TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Analysis of New Zealand Specific Electric Vehicle Adoption Barriers and Government Policy

Supervisor: Dr David Stewart

By Jiayi (Jason) Zhu

ID: 300333845

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

ANALYSIS OF NEW ZEALAND SPECIFIC ELECTRIC VEHICLE ADOPTION BARRIERS AND GOVERNMENT POLICY

BY JIAYI (JASON) ZHU

A thesis submitted to the Victoria University of Wellington in fulfilment of the requirements for the degree of Master of Business Administration

Victoria University of Wellington

(2016)

Abstract

The New Zealand (NZ) Transport sector represents over 40% of the country's greenhouse gas emissions from the energy sector. Electric Vehicles (EV) are fast emerging globally as a viable alternative to traditional fossil fuel burning cars. In hope of addressing the low EV adoption in NZ, the Ministry of Transport published a series of EV policies in May 2016.

The literature review found a broad spectrum of EV adoption barriers from a global perspective covering technology, economic, social, environmental, and political factors. However, the analysis of barriers from a NZ perspective is overly simplistic and largely based on international findings with little empirical evidence specific to NZ. The most influential barriers specific to NZ are deemed as 1) range; 2) charging time; 3) purchase price; 4) charging facilities and 5) NZ car market.

While there is literature which evaluates global policies and suggests effective policies for NZ, there is no current research that evaluates whether the latest NZ government policy is going to be effective in improving EV uptake in NZ. These papers tend to prescribe a solution of government policies without truly knowing whether their assumptions about EV adoption barriers apply to NZ.

Using a mixed methodology, a questionnaire containing both quantitative and qualitative research questions was carried out.

The findings of this paper show there are four major NZ specific barriers, namely 1) high purchase price; 2) unknown cost of ownership (i.e. service, maintenance and repair); 3) lack of charging facilities and 4) lack of EV knowledge. Other barriers highlighted by literature such as range and charging time are found to be less influential barriers.

Overall, the sentiment for EV adoption is positive and the government policy is deemed to be reasonably effective as it either directly or indirectly addresses the above four barriers; however, certain policies such as ones addressing the cost of ownership can be improved.

Acknowledgement

I would like to extend a word of thanks to everyone who made this project possible, my supervisor David Steward and all survey respondents. I know that survey took more than 20 minutes to complete.

I would also like to thank everyone who made this MBA journey delightful, a special mention goes to my MBA comrades who fought alongside me from day one: Sophia Ling, Sumeet Reddy and Jimad Khan. Through arguments and assignments, we grew – the team of "masterteers".

I would not have done this degree without the endless support from my wife Mariska Kecskemeti, you are entitled to half of my MBA, I promise.

Lastly to our precious boy Éliás, thanks for not keep me awake at night so I can finish this research project sanely. Hopefully one day you will find as much pleasure in learning as your father.

Table of Contents

1 Introduction

While the transportation sector has benefited immensely from the development and use of internal combustion engines (ICE) in 1807, there is a growing awareness of the negative impact fossil fuels have brought upon the well-being of the environment and society. ICE powered vehicles are now the main global source of carbon dioxide emissions (Lemon and Miller, 2013). As a result, Electric Vehicles[1] (EV) are fast emerging as a viable alternative to traditional fossil fuel burning cars.

Transport represents over 40% of NZ's greenhouse gas emissions from the energy sector. Consequently, the Ministry of Transport is investigating the government's role to encourage increased use of EV in NZ's light vehicle fleet[2] (Ministry of Environment, 2016). NZ has a very low adoption rate of EV. As of May 2016, there were 1,304 registered EVs out of approximately three million light vehicles registered on the road (Ministry of Transport, 2016a). However, there has been exponential growth since 2010 (Figure 1).

1 There are two main types of EVs, namely battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV). BEVs operate solely on a battery pack that is electrically powered, whereas PHEVs can be charged from the grid as well as having a combustion engine to extend their range (Concept Consulting Ltd, 2016).

2 Light vehicles are those that have a gross vehicle mass less than 3.5 tonnes and include cars, vans, 4WDs, utes and light trucks (Ministry of Transport, 2011).

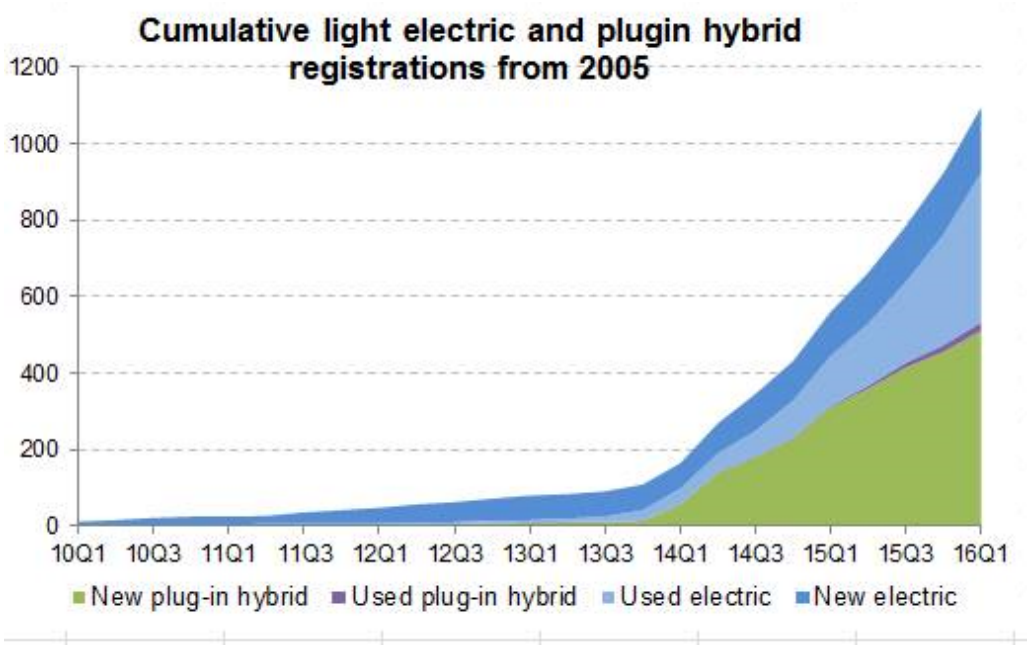


Figure 1: Cumulative Light Electric and Plugin Hybrid Registration showing exponential growth, (Source: Ministry of Transport, 2016a)

On 5 May 2016, Transport Minister Simon Bridges announced new government policies to encourage EV uptake (Figure 2). Bridges also declared a target of 64,000 EVs in use in NZ by 2021– which represents approximately an 118% annual compound growth rate[3] and 2% of the entire NZ light vehicle fleet (Ministry of Transport, 2016a). The EV policies will play a critical role in achieving this target. However, many critics are already speculating the new policies are underpowered (Maude, 2016); it remains to be seen whether they will effectively address the specific barriers restricting NZ EV uptake.

3 Calculated from the number of existing 1,304 registered EV in 2016 (Ministry of Transport, 2016).

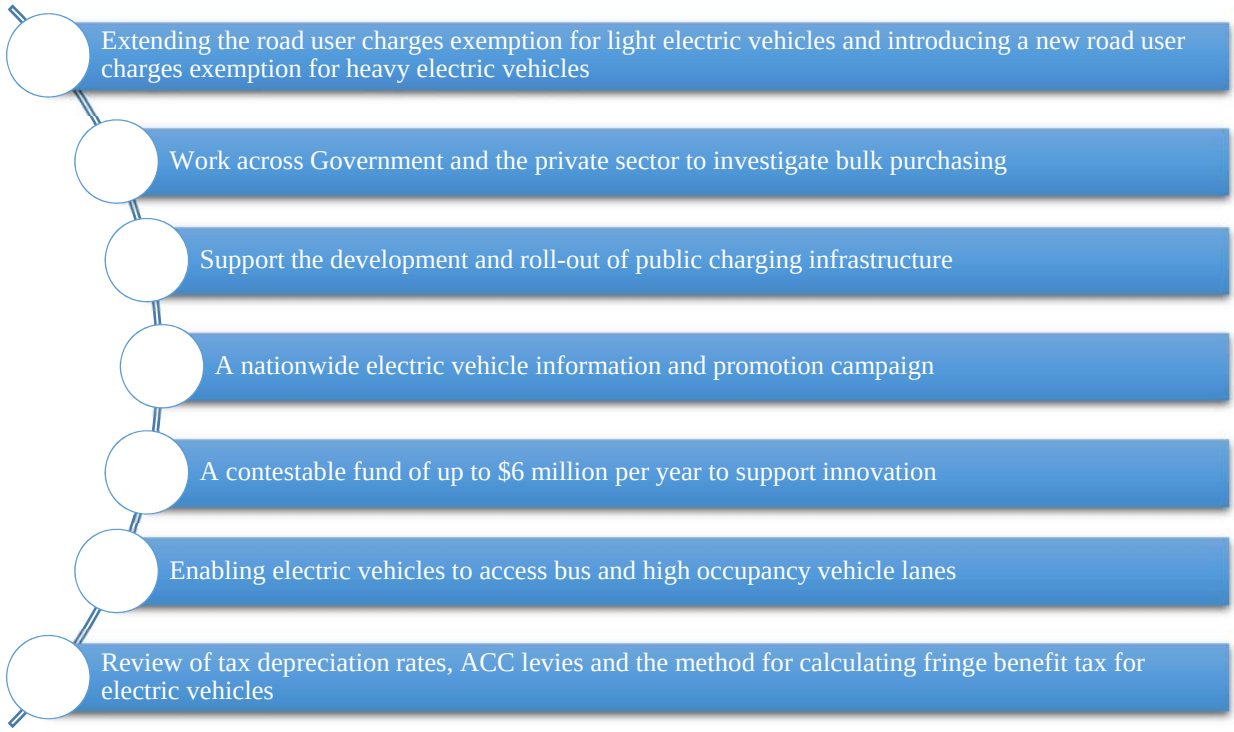


Figure 2: NZ Government EV policy announced on May 2016 (Source: Ministry of Transport, 2016b)

In light of these policies, this research paper will address two questions: a) "what are the NZ specific barriers to EV uptake?" and b) "is the new government policy going to be effective in addressing these barriers?" These questions will be addressed by conducting a literature review of common EV barriers in an international and NZ context. This will be followed by the methodology and the presentation and analysis of survey results to provide an in-depth look at NZ specific barriers to EV uptake. Finally, once the NZ specific barriers are identified, the effectiveness of the new government policy will be evaluated against them.

2 Literature review

Various papers have discussed and identified EV barriers in relation to technological, economic, social, political and environmental factors in an international context (Barton and Schütte, 2015; Business NZ Energy Council, 2016; Concept Consulting Ltd, 2016; Element Energy, 2013; Ford et al., 2015; Giffi et al., 2010; Giffi et al., 2011; Hosseinpour et al., 2015; Lemon and Miller, 2013; Metcalfe and Kuschel, 2015; Tran et al., 2013). Most NZ EV studies are based on barriers derived from these global studies. The only paper based on empirical evidence obtained through a NZ market source is by Ford et al. (2015).

Figure 3 illustrates EV adoption barriers with NZ specific barriers highlighted.

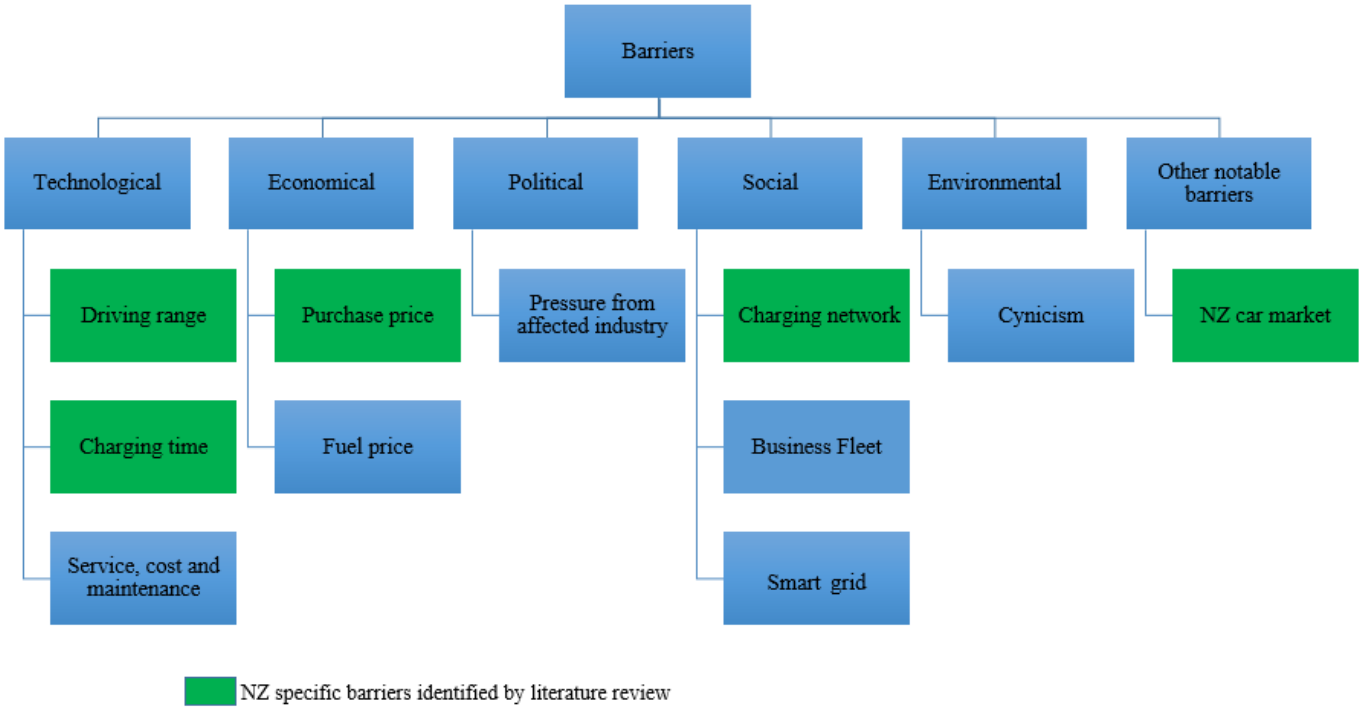


Figure 3: Overview of main EV issues with highlighted NZ barriers

2.1 Barriers that apply to NZ context

2.1.1 Technological – Driving range

Studies have consistently found range is one of the major barriers in customers' decision to adopt EV (Element Energy, 2013; Giffi et al., 2010; Giffi et al., 2011; Lemon and Miller, 2013). A 2010 Deloitte survey (Giffi et al., 2010) of 2,000 US vehicle purchasers showed that 22% of respondents stated limited driving range as one of the major reasons in deferring purchasing an EV. Similar findings are presented in surveys done in 17 countries (Giffi et al., 2011) and a survey done by Oxford Brookes University (Element Energy, 2013).

