling a conventional vehicle? Do you prefer one over the other?
    - i. Why do you like/dislike the process of charging your vehicle?
- ➲ What are your thoughts on public charging? Is it a necessity or something you can do without?
    - i. Are there certain places you would like to see a public charging station? Would you visit certain places more if they had chargers?
    - ii. Would you have still bought your vehicle if public charging was less abundant?
    - iii. How does it compare to charging at home? To work? Do you prefer one over the other?
- ➲ *PHEV:* How often do you drive using the battery compared to gasoline? Do you try to maximize your use of one? Why?

☐ Do you feel the car has met your expectations or fallen short?
- ➲ Have you learned things over the time you have owned it?

- ☐ Do you talk to others about your vehicle or about PEVs?
    - ➲ Do you participate in any electric vehicle groups? Did you know of these before you purchased your vehicle?
    - ➲ Do you recommend the car to others?
    - ➲ Do you enjoy this social aspect? Did you engage in these discussions with your previous vehicle?
- ☐ Have you changed anything else in your life since you bought the vehicle?
    - ➲ Are you doing different activities? Talking to different people or having different conversations? Have different interests?
    - ➲ Spend more or less time with the different groups?
- ☐ *Homework - Pictures:* We asked you to provide a couple pictures that express the thoughts and feelings you have about your car. Can you show and explain them to us?
    - Does the electric vehicle "fit" your personality?
    - Would you associate these same pictures with a BEV/PHEV?

4. Charging Design Game

- ☐ Conduct the games
    - ➲ Why are you willing to pay for ___% of green electricity? Why not more/less?
    - ➲ Before this game, had you ever considered where electricity comes from or its environmental impacts?
    - ➲ Do you think you would have been willing to pay for green electricity if you did not have your electric vehicle?
    - ➲ What are your initial thoughts of UCC?
        - i. What do you think is most beneficial about UCC?
        - ii. Would you let a utility manage recharging to reduce the environmental impacts of electricity generation?
        - iii. What if it saves you money?
        - iv. Are there any conditions you would need to accept this?
        - v. What concerns do you have?

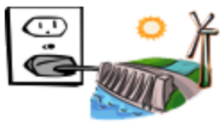
5. Lifestyle

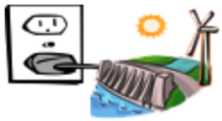
- ☐ Before we conclude the interview, we like to get some general background information about you so we have a better understanding of the people we interview.
- ☐ Can you tell us a bit more about how you spend your time? Activities? Interests?
    - ➲ Why do you choose to spend your time on these?
    - Has this changed since purchasing a PEV?
- ☐ What are your thoughts about preserving the environment? Do you generally do things to help the environment?
- ☐ You identified yourself in the survey as "____ green". I am curious what that means to you? What do you do that made you decide you are a ____ green?
- ☐ What's next for you? The electric vehicle sounds like it was a major purchase. Do you have any plans for other purchases?

- You sound interested in the (environmental/technical/social) aspect of your electric vehicle. Has your experience with it caused you to think about making other changes or purchases soon?
- Has the vehicle provided any new opportunities for you?

Appendix B.

Example design game

Charging Style	Source of Green Electricity	% of green electricity	Guaranteed Minimum Charge	Monthly Electricity Bill	Your Choice
Current 	Your Current Mix	Your current mix	100%	$_35_	☐
New 	☐ Wind ☐ Solar ☐ Small Hydro ☐ Mix	☐ 25% ☐ 50% ☐ 75% ☐ 100%	→ 90% → 80% → 65% → 50%	$_35_	☐

Charging Style	**Source of Green Electricity**	**% of green electricity**	**Guaranteed Minimum Charge**	**Monthly Electricity Bill**	**Your Choice**
Current 	Your Current Mix	Your current mix	100%	$_35_	☐
New 	Your Current Mix	Your current mix	☐ 90% ☐ 80% ☐ 65% ☐ 50%	→ $_33.25_ → $_31.50_ → $_28.88_ → $_26.25_	☐

Appendix C.

List of motivations

Motivation	Number of mentions	Participants with at least 1 mention	Average mentions per participant that reported PEV behaviour			
			Tech Enthusiast	Low-tech Green	High-tech Green	Other
Plug-in electric vehicle purchase						
Functional						
Practicality	80	16	5.4	2.7	2.7	6.0
Driving experience	20	13	0.8	0.3	2.0	1.5
Symbolic:						
Embracing technology	62	12	6.8	0.0	6.3	1.5
Supporting innovative companies	23	7	2.6	0.0	2.7	0.3
Societal:						
Environmental protection	76	13	1.8	11.0	3.7	3.8
Reduced oil dependence	16	8	0.4	3.3	0.3	0.5
Interest in plug-in electric vehicle type (BEV vs. PHEV)						
Functional:						
Superior technology	16	5	3.0	0.5	4.5	0.0
Societal:						
Environmental protection	20	6	2.0	4.5	3.0	0.5
Reduced oil dependence	9	5	0.5	2.5	0.5	1.0
Plug-in electric vehicle use						
Functional:						
Low operating cost	21	12	2.0	1.1	2.0	1.8
Driving experience	10	8	0.7	0.5	1.7	0.3

List of motivations continued

Motivation	Number of mentions	Participants with at least 1 mention	Average mentions per participant that reported PEV behaviour			
			Tech Enthusiast	Low-tech Green	High-tech Green	Other
Symbolic:						
Reduced environmental impact	5	3	0.7	0.0	0.3	0.3
Public charging use						
Functional:						
Convenient	37	15	1.8	1.0	2.3	3.0
Cost savings	6	6	0.0	0.3	0.3	0.7
Unnecessary	31	13	2.4	0.7	1.0	2.3
Symbolic:						
Be an ambassador	37	13	1.8	0.7	3.3	2.7
Stated interest in utility controlled charging						
Functional:						
Loss of control	15	9	9.0	0.6	1.3	1.3
Battery degradation	5	4	4.0	0.0	0.3	1.0
Privacy concerns	3	2	2.0	0.2	0.0	0.0
Symbolic:						
Embracing new technology	9	5	0.8	0.3	1.3	0.0
Societal:						
Environmental protection	20	10	1.0	2.7	1.0	0.7