Electric Vehicles in Ireland: the Past, the Present and the Future?

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Electric Vehicles in Ireland: the past, the present and the future?

Emma Sadleir
Electric Vehicles in Ireland: the past, the present, and the future?

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Declaration

This dissertation, which I now submit for assessment on the programme of study leading to the award of a Masters Degree in Business, is entirely my own work and has not been submitted in whole or in part for assessment for any academic purpose other than in partial fulfillment for that stated above.

Signed

Date 02/08/2016
I would like to express my sincerest thanks to my supervisor, Dr. Angela Wright. Her support, guidance and encouragement made this research possible. I wish to thank the Irish Electric Vehicle owners who have taken the time to complete the survey, and also the local Electric Vehicle suppliers who have provided their time to demonstrate the capabilities of Electric Vehicles. Lastly I would like to thank my employers at Azotel Technologies, along with my family and friends, for their endless encouragement.
Abstract

This research is undertaken as part of the researcher's efforts to achieve a Masters Degree in Business from Cork Institute of Technology. The research topic of Electric Vehicles in Ireland and the concentration on those vehicles exclusively or primarily powered by battery was prompted by interest and curiosity, but with a significant undertone of concern for the environment, all of which led to the research question: Electric Vehicles in Ireland: the past, the present, and the future?

It was not possible to start with a complete void and therefore initially assumptions were made, particularly that serious environmental damage arises from carbon emissions with a significant contribution from petrol and diesel powered motor vehicles and that a switch to battery powered vehicles was likely to alleviate the environmental problem. Secondary research was completed starting from this subject and others, followed by exploring the topic of Electric Vehicles, particularly in an Irish context. Primary research was undertaken largely applying quantitative methods, involving the use of a survey to Electric Vehicle users in Ireland and an analysis of its results.

The findings, so long as the assumed environmental benefit of Electric Vehicles holds true, support the view that a switch to Electric Vehicles will tend to alleviate the problem of emissions and that there is a future for Electric Vehicles in Ireland. This future, however, is subject to what may emerge over a longer period of experience with these vehicles and the outcome of further research suggested at the end of this work. That future depends also on, whether by maintenance of government incentives or pricing policies, the possibility for users or potential users to see a material advantage and not to be put off by poor charging infrastructure.
Chapter 1: Introduction

1.0 Introduction

The research topic chosen for this study will be the subject of Electric Vehicles (EVs) in Ireland. The research question chosen by the researcher is “Electric Vehicles in Ireland: the past, the present and the future?” These terms will be discussed in detail in Chapter Three.

This study will explore the past, the present and the future of EVs in Ireland, based on a review of existing literature on the topic. It will also include some empirical research involving information gathered from existing EV owners, users and suppliers in Ireland, along with the researcher’s own experience with driving EVs. The purpose of this study is to review and analyse the existing literature and the results of the research just mentioned, to come to a conclusion as to the future for EVs in Ireland and to identify areas that might merit further study.

In the course of this study, the researcher will use a number of abbreviations to refer to some key terms. A complete list of abbreviations and definitions can be found in the glossary on page 144. For example, throughout the study the researcher will refer to EVs, which unless otherwise stated can be assumed to be any Electric Vehicle primarily powered by battery, and charged by plugging the vehicle into a charger. When specifically discussing an EV powered solely by battery, the term BEV will be used. PHEVs will refer to Electric Vehicles primarily powered by battery that can be plugged in and charged, but with a possibility of back up power using petrol or diesel. The term HEV solely refers to hybrid electric vehicles that do not have an option to plug in and charge the vehicle. All standard
petrol or diesel vehicles will be referred to under the term ICE, which is an Internal Combustion Engine.

1.1 Background of the Study

A combination of factors has led the researcher to undertake this study in relation to EVs. For example, the Paris Agreement on climate change is set to come into force in 2020, and has set targets to reduce emissions in Ireland, and in other countries. In parallel, technological advancements are leading towards many new developments, including EVs, and even driverless cars. Despite this, the uptake of EVs, boasting zero emissions at the tailpipe, has been slow to date. There are many related issues that would merit study in more detail and some, at least, of these will be mentioned at section 1.1.2 and 1.1.3 below, but first the researcher will provide a brief overview of the history of EVs.

1.1.1 A Brief History of Electric Vehicles

Trigg (2012) suggests that EVs have been in existence for over 100 years, but were displaced by the 1930s by the ICE in the case of light-duty passenger cars, (in Trigg & Telleen, 2013:8). The current wave of EVs is considered to be the Third Age of EVs, the first having appeared in the early 1900s, with the second briefly appearing in the 1990s, and the third, in the last 10 years, a reincarnation prompted by volatile oil prices, deteriorating urban air quality and climate change, (Trigg (2012) in Trigg & Telleen, 2013:8).

In an Irish context, the researcher was also aware that at one time there were a number of battery-operated vehicles available, primarily bread delivery vans and laundry vans. In the 1970s there were more than six hundred BEVs on the streets of Dublin, (askaboutireland.ie, 2016). Askaboutireland.ie (2016) states that the decline of BEVs in the case of bread delivery may have been due to corporate mergers, and
the arrival of supermarkets, which brought about changes in shopping patterns. In the case of BEVs used for laundry service, domestic washing machines and launderettes may have led to their demise, (askaboutireland.com, 2016). An example of one of these BEVs is shown in Appendix B.1.

1.1.2 Environmental Concerns

The subject of EVs is becoming more relevant, as globally, environmental concerns are becoming more urgent. McDonald (2015) states that the period of 1983 to 2012 was likely the warmest 30 year period in the past 1,400 years in the northern hemisphere, and 2014 alone was the hottest worldwide since records began. According to McDonald (2015) harmful emissions can be reduced through "changes in consumption patterns, switching to renewable-energy sources, such as solar or wind, and adopting simple energy-saving measures".

SEAI (2016a) states that renewable energy is energy that comes from energy sources that are continuously replenished through the cycles of nature and unlike fossil fuels, the sources of renewable energy will never become exhausted. Sources of renewable energy include solar energy, wind energy, moving water, geothermal energy and biomass, (SEAI, 2016a). According to SEAI (2016a) Ireland is heavily reliant on imported fossil fuels, and now imports 89% of the fuels needed for energy. By tapping into the renewable energy resources available in Ireland, we could reduce this reliance on imports, and achieve a more secure and stable energy supply for the long term, (SEAI, 2016a).

McDonald (2015) states that the Kyoto Protocol was the first international treaty on climate change, ratified initially by the EU, and in 2005 by Russia, bringing it into force. SEAI (2007:5) explains that Ireland's CO₂ levels peaked in 2001 at 31% above 1990 levels, and the Kyoto Protocol was put in place to limit carbon dioxide emissions.
during the period of 2008 to 2012 to a maximum of 13% above 1990 levels.

"At the Paris Climate Conference (COP21), in December 2015, 195 countries adopted the first-ever universal legally binding global climate deal", (European Commission, 2016). The agreement is set to enter into force in 2020, and sets out a global action plan to limit global warming to well below 2°C above pre-industrial levels, (European Commission, 2016). The agreement will enter into force after 55 countries that account for at least 55% of global emissions have deposited their instruments of ratification, (European Commission, 2016).

According to Scheer et al., (2016:2), by 2020, 16% of final energy use and 10% of energy use in the transport sector must be derived from renewable sources. Ireland is just over half way to meeting its 2020 renewable energy target, as 8.6% of gross final consumption was derived from renewables in 2014, (Scheer et al., 2016:4).

McDonald (2015) feels that although the then Minister for the Environment, Alan Kelly, and his predecessors have repeatedly pledged that Ireland will meet its EU obligations on climate change, at the rate the country is going it will fail to achieve the EU target for 2020.