The ideal driving range expected by consumers has been found to be between 300km to 450km (Giffi et al., 2010, Giffi et al., 2011; Element Energy, 2013; Lemon and Miller, 2013). However, arguably this problem is a *perceived* rather than a real issue, with 85% of the 2010 Deloitte survey respondents travelling less than 160km per day. Similar disparities between range expectations vs. actual performance required were found by a UK National Travel survey (Element Energy, 2013) which identifies that EVs with a 150km driving range could easily satisfy over 90% of car drivers' daily use.

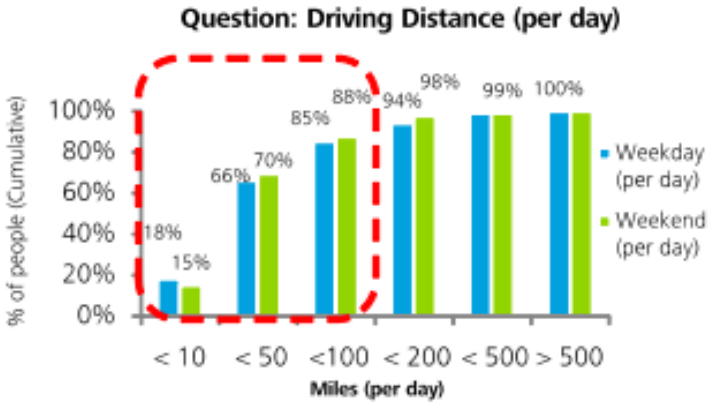


Figure 4: 85% of survey respondents only drive less than 100 miles (160km) per day (source: Giffi et al., 2010)

Almost all NZ studies (Barton and Schütte, 2015; Business NZ Energy Council, 2016; Concept Consulting Ltd, 2016; Lemon and Miller, 2013; Metcalfe and Kuschel, 2015) tend to agree that range is one of the concerns for potential EV purchasers, drawing references from international surveys and studies. Ford et al. (2015) conclude from their NZ surveys and interviews that range is one of the adoption barriers.

It should be noted that most international surveys were conducted in early 2010. There has since been an incremental improvement in battery technology. Tesla Motors (Tesla) recently released the affordable Model 3 – capable of a 350km range per charge (Tesla Motors, n.d.). Based on the international surveys cited above, theoretically speaking this should ease consumer anxiety about range and resistance to EV uptake; however, no recent studies assess how Tesla's new market development impacts the perception of potential EV consumers. There is also no study addressing rapid technology developments (see Table 1) – for example, the most popular BEV model sold in NZ, Nissan LEAF, announced in 2016 that the next generation model will go up to a 540km range, expected to be available in 2018 (Collett, 2016). By 2020 Skoda intends to produce a model with 480km range, 15-minute charging time and that is cheaper than comparable ICE vehicles (Rendell and Huntingford, 2016).

	**Tesla** – Model 3 Year to be released: 2017 -2018 Target Range: 350km
	**Chevrolet** - Bolt Year to be released: 2017 Target Range: 320km
	**Audi** – Q6 Crossover Year to be released: 2018 Target Range: 480km
	**Nissan** - LEAF Year to be released: 2018 Target Range: 540km
	**Hyundai** – models are not specified Year to be released: 2018 Target Range: 320km
	**BMW** – 3 series EV version Year to be released: 2018 Target Range: 480km
	**Skoda** – models are not specified Year to be released: 2020 Target Range: 480km

Table 1: Examples of new EV and targeted range

2.1.2 Technological – Charging time

Another common barrier related to battery technology is constraints in the charging period (Element Energy, 2013; Hosseinpour et al., 2015; Kodjak, 2012; Ford et al., 2015). Element Energy (2013) concludes that customer concerns come from two aspects. First, the long charging time causes inconvenience for on-road use – i.e. the inability to quickly top up and go. Second is a loss of flexibility when charging at home – i.e. the owner cannot make unexpected trips when the EV is being charged. There is a variation in what is considered to be the desired charging period, between 2 – 5 hours (Element Energy, 2013). NZ studies (Lemon and Miller, 2013; Metcalfe and Kuschel, 2015) adopt this as a barrier but lack any empirical evidence or significant discussion on this topic. Ford et al's (2015) survey also concludes that charging time is a problem for NZ consumers – similarly, very little detail is given as to why this is a significant barrier.

There is also a lack of discussion about the impact of developments in charging technologies. Kodjak (2012) briefly mentions that fast chargers are not fast enough and implies that on-road charge time expectation is 5 minutes – the time it takes to top up an ICE vehicle in a gas station. However, Tesla's supercharger allows an 80km range to be added within a mere 6 minutes charging [4] and achieves 80% of full range in 45 minutes (Gordon-Bloomfield, 2014). Furthermore, the Japanese standard DC CHAdeMO quick charging system is capable of refilling the Mitsubishi i-Miev and Nissan LEAF from 20% to 80% in 30 minutes (Weissler, 2013). No study has shown whether these technological developments have impacted customer perceptions.

[4] When Battery is less than 10%

2.1.3 Economical - Purchase price

EV selling price is arguably the barrier most consistently identified amongst all the literature (Element Energy, 2013; Ford et al., 2015; Metcalfe and Kuschel, 2015; Giffi et al., 2011; Hidrue et al., 2011; Hosseinpour et al, 2015; Lemon and Miller, 2013; PricewaterhouseCoopers, 2013; Royal Society of New Zealand, 2016). A PricewaterhouseCoopers (2013) survey suggests that customers think there is a significant premium to be paid for EVs compared to a similar sized ICE vehicle. Hosseinpour et al. (2015) suggest that customers believe EVs should be sold at a lower price than ICE vehicles due to their limited functions.

However, although higher in upfront costs, the running cost for EVs is actually lower than ICE vehicles making the total ownership cost similar (Element Energy, 2013). Despite this, Lemon and Miller's (2013) cost-benefit analysis argues that regardless of low annual running costs of EVs, customers perceive this is inadequate to offset the high upfront cost. Similarly, Element Energy (2013) concludes that customers place more value on upfront costs rather than running costs.

Conversely, studies by Hidrue et al. (2011), show customers are willing to pay a premium on top of the existing EV selling price if they get increased driving range and a decreased charging period. Tran et al. (2013) suggest the most attractive attribute of EVs is the economic benefits. Element Energy (2013) briefly discusses business model innovations that can offset the high capital cost of EV – for example, Renault now offers battery leasing as part of its sales package (Renault, n.d.) which significantly reduces the initial purchase price and removes concerns around battery maintenance. These studies are contradictory to findings concluding EV is too expensive.

2.1.4 Infrastructure - Charging network

There are mixed views regarding charging infrastructure as an entry barrier. As a result of the perceived need to drive longer distances, potential EV buyers and EV owners often demand more public charging infrastructure (Element Energy, 2013). Giffi (2010) also suggests that customers will not consider buying EV until charging infrastructure is widely acceptable. Element Energy acknowledges the issue but does not view a ready charging network as a "pre-requisite to the emergence of an EV market" (2013: 34). While some NZ papers (Metcalfe and Kuschel, 2015; Lemon and Miller, 2013; Stephenson, n.d.) refer to a lack of charging infrastructure as a barrier, Barton and Schütte (2015) point out that customers can rely on their ordinary garage electrical outlet for overnight charging. They state that 85% of NZ dwellings have access to garages/carports, implying that charging facilities are not an issue for NZ. Furthermore, efforts for installing fast chargers are underway to cover NZ's main routes by 2017 (Figure 5).

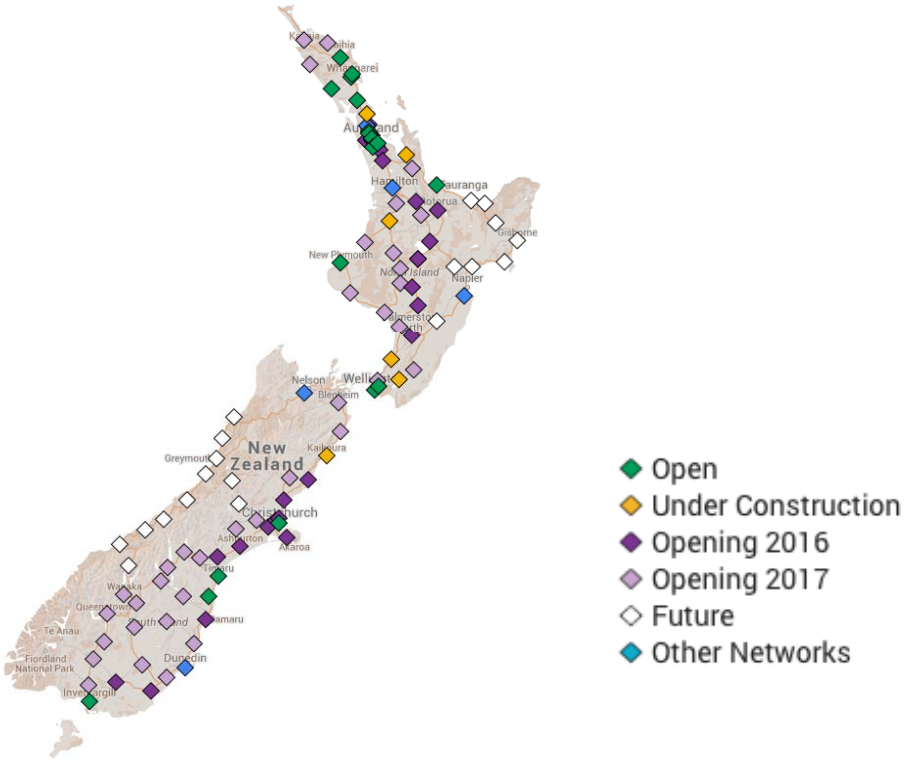


Figure 5: NZ charging station overview – fast chargers (Source: Charge.net.nz)

2.1.5 NZ car sale market

A common theme raised by NZ studies is that the NZ car market is dominated by the second-hand car market (Ford et. al, 2015; Lemon and Miller, 2013). Ford et. al's (2015) study concludes age is the least concerning factor when buying a vehicle. This suggests NZers are willing to purchase second-hand EVs. The majority of NZ's EV supply is through importers, private car dealerships and dealers who are providing second-hand EVs through auction site Trade me.

Lemon and Miller criticise the lack of supply and state that "until cheap second-hand or refurbished electric vehicles are able to enter New Zealand, it is likely that electric vehicles will have relatively little appeal for this portion (the second-hand car market) of the market" (2013: 2). But the point of discussion was brief and lacked any details to prove whether this was a real barrier for NZ.

The Royal Society of New Zealand (2016) also very briefly touch upon the slow EV uptake in NZ. They make the assumption that this is due to the NZ market being heavily based on second-hand car trading, lack of supply of EVs and the policy environment not incentivising EV ownership. Again, there is no tie to NZ research to back these statements.

2.2 Minor acknowledged NZ-specific barriers

There are many other barriers identified in the EV literature that are not widely acknowledged as NZ specific barriers. From a technological aspect, Tsang et al. (2012) show that unknown cost of service, maintenance and repair pose an unknown risk factor to consumers considering buying an EV. From an economical aspect, Hosseinpour et al (2015) suggest the price of gasoline incurred a reverse proportional relationship with the rate of adoption of EV.

From a political aspect, Hosseinpour et al (2015) used the failure of GE's EV1 as a showcase of how strict regulations can act as a barrier to EV production and adoption. Additionally, the oil and gas industry contributed over $2.5 billion to NZ GDP in 2009 and the NZ Government collects around $400 million in royalties per annum from petroleum (PEPANZ, n.d.). Therefore, providing tax incentives to encourage EV uptake while killing one of its most lucrative sources of income is a dilemma for most governments wanting to support EV.

From a social aspect, Royal Society of New Zealand (2016) proposes that in order to speed up EV adoption, it requires the aid of organisations, for example by purchasing EV as their commercial fleets. The underdevelopment of a smart grid, which is essential in determining how cheaply and what time EV owners can charge their car, can also be a barrier, (Dawes et. al, n.d.).

Lastly, from an environmental aspect, whether EVs are manufactured from a renewable source and how the electricity that powers them is generated creates cynicism amongst consumers and forms an adoption barrier (Wilson, 2013).

2.3 Evaluation of NZ specific entry barriers in literature

Overall, papers that specifically address NZ entry barriers lack depth or NZ customer perceptions. Most NZ EV studies are based on barriers derived from global studies with authors making the assumption that global issues directly apply to the NZ market. The report by Element Energy (2013) is the most heavily referenced paper by NZ studies. Also, there is no empirical evidence to show these barriers directly apply to NZ. Another issue with this method is that there is often a time lag between studies and new EV market developments, meaning some study findings can be obsolete and customer perceptions might have changed. Lastly, as

outlined in section 2.2, there are many barriers not discussed or acknowledged within a NZ context.

Ford et. al (2015) provide the most recent study that directly discusses barriers within a NZ context and is based on empirical data. However, it should be noted this analysis is focused purely on the demand side of customer attitudes. Ford et. al's interviews and surveys focused on five categories of price, ongoing (ownership), range, age and charge, which identified upfront cost, charging time and range as the three main NZ barriers. A limitation of this survey is that the categories may have limited respondents' answers, and thus lacks an in-depth view of the EV barriers as a whole.

2.4 Effective policies addressing entry barriers

Studies have been done to compare and analyse the policies of high EV uptake countries such as Norway and Germany (Element Energy, 2013; Barton and Schütte, 2015; Lemon and Miller, 2013; Metcalfe and Kuschel, 2015), before drawing conclusions about what effective policies should look like.

Metcalfe and Kuschel concluded that most of the effective policies have been fiscal in nature, as well as "market-based, regulatory, informational, infrastructure creating and overcome the barriers to their adoption" (2015: 5). Element Energy (2013) concludes that governments can encourage EV uptake through non-financial measures that are valued by consumers, for example, free access to parking and ability to use bus lanes during peak traffic. These policies have been proven in countries where uptake of EVs is much higher.

Barton and Schütte's (2015) report is the most influential paper within a NZ context regarding policies. They proposed five policy measures: 1) provide price benefits to EV, or penalise carbon emissions of the vehicles; 2) improve public awareness; 3) encourage the growth of

public charging infrastructure; 4) demonstrate a clear policy intent; and 5) charge a high carbon price through the Emission Trading Scheme (ETS). However, the limitation of these proposed policies is they are based on Element Energy's conclusions regarding EV adoption barriers (2013) and assumes the barriers directly link to NZ.

Kley et al. (2012) propose four categories of measurement for supporting the adoption of EVs. These are: 1) economic measures which refers to government intervention in the market such as sales tax reduction and subsidies, bonus/malus systems, scrappage schemes, annual tax and cost reductions, and fuel taxation; 2) 'suasive' measures involving the use of informational sources to hasten EV uptake; 3) regulatory measures which include compulsory emission targets for new vehicles; and 4) organisational measures such as involving local governing and supervisory bodies to develop local charging infrastructure.

Lemon and Miller (2013) based their analysis on Kley et al. (2012) and propose three chronological stages of EV adoption. In the short term, they argue for the use of suasive measures such as increasing consumer awareness about fuel economy and tightening fuel standards. In the medium term, they argue for the use of organisation measures by carrying out capital investment such as the installation of charging stations and EV provisions for new homes and car parks. Finally, in the long term, they argue for the use of economic measures. While Lemon and Miller's presentation of policies is logical, an issue is that policies do not necessarily happen sequentially and are not bound by timelines. For example, there are already initiatives to install charging stations around NZ which is a medium-term policy measure.

While these articles point out possible future directions, there is no literature evaluating the effectiveness of the government's new EV policy. Barton and Schütte (2015) and Lemon and Miller (2013) both have the limitation that they are trying to prescribe a solution without fully understanding the problem first. They based their barriers on the assumption that EV barriers

directly translate to NZ market. This research paper will suggest a better approach is to understand existing NZ specific barriers first, then evaluate current policies against these barriers before reaching a conclusion about whether these policies are effective.

2.5 Conclusion of literature review

Overall there is a broad spectrum of barriers covering technology, economic, social and political factors which have been well researched and studied from a global perspective. The majority of studies agree that customers' perceptions regarding driving range and price act as major entry barriers. However, as shown, the analysis of barriers from a NZ perspective is overly simplistic. There is no doubt issues such as driving range and price are well known to consumers and are barriers that influence EV adoption in NZ, but these are over simplified answers to a very complicated question. A broader analysis of EV barriers in NZ is required, including areas such as influence from the petrol industry, whether there is a negative impact on the economy, impacts on the national grid, and the status of the NZ car market. Moreover, with the rapid development of EV technology and business models, it is hard to get a timely measure of consumer perceptions.

While there is literature which evaluates global policies and suggests effective policies for NZ, there is no current research evaluating whether the latest NZ government policy is enough to improve the EV uptake in NZ. Therefore, it is vital to first understand customer perceptions and true barriers and then determine appropriate policies to fast-track uptake.

3 Methodology

This research paper primarily adopts a positivist paradigm with the focus on quantitative, empirical data collection and analysis (Creswell, 2014). In order to explain the phenomena of EV adoption barriers, a large enough sample size was needed to reflect the view of the general

population, thus requiring the research to “collect numerical data that (can be) analysed using mathematically based methods” (Muijs, 2011: 2). While quantitative research can provide the scope of information, a shortcoming is not being able to analyse the subject in depth and really “get under the skin of a phenomenon”. (Muijs, 2011: 8). Therefore, a mixed method research design was utilised to enable incorporation of both inductive and deductive reasoning, hence leading to a better interpretation of the subject matter (Creswell, 2014; Sreejesh & Mohapatra, 2014). This design approach also reflects the fact that in public policy, positivist approaches are “no longer, except in rare instances, sufficient on their own to generate satisfactory advice” (Wolf, 1999).

One of the most commonly used types of mixed method research is embedded design (Figure 6). This approach was used during this research paper, with quantitative research as the priority, while also utilising qualitative methods to supplement the initial data (Bryman & Bell, 2015).

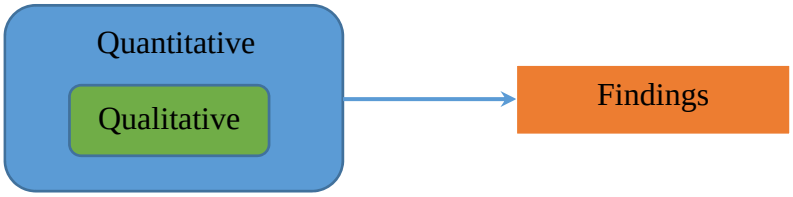


Figure 6: Mixed methods design - Embedded design for this research project (source: Bryman and Bell, 2015)

3.1 Research Method

The data collection for an embedded design can be simultaneous or sequential (Bryman & Bell, 2015). To achieve simultaneous data gathering of both quantitative and qualitative data, as well as access a wide number of respondents, a survey was administered which included both closed (quantitative) and open-ended (qualitative) questions. As noted by Andres (2012), such surveys

are in harmony with mixed method approaches as promoted by many mixed method researchers.

The quantitative data obtained through closed questions enabled statistical analysis of the EV barriers and the qualitative open-ended questions helped provide further in-depth interpretation of people's behaviour and decisions to adopt EV. The nature of the qualitative responses meant that empirical analysis could also be carried out on this data set. The survey was designed and distributed through the online survey tool SurveyGizmo[5].

3.2 Sampling size and technique

The research survey had a sample size of 122 respondents. This sample size reflects the size of the general population and enabled meaningful statistical analysis to be carried out. To access participants, snowball sampling was adopted. This involved "identifying respondents who are then used to refer researchers on to other respondents" (Atkinson & Flint, 2001:1). Snowball sampling has an advantage over other sampling techniques in getting "easy" access to a large sized sample (Atkinson & Flint, 2001). It should be noted a limitation of this data collection method is sampling bias whereby initial subjects tend to nominate people they know well (Explorable, n.d.). This gives rise to the potential problem that nominated subjects share the same traits and characteristics with initial respondents. The quality of analysis, therefore, can be diluted.

3.3 Survey design

The research survey collected a general profile of respondents with demographic questions about their age, gender and locations etc. The survey then examined a wider range of EV adoption barriers as identified in the literature review including technological, economic, social,

[5] https://www.surveygizmo.com/

political and environmental factors. This part of the survey was designed using programme logic to enable interactive questioning with respondents. This meant specific questions were only prompted by specific answers, thus allowing for better analysis.

For example, a question asked “is the driving range of an EV a major reason to stop you purchasing an EV”? If the respondent answered “Yes”, he/she was prompted to respond to questions that further drilled down into their perception of driving range and why it is a major concern for them. This was followed up by showing respondents information about actual performance and recent EV advancements to determine if it altered their attitudes. If the respondent answered “No”, then he/she was prompted to elaborate on their answer and skip the rest of the questions regarding driving range.

Finally, the research survey also included questions about what policies would incentivise people to purchase EV. These questions included the current government policies to evaluate if people actually deem them effective. Survey questions are attached in Appendix A.

3.4 Data analysis

The quantitative questions in the research survey were assessed using statistical analysis to get an understanding of the most common EV adoption barriers. The categorical and continuous variables (Bryman & Bell, 2015) were identified in the dataset and tabulated to identify patterns by calculating their frequency and percent distribution (The Pell Institute, n.d.). This provided a comprehensive overall picture and trends from the raw data. For the purposes of this research, an adoption barrier had to impact the majority of the respondents (i.e. over 50%) to be classified as significant.

The qualitative questions were assessed using thematic analysis. Thematic analysis is a method for interpreting qualitative data by “identifying, analysing and reporting patterns (themes)

within data" (Braun & Clarke, 2006: 79). Themes can be developed in various ways, including through inductive and deductive reasoning. Using the approach set out by Braun and Clarke (2006), the survey data was assessed and initial codes generated according to respondents' descriptions. Themes were developed by grouping these descriptions into patterns/categories. The themes were then reviewed and clarified after which they were analysed in detail. A limitation of thematic analysis is it is up to the researcher to ensure themes are consistent and distinctive. Additionally, there is a chance the researcher's own biases and opinion influence how the qualitative questions are analysed.

The theoretical framework of diffusion of innovation and adoption theory (Stewart and Saren, 2014) was applied to measure the rate of EV adoption. This model categorises each adoption stage by certain groups, namely "innovators", "early adopters", "early majority", "late majority" and "laggards". There are four factors within the framework that are used to help analyse the rate of adoption: trialability, compatability, relative advantage and observability (Stewart and Saren, 2014).

3.5 Research validity and credibility

To ensure the research validity, the quantitative questions were designed to satisfy the criteria of measurement validity, namely internal validity, external validity, reliability and objective validity (Bryman & Bell, 2015). The survey incorporated a wide number of variables to address each of the core barriers identified in the literature review. To ensure credibility and trustworthiness of the data, the qualitative questions were designed to help explore the deeper root cause of EV barriers in each category. The combination of these various methods is known as 'triangulation', and it contributed to the overall credibility of research (Bryman & Bell, 2015).

Once NZ specific barriers were known, the government policy was assessed across these findings by looking at respondents' sentiment towards the new policy. This approach makes sense both academically and practically as it assesses the new government policy on real evidence, rather than prescribing a solution with assumed barriers.

4 Data presentation and analysis

The survey was administered from 17 August to 6 September 2016. A total of 122 responses were made. Of the final respondents, 61% were male and 39% female. The age groups for respondents were 18-24 (1.6%), 25-34 (38.5%), 35-44 (32%), 45-54 (22.1%), 55-64 (4.9%), and 65-74 (0.8%). The vast majority of respondents were based in urban centres, although a small number (3.2%) were based in rural centres.

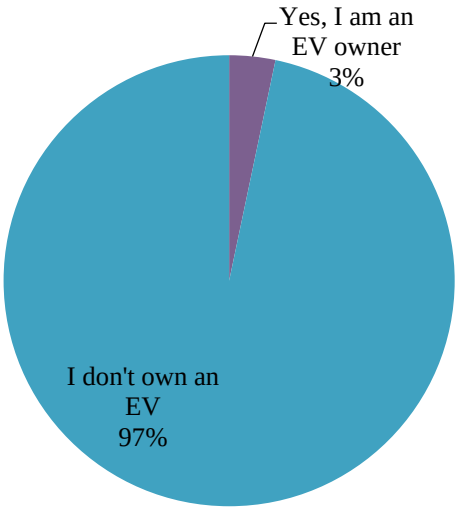


Figure 7: Responses to "do you already own an electric vehicle"?

Figure 7 shows the number of respondents who currently own an EV. According to the diffusion of innovation curve, the small number (3%) suggests that EVs are currently in the innovator stage.

4.1 Range

Range was one of the greatest concerns identified in the literature. However, the survey responses showed a perfect 50/50 split on whether range is a major barrier for people considering purchasing an EV (Figure 8) indicating, although somewhat influential, this barrier is not as big a concern for the majority (i.e. over 50% of respondents) as some studies suggest (Element Energy, 2013; Giffi et al., 2010; Giffi et al., 2011; Lemon and Miller, 2013).

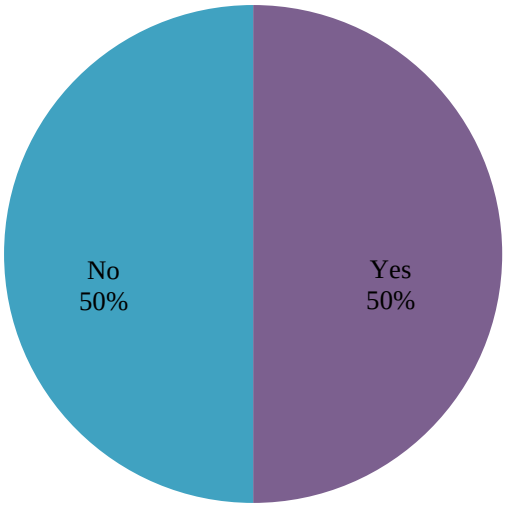


Figure 8: Responses to "Is the driving range of an EV a major reason to stop you purchasing an EV?"

4.1.1 Non-barrier group

For the respondents who said range is not a barrier, the reasons can be categorised into three major themes. First, is short distance driving requirements. The existing range of EV is adequate for these respondents because their driving habits only required EV for short distance usage or EV will be used as a second car/city car. This aligns with the Deloitte 2010 survey which found that most people only travel a short distance each day (Giffi et al., 2010). For longer distance travel, respondents noted they can either hire a car or have another car available

to use. These responses account for 46% of this group. Second, is the identification of other barriers. Respondents noted that other factors are more of a showstopper for them entering the EV market, with price as a reoccurring theme. This accounts for 32% of this group. Third was optimism of future trends. This accounted for a small percentage of people (7%) with one respondent stating “by the time I purchase EV (several years from now), range would have improved”. The above data shows there is wide recognition of respondents’ personal driving habits and their expectations about distance are well within the range of current EV capacity. This awareness did not translate to unreasonable EV range expectations as suggested by the literature (Element Energy, 2013; Giffi et al., 2011). Furthermore, the high percentage of people who consider other barriers are more important implies that range alone is not enough to pose as a primary concern for the NZ market.

4.1.2 Barrier group

For those who agreed range is a major concern, the survey asked respondents to state their desired range before considering purchasing an EV (Figure 9). 75% expected performance to be under 500km. EVs are expected to achieve this range in five years’ time, indicating that range will likely be satisfactory for a majority of the barrier group in the future. 17% of the barrier group wanted more than 500km, a range that exceeds even some ICE vehicles.

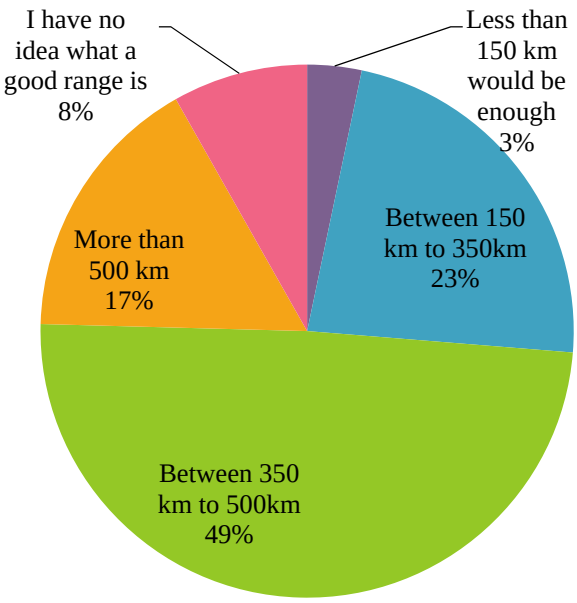


Figure 9: Desired EV range

Table 1 in section 2.1.1, which showed a wide range of upcoming EVs with long range, was subsequently shown. 81% of the barrier group had not heard about the development of new EVs. The large number of respondents who were not aware of such developments indicates there is a lack of understanding about EV developments and/or communication to the public regarding EV industry developments and people are still making judgements on old information.