According to Lynch (2016) Ireland remains one of two countries on track to miss its targets for 2020 and recently, the Irish government has secured significant concessions in new EU emissions targets for 2030. Ireland and other countries including Latvia have argued that they should be allowed compensate for high emissions in areas such as agriculture because of forests and other managed grasslands that act as 'carbon sinks', although these arguments have been heavily criticised by environmentalists, (Lynch, 2016).
The World Economic Forum (2016:7) feels that although solar and wind energy have been growing at double digit rates, they do have their limitations, and in many places are confined to niche roles because of the lack of an affordable, reliable technology to store the excess energy produced when conditions are at best and to release power onto the grid as demand picks up. “Better batteries could solve this problem, enabling emissions-free renewables to grow even faster and making it easier to bring reliable electricity to the 1.2 billion people who currently live without it”, (World Economic Forum, 2016:7).

The motor industry and Information and Communications Technology (ICT) have been crossing paths for some time now, with recent consideration of such developments as driverless cars. World Economic Forum (2016:10) states that the world is on the cusp of a shift from vehicles driven by humans to self-propelled vehicles, and a half a dozen states have already authorized autonomous road vehicles. Some models already offer some features such as hands-off parallel parking, automatic lane keeping, emergency braking and cruise control, (World Economic Forum, 2016:10).

Autonomous vehicles may have their software bugs, but overall could assist in preventing accidents that can be caused by the various distractions associated with the current driving patterns of humans, (World Economic Forum, 2016:10). This indicates that advancing technology in vehicles could not only contribute to a reduction in emissions, like in the case of EVs, but also have the added bonus of making the roads safer, as technology grows and vehicle automation advances. This study will focus primarily on EVs, but it is also important to acknowledge the power of technology in relation to the
motor industry, and the impact it can have in overcoming barriers once thought to be impossible to pass.

Discussing technology as an enabler for progressing our path towards cleaner energy, O'Brien (2016a) hopes that research and development will continue to conjure up new technologies not thought of yet, and feels there is also plenty of scope to squeeze more from existing technologies.

1.2 Research Context

Some previous authors have examined the subject of EVs, in a variety of contexts.

Smith (2010) examines whether EVs can address Ireland's CO₂ emissions from transport, in the context of personal cars, and finds that substantial reductions in greenhouse gases (GHGs) could be achieved for urban based driving, but that such achievement will be difficult for inter-city travel. Brady & O'Mahony (2011) also examine the potential impacts of EV use on climate change, this time in the context of Dublin commuters, and find that there is a potential for a positive impact, but that a significant impact in the next decade is unlikely.

Driscoll et al., (2013) explore a simulation of demand for EVs in the Irish market, using three scenarios: current recommended retail price (RRP) including the €5,000 government grant; current RRP excluding the €5,000 government grant; current RRP excluding the €5,000 government grant and adding on Vehicle Registration Tax (VRT), and find that a subsidy greater than that already applied to the RRP in the scenarios described above would be required in Ireland for a greater uptake. Driscoll et al (2013: 693) also note that research to date may have produced some overestimations of potential uptake in the
demand for EVs, due to the fact that there had been very few EVs sold in Ireland when the research was undertaken, and because it would take time for the benefits of new vehicles to actually reach the market.

Axsen & Kurani (2013) performed a Californian survey, representing 508 households in San Diego in 2011, to determine consumer preference when buying a car as between HEV, PHEV and BEV. The survey contained an element of consumer design or selection of features for their own requirements around a proposed new vehicle, to provoke more in-depth analysis on the demand for the various features of these vehicles, (Axsen & Kurani: 2013: 534). The study found that where participants were allowed to specify features required in such vehicles, less than one sixth of participants opted to stay with their ICE model as a potential next car.

O'Mahony & Wright (2012) explored the concept of EVs becoming a feature of the future in Ireland, and interviewed key influencers in the motor industry, in government, and in other significant roles to determine the opinion of the Irish market on EVs.

Blythe et al., (2015) performed a survey among U.K and Irish EV users, where U.K participants represented over 80% of the sample, and Irish users represented less than 20%, to gain insight into current battery charging patterns and usage of EVs. More recently, Weldon et al., (2016) performed an investigation into the usage patterns of fifteen EVs in Ireland, for both residential (8 vehicles) and business purposes (7 vehicles), over a period of approximately three years. The main findings of the survey showed that EV users typically take short journeys, and that battery charging happens regularly and far more often than is required.
1.3 Justification for Research

Much of the research to date in relation to EVs has taken place outside of Ireland, such as, Axsen & Kurani, (2013). Some earlier research on this topic, in Ireland, took place during an economic recession, and at a time when the EV user rate was quite low in Ireland (O’Mahony & Wright, 2012). Driscoll et al., (2013) found that there were not enough EV users on the roads in Ireland to make an accurate prediction as to how EV sales would turn out under the various pricing schemes proposed.

New car sales in the EV category have risen recently, with 2015 figures doubling the count for 2014, (see Chapter 2, page 42) suggesting that this may be a suitable time to review the situation in an Irish context, using empirical data gathered in the manner described in Section 1.0.

To date, there has been limited primary research into the use of EVs in Ireland, possibly due to the slow uptake of these in earlier years. Now, the Irish community of EV users is becoming more prominent, with increasing numbers last year, online forums and countrywide presence. With the experience of these users in Ireland, and the increasing urgency for action in relation to climate change, it is time to discover what the experience of EV users in Ireland has been to date, and what the future may hold for EVs in Ireland.

1.4 Aims and Objectives

The main aims and objectives of the researcher, in this study, are as follow:

(a) To review existing literature in relation to EVs including journals, reports, books, and newspaper articles.
(b) To identify any limitations in the knowledge gained from previous research.
(c) To investigate the past, present and future status of EVs in Ireland.
(d) To evaluate these findings.
(e) To identify potential points of future research in this area.
(f) To make some recommendations regarding the future of EVs in Ireland.

1.5 Personal Experience

Prior to engaging in this study, the researcher had quite limited experience of EVs, had previously driven a HEV, but had not yet driven, or been a passenger in a BEV or in a PHEV. One of the reasons for choosing this research topic was to gain more knowledge on the area, and to achieve this the researcher sought and gained opportunities to experience some different types of EV and thus gain further understanding. These experiences will be documented in sections 1.5.1 – 1.5.4.

1.5.1 Personal Experience: Driving a HEV

The researcher had the opportunity, on occasion, to drive a HEV, as a family member has owned this type of vehicle for a number of years. The model driven was a Toyota Prius (2007), as shown in Appendix B.2. This model operates using a petrol engine, and an electric motor. The first observation made by the researcher in relation to this vehicle was regarding the automatic transmission; the brakes and accelerator were more responsive in this vehicle, than in a manual transmission petrol based ICE, which the researcher normally used. Although automatic transmission is not unique to EVs, or to HEVs, it is worth noting that manual transmission vehicles remain far more common in Ireland. As outlined by Briscoe (2014) in an Irish report, “according to
a recent survey by Ford, 85 per cent of European buyers choose manuals and here at home it's a whopping 96 per cent". So the manual transmission is still a key difference to be aware of, as it may influence an Irish driver's perception of an EV, or a HEV.

The owner of the HEV driven by the researcher has noted that when it runs from its electric motor, there is a lack of engine noise, which was surprising initially, not only to the owner but also to pedestrians in the vicinity of the vehicle. For this reason there is a need for attention, particularly when reversing, but overall people are becoming more aware of quieter cars as they are becoming more common.

Overall there were not any other remarkable differences noted between driving the HEV and a standard petrol car. The owner advised, however, that the cost of fuelling the vehicle was significantly lower than for the previous vehicle owned, which was a pure petrol vehicle. Although it was interesting to experience driving a HEV, the researcher needed to experience driving an EV, as it is the primary focus of this research.