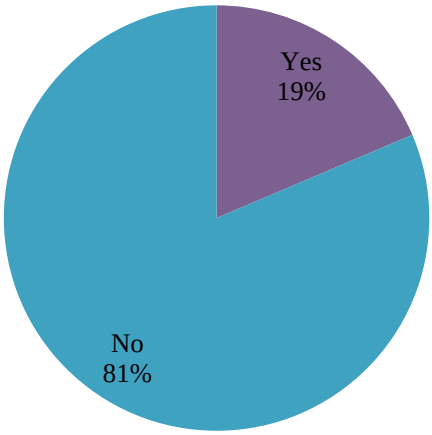


Figure 10: Responses to "Did you know that there are a number of EVs with a decent range to be released in the market?"

When asked whether the new information about EV range has impacted their perception, 55% of the barrier group agreed it had. A further 20% expressed the new information made them more relaxed about range but, like the non-barrier group, the theme of identifying other barriers emerged with respondents remaining sceptical about other factors such as price, infrastructure and maintenance. The large number of people whose perception changed based on the newly received information indicates that EV information campaigns could be effective in addressing this barrier.

Approximately 20% of the barrier group answered with a firm no change as the range presented was still not good enough for them. This is roughly in line with the amount of people who were expecting EV to go beyond 500 km. As explained by the diffusion of innovation theory (Stewart and Saren, 2014), because this group does not perceive the 'relative advantage' of EVs, they will likely remain as 'laggards' in EV uptake.

4.2 Charging time

The responses to whether charging time is a barrier for users considering EVs is shown in (Figure 11). This result is contradictory to the literature (Element Energy, 2013; Hosseinpour et al., 2015; Kodjak, 2012; Ford et al., 2015), suggesting charging time is not a primary concern factor for EV uptake.

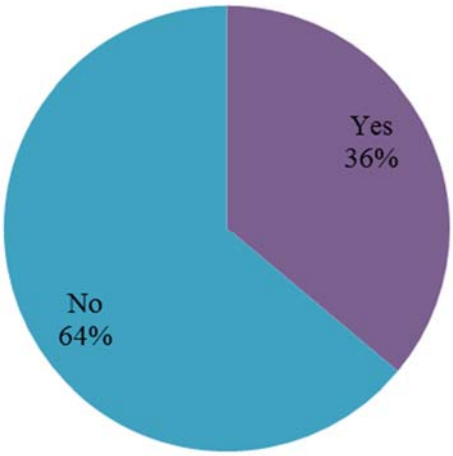


Figure 11: Responses for "Is battery charging time a major reason to stop you from adopting/using an EV?"

4.2.1 Non-barrier group

The primary reason for the non-barrier group is that they expect to charge their EV at home and/or charge overnight (53%). For example, one respondent noted, "we are now all used to iPhones that need to be charged every night, so behaviour wise we should be ok to manage long charge times over the evening". The secondary reason is they expected to drive short distances or existing chargers are sufficient to meet their needs (17%). One respondent noted, "I don't drive frequently, so I would be able to plan when I will use my EV and therefore when to charge it". The third reason was the identification of other barriers (primarily price and battery maintenance) as more of a concern (10%).

These findings show there is a significant awareness by respondents of their charging and driving needs, notably that they travel short distances and/or infrequently. Consequently, this indicates charging times is not a NZ specific barrier as suggested by the NZ literature (Lemon and Miller, 2013; Metcalfe and Kuschel, 2015).

4.2.2 Barrier group

For the barrier group, the survey further explored what they thought was an appropriate charging time in four scenarios. These results are presented in Table 2, which show the scenario with the least tolerance for charging times was during a road trip with a mean of 0.5 hours. However, it should be noted that the mean results from the data set are well within the current capability of existing chargers.

Table 2: Tolerance for charging time for different scenarios

Information about charging speeds[6] and development of faster chargers was then presented to this group. Upon receiving the new information, 52% of the barrier group stated it made an impact on their views of EV charging speeds. Within these answers, over 50% respondents indicated they did not know about charging information, suggesting a lack of education/market knowledge about charging information. For a further 13% of respondents, the theme of identifying other barriers again emerged. While the information made an impact, they were

[6] Tesla's supercharger allows an 80km range to be added within 6 minutes charging time and achieves 80% of full range in 45 minutes. The Japanese standard DC CHAdeMO quick charging system is capable of refilling the Mitsubishi i-Miev and Nissan LEAF from 20% to 80% in 30 minutes.

still concerned with other factors. For example, one respondent answered, "The speed is okay, but do we have enough charging infrastructure?" 32% of this group gave an affirmative "no change" as an answer with the main reasons being either the availability of infrastructure, the EV is still not charged to 100%, or the charging speed is not fast enough.

The large change in perception by respondents again confirmed that there is a lack of education/market awareness about EV technology advancements. Once people understood the capability of new chargers, their perception of charging time as a barrier shifted. For the minority of respondents for whom the new information did not change their perception, it is evident their expectations (such as having EV recharged as fast as an ICE in a petrol station) are unlikely to be met in the near future. Again, this is in line with the diffusion of innovation theory where this group of people do not perceive the ‘relative advantage’ and they will remain late majority/laggards in EV adoption.

4.3 Purchase price

Upon being asked “Are current EV prices a major reason to stop you from adopting/using an EV?” only 13% of the survey respondents answered no. 64% of respondents chose “yes”, and a further 23% had no existing knowledge of EV costs (Figure 12). In the literature, purchase price was one of the most identifiable common barriers for EV adoption. This survey validates this finding with a high percentage of respondents in the barrier group. However, 23% of respondents were not aware of EV purchase price, indicating a lack of education/market awareness.

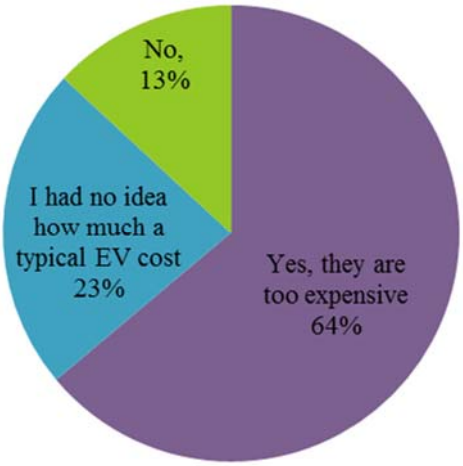


Figure 12 : Responses to "Are current EV prices a major reason to stop you from adopting/using an EV?"

4.3.1 Non-barrier group

For the non-barrier group, there were two main themes for why EVs were considered affordable: either because second-hand EVs are reasonably priced or because the upfront costs are recouped during the life of the EV. These comments especially revolved around the Nissan Leaf's affordability. There was also a third theme of user needs or 'compatibility' (Stewart & Saren, 2014), with respondents noting that although certain models are cheap and price is not a barrier, the existing EV models on the market do not meet their vehicle needs. This data shows there are affordable, but limited EV models available.

4.3.2 Barrier group

Of those respondents who identified price as an entry barrier or who had no idea about EV prices were asked to enter their budget for their next vehicle purchase. The responses ranged from $8,000 to $50,000 with an average budget of $21,656. There are EV models within a reasonable price range of $20,000 that fall within this average budget.

Analysis of comments revealed that barriers about purchase price are multi-dimensional. The major theme was that affordability is highly dependent on a customer's vehicle requirements and consumer choice with one respondent noting "it depends what your key driver is for purchasing a car. Personally, I go for the look, meeting my requirements (e.g. boot space, family etc.) and safety". For respondents who did not find EV price a problem, most of them were referring to the Nissan LEAF, a small, economical family city car. However, the issue was a lack of model selection at this affordable price range. Conversely, for those who found EVs expensive, most of them looked at a bigger car such as a station wagon (Audi A3) or SUV (Mitsubishi Outlander).

4.3.3 Upfront cost

The barrier group were asked to consider a scenario where they have to choose between purchasing a 3-year-old, low kilometre EV such as the Nissan Leaf for $27,000, or a similarly sized Toyota Corolla for $20,000. The annual cost of fuel[7] was given in comparison to the cost of running an EV. When asked whether the low running cost of EVs justified the higher purchase price based on this information, 37% of the barrier group changed their mind and said it impacted on their cost perception. As with other barriers, it is evident that education/market awareness has an impact on purchaser's decision-making processes.

28% of this group commented they were more concerned about other factors such as battery replacement and maintenance/service costs, with a respondent noting they were "concerned about how many years use I can get from the battery before I need an expensive repair or

[7] The annual cost of fuel is roughly $2,005 according to AA, based on a similar sized car and current petrol price.

replacement". This trend is consistent with the previous barriers where, upon gaining more information, the respondents began identifying other barriers as a concern.

27% of this group gave a definite no change. There were three themes for why upfront cost did not justify a higher EV price. Firstly, was the return on investment with respondents noting the 3-5 year payback period is too long – they might need a new battery by then or would want to upgrade. Secondly, there was a perception of reliability. For example, although respondents felt the Toyota is very reliable; they did not know how reliable the Nissan (LEAF) is. Finally, a theme was that EVs did not meet user needs with one respondent commenting that the challenge is getting the right "type" of car that suits them. Again, this barrier group matches the pattern shown in previous responses indicating they do not perceive the 'relative advantage' of EVs and they will be late majorities/laggards in EV adoption.

4.4 Charging facility

The survey looked at EV infrastructure by asking "is the availability of current public charging stations a major reason to stop you from adopting/using an EV?" (Figure 13). The results indicated the amount of public charging facilities was seen as a barrier by most survey participants. This barrier was only acknowledged as a minor barrier in other studies (Element Energy, 2013).

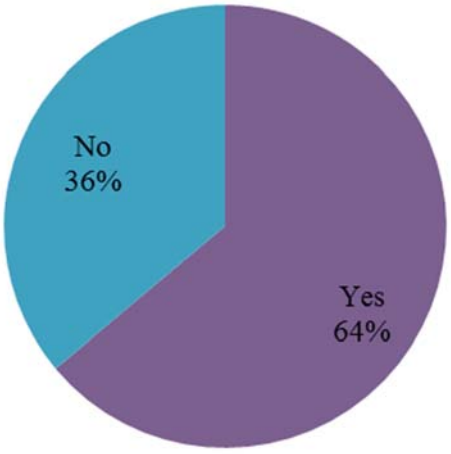


Figure 13: Responses to "is the availability of current public charging stations a major reason to stop you from adopting/using an EV?"

4.4.1 Non-barrier group

For the non-barrier group (36%), there were three major reasons charging facilities were not an issue. Firstly, this group primarily planned to charge their EVs at home so they saw the provision of public chargers as a secondary requirement. Secondly, this group stated the majority of their trips were going to be short distance, implying that home charging would be sufficient for their use. Lastly, this group felt optimistic about future development trends, noting there would be sufficient chargers by the time they intend to purchase an EV. This indicates that, although not innovators, a portion of the non-barrier group would be willing to be early majority adopters of EV.

The above reasons are very similar to the responses in 'range' and 'charging time' although the percentage of respondents is much smaller for this barrier. This indicates that, although respondents are aware they are travelling short distances and charging EVs at home, the 'observability' or expectation of seeing better charging facilities around the country is still a high priority for them to purchase EV. This is potentially because range anxiety still exists with EV owners seeking reassurance they can charge their EVs as needed. This is comparable to

infrastructure and service expectations for ICE vehicles, where owners are comfortable in driving his/her car when it only has a half tank of gas because he/she knows it is easy to find a petrol station almost everywhere they go.

4.4.2 Barrier group

For the barrier group, the NZ fast charger development map (Figure 5) showing new planned charger facilities along major state highways was provided. Upon receiving this information 47% of the barrier group shifted their perception with many of them not even knowing such a project had commenced. Again, this indicates there is a lack of knowledge/market awareness and so communicating recent developments can be effective to increasing EV uptake.

45% of the barrier group answered with a firm “no change”. The common theme for these respondents was accessibility and coverage – they still compared EV charging facilities to the availability of petrol stations. Some also commented that there is not enough coverage in rural areas as new EV charging stations are only focused on major state highways. This indicates there need to be greater developments in charging facilities to give people reassurance to uptake EV.

4.5 NZ car market

NZ customers’ buying behaviour and preferences were explored by asking respondents if an EV was within their budget, whether they would choose a second hand or new vehicle. It was almost an even split with 30% of respondents specifying that they would only purchase EVs second hand, with another 31% of respondents specifying they would only purchase a brand new EV with a battery maintenance warranty. A further 29% did not have a preference towards a second hand or new car given that their budget price was met.

There is nothing conclusive about buyers' preference for new or second-hand EVs. Therefore, the assumption the EV adoption rate will be low “until cheap second-hand or refurbished electric vehicles are able to enter New Zealand” is only partially correct (Lemon and Miller, 2013: 2). The fundamental problem is still purchase price, as long as the price is set right, people were not bothered about buying in the second hand or new market. Some would even prefer to buy new EVs in order to obtain manufacturer’s battery warranty. Consequently, NZ’s car market characteristics cannot be defined as a barrier.

4.6 Service, maintenance and repair (cost of ownership)

The survey asked, "is the unknown cost of service, maintenance, and repair a major reason to stop you from adopting/using an EV?” An overwhelming 68% of survey respondents responded yes (Figure 14), indicating the cost of ownership is a major barrier for NZ EV uptake. This is contradictory to other NZ findings; for example, Ford et. al (2015) examined this topic within their study but deemed it was not a major NZ barrier.

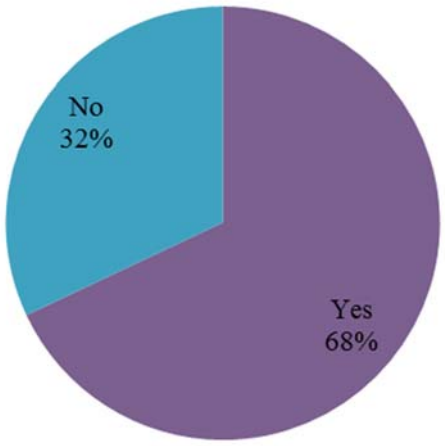


Figure 14: Responses to “Is the unknown cost of service, maintenance, and repair a major reason to stop you from adopting/using an EV?”

4.6.1 Non-barrier group

For the non-barrier group (45%), many respondents were not concerned about ownership costs because they perceived EV to have cheaper maintenance costs stating that “It will be a lot lower than the cost of a petrol or diesel vehicle”. A further 21% within this group thought that all cars have costs to some extent and they were, therefore, indifferent to the cost of ownership. Finally, another 26% identified other barriers, such as purchase price, as more of a concern than ownership costs.

4.6.2 Barrier group

The survey gave further information to the barrier group regarding maintenance costs, pointing out that there are no fluids to change and no wear or heat that typically occurs in a combustion engine; manufacturers such as Nissan offer an eight-year, 160,000 km warranty for its battery; and if the battery degrades below 75% of capacity the manufacturer will replace it.

62% of the barrier group agreed this information changed their perception of EV maintenance costs. In particular, respondents commented that a battery warranty gave them a significant boost for EV ownership. Again this indicates that education/market awareness is key to easing worries about EV adoption. However, whilst the information eased their concerns about the battery, a further 10% within this group immediately asked about other maintenance costs such as servicing and electrical components. This indicates the full cost of ownership will likely continue to remain unknown and a barrier for EV adoption until people are better informed.

Finally, 24% of the barrier group responded with “no change”. A typical sentiment for this group was that the information made them less worried about battery, but their focus started to shift to other maintenance barriers, such as how many EV workshops exist, whether other car parts are expensive, and are there skilled technicians to carry out EV maintenance work. This

indicates people need to be reassured about the more practical aspects of EV ownership in order to make the leap to adopt EV.

Within the barrier group, there was also an individual element which determined one's answer about the 'unknown' maintenance factor, namely respondents' knowledge and experiences in car maintenance. For example, a respondent noted they do their own service on their petrol car, but would not be able to do this with an EV. Another respondent who stated they were an electrical engineer claimed they knew the cost of dealing with EV electrical maintenance is low.

4.7 Fuel price

Survey respondents were asked whether a historical low/high petrol price impacted their decisions to purchase an EV. As Figure 15 shows, 34% of respondents were more likely to consider an EV if petrol prices go up but for the majority (66%) it would not be a decisive factor.

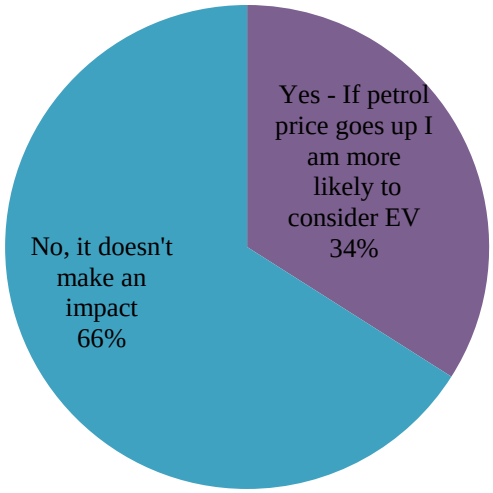


Figure 15: Responses to "Is rising petrol price a barrier for you to adopt EV?"

Even though literature suggests the price of gasoline incurred a reverse proportional relationship with the rate of adoption of EV (Hosseinpour et al, 2015), based on the survey results, while somewhat influential, fuel price did not prove to be a major barrier factor to respondents' decision to adopt EV. The survey results suggest that fuel price was taken into consideration by a small portion of potential buyers; however, this validates the findings that upfront cost is the most influential price component when considering EV purchase.

4.8 Political

Survey respondents were asked their view on the NZ government's commitment to implementing EV. Over 57% of respondents felt the NZ government has a vested interest in the petrol industry and therefore cannot be fully committed to promoting EV. 16% of respondents felt the government is genuinely trying to promote EV and there will not be any political barriers.

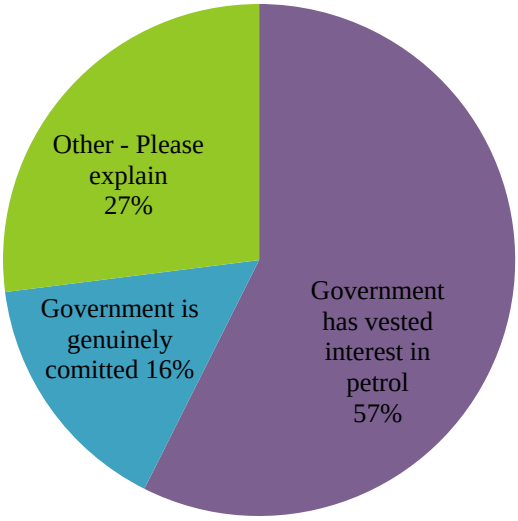


Figure 16: Responses to "Do you think the NZ government is genuinely trying to promote EV?"

Out of the 27% of respondents who chose “other”, the main theme was they did not see any correlation between the petrol industry and EV market. Approximately half of this group were sceptical about the government’s commitment to EV promotion, i.e. not because of the government’s interest in the petrol industry, but for other reasons such as lack of environmental care by politicians. The other half of this group believed the free market should operate without intervention or that it is normal for the government to have a vested interest in the petrol industry while still promoting EV.

While the survey cannot determine whether the NZ government indeed has a conflict of interest in EV adoption, the results show there is a certain amount of cynicism amongst users about the government’s commitment towards EV. The responses in this section were influential in determining respondents’ perception about the government policies discussed in section 6.

4.9 Business fleet

The survey asked respondents whether an increased use of EV in corporate fleets would have any direct impact on their decisions to adopt an EV. The responses were a perfect split of 50/50 as shown in Figure 17.

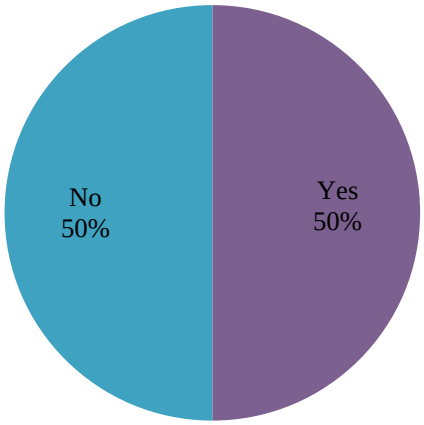


Figure 17: Responses to "Would an increased use of EV in corporate/organisational fleets be a reason for you to adopt/use EV?"

4.9.1 Non-barrier group

There were three major themes for respondents in the non-barrier group. Firstly, comments focused on 'test before you buy' or the 'trialability' and 'observability' of EVs within the diffusion of innovation framework (Stewart & Saren, 2014). These respondents believed they would have a better chance to test drive and thus gather more knowledge about the characteristics of EV. They believed this would help them to make a better decision on whether an EV is the right choice for them. Secondly, there was a strong belief that increased corporate fleets would result in a large injection of EVs into the second hand EV car market as most organisations retire their vehicles after certain mileage and years in service. These respondents felt the price of EV will come down and the availability of second-hand models will dramatically increase as a result. Lastly, respondents believed there will be an increased demand for chargers (e.g. in company car parks). This will be more convenient for private EV owners as more EV support facilities are installed which they can use.

4.9.2 Barrier group

For the respondents who did not believe corporate fleets would impact their decision the reasons varied. One reoccurring theme was personal beliefs. For example, one respondent said, "My purchase decision would be based on personal moral/ethical reasons and not influenced by corporate fleet adoption." The other respondents did not believe corporate fleets would have any direct impact on them.

Overall, EV uptake in business fleets cannot be regarded as a major barrier for NZ EV adoption, However, these results indicate it can be beneficial for those who are contemplating EVs by giving them the chance to try out EVs and addressing many of the barriers caused by “unknown factors” such as range, charging time, performance etc. There was also a wider belief that corporate uptake will encourage the availability of second-hand models and other facilities. This was correlated by respondents’ support for the government policy to “Work across Government and the private sector to investigate bulk purchasing.” These results validate the literature findings (Sustainable Business Council, 2015).

4.10 Smart grid

The survey explored whether supporting technology such as a smart grid would affect EV adoption. As shown in Figure 18, this is not a major barrier for NZ EV adoption.

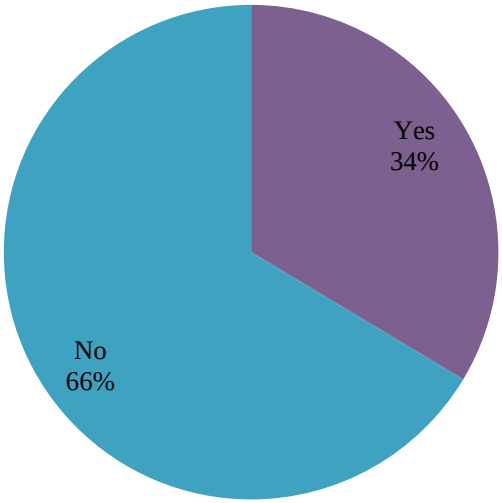


Figure 18: Responses to "Is the lack of a smart grid in NZ a major reason to prevent you from adopting/using EV?"

4.10.1 Non-barrier group

The majority of respondents (66%) were not bothered by the existence of such a system, the major reason being that the NZ electricity market already has some mechanism to determine when it is cheaper to charge electricity. For example, the NZ spot market has night rates and a number of respondents said that they use smart meters and online applications from electricity company Flick to get instantaneous access to these prices.

4.10.2 Barrier group

For the respondents who wanted a smart grid system, they noted that they would like to charge EVs at the cheapest rate possible and they would see benefits to having an automated system (i.e. where EVs can start charging automatically upon detection of a certain price range).

Overall, the survey results show a smart grid is a 'nice-to-have' feature rather than a necessity for respondents. But the benefits of a smart grid may be not apparent unless a household has lots of other smart appliances (i.e. dishwashers or washing machines that will start themselves

only at the cheapest rate during night). Therefore, the total savings may not be significant enough for people to really take this into consideration when purchasing an EV. Additionally, there was a general lack of understanding or appreciation of the functionality of the smart grid as a number of respondents confused having a smart meter with having a smart grid.

4.11 Environmental

The survey showed the majority of respondents (86%) still believe that EVs are a superior environmental choice than ICEs (Figure 19), indicating that cynicism about the environmental claims of EV is not a barrier.

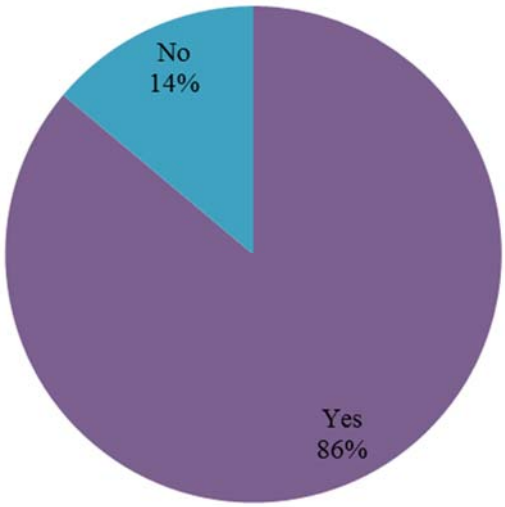


Figure 19: Responses to "Do you believe EVs are better for the environment than petrol cars?"

4.11.1 Non-barrier group

The following statement was given to the respondents who believed EVs are environmentally better off: "some argue that EVs aren't as beneficial to the environment as the industry claims. For example, they note that EVs aren't manufactured from a renewable source and the electricity that powers them is not clean. Additionally, there are concerns about the impact of lithium-ion batteries on the environment."

When asked whether the above argument changed their perception on how environmentally friendly EVs are, only 16% started showing concerns while the other 84% remained unchanged. The results validate other literature that for most people, morally, the biggest motivator in choosing an EV is for environmental benefits (Hosseinpour et al., 2015).

For those who started to question EV's environmental friendliness, the major reason related to concerns about battery disposal. These respondents worried about the environmental impact from the high volume of lithium battery disposal. For those who remained unchanged, the main responses revolved around NZ's high percentage of renewable power generation. A lot of respondents held the view that this reduced carbon footprint and the reduced emissions during an EV's life time far exceeds the negative impact of battery disposal.

4.11.2 Barrier group

The same information was also presented to the barrier group, with 100% of respondents agreeing with this statement. Consequently, EVs will be a very hard sell to this group and they would be unlikely to ever adopt EVs.

5 Discussion of NZ specific barriers

5.1 NZ specific barriers

From the survey results and analysis, it can be concluded there are four main barriers to EV adoption in NZ.

The greatest NZ specific adoption barrier is price. This aligns Ford et al's NZ survey (2015) and other relevant literature. However, it is clear price is not a one dimensional problem as there are affordable EVs currently available. Rather, there are only one or two models on the market, and so to overcome this barrier there have to be many more types of affordable EV models made available.

The unknown cost of ownership, namely maintenance, servicing and repair, was the second largest NZ specific barrier whereas the literature considered this a minor barrier (Tsang et al., 2012). The practical, everyday aspects of ownership were found to be a huge psychological barrier for potential users with particular concerns about battery maintenance, repair, degrading, cost in replacing parts, and finding a good service centre that specialises in EV.

Charging facilities was the third largest NZ specific barrier, which agrees with some (but not all) NZ studies (Lemon and Miller, 2013; Metcalfe and Kuschel, 2015). Until potential users physically see the adoption of EV happening around them through increased infrastructure etc., the risk of being an early adopter always exists in their mind. Therefore, increased charging facilities would serve as an antidote for user anxieties.

The fourth barrier was a general 'lack of education/market awareness' of EV. There is especially a lack of knowledge on latest EV technological advancements. As evident in the survey results, the high rate of change in perception after new information was presented to respondents shows most people are still basing their decision to adopt EV on dated or incorrect information. This lack of knowledge was also reflected in the identification of other barriers, whereby as soon as people understood one aspect of EVs (e.g. battery warranties), they immediately began to question other unknown factors that were of a concern (e.g. service stations, maintenance). Until all these unknown factors are addressed through effective information campaigns, purchasers will continue to remain sceptical and see a risk in being an early adopter.

5.2 Low influential barriers

Range was defined as a major barrier for NZ by the literature (Barton and Schütte, 2015; Ford et al, 2015; Lemon and Miller, 2013). However, this study has found that range cannot be categorised as a significant NZ specific barrier. The reason for this is that most people's driving

routine is short distance in nature and users are aware of their driving habits and requirements. These users are reasonably comfortable with existing EV range and trust it can satisfy their needs.

Charging time was another major EV adoption barrier identified as NZ specific (Ford et al., 2015); however, this study found its influence was low. The contributing factor was that most people are aware of night time charging and would use this as their main charging option if they purchased an EV.

Another barrier identified as NZ specific, namely NZ's culture in buying second-hand vehicles (Lemon and Miller, 2013), was found to be an over simplified explanation and just an extension of the price barrier. Provided EV prices are low enough and there are enough models, most users would not mind buying either in the second hand or new car market. The determining factor was purchase price, not the market where the car is sold.

6 EV policy

6.1 Market sentiment on new EV policy

The survey asked respondents their sentiment about the new government policy. Overall a slight majority of respondents felt the government's policies would impact their decision to adopt EV. The charging facility policy was the most touched on subject when respondents were asked why they thought the policy will make a difference. This is probably because the policy intent is clear and the results are more likely to be seen short term.

For those who did not think government policy can make a difference, many stressed the cost factor is lacking. This group would like to see similar EV tax rebates that are implemented in Europe while another popular suggestion was to have heavy taxes on non-EV vehicles. Finally, there were those respondents who felt that EV adoption should be left to the free market with no government intervention through EV policies.