1.5.2 Personal Experience: Driving an EV: BMWi3

During the course of the research study, the researcher met with a sales specialist from Keary's Motors in Little Island, Cork, to discuss the BMWi3 (BEV), as shown in Appendix B.3. The sales specialist agreed to arrange for the researcher to take a test drive of the EV on June 11th 2016. On arrival for this purpose at Keary's Motors, the salesperson explained a little bit about the model of the EV, and how it was designed. The discussion will be summarised in the remaining paragraphs of section 1.5.2 with comments on the experience of the researcher.
The environmental aspects of the vehicle in relation to its production and performance are prioritised, for example, the car is manufactured in a plant that is powered by renewable energy, and most of the materials used are lighter and more durable. This lightness was demonstrated by tapping on the exterior of the vehicle. In fact, 95% of the materials used to produce the vehicle are recyclable, according to the salesperson. These include the inside of the doors which were made using a form of plant-based material and parts of the seats which were made using recycled coca cola bottles. The researcher was also presented with a BMW i3 brochure, and the salesperson advised that the brochure was also made from recycled material.

The salesperson explained a little bit about how the vehicle works before the researcher experienced driving it. The BMWi3 operates using automatic transmission and the gears are operated from a knob on the steering wheel, using a twist function between “R” (reverse), “N” (Neutral) and “D” (Drive). The car starts using a “start/stop” button near the steering wheel. The handbrake is operated by a button located between the two front seats, and it activates and de-activates automatically. For example, when the accelerator is pressed, while the car is in gear, the handbrake can release automatically, for convenience. The vehicle was equipped with many modern technical features such as a rear view parking camera, a sat-nav\(^1\) system, a screen to show and report information about nearby parking, charging points, and much more. The salesperson was able to demonstrate the possibilities of the “ConnectedDrive\(^2\)” features on the dashboard.

Once the vehicle was turned on, by pressing the start/stop button, the first thing noticed by the researcher was the silence in the car, due to the absence of engine noise. This persisted throughout the ten-minute test drive, except for the sound of the wheels. The researcher

\(^1\) Satellite Navigation
\(^2\) ConnectedDrive is a BMW specific form of technology enabling control of the car from a phone or device.
felt that the lack of noise represents a key difference when comparing the experience of driving an EV with that of driving an ICE. It was pleasant to drive the EV with limited noise. The researcher did not observe any issue that would prompt a lack of pedestrian awareness of the vehicle approaching, as the vehicle was being driven in an area with a 50 kilometre per hour (KPH) speed limit, and high visibility as it was driven during daylight hours. The salesperson mentioned the possibility of purchasing additional sound to alert pedestrians to the vehicle approaching, but this does not appear to be a requirement in Ireland.

The second major difference experienced by the researcher in comparison to driving a petrol vehicle was the power of the car, which can be noticed when moving forward after pausing, for example at a roundabout. This EV is able to reach the desired speed much quicker than a standard petrol car of manual transmission.

The technical features in the vehicle were exciting, although a number of these may already be available in modern non-electric cars of a high specification. It is very re-assuring to know that these features offer the possibility to search the area in which the EV is being driven for nearby charge points, and see further information about the exact type of charge point available at the click of a button. The researcher enquired about where the charge point information originates, and the salesperson noted that although the charge point location is mapped out, unfortunately in Ireland it is not live, so information is not readily available concerning which charge points are in use, or which are out of order. The salesperson explained that EV users are relying on one another to report failures to those in charge of the technology, (mainly the ESB), and to post on social media to warn other drivers. This could be problematic, as the need to charge a vehicle can become fairly urgent if multiple charging points in the area are out of order.
Another interesting technical feature was the ability by the use of a finger to draw the letters of the desired destination on the control dial, and have the dashboard features search for that location, to eliminate the need for typing using a keyboard, although this may also be available in non-electric cars. There was also a possibility to have the features of the car read sections of the news to the driver, and communicate steps for navigation. The salesperson noted that the technology in the car could alert drivers to a possible battery range issue. For example, if the driver was planning to travel from Cork to Dublin using the sat-nav, but only had a 50km battery range remaining, the technology in the vehicle would be able to communicate to the driver that he/she did not have sufficient battery range to drive there, and remind the driver to charge the vehicle. The battery range in the BMWi3 is currently reported as up to 160km, according to BMW (2016).

An obvious difference between the BMWi3 and most non-electric cars was around the design and appearance, and the technical features. The layout of the car, and its features differed from what the researcher was accustomed to, but despite this and even with the high level of technology in the car, it was reasonably user friendly on an initial and brief trial and the researcher felt that over a more prolonged period, acceptance and even a liking for it would develop.

The salesperson explained that one major incentive to purchase a BMWi3, was that the sales team would be in the position to arrange all of the available incentives and grants for the purchaser, for example Sustainable Energy Authority of Ireland (SEAI) grants, if applicable, can be calculated as part of the net price, and arranged by the sales team, with minimum paperwork and effort required by the purchaser. The grants and incentives available for EVs will be discussed in further detail in Section 2.4.1, page 36 and the cost of EVs is set out in Appendix C.
Although the salesperson was actively promoting the positive features of the BMWi3, he also noted that similar to non electric vehicles, there are many different types of EVs, designed for different consumer preferences, and it would be important to experience more than one model to get a true understanding of EVs from a research perspective.

1.5.3 Personal Experience: Driving an EV: Nissan Leaf

The researcher was also in touch with Keary’s Motors, in Cork city, to arrange a test drive of a Nissan Leaf (BEV). The test drive was carried out on June 13th 2016. The model driven is shown in Appendix B.4.

The first observation made by the researcher was in relation to the silence of the vehicle. Similar to the BMWi3, there was a notable silence when driving, and the researcher was more aware of external noise. The vehicle was extremely easy to drive, and once again it is worth noting that this vehicle operates using automatic transmission. Ease of use appears to be a key feature in the Nissan Leaf.

The Nissan Leaf was not as technologically advanced as the BMWi3, and the researcher felt that there could potentially be a smoother transition from an ICE to a Nissan Leaf, due to the familiar dashboard and simplicity of use. For example, in place of the petrol gauge, there is a section showing the remaining battery, and it is easy to read and understand. The car had a similar internal layout to a standard Nissan car. On the other hand, a new EV driver might be expecting a certain level of technology in an EV, but perhaps the next model of the Nissan Leaf will deliver more advanced features.

During the test drive, the salesperson was able to guide the researcher as to how to use the car in ‘regeneration mode’, which is activated by switching to a particular setting on the gear lever, and so that once
the accelerator is released battery regeneration will occur. This process known as regenerative braking is described in further detail by SEAI (2007:7) "most new BEVs also use ‘regenerative braking’, which allows the electric motor to act as a generator in order to re-capture energy that would normally be lost through heat dissipation and frictional losses – this improves energy efficiency and reduces brake wear”.

Although the salesperson was promoting the acceleration in this vehicle, compared to a standard petrol or diesel car, the researcher was unconvinced and felt that there was no significant difference, in contrast to recent experience with the BMWi3. This point is clarified by the Irish Examiner (2014), which states that cars like the Tesla (discussed in Section 1.5.4) can reach from 0km to 60km in 3.7 seconds and can reach top speeds of 200 KPH, whereas the Nissan Leaf can reach from 0km to 60km in 10 seconds, and can drive up to 140 KPH. Nissan (2016) states in a website brochure that the driving range on the Nissan Leaf can be from 100km to 200km, depending on the exact model.

The salesperson spoke a little about Nissan Leaf sales in general, explaining that the vehicle came to the Irish market in 2011. He advised that sales have been quite strong, particularly in the past year, and since Nissan have introduced a higher performing new battery. Initially, the typical clientele for the Nissan Leaf would have had an interest in technology and in the environment, but now, the user base is much more diverse. The typical reasons for purchasing a Nissan Leaf can vary, but recently, according to the salesperson, the most common reasons for purchase are for environmental and financial reasons, in particular, for fuel cost savings.

The salesperson was able to show the researcher the type of cable that comes with the car, for ordinary charging, and also the ‘granny cable’
that some users will also purchase to allow for slow charging with a 3 pin or household plug, in cases where the designated charging points are not available.

The researcher found that compared to the BMWi3, the Nissan Leaf is a less expensive car, with more limited technical features, but would be a very good choice as an initial venture in a transition from petrol or diesel due to its ease of use, and more modest initial cost. The cost of this EV is documented in Appendix C.