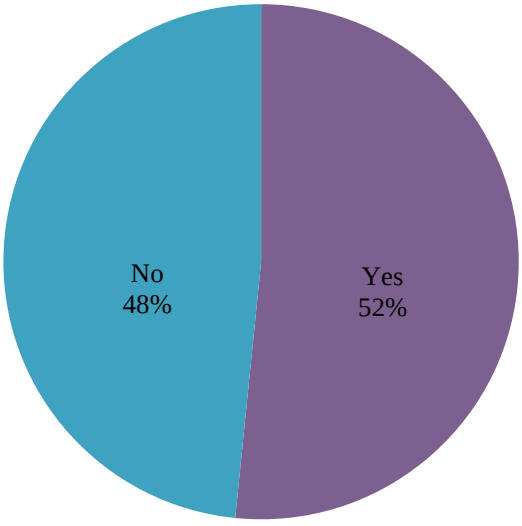


Figure 20 Responses to "whether government's new EV policy would make an impact on your decision in adopting an EV?"

The survey also asked about respondents' intention to purchase an EV in the next three to five years (Figure 21). 48% of respondents gave a firm yes, suggesting that EVs are likely to leap from the innovator stage and enter the early majority stage in the next five years. However, the four factors within the diffusion of innovation (i.e. trialability, compatibility, relative advantage and observability), must be addressed to ensure the effective adoption of EV.

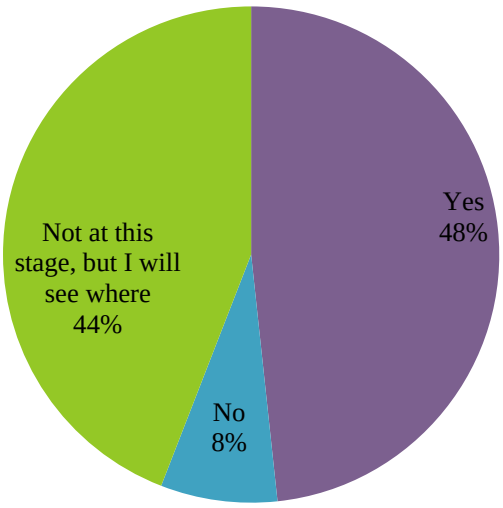


Figure 21 Responses to "would you consider buying an EV in the next 3-5 years?"

6.2 Evaluation and discussion of EV policy against NZ barriers

The NZ government policies are evaluated below based on their alignment to the survey results and the four NZ specific barriers identified in section 5.

6.2.1 Pricing barrier policy

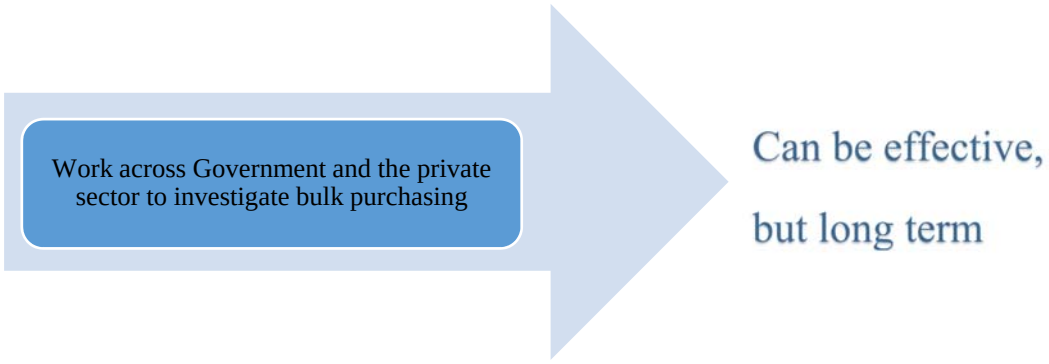


Figure 22: Evaluation of policy addressing price barrier

As noted during the data analysis, the issue with price is the availability and choice of different EV models. Encouragement by the NZ government and private sectors in adopting EVs for business fleets will likely help create an influx of used EV models. This was supported by the survey results in section 4.9. The current typical corporate fleet life is between 5 – 8 years. Therefore, this policy (Figure 22) will indirectly address the price issue; however, results will only become obvious after one or two business fleet life cycles. The advantage is this policy will allow the free market to determine the EV price. This approach is completely opposite to the literature's suggestion for government economic interventions, such as imposing sales tax reduction and subsidies (Lemon and Miller, 2013; Kley et al. 2012).

6.2.2 *Cost of ownership policies*

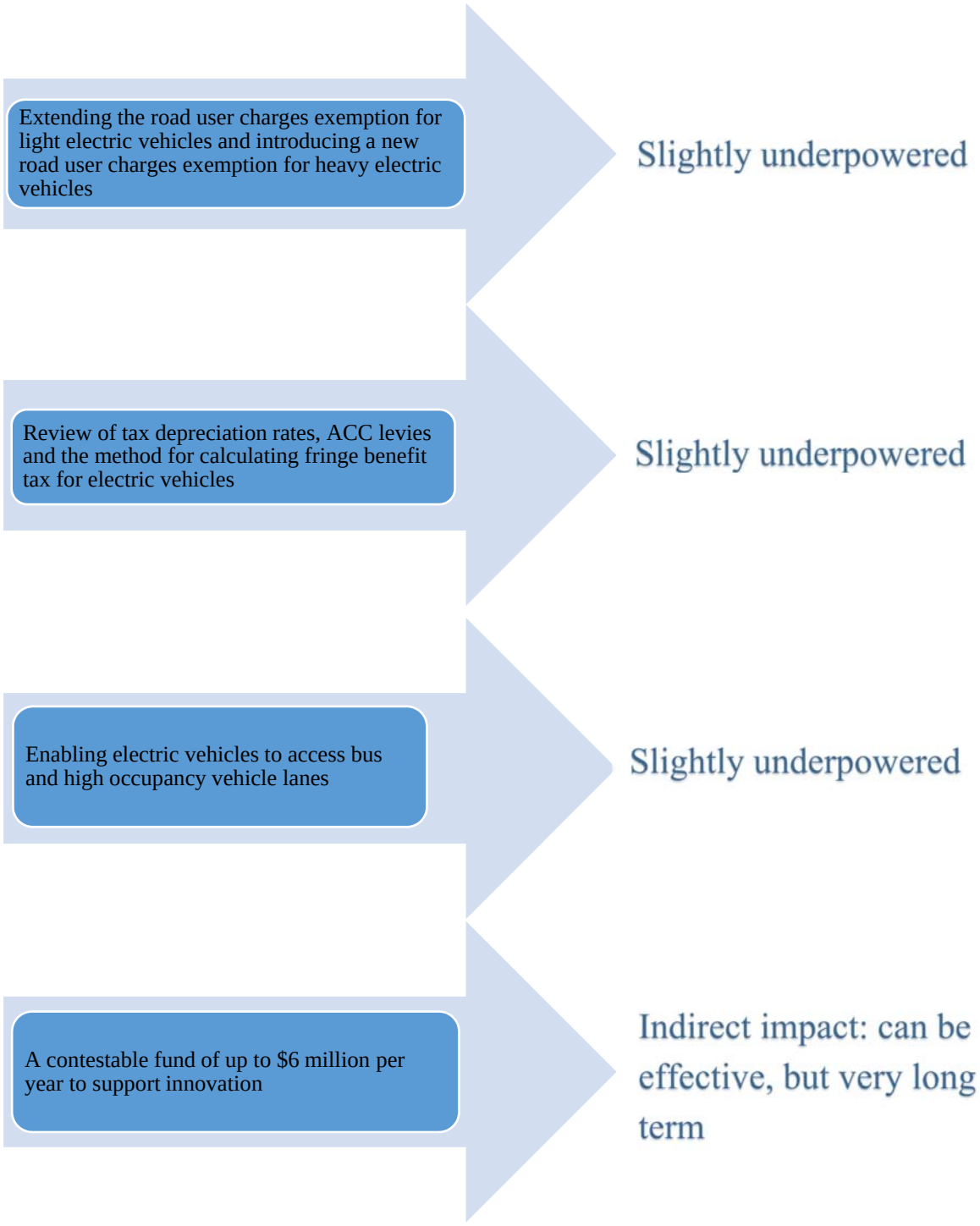


Figure 23: Evaluation of policies addressing cost of ownership barrier

Reducing road user chargers and ACC levies are an economic measure in terms of reducing EV cost (Kley et al., 2013). The ability to access bus lanes can be categorised as a non-financial measure that brings benefit to owning an EV (i.e. reduced travel time equals convenience)

(Element Energy, 2013). However, these policies only address a very small part of ownership cost barriers, hence they are deemed as underpowered. As the literature suggests, the government must utilise more aggressive economic measures such as providing annual tax and cost reductions, or penalise carbon emission of vehicles (Barton and Schütte, 2015; Kley et al., 2012).

Additionally, as the survey showed, a greater portion of users are more concerned about other costs such as EV maintenance and repair. However, there is little the NZ government can do as this is largely determined by technological developments. The investment in innovation policy can bring benefits but the return on investment is likely to have a very long timeframe. Instead, it is suggested the government implement policies that support the private sector in EV maintenance and/or incentivise more training of skilled work forces to repair EVs.

6.2.3 Charging facility policy

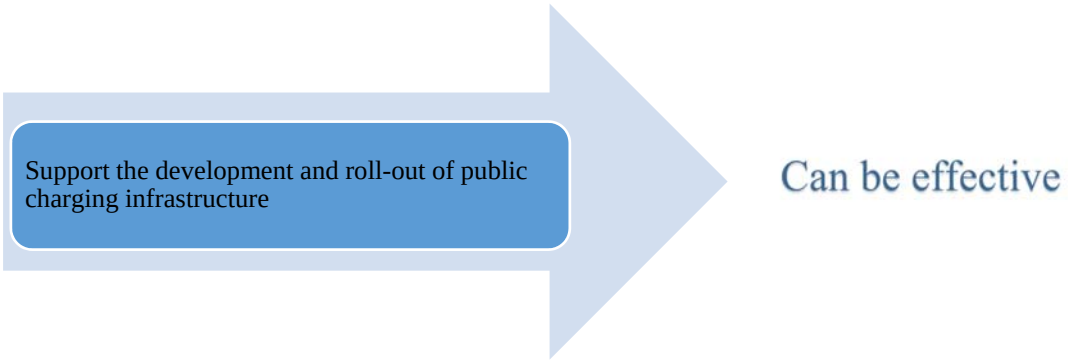


Figure 24: Evaluation of policy addressing charging facility

The government's policy to improve charging facilities will address many people's concerns about public infrastructure, therefore, it is deemed effective. It will help change perceptions by providing concrete evidence for potential users that EV evolution is happening. This policy is in line with the survey results and suggestions in the NZ literature; Barton and Schütte (2015) specifically proposed encouraging the growth of public charging facility, while Lemon and Miller (2013) suggested capital investment such as installation of charging stations.

6.2.4 EV education policy

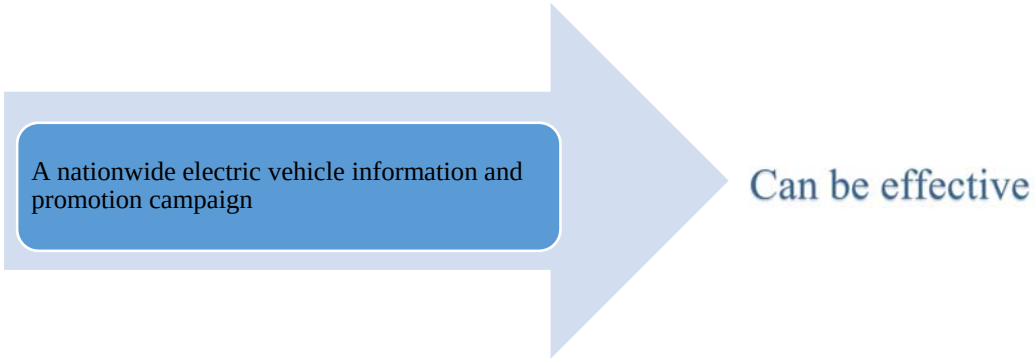


Figure 25: Evaluation of the policy addressing the lack of EV knowledge

As the literature suggests, increased public awareness can be hugely beneficial to adoption (Lemon and Miller, 2013; Kley et al.,2012; Barton and Schütte, 2015). This was supported by the survey results which show that a government promotion programme would be extremely helpful to improving EV adoption. It was clear many of the respondents were basing their decision to adopt EV on outdated or incorrect information. When presented with up to date information, many respondents changed their perception about EV barriers. Ultimately, there needs to be a practical component attached to the promotion campaign, people need to experience EV to believe in it (i.e. to have people test drive an EV rather than just talk about it). Consequently, this policy is deemed as effective.

7 Conclusion

This research has found there are four major NZ specific EV adoption barriers: firstly, the purchase price, reflected by the lack of affordable and wide range of models; secondly, the cost of ownership in maintaining, repairing and running an EV; thirdly, the lack of charging facilities; and lastly, a general lack of education in EV knowledge.

The public sentiment about the new EV policy is slightly positive. As the survey results suggest, EV adoption is likely to move into an early adoption/early majority phase in the next five years. The research also found that there will be a late group likely to remain majority/laggard in the

adoption of EV, aligned with the diffusion of innovation theory. These groups are sceptical about the economics of EV, its environmental claims, do not trust EV technologies and/or bound by other constraints such as living in remote areas. The focus on the EV policy should, therefore, concentrate on encouraging the early adopter group through effectively addressing the four NZ specific barriers identified above.

The government policy will most likely effectively address barriers regarding lack of charging facilities and lack of EV education. It is also likely to address the purchase price issue, but only in the long run. The policy lacks the firepower in dealing with reducing EV ownership costs so more drastic cost reduction benefits should be provided to EV users; alternatively, aggressive tactics such as increasing ICE vehicle ownership costs can be implemented. Overall, the policy is not completely incompetent or underpowered like many claimed to be, it does address the four major barriers either directly or indirectly. However, it needs further refinement and improvement in order to drastically increase EV uptake in NZ.

References

Andres, L. (2012). *Designing & doing survey research.* (pp 1-197). London: Sage.

Atkinson, R. & Flint, J. (2001). 'Accessing Hidden and Hard-to-Reach Populations: Snowball Research Strategies'. *Social Research Update,* 33.

Barton, B., & Schütte, P. (2015, November). *Electric Vehicle Policy: New Zealand in a Comparative Context.* (pp 1-56). Centre for Environmental, Resources and Energy Law, University of Waikato: Hamilton, New Zealand.

Braun, V. & Clarke, V. (2006). 'Using thematic analysis in psychology'. *Qualitative Research in Psychology*, 3: 77-101.

Bryman, A. & Bell, E. (2015). *Business Research Methods*. 4th edition. Oxford: Oxford University Press.

Business NZ Energy Council (2016). *E-Mobility: Closing the emission gap - The NZ case study*. Business NZ Energy Council: Wellington, New Zealand. Retrieved June 23, 2016 from: https://www.bec.org.nz/__data/assets/pdf_file/0014/116006/New-Zealand-Case-Study_E-Mobility_Closing-the-emission-gap_FINAL.pdf

Concept Consulting Ltd. (2016a, March). *Electric Cars, Solar Panels and Batteries – How Will They Affect New Zealand's Greenhouse Gas Emissions?* (Report). Concept Consulting Ltd.: Wellington, New Zealand. Retrieved June 24, 2016 from: http://www.concept.co.nz/uploads/2/5/5/4/25542442/new_technologies_emissions_report_final.pdf

Concept Consulting Ltd. (2016b, June). *Electric cars, solar panels, and batteries in New Zealand Vol 2: The benefits and costs to consumers and society* (Report). Concept Consulting Ltd.: Wellington, New Zealand. Retrieved June 24, 2016 from: http://www.concept.co.nz/uploads/2/5/5/4/25542442/new_technologies_economic_report_v2.0.pdf

Collet, T. (2016, June 28). '2018 Nissan Leaf To Match It With Model S - Up To 540Km Of Range'. *The Motor Report.* Retrieved 7 July, 2016 from: http://www.themotorreport.com.au/63671/2018-nissan-leaf-to-match-it-with-model-s-up-to-540km-of-range

Creswell, J. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* 4th edition. Sage publications: Thousand Oaks, California, USA.

Dawes, J., Zakeri, G., & Pritchard, G. (n.d.). *Efficient Electric Vehicle Charging: Investigating the impact of electric vehicle uptake on electricity prices in New Zealand*. University of Auckland: Auckland, New Zealand. Retrieved July 7, 2016 from: https://secure.orsnz.org.nz/conf49/program/Papers/papers/paper_102.pdf

Element Energy Limited. (2013, December). *Pathways to high penetration of electric vehicles. Final report for the Committee on Climate Change* Element Energy Ltd.: Cambridge, UK. Retrieved July 7, 2016 from: https://www.theccc.org.uk/wp-content/uploads/2013/12/CCC-EV-pathways_FINAL-REPORT_17-12-13-Final.pdf

Explorable. (n.d). 'Snowball Sampling'. Retrieved August 6, 2016, from: https://explorable.com/snowball-sampling.

Ford, R., Stephenson, J., Scott, M., Williams, J., Rees, D. & Wooliscroft, B. (2015). *Keen on EVs: Kiwi perspectives on electric vehicles, and opportunities to stimulate uptake.* Centre for Sustainability, University of Otago: Dunedin, New Zealand.

Giffi, C., Gardner, M., Hill, R., & Hasegawa, M. (2010). *Gaining traction: A customer view of electric vehicle mass adoption in the U.S. automotive market*. (pp. 1-20). Deloitte Development LLC.

Giffi, C., Vitale Jr, J., Drew, M., Kuboshima, Y., & Sase, M. (2011). *Unplugged: Electric vehicle realities versus consumer expectations* (pp 1-32). Deloitte Global Services Ltd.

Gordon-Bloomfield, N. (2014, July 3). 'How Fast Does A Tesla Supercharger Charge an Electric Tesla Model S? This Fast'. *Transport Evolved*. Retrieved 7 July, 2016 from: https://transportevolved.com/2014/07/03/fast-tesla-supercharger-charge-electric-tesla-model-s-fast/

Hidrue, M. K., Parsons, G. R., Kempton, W., & Gardner, M. P. (2011, September). 'Willingness to pay for electric vehicles and their attributes,' *Resource and Energy Economics*, 33(3): pp. 686–705.

Hosseinpour, S., Chen, H., & Tang, H. (2015), '*Barriers to the Wide Adoption of Electric Vehicles: A Literature Review Based Discussion*' (pp 2329-2336). 2015 Proceedings of Portland International Conference on Management of Engineering and Technology (PICMET), IEEE Conference Publications. DOI: 10.1109/PICMET.2015.7273259

Kodjak, D. (2012). 'Consumer Acceptance of Electric Vehicles in the US'. Washington, DC: Presentation to Mobile Source Technical Review Subcommittee, December 2012. Retrieved, July 16, 2016 from: https://www.epa.gov/sites/production/files/2014-09/documents/kodjak121312.pdf

Kley, F., Wietschel, M., & Dallinger, D. (2012). 'Evaluation of European electrical vehicle support schemes' in *Paving the Road to Sustainable Transport.* (pp. 75-95). Routledge: New York.

Lemon, S., & Miller, A. (2013). 'Electric vehicles in New Zealand: from passenger to driver? A National Energy Research Institute invited white paper'. National Energy Research Institute (NERI), University of Canterbury: Christchurch, New Zealand.

Maude, S. (2016, May 5). 'Government's new electric car package underpowered, critics complain'. *Stuff.co.nz*. Retrieved July 7, 2016 from: http://www.stuff.co.nz/motoring/79665738/Governments-new-electric-car-package-underpowered-critics-complain

Metcalfe, J. & Kuschel, G. (2015, June 30). *Research into the long-term trends for electric vehicle pricing and supply – understanding developments in the global market. Final report prepared for the Ministry of Transport.* Ministry of Transport: Wellington, New Zealand. Retrieved July 2, 2016 from: http://www.transport.govt.nz/assets/Uploads/Our-Work/Documents/Report-New-Electric-Vehicle-Trends.pdf

Ministry for the Environment. (2016). *New Zealand's Greenhouse Gas Inventory 1990–2014* (pp. 1-519). Ministry for the Environment: Wellington, New Zealand. Retrieved July 7, 2016 from: http://www.mfe.govt.nz/sites/default/files/media/Climate Change/national-inventory-report-2016.pdf

Ministry of Transport. (2011, May). *Sector Report: Aging of the light vehicle fleet* (pp. 1-9). Ministry of Transport: Wellington, New Zealand. Retrieved July 4, 2016 from: http://www.transport.govt.nz/assets/Import/Documents/Light-vehicle-sector-report-aging-of-the-fleet-June-11.pdf

Ministry of Transport. (2016a). *Monthly Light Vehicle Registrations: May 2016* (pp. 1-7). Ministry of Transport: Wellington, New Zealand. Retrieved July 2, 2016 from: http://www.transport.govt.nz/assets/Uploads/Research/Documents/EV-report/Monthly-light-vehicle-registrations-201605-final.pdf

Ministry of Transport. (2016b, May 30). 'Electric vehicles programme'. Retrieved July 07, 2016 from: http://www.transport.govt.nz/ourwork/climatechange/electric-vehicles/

Muijs, D. (2011). 'Introduction to Quantitative Research'. In *Doing Quantitative Research in Education with SPSS*. (pp. 1-10). London: SAGE Publications Ltd.

Petroleum Exploration & Production Association New Zealand (PEPANZ). (n.d.) 'Economic contribution to NZ'. Retrieved July 07, 2016 from http://www.pepanz.com/news-and-issues/issues/economic-contribution-to-nz/

PricewaterhouseCoopers (PwC). (2013). *Charging forward: PwC's 2012 electric vehicle survey*. PricewaterhouseCoopers LLP.

Renault New Zealand (n.d.). 'Electric vehicles'. Retrieved 7 July, 2016 from: http://www.renault.co.nz/electric-vehicles/?gclid=CjwKEAjw-r27BRCzsNyzrMrM-j0SJACp2TiBAhcdRebTJQldUf2DWUpYx59dxX3AFlX8c809VKKfAhoC8P3w_wcB

Rendell, R. & Huntingford, S. (2016, June 23). 'Skoda electric SUV under development'. Retrieved July 18, 2016 from: http://www.autocar.co.uk/car-news/industry/skoda-electric-suv-under-development

Royal Society of New Zealand. (2016, April). *Transition to a low-carbon economy for New Zealand.* (pp. 1-200). The Royal Society of New Zealand: Wellington, New Zealand.

Sreejesh, S. & Mohapatra, S. (2014). *Mixed Method Research Design: An Application in Consumer-Brand Relationships (CBR)*. (pp 1-174). Springer: New York.

Stephenson, J. (n.d). 'The Potential for uptake of Electric Vehicles in New Zealand'. Centre for Sustainability, University of Otago, Dunedin: New Zealand. Retrieved June 23, 2016 from: http://www.epecentre.ac.nz/docs/green%20grid%20conf%20presentations/8.%20UO-GG-16-CP-JS-01_EV%20presentation.pdf

Stewart, D. & Saren, M. (2014). *The Marketing Pathfinder: Key concepts and cases for marketing strategy and decision making*. Wiley: UK.

Sustainable Business Council. (2015). *Accelerated Uptake of Electric Vehicles in Corporate Fleets* (pp. 1-14). Sustainable Business Council: Wellington, New Zealand.

Tesla Motors. (2016). 'Model 3 Accelerating Sustainable Transport'. Retrieved July 07, 2016 from: https://www.teslamotors.com/model3

The Pell Institute. (n.d). 'Analyze Quantitative Data'. Retrieved August 6, 2016, from: http://toolkit.pellinstitute.org/evaluation-guide/analyze/analyze-quantitative-data/

Tran, M., Banister, D., Bishop, J.D.K., & McCulloch M. D. (2013, June). 'Simulating early adoption of alternative fuel vehicles for sustainability,' *Technological Forecasting and Social Change*, 80(5): pp. 865–875.

Tsang, F., Pedersen, J.S., Wooding, S., & Potoglouo, D. (2012). *Bringing the electric vehicle to the mass market: A review of barriers, facilitators and policy interventions*. RAND Working Papers: Santa Monica, CA.

Weissler, P. (2013, June 24). 'Nissan commits to extensive public EV infrastructure'. *SAE International*. Retrieved 7 July, 2016 from: http://articles.sae.org/12270/

Wilson, L. (2013, February). *Shades of Green: Electric Cars' Carbon Emissions Around the Globe* (Report). Shrink That Footprint: UK.

Wolf, A. (1999). *Working Paper No. 7. Building Advice: The Craft of the Policy Professional*. State Services Commission: Wellington, New Zealand.

Appendix A Survey questions

Information Letter for Anonymous Survey

Date: 15th August 2016

Researcher: Jiayi (Jason) Zhu, Victoria School of Management, Victoria University of Wellington

I am an MBA student at Victoria University of Wellington. As part of the mandatory course requirement for MMBA532, Business Research Project, I am undertaking research leading to a report. In this project I will be examining EV adoption barriers and the effectiveness of the New Zealand government's new EV policy.

I'll be using a survey instrument which will consist of a number of multiple choice and open-ended questions. It will be an electronic survey and all responses will be anonymous. There is no obligation to participate or complete the survey.

The survey does not record any individual respondent details other than broad demographic details. The survey will be carried out and collected through survey monkey. The report will be presented in an aggregated form. No one else, other than the researcher and the supervisor, will have access to the raw data. Within two years of completion of the research project, the data will be destroyed.

Victoria University of Wellington has granted ethical approval to this project and it has been reviewed by the MMBA 532 Course Coordinator.

If you have any questions or would like to receive further information about the project, please contact me at Jiayi (Jason) Zhu, email zhujiay@myvuw.ac.nz or my supervisor, Dr David Stewart, at the Victoria Management School at Victoria University, P O Box 600, Wellington, phone 04 463 5150.

Name of student: …….Jiayi (Jason) Zhu……

Profile

1. What is your age? *

- 18 to 24
- 24 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 or older

2. What is your gender? *

- Male
- Female

3. Where are you mainly based? *

- Auckland
- Wellington
- Christchurch
- Hamilton
- Tauranga
- Nelson
- Dunedin
- Palmerston North
- Other

4. How many cars do you currently own? *

- 0
- 1
- 2
- 3 or more

LOGIC Show/hide trigger exists.

5. Do you already own an electric vehicle (EV) ?
NB: Battery or plug-in hybrid electric vehicle *

- Yes, I am an EV owner
- No, I don't own an EV

LOGIC Hidden unless: Question "Do you already own an electric vehicle (EV) ?
NB: Battery or plug-in hybrid electric vehicle " #5 is one of the following answers ("Yes, I am an EV owner")

6. What model of EV do you currently own? *

LOGIC Show/hide trigger exists. Hidden unless: Question "Do you already own an electric vehicle (EV) ?
NB: Battery or plug-in hybrid electric vehicle " #5 is one of the following answers ("No, I don't own an EV")

7. Would you consider buying an EV in the next 3 - 5 years? *

- Yes
- No
- Not at this stage, but I will see where the market goes

LOGIC Hidden unless: Question "Would you consider buying an EV in the next 3 - 5 years?" #7 is one of the following answers ("Yes","No","Not at this stage, but I will see where the market goes")

8. Which EVs available in the NZ market (between now and 2017) are you aware of?

*Tick one or more.

*Skip to the next question if you are not aware of any of these EVs.

VW Golf

Renault Zoe

Tesla Model 3

BMW i3

Audi e-tron

Nissan Leaf

Mitsubishi iMiev

Mitsubishi Outlander

Technological Barriers

LOGIC Show/hide trigger exists.

9. Is the driving range of an EV a major reason to stop you purchasing an EV? *

- Yes
- If no, please explain why

*

LOGIC Show/hide trigger exists. Hidden unless: Question "Is the driving range of an EV a major reason to stop you purchasing an EV?" #9 is one of the following answers ("Yes")

10. If you had to purchase an EV, what would be the ideal driving range for you? *

- Less than 150 km would be enough
- Between 150 km to 350km
- Between 350 km to 500km
- More than 500 km
- I have no idea what a good range is

Technological barriers

LOGIC Hidden unless: Question "If you had to purchase an EV, what would be the ideal driving range for you?" #10 is one of the following answers ("Between 150 km to 350km","Between 350 km to 500km","More than 500 km","I have no idea what a good range is")

Below are some examples of EVs in development by manufacturers and their targeted range.

Manufacturer	**Year expected to be available**	**Targeted Range**
Tesla – Model 3	2017	350km
Chevrolet – Bolt	2017	320km
Audi – Q6 Crossover	2018	480km
Hyundai – models are not specified	2018	320km
Nissan – LEAF	2018	540km
BMW – 3 series EV version	2018	480km
Skoda – models are not specified	2020	480km

LOGIC Show/hide trigger exists. Hidden unless: Question "If you had to purchase an EV, what would be the ideal driving range for you?" #10 is one of the following answers ("Between 150 km to 350km","Between 350 km to 500km","More than 500 km","I have no idea what a good range is")

11. Did you know that there are a number of EVs with a decent range to be released in the market as listed above? *

- Yes
- No

LOGIC Hidden unless: Question "Did you know that there are a number of EVs with a decent range to be released in the market as listed above?" #11 is one of the following answers ("Yes","No")

12. Assuming the vehicles will be available in NZ, how does the above information change your view about the driving range of EVs? *

Technological Barriers

LOGIC Show/hide trigger exists.