1.5.4 Personal Experience: Driving an EV: Tesla Model S

The researcher also had the opportunity to drive the Tesla Model S, produced by the American automotive and energy storage company Tesla Motors, on June 20\textsuperscript{th} 2016. This model is shown in Appendix B.5. These vehicles are not yet available for purchase in Ireland, but it appears likely that when available, the cost will be significantly more than the Nissan Leaf, and more expensive than the BMWi3. As noted in Appendix C, the Tesla Motors website estimates the vehicle to cost from €64,300, depending on the features chosen. According to Tesla (2016) the driving range for these vehicles can be from 408km to 509km, depending on the specification. The main notable features in the Tesla Model S are in relation to the vehicle design, the technical features, and the power of the car.

For example, on approach, the door handles are not exposed until the car is unlocked. Once inside the car, there are very few buttons and dashboard features. All settings are either on the large touch screen, or on the levers attached to the steering wheel. The gears can be changed by adjusting a lever that is similar, in appearance, to an indicator in a standard car. The location for the connection to charge the battery in this model is at the rear, and the section that would
normally be used for engine space, in a standard ICE vehicle, under the bonnet, can be used to store other items, if desired.

The vehicle had many impressive technical features. At a click of a button (on the touch screen), the driver can specify which driver is currently using the car, and have the seat, steering wheel and mirrors automatically adjusted to the preferences of the driver. Of course this feature requires initial configuration by the driver to set and save these preferences, but once drivers preferences have been entered on the touch screen, the settings can be remembered and re-used.

The owner of the vehicle also mentioned that Tesla has a very good mobile app that allows the driver to control and set certain features from the mobile phone. For example, it is possible to unlock the car using the app, to set the temperature of the vehicle, to view the location of the vehicle, and more.

During the drive, the researcher was able to avail of “driver assist”, meaning that at the flick of a lever, and by releasing the accelerator, the car could without further driver input manoeuvre at a designated speed limit, following the car in front at a safe distance. The driver can pre-configure in the settings the desired speed of travel taking into account applicable speed limits, which appeared to be automatically detected by the vehicle, and the vehicle will follow these settings. It was also possible to allow the car to stop automatically, for example at traffic lights, based on the behaviour of the vehicles in front. The “driver assist” function in the Tesla also allowed for hands free steering and lane switch, although it is worth noting that every few seconds, the Tesla makes an audible warning urging that for reasons of safety hands should be on the steering wheel.

The power of the car was immediately evident. When moving from a stopping position to a fast paced dual carriageway it could accelerate
from 0 to 60km in no time at all, in comparison to non-electric cars, and even to the Nissan Leaf and the BMWi3. See also reference on page 15 to Irish Examiner (2014) comparing the acceleration of a Nissan Leaf and a Tesla. This vehicle was by far the most impressive in terms of power, technology, and ease of driving, however the price is likely to be less attractive than for the other EVs tested. However, it is worth noting that per the Tesla website, Tesla are developing the Model 3, which is said to have a starting price of $35,000, and a driving range of 345km.

1.6 Research Focus of the Study

This chapter has sought to present the background to the topic of EVs and address some related themes, by way of prelude to the study. The chapter has also documented the researcher’s personal interest and experience in the subject. Few would now doubt that there is a problem of climate change to which the use of fossil fuels contributes in a significant way. The background reviewed would appear, at least, to suggest an investigation of the use of EVs as a possible step towards improvement.

Chapter Two will review the relevant literature relating to travel and transport in Ireland, the motor industry, EVs in a global context, and finally EVs within an Irish context.

Chapter Three will provide an outline of the research methodology in the context of this study, and how it was used by the researcher in relation to the current research.

Chapter Four will provide the main findings of the research, based on the results of a survey sent to a sample of the EV users in Ireland.

Chapter Five will conclude the study, and expand on the main findings, and establish conclusions and recommendations of the research.
Chapter 2: Literature Review

2.0 Introduction

This chapter will explore the concept of Electric Vehicles (EVs) both globally, and in an Irish context, using secondary research from peer reviewed literature, and books sourced in the Cork Institute of Technology (CIT) library, along with newspaper articles obtained on the newspaper websites. Some further literature was retrieved from the Electricity Supply Board (ESB), the Society of the Irish Motor Industry (SIMI), the Department of Communications Energy and Natural Resources (DCENR), and the Sustainable Energy Authority of Ireland (SEAI). The Central Statistics Office (CSO) was a source of some helpful statistics.

First, the researcher will analyse the patterns for transportation in Ireland, in order to gain an understanding of the travel behaviour of Irish people. The researcher will follow on with an overview of the motor industry, to determine its significance both globally and in Ireland, and to establish a connection to EVs. The researcher will then briefly concentrate on the concept of EVs globally, before finally focusing on EVs in Ireland.

2.1 Travel and Transportation in Ireland

The average journey undertaken by Irish people surveyed by the CSO in 2014 was of 16.4km or 22.2 minutes at an average speed of 44.2 KPH in all areas outside of Dublin, and 10.3km or 23.7 minutes, at an average speed of 26.1 KPH in Dublin, (CSO, 2015a). 59% of journeys across all regions were taking under 15 minutes, (CSO, 2015a). It
was found that longer journeys are also being taken, but most of the longer journeys take place outside of Dublin, (CSO, 2015a).

Most of the CSO survey participants travelled for work (25%) or shopping (24%), and most trips were taken by private car as a driver (69.1%) or a passenger in a private car (5.3%), (CSO, 2015a). “The results show a strong affinity to the car when choosing a particular mode of transport”, (CSO, 2015a).

2.1.1 Irish Economy and Motor Industry Overview

According to Power (2016:4-5), in early 2015, the Irish economy re­attained pre-crisis levels of activity both in Gross National Product (GNP) and Gross Domestic Product (GDP) terms, and this trend seems to have carried on into the first quarter of 2016.

There was a strong recovery in new car sales in 2015, with 124,945 new passenger cars registered and this represented an annual increase of 29.8% over the previous year, (Power, 2016:12). McHugh (2016) agrees that motor sales in 2015 (124,945) were 30% ahead of the 2014 figure (96,284). “In September 2015, a total of 78,608 motors ads were carried on the DoneDeal website, which was 5.5% higher than a year earlier and was almost 38% up on September 2012”, (Power, 2015:3). The first quarter of 2016 saw a 28.38% increase in new car sales on the first quarter of 2015 with 82,830 such sales, (Power, 2016:12). Cunningham (2016a) explains that registrations of new cars in 2016 were up to 131,264 by the month of July, and experts are predicting the total sales for 2016 to reach between 150,000 and 153,000.

McAleer (2016a) feels that a recent increase in commercial vehicle sales is also a good sign for the growth of the economy, and sales of
light commercial goods vehicles are up 26 per cent up to July this year, and registrations for heavy goods vehicles are up 42 per cent.

Power (2016:12) accredits the overall boost in new car sales to improved consumer confidence about the future, improvement in employment and earnings, and a functioning credit model.

2.1.2 The Cost of Motoring

Power (2015:18) explains that the cost of motoring is variable, due to fluctuating car sale cost, fuel and insurance cost. For example, petrol prices declined in Ireland by 11.8% up to September 2015, relative to the previous year, and the price of a new car declined by 3% over the same period, whereas motor insurance costs have increased by 35.2% over the past two years, (Power, 2015:18). Pope (2016) agrees that insurance costs have not been stable over the years, as insurance prices in Ireland dropped significantly between 2010 and 2014 due to competition between insurers. On the other hand in 2016 there has been a significant increase in the cost of premiums, for a number of reasons, including the demise of Setanta Ireland in 2014, overall losses in the insurance industry, insurance fraud, and increases in insurance claims, (Pope, 2016).

Power (2016:19) notes that in the year to March 2016, the average price of a car declined by 2.8%, as the price of petrol declined by 11.1%, and diesel by 17.7%, but the cost of motor insurance increased by 47.6%, an increase on the 2015 figures mentioned in the previous paragraph.