13. Is battery charging time a major reason to stop you from adopting/using an EV? *

- Yes
- If no, please explain why

*

LOGIC Hidden unless: Question "Is battery charging time a major reason to stop you from adopting/using an EV?" #13 is one of the following answers ("Yes")

14. If you had an EV, what is your expectation around a reasonable charging time? *

Please specify in minutes or hours

At home, in a garage overnight	
At a public charger, during a road trip	
At a public charger, parked at a mall	
At a public charger, during the day or on the way to work	

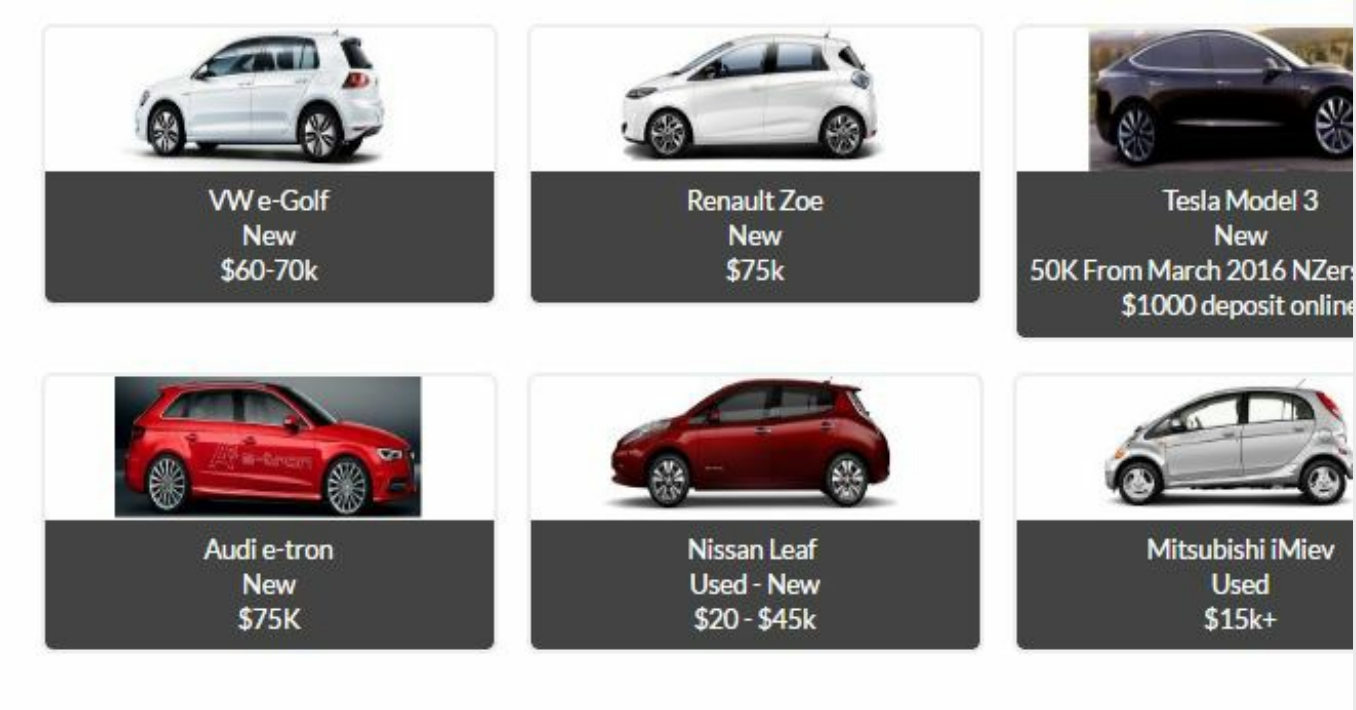
Technological Barriers

LOGIC Hidden unless: Question "Is battery charging time a major reason to stop you from adopting/using an EV?" #13 is one of the following answers ("Yes")

15. Tesla's supercharger allows an 80km range to be added within 6 minutes charging time and achieves 80% of full range in 45 minutes. The Japanese standard DC CHAdeMO quick charging system is capable of refilling the Mitsubishi i-Miev and Nissan LEAF from 20% to 80% in 30 minutes.

How does the above information change your view about EV charging times, if at all? *

Economic barriers



LOGIC Show/hide trigger exists.

16. Are current EV prices a major reason to stop you from adopting/using an EV? *

- Yes, they are too expensive
- I had no idea how much a typical EV costs
- If no, please explain why

*

LOGIC Show/hide trigger exists. Hidden unless: Question "Are current EV prices a major reason to stop you from adopting/using an EV?" #16 is one of the following answers ("Yes, they are too expensive","I had no idea how much a typical EV costs")

17. What would be your budget for your next car ?

NZD

LOGIC Hidden unless: Question "What would be your budget for your next car ?" #17

18. If an EV is available at your budget, would you *

Select one or more

- [ ] Only buy if there are more EV models available
- [ ] Only buy in second hand market
- [ ] Only buy new with manufacture battery warranties.
- [ ] Doesn't bother me to buy new or second handed.

LOGIC Show/hide trigger exists. Hidden unless: Question "Are current EV prices a major reason to stop you from adopting/using an EV?" #16 is one of the following answers ("Yes, they are too expensive","I had no idea how much a typical EV costs")

19. Consider the scenario:

You have to choose between purchasing a 3-year-old, low kilometre EV - Nissan Leaf for $27,000, or a similarly sized Toyota Corolla for $20,000.

The annual cost of fuel is roughly $2,005 according to AA.
The cost of charging an EV is equivalent to paying around 30 cents per litre for petrol according to EECA.This means excluding maintenance and ownership cost, comparatively, an EV would cost $316 to run annually.

How does the above information change your view about high upfront EV costs? Do you think the low running costs of EV justify the higher purchase price? *

LOGIC Hidden unless: Question "Consider the scenario:
You have to choose between purchasing a 3-year-old, low kilometre EV - Nissan Leaf for $27,000, or a similarly sized Toyota Corolla for $20,000.

The annual cost of fuel is roughly $2,005 according to AA.
The cost of charging an EV is equivalent to paying around 30 cents per litre for petrol according to EECA.This means excluding maintenance and ownership cost, comparatively, an EV would cost $316 to run annually.

How does the above information change your view about high upfront EV costs? Do you think the low running costs of EV justify the higher purchase price?" #19

20. We have historically low prices for gasoline, with prices of 185.9 per litre for 95 unleaded. Is the cheap petrol price a major reason of whether you adopt/use an EV? *

- Yes - If petrol price goes up I am more likely to consider an EV
- No - it doesn't make any impact to my view on EV

Economical Barrier

LOGIC Show/hide trigger exists.

21. Is the unknown cost of service, maintenance, and repair a major reason to stop you from adopting/using an EV? *

- Yes
- If no, please explain why

LOGIC Hidden unless: Question "Is the unknown cost of service, maintenance, and repair a major reason to stop you from adopting/using an EV?" #21 is one of the following answers ("Yes")

22. In an EV, there are no fluids to change and no wear or heat that typically occurs in a combustion engine. Therefore servicing an EV is much cheaper than an equivalent petrol car.

Manufacturers such as Nissan offer an eight-year, 160,000km warranty for its battery. If the battery degrades below 75% of capacity, the manufacturer will replace it.

Does the above information change your views about the cost of maintenance for an EV? *

Infrastructure

LOGIC Show/hide trigger exists.

23. Is the availability of current public charging stations a major reason to stop you from adopting/using an EV? *

- Yes
- If no, please explain why

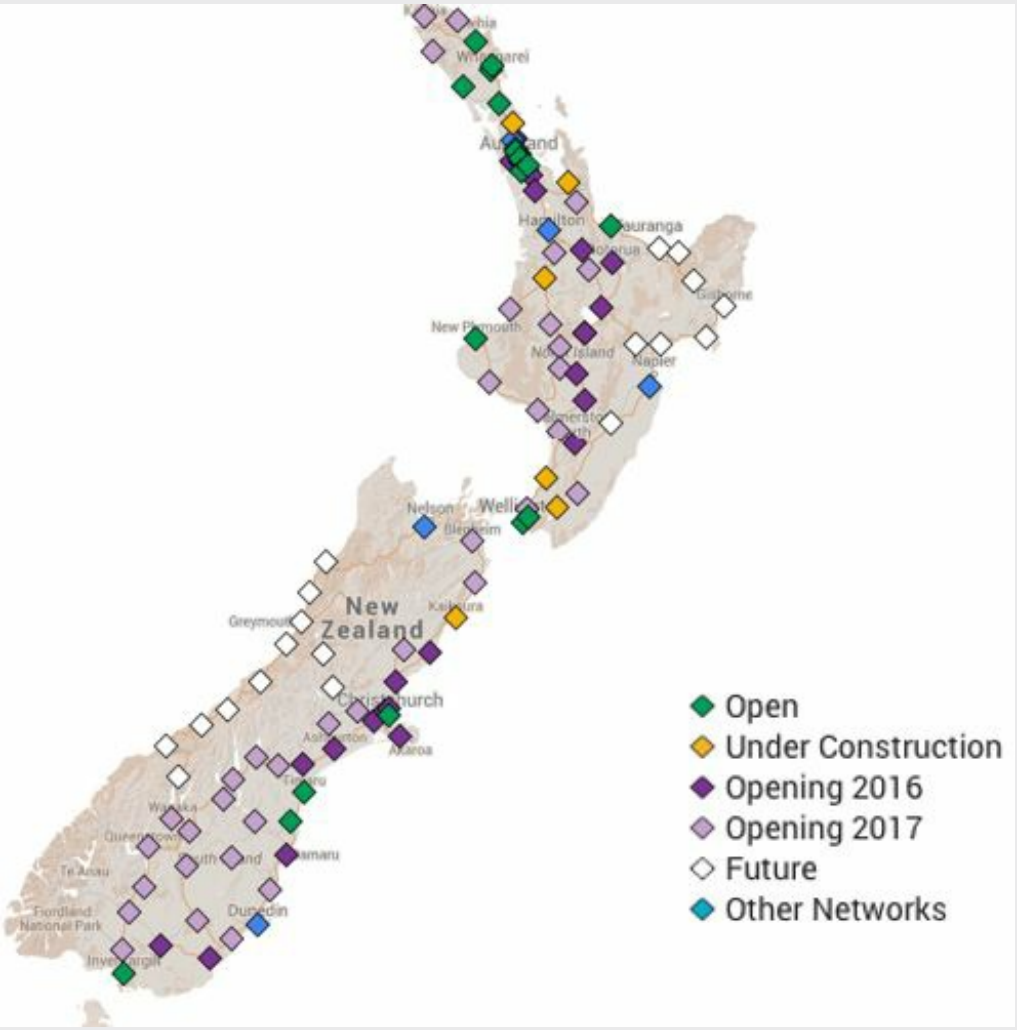
*

LOGIC Hidden unless: Question "Is the availability of current public charging stations a major reason to stop you from adopting/using an EV?" #23 is one of the following answers ("Yes")

24. The Charge Net NZ network comprises nearly 100 sites. These are being installed at an average rate of about one every two weeks. Efforts for installing fast chargers are underway to cover NZ's main routes by 2017.

Tesla also announced that there is plan to install fast charger network in NZ.

How does this information change your view about EV charging station facilities, if at all?



*

Other barriers

25. Would an increased use of EV in corporate/organisational fleets be a reason for you to adopt/use EV? *

Comments optional

- Yes
- No

Comments

26. Is the lack of a smart grid in NZ a major reason to prevent you from adopting/using EV? (NB: A smart grid helps determine the best times to charge an EV at the cheapest electricity rates) *

Comments optional

- Yes
- No

Comments

LOGIC Show/hide trigger exists.

27. Do you believe EVs are better for the environment than petrol cars? *

- Yes
- No

LOGIC Hidden unless: Question "Do you believe EVs are better for the environment than petrol cars? " #27 is one of the following answers ("Yes")

28. Some argue that EVs aren't as beneficial to the environment as the industry claims.
For example, they note that EVs aren't manufactured from a renewable source and the electricity that powers them is not clean. Additionally, there are concerns about the impact of lithium-ion batteries on the environment.

Does the above information change your view about how environmentally friendly EVs are? Comments optional. *

- Yes
- No

LOGIC Hidden unless: Question "Do you believe EVs are better for the environment than petrol cars? " #27 is one of the following answers ("No")

29. Some argue that EVs aren't as beneficial to the environment as the industry claims.
For example, they note that EVs aren't manufactured from a renewable source and the electricity that powers them is not clean. Additionally, there are concerns about the impact of lithium-ion batteries on the environment.

Do you agree with the above information? Comments optional. *

- Yes
- No

LOGIC Hidden unless: Question "Do you already own an electric vehicle (EV) ?
NB: Battery or plug-in hybrid electric vehicle " #5 is one of the following answers ("No, I don't own an EV")

30. Is there any other aspect you believe is a major reason for you to not own an EV?
For example, current EV models lack social appearance (don't look cool), don't want to buy EV too soon as there is uncertainty on technological advancement etc.

Answer Optional

Policy

31. The NZ oil and gas industry contributed over $2.5 billion to NZ's GDP in 2009 and the NZ Government collects around $400 million in royalties per year from petroleum.

What do you think about the Government's position in encouraging EV uptake while also reducing their tax revenue from the oil industry? *

- Government has vested interest in petrol industry and therefore can not fully commit
- Government is genuinely commited to promote growth of EV industry
- Other - Please explain

*

32. The NZ Ministry of Transport published a new EV policy in May 2016. Please give the policies a star rating according to how they would impact your decision to adopt/use EV *

	Rating
Extending the road user charges exemption for light electric vehicles and introducing a new road user charges exemption for heavy electric vehicles	
Work across Government and the private sector to investigate bulk purchasing	
Support the development and roll-out of public charging infrastructure	
A nationwide electric vehicle information and promotion campaign	
A contestable fund of up to $6 million per year to support innovation	
Enabling electric vehicles to access bus and high occupancy vehicle lanes	
Review of tax depreciation rates, ACC levies and the method for calculating fringe benefit tax for electric vehicles	

33. Can you please briefly discuss your highest rated policies and why these are most important to you. *

34. Do you believe the NZ Government's EV policy will make a difference to your decision about using EV? *

- If yes, why do you believe so? *
- If no, what policy should the NZ Government implement? *

Thank You!

If you would like to be in a draw to win a $40 prezzie card, please email zhujiay@myvuw.ac.nz, with an email title "I have completed your survey". The winner will be drawn and notified by 18th Oct 2016.

Thank you for taking my survey. Your response is very important to my study.

Thanks
Jason