2.1.3 Motor Industry Contribution to the Economy

Power (2015:18) estimates that for every 1,000 new car sales, 130 additional employees are hired in the motor sector. “Employment in
the sector has increased by 9,500 since the low point at the end of 2009, but is still 4,800 down on the peak employment level of 49,500 in the final quarter of 2007", (Power, 2015:17). In contrast, Todd et al., (2013:7) suggest that most communities do not produce enough oil and gas for personal transportation, and therefore local residents spend more money on petrol, which in turn exits the local economy.

Todd et al., (2013:5) believe that although increasing EV use is likely to create some job losses in the oil industry, it may also create a range of jobs across a host of industries, in auto manufacturing, advanced batteries, research and development. Todd et al., (2013:5) also expect that due to the cheaper running costs of EVs, consumers may see a rise in their disposable income, and spend their money in other sectors such as housing and services.

2.1.4 Fuelling the Motor Industry

Zapata & Nieuwenhuis (2010:17) state that despite the pioneering use of ethanol in various models, such as the Model T, petrol became the fuel of choice for the automotive industry due to its relatively low cost and its abundance.

Challenges involved in introducing new methods of fuelling our transport, such as using natural gas, include the reluctance of companies to invest in building the infrastructure for these methods unless required by government, or by pressure from the consumer, (Steenberghen & Lopez, 2008:579).

2.1.4.1 Fuelling the Motor Industry: Biofuel

Brazil is the country that has achieved the most successful adoption of biofuels, with the sugar cane derived ethanol fuel, (Zapata & Nieuwenhuis, 2010:17).
Referring to Ireland, Scheer et al., (2016:13) state: “It is estimated that between 440 and 500 million litres of biofuel will be required in order to meet the 10% RES-T^4 target.” Currently all transport fuel in Ireland contains approximately 3.1% of biofuel by volume, (Scheer et al., 2016:13). Passenger cars in Ireland travel an average of 500km every year using biofuel that has been created by blending regular petrol and diesel with biofuel, and by the end of 2014, 5.2% of Ireland’s 10% renewable energy target had been achieved, (Scheer et al., 2016:4).

2.1.4.2 Fuelling the Motor Industry: Hydrogen

The hydrogen fuel cell car, powered primarily by hydrogen, was thought to answer some of our environmental concerns, (Zapata & Nieuwenhuis, 2010:18). One key problem, however, is that energy is required in order to extract the hydrogen and for this reason it may not be the environmentally optimal fuel, (Zapata & Nieuwenhuis, 2010:18). Steenbergham & Lopez (2008:581) clarify that short to medium term development of hydrogen-based transport would rely on natural gas reformation, which would be the cheapest and quickest method, but does not solve the problem of over reliance on fossil fuels. “Hydrogen is readily prepared by splitting water electrically into its component parts hydrogen and oxygen; a process called electrolysis. However, this process requires a significant energy input and has proven most effective with ruthenium oxide, which is a scarce and expensive material”, (Kennedy, 2016).

Steenbergham & Lopez (2008:581) observe that although the hydrogen fuel cell technique has been known for 150 years, its application to transport is still in the developing stage. “There is also a chicken-and-egg situation in that few fuel cell vehicles would be sold

without a fuelling infrastructure, while no commercial organization would build an infrastructure without some guarantee of demand", (Zapata & Nieuwenhuis, 2010:19). Kennedy (2016) notes that researchers at the Crann nanoscience institute at Trinity College Dublin have recently developed a material to enhance the splitting of water at a low-energy cost.

Steenberghen & Lopez (2008:568) believe that the year 2020 is possibly too soon for hydrogen-fuelled cars to be used commonly, but if it is to happen after the year 2030, preparation needs to start today. Thomas (2012:6061) argues that the need to reduce Green House Gas (GHG) emissions and oil consumption is simply too urgent to choose just one method of reducing them, that the available options should not be limited and that multiple solutions should be developed using BEVs, PHEVs and Fuel Cell Electric Vehicles (FCEVs), rather than to focus on one single method.

2.1.4.3 Fuelling the Motor Industry: Electric Vehicles

"In the United States, battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) have replaced fuel cell electric vehicles (FCEVs) as the alternative vehicles promoted and funded by the Federal government to cut GHGs and oil consumption", (Thomas, 2012:6053).

The Toyota Prius (HEV) is equipped with both a petrol fuelled engine and an electric motor, and automatically switches between the petrol fuelled engine and the electric motor, depending on the power needed to move the vehicle, relying less on the petrol engine at low speeds, (Zapata & Nieuwenhuis, 2010:18)

"Battery electric vehicles (BEVs) are powered by electricity stored in large batteries within the vehicles. These batteries are used to power an electric motor, which drives the vehicle. This system allows BEVs to operate with zero emissions at their point of use," (SEAI, 2008:7).
BEVs are powered by either a large electric motor connected to a transmission, or smaller electric motors within the wheel hubs, and the energy used to power the motors comes from battery packs located within the vehicles, and these must be charged from an external source of electricity, (SEAI, 2007:8).

Thomas (2012:6058) suggests that BEVs charged using the U.S grid will actually generate from 33% to 35% more GHGs than FCEVs running on hydrogen made from natural gas, over the period from 2012 up to 2035. Although BEVs would reduce GHG emissions, and dependence on petroleum, their contribution alone may not do enough, (Thomas, 2012:6061).

### 2.1.5 The Future of the Motor Industry

According to O'Mahony & Wright (2012:11) “Transport in Ireland has become unsustainable, primarily as a result of years of poor planning, leading in turn to an over dependence on the private car as a single means of transport”. Similarly, Gorey (2016a) feels that with expectations that 66 percent of the world’s populations will live in cities by the end of the decade, a decision to move from private transportation to a Mobility as a Service (Maas⁵) option might not just be a better option, but a necessity.

According to SEAI (2011), one third of Ireland’s energy requirements and energy related CO₂ emissions come from transport, which is almost entirely dependent on oil. The Irish government is backing the promotion of EVs and has aims to achieve a target of 10% of all vehicles on the road being in the EV category by 2020, (O'Donohue, 2014). Scheer et al (2016:13) clarify that this target has been revised to a target of 50,000 EVs in the transport fleet by 2020, which means

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⁵ A scenario where all transportation needs are bundled, and handled by a service provider.
that EVs would account for 20% of all new cars sold in Ireland by 2020.

Rochford (2016) feels that the motor industry is changing in three key areas: a move to EVs; automation, and a change in how cars are purchased. Rochford (2016) predicts that some automation will develop to assist with car parking, and even to alert car users to a potential lack of driver concentration, by monitoring the driver's pupils with a small camera. Keogh (2016) suggests that vehicle hardware has almost taken a backseat in the motor industry in favour of software and data management, and predicts that in the future motorists may no longer even need a car, as they may commute in self-driving vehicles and only pay for the use of these vehicles.

Rochford (2016) also foresees the implementation of car 'shops' in the city where one or two cars will be physically displayed, but the shopper can browse ipads or tablets in the store to pick out the favoured model. In addition, a test drive could be booked online, with the car arriving at the home of the customer on the test drive date, (Rochford, 2016). Sheridan (2016) describes stores opened by Tesla in the U.K: "each store has a car, some technical displays and lots of interactive screens. Buyers can also go online to purchase their car: buying a Tesla is more like shopping for a piece of tech than an oily chunk of metal". McAleer (2016b) describes the recent debut of the Tesla model 3 electric car in April 2016 and explains that potential buyers were queueing outside the showrooms to put a deposit down for the new model, although it has not yet been seen, and may not be available until 2018.

2.2 Electric Vehicles Overview

Young (2015) states that EVs made up half of one percent of the 85 billion new vehicles sold globally in 2014, but German energy
researchers (in Young, 2015) say that this tiny portion makes up almost half of all battery-powered passenger engines on the road today. The market for the batteries going into EVs is expected to grow seven fold by 2020, due to increased demand, (Young, 2015).

2.2.1 Types of Electric Vehicles

Axsen & Kurani (2013:533) describe the three types of EVs available as Hybrid Electric Vehicles (HEVs), Plug-in hybrid electric vehicles (PHEVs) and Electric Vehicles (EVs). EVs are also referred to as BEV or 'battery powered' in Smith (2010:4514).

HEVs are never plugged in, and rely on gasoline, an electric motor and a battery, offering improved energy efficiency and recapturing kinetic energy, (Axsen & Kurani, 2013:533). According to O'Mahony & Wright (2012:5), “the Hybrid vehicle will greatly assist during the transition from the internal combustion engine to the electric vehicle”.

PHEVs can be powered by grid electricity and gasoline, and can operate in either all-electric mode, or in a blended mode, meaning that both battery and gasoline are used, (Axsen & Kurani, 2013:533). Trigg & Telleen (2013:18) suggest that the PHEV is more popular than the BEV, being more flexible and having the capacity to keep fuel for greater range, but finds that it is conceivable that BEVs could similarly gain momentum.

The EV is powered solely by electricity, (Axsen & Kurani, 2013:533). The charge-depleting range is the distance a fully charged vehicle can be driven before depleting its electric battery, (Axsen & Kurani, 2013:533).

2.2.2 Environmental Impact of Electric Vehicles

BEVs produce no emissions at their point of use, but as there are emissions associated with generating the electricity used to power
them, the overall emissions performance will depend on the source of energy used to charge the battery, for example, using fossil fuels such as coal leads to higher carbon dioxide and air quality emissions compared to electricity sourced from wind or hydroelectric power (SEAI, 2007:11).

Appendix D displays the average fuel mix across the power system in Ireland, and highlights usage of renewable energy in Ireland, relative to other sources, over a period of 24 hours and over one month. Over the period of 24 hours on August 7th 2016, renewable energy accounted for 53.2% of the fuel mix, though it is worth noting that it was a windy day. Over a period of a month, renewables accounted for 17.08% of the fuel mix, gas represented 57.17%, coal represented 22.61% and other fuels represented 8.92%, (Eirgrid, 2016). See also Appendix D.

Thomas (2012:6054) argues that the reduction of GHGs using a BEV is dependent on two factors: the GHGs generated by the electrical power plants used to charge the batteries, and the number of BEVs that could be sold to the American public, as using a BEV may not be feasible for certain drivers such as those driving a Sports Utility Vehicle (SUV).

2.2.3 Electric Vehicles in a Global Context

According to Trigg & Telleen, (2013:8) early EV sales have been strong, counting over 180,000 passenger car EVs sold in 2012 worldwide, but they only represent 0.02% of the total passenger car stock, so greater rates of EV adoption will be required up to 2020. “Overall, sales numbers to date are considered lower-than-expected by some car manufacturers and market watchers, but in a weak car market during a recession, the doubling of sales between 2011 and 2012 can at least be considered progress for vehicle electrification”, (Trigg & Telleen,
“At the end of 2012, the highest sales shares of EVs were in Norway, Japan, Ireland, the Netherlands, and the United States”, (Trigg & Telleen, 2013:11).

### 2.2.4 Global Initiatives for Electric Vehicles

Young (2015) states that there is a clear link between the recent rise in EV purchasing and government incentives, tax breaks and a desire for energy efficiency that will help to combat smog and reduce respiratory ailments. Trigg and Telleen (2013:25), however, found that most EVs could remain more expensive in the short term than petrol vehicles, even when combined with the government purchase subsidies offered in many countries.

SEAI (2008:27) notes some important factors to consider as lessons when implementing government initiatives, for example, although each measure can be introduced as a standalone measure, it can be beneficial to bundle any available incentives together. It is also important to remember that the success of a clean vehicle programme is reached gradually, and cannot be forced, so it must be scheduled over a long period of time to allow the market to react, (SEAI, 2008:27).

Young (2015) explains that Germany has been relatively conservative in relation to incentives, and had only 0.07 per cent market penetration of EVs in 2014, lagging behind other European countries. Trigg & Telleen, (2013:25) add that many of the governments offering fiscal relief have set limits on this relief and some of the schemes are set to expire soon; therefore a cost reduction for EVs must be achieved soon, to maintain interest in purchasing EVs after the incentives have been removed. McAleer (2016b) suggests that a recent rush to buy the Tesla Model 3 in the United States may be driven by the fact that a credit that was set up to encourage development of electric cars is near its expiration date.
According to the Irish Examiner (2014) benefits for companies in Ireland include accelerated capital allowance scheme permitting write-off of capital investment within one year, the government incentive of up to €5,000 grant per vehicle, and zero VRT relief up to €5,000, along with much lower running and maintenance costs for the vehicle. Cunningham (2016b) mentions that many EV stakeholders would like to see BIK\(^6\) being removed for company fleet EVs in Ireland, as this has been done successfully in other countries.

### 2.2.5 Global Challenges for Electric Vehicles

SEAI (2007:7) explain that although BEVs produce zero emissions at point of use, when considering wider scale environmental benefits, it is important to consider the source of electricity used, for example, if renewable energy is used then EVs offer a much reduced environmental impact over other technologies. Other key challenges to the development of clean vehicles on the market are a lack of marketable technology; high cost; lack of supporting infrastructure and conservative attitudes leading to lack of social acceptance, (SEAI, 2008:22).

Young (2015) mentions that EVs continue to struggle to become relevant due to the other attractive options on the market for consumers, such as SUVs, and the drop in gas\(^7\) prices, which can quickly steer consumers back to using ICE cars. Brady (2016) highlights an issue around awareness of EVs, and feels there is a lot of public relations (PR) work to be done to convince motorists that EVs are not just for ‘early adopters’. In a U.K context, Brady (2016) states: “While sales are on the up, public perception of electric cars is seemingly stuck in 2013. More than half (55%) of drivers surveyed by the government revealed they hadn’t even considered a plug-in vehicle (...) just 5% said they’d think about an electric car in the future.”

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\(^6\) Benefit in Kind  
\(^7\) Terminology used in the U.S.A to describe petrol or diesel.
contrast, Walsh, an Irish man of age 100 has recently converted to a Nissan Leaf EV, having first sampled driving in a Ford Model T more than 80 years ago, (O'Brien, 2016b). Walsh, in O'Brien (2016b) explains his motivation to purchase an EV: “I am convinced that we have to do something about global warming and pollution. I am a late convert to environmental protection and a bit of a late starter driving an electric car but this is my way of playing my part”.

The recent death of a Tesla Model S motorist has raised questions about autonomous and semi-autonomous vehicles as the auto pilot feature of this particular model, for example, allows a driver to turn over controls to the car on motorways, (Gorey, 2016b). Gorey (2016b) also notes that under Tesla’s agreement with customers, drivers using autopilot mode must keep their hands on the wheel at all times while activated, (Gorey, 2016b).

According to Briscoe (2016), the Nissan Connect EV application\(^8\) suffered a security vulnerability, whereby any user with the identification number of the electric vehicle could login and gain control of the vehicle, so the app had to be taken offline. “While the stakes were not especially high in this particular case (nothing worse than a flat battery could be caused) it does point to concerns that increasing connectivity in our cars can lead to cyber-vulnerability”, (Briscoe, 2016).

According to Brady (2016) the biggest turn-off cited by some members of the U.K public were concerns around recharging. EV users in the U.K have recently been dealt a huge blow, in that Ecotricity, the firm responsible for 300 rapid chargers across the U.K, has announced that from July 11\(^{th}\) 2016 it will begin to charge £6 for a 30 minute charge on the public network, (Brady, 2016). Brady (2016) feels that the fees for public charging would not signify the end of EVs in the

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\(^8\) A mobile application available for Nissan EV drivers, to control certain settings and actions in their vehicle.
U.K, but they will cause some challenges, as they have perhaps been introduced too early.

Other challenges identified by Trigg & Telleen (2013:32) include the difficulty of installing appropriate charging infrastructure in multi dwelling units, and also the lack of signage present to indicate charging points.

2.2.6 Charging and Usage Behaviour: a global context

According to Trigg & Telleen (2013:14) definitions of charging speed can vary country to country, and even region to region, when it comes to EVs, but by 2020 Electric Vehicles Initiative (EVI)\(^9\) countries have a target to have approximately 2.4 million slow chargers and 6,000 fast chargers. Trigg & Telleen (2013:15) explain that the ratio required for EVs to charging points is currently unknown, but it is suspected that less fast charging points will be required than previously thought. In contrast, Blythe et al., (2015:3) find that when charging in public, the preference is for fast chargers, but 71.1% of energy charging is done at home.

Blythe et al., (2015:26) found that 95% of the EV users contributing to the survey preferred to use the public chargers at motorway service stations, and petrol stations were the next preferred location for public charging. Furthermore, it was found that the main motivation to use a rapid charger was to extend the range on a long journey, as stated by 76% of study participants, (Blythe et al., 2015:26).

According to Blythe et al., (2015:29), based on the findings of a survey of EV users in the U.K and Ireland, the majority of EV charging takes place during the day, particularly between 12.00 and 18.00, with the average charging time lasting just over 26 minutes.

\(^9\) Electric Vehicles Initiative, a multi governmental policy forum, across 15 members, designed to accelerate the adoption of EVs worldwide.
2.3 Consumer Purchasing of Electric Vehicles

According to Accenture (2014:10), in a study conducted over 7,000 people in 13 countries, it was found that 60% of those who intend to purchase a car in the next decade would probably or certainly consider purchasing an EV model, (Accenture, 2014:10), contrary to Brady’s findings on page 31, in a U.K setting.

2.3.1 Market Leaders for Consumer Purchase

McCarthy (2015) finds that Norway is currently leading the world’s market for EVs in terms of market share, where in the first quarter of 2015, 8,112 EVs and PHEVs were sold. Similarly, Blythe et al., (2015:58) explain that Norway’s EV market stood at around 5% of car sales at the end of 2013, and was at 20% by June 2015. Young (2015) clarifies that the United States is in fact leading by volume, but the market share came in under 1% in 2014, whereas the market share in Norway was 1.6% in 2014, with a lower volume of EV sales than the United States.

McCarthy (2015) points out that Norway is leading the EV market due to the introduction of a number of incentives such as tax cuts, and toll and parking fee exemptions in some cases. Reuters believe, however, that this has actually created a tax shortfall of 2 billion crowns, (in McCarthy, 2015). Blythe et al., (2015:58) note that the Netherlands is in second place in terms of the number of EV users in Europe, although market share has dropped from 5% around December 2013 to 3% in June 2015, possibly due to the withdrawal of registration tax incentives in January 2014.

“In 2010 there were 16 EV models on sale and around 20 in 2012. However, only 2-3 EV models on the market in 2010 were widely available to consumers, which increased in 2012 to about 6-8 EV
models widely available to the general public in several countries," (Trigg & Telleen, 2013:9). Of the 117,000 Electric Vehicles sold in the United States in 2014, the leading models were The Nissan Leaf, Tesla Model S and BMW i3 respectively, (Young, 2015).

2.3.2 EV Marketing Strategies to Consumers

Axsen & Kurani (2013:534) observe that where some previous studies have tended to highlight the functional limitations of EVs, the EV market is relatively new and therefore potential consumers do not have existing knowledge on their preferences, unlike when purchasing a conventional gasoline based car. This is a learning curve for customers who purchase an EV, and they must construct their interests and preferences while they learn from EV technology, (Axsen & Kurani, 2013:534). The research approach used by Axsen & Kurani (2013) gives respondents the opportunity to design a car with preferred features for potential future purchase, through a set of multi-step and multi-method questions. It was found that the HEV, PHEV and EV designs were broadly supported in this survey sample, in particular the PHEV, (Axsen & Kurani, 2013:541).

Accenture (2014:6) suggest that EV consumers may prefer to lease, rent or share green vehicles rather than to purchase them, and that this may be a differentiation point for EVs. Another point of differentiation observed by Accenture (2014:10) is the enhanced possibility of purchasing a car online, or having a field salesperson perform the sale in the comfort of a consumer’s own home.

2.4 Consumer Experience with Electric Vehicles

Accenture (2014:10) suggests that there are many advantages to EV ownership such as fuel cost savings, lower emissions, low maintenance cost, fewer maintenance cycles, sales and tax incentives,
and avoidance of volatile fuel prices. Rochford (2014) states that customers can be put off by high purchase costs, complicated battery leases, and limited range, but feels that now is the time for EV use to take off in Ireland. The known advantages and disadvantages of EVs will be discussed in detail in section 2.4.1 and 2.4.2.

### 2.4.1 Advantages of Electric Vehicles

SEAI (2007:7) states that BEVs benefit from the high levels of torque found in electric motors, along with gearless operation and deceleration and that they have no emissions at point of use and operate in almost complete silence, except from the tyre noise.

According to Trigg & Telleen, (2013:7) EVs reduce dependency on petroleum, and can tap into a source of electricity that is often domestic and quite inexpensive. Leitman and Brant found that even if all EVs used electricity generated at power plants to charge their batteries, the emissions required to produce this electricity would still be less than the emissions created by their equivalent in ICE vehicles, (in O'Mahony & Wright, 2012:6). Blythe et al., (2015:4) clarify that although BEVs have a higher environmental impact at the production stage, an ICE vehicle has around a 25% higher environmental impact over its lifetime.

A grant support scheme was introduced in Ireland in April 2011, offering grants of up to €5,000 to encourage motorists to switch to using electric transport, (McCarthy, 2014). In addition to the €5,000 grant, there is also the incentive of having no Vehicle Registration Tax (VRT), and free public charging, for the time being, (Gorey, 2015). In DCENR (2015a) motor tax for an EV in Ireland is reported to cost €120 per year, from January 2016, whereas motor tax would cost €385 annually for a petrol or diesel car with a 1.4 litre engine, or €710 for a two litre engine for example. Weldon et al., (2016:209) explains that the first 2,000 EV owners in Ireland will also be able to avail of an
ESB facility, available for the moment at least, for free installation of a home charging point.

According to McCarthy (2014) “average annual savings for a motorist using an EV who drives an annual distance of 16,000 km is estimated at €797 compared to a diesel model and €1,264 to a petrol vehicle”. The ESB (2011:14) also compare the price per kilometre driven on a petrol, diesel and electric car respectively as 10.78 cent per km, 5.65 cent per km and 1.20 cent per km.

SEAI (2010) found an unexpected benefit of EVs, when performing a commercial EV trial with the company ‘Celtic Linen’, was the low noise level from the vehicle when delivering to hospitals in the early hours of the morning, and also the vehicle’s performance in the snow and ice of December 2010. EVs are also credited with unlocking innovation and creating new advanced industries, in turn spurring job growth and economic prosperity, (Trigg & Telleen: 2013:7).

Seba (2016: 3:09) explains that a regular gasoline car has at least 2,000 moving parts, whereas an EV such as the Tesla Model S has 18, fewer than 1% of the parts involved in an ICE vehicle.

Driscoll et al., (2013:692) observe that EV sales may be boosted by appealing to environmental motives and by raising ecological awareness of potential buyers. Axsen & Kurani (2013:541) found that HEVs, PHEVs and EVs were associated with intelligence, responsibility and support for the nation and the environment. Driscoll et al (2013:693) predict that EVs will benefit from government information and advertising campaigns related to environmental benefits and energy efficiency.
2.4.2 Disadvantages and Challenges of Electric Vehicles

Axsen & Kurani (2013:541) state that among those surveyed who have not chosen a plug-in EV design for their next car, the four most commonly stated barriers were a lack of electric range; a lack of chargers at places other than the home; the unproven nature of the technology and the high purchase price of the vehicle.

O'Brien (2014) concurs, "there are few people that would claim that electric vehicles are designed to do long distances." Driscoll et al., (2013:690) suggest that most EVs currently for sale actually have ranges lower than those available for petrol vehicles. Thomas (2012:6054) finds that BEVs may not be sufficient for certain car users, as the lithium-ion batteries that are used in the vehicles today are too heavy and seem to occupy too much volume to be used in large vehicles that drive long distances.

According to McCarthy (2014), "many motorists are still believed to favour having the choice to switch between electric power and either petrol or diesel amid concerns about the limited daily range of pure EVs without recharging". O'Brien (2014) refers to the fear of running out of electricity before the next charging point as 'range anxiety'. This term is further defined by Accenture (2014:10) as "a key concern about batteries in electric cars losing power before reaching a destination or charging point".

Smith (2010:4515) notes that the amount of time required to charge the battery itself is a key, but rarely discussed limitation of the electric vehicle, where "even the use of a 50 kW, dedicated EV charging point would require almost an hour of charging time in each direction assuming that a charging point is available on demand", (Smith, 2010:4515). O' Brien (2014) notes that although charging at home is
advantageous, it is not practical for everyone, especially those living in an apartment building or having a communal parking area, where it is not possible to run a cable across a public path as it is a trip hazard.

In some Rapid Charge Network (RCN) research, Blythe et al., (2015:3) found that over 32% of charging transactions monitored were over 30 minutes, and many respondents expressed the need to enforce time restrictions per charging event. Less than 5% of respondents expressed willingness to wait longer than 30 minutes if the rapid charger was in use by another vehicle, (Blythe et al., 2015:29). Blythe et al., (2015:3) also note that over 15% of transactions failed, emphasizing the need for a reliable charging network.

O'Mahony & Wright (2012:7) found that there is a safety issue around EVs due to the lack of drive train noise. Esb.ie, (2016a) explains that an environmental benefit of the EV is that it is quiet, but this can present a risk in high pedestrian density areas, as people do not hear the sound from the car. “Some manufacturers are now fitting artificial sounds for speeds up to 30km/hr to make people more aware of the car’s presence”, (esb.ie, 2106a). Similarly, SEAI (2016b) add, “In the case where the EU does decide to apply future legislation to EVs concerning low speed noise, some manufacturers are equipping their vehicles to be retrofitted or adjusted accordingly to produce appropriate audible warnings at low speed which is unlikely to add significantly to the future cost of Evs”.

“There is a lack of consistent information in the public domain about the electric vehicle”, (O'Mahony & Wright, 2012:4). Gorey (2015) concurs that when testing EVs in Ireland he has encountered curiosity from Irish people regarding the cars, their range and their efficiency, which he feels indicates that at present there is little knowledge on the subject, outside of a small community in Ireland. O’Mahony & Wright (2012:4) previously found a need for the government
to work with the automobile manufacturers to create a clear
communication strategy with the aim of educating the consumer.

Gorey (2015) also notes that although the charging points provided by
the ESB are sufficient for now, there is a tendency for non EV users to
park at the charging points and this trend is not monitored and acted
upon sufficiently yet. This trend was previously described by O'Brien
(2014), where it has gained a nickname among EV users as being
'ICED', i.e Internal Combustion Engined.

O'Brien (2014) weighs up both the pros and cons of EV driving, and
would consider doing so sometime in the future, but finds that at
present the single biggest concern is that driving an EV would appear
to take away from the spontaneity of driving, as drivers must plan in
advance to arrange charging points.

2.5 Electric Vehicles in Ireland

According to Weldon et al., (2016:208), "Ireland is uniquely placed to
become a model for EV integration". The ESB (2011:3) consider factors
such as the mild Irish climate being suitable to battery performance,
and a high level of home ownership as key components to Ireland’s
suitability as an EV country. Weldon et al., (2016:208-209) attribute
Ireland’s suitability as a model of EV integration to the size of the
country, with its closely spaced urban centres, and its potential to
generate electricity from renewable resources, such as wind energy.

Rochford (2016) clarifies that a switch to vehicle electrification is
happening incrementally, but things are now picking up, with EV
sales in Ireland doubling in 2015 from their 2014 figure. Cunningham
(2016a) states that PHEVs have grown in popularity up to July 2016,
where 208 PHEVs were registered in Ireland, compared to only 78 in
the previous year.
In contrast, McAleer (2016a) states that diesel remains the preferred option for new car buyers in 2016, as they made 70.5 per cent of sales so far, followed by 27.5 per cent for petrol. Electric car sales appear to be down 8.6 per cent on 2015 with just 286 registrations over the first six months of 2016, (McAleer, 2016a). Similarly, Cunningham (2016a) comments that electric car registrations are currently running at 341 registrations up to the end of July 2016, and this is 14% down on figures from 2015. There has been a growth in sales of petrol-electric hybrid as they are up from 828 in 2015 to 1,613 in 2016 so far, (McAleer, 2016a). Cunningham (2016a) observes something similar, and finds that sales of petrol-hybrid electrics have increased by 90% from last year, up to 2,238 registrations up to July 2016.

2.5.1 The Price of EVs in Ireland

Toyota (2016) provides the price of a new Toyota Prius HEV, as starting from €31,450. Renault (2016) states that the new Renault Zoe BEV is available at a starting price of €17,490. According to Nissan (2016), the current selling price of the Nissan Leaf XE is from €21,490, the Nissan Leaf SV is from €23,990, and the Nissan Leaf SVE is from €26,390 and each of these models are BEVs. BMW (2016) report the starting price of the BMWi3 BEV to be €43,590.

Donedeal.ie (2016) also provides prices sought for secondhand EVs. By performing a search for “Nissan Leaf” for example, the price sought for the 2011 model was €9,000 – €11,000, while the price sought for the 2014 model was roughly €14,000.

The cost of EVs can depend on the cost of the battery, but some manufacturers are offering an option to lease the battery, to ease on cost, (SEAI, 2007:17).
2.5.2 Status of Irish EV Targets

McGee (2015) explains that Alex White, the then Minister for Communications, Energy and Natural Resources, had accepted that the target of 50,000 EVs on the road by 2020 may be unattainable, and that few countries had reached their targets, possibly due to the recession.

Contrary to an earlier statement by Trigg & Telleen (2013), that Ireland was in the top five countries with the highest EV market share (Chapter 2.2.3: 30), Gorey (2015) clarifies that the incentives offered by the government, for EVs, may be driven by the poor level of EV ownership in Ireland, which as a nation is one of the lowest buyers of EVs in Europe. In contrast, Rochford (2016) found that in 2015, EV sales more than doubled from their number from 2014, rising to 466 overall. In 2013, only a little over 50 EVs were sold across Ireland, however 256 sales were recorded in 2014, a 200% rise, (Gorey, 2015).

Between 2008 and the end of 2015, a total of 1,312 EVs have been registered in Ireland for the first time, (CSO, 2016). Whereas Beepbeep.ie (2016) shows slightly different figures, and shows the number of EVs registered for the first time in Ireland between 2008 and 2016 (Q1) as 1,218 and the total of PHEVs from 2014 to 2016 (Q1) to be 277, bringing the total of registered EV and PHEV in Ireland for this period to 1,495.

Driscoll et al., (2013:693) believe, however, that even with subsidies in place, the market share of EV sales is still very low in comparison to the government targets for 2020, and it would take very high new car penetration rates for the stock of electric vehicles to reach 10% by 2020. Beepbeep.ie (2016) demonstrates that the number of EVs registered for the first time in Ireland in 2015 was 466, which consists of 0.37% of the overall registrations, and petrol PHEV registrations
were 116, 0.09% of overall registrations. Rochford (2016) explains that although the 466 EVs sold in 2015 may appear low in comparison to the 124,000 new car sales overall, it is worth noting that more EVs were sold in 2015 than certain other brands, for example the Volkswagen Passat Estate.

2.5.3 Electric Vehicle Charging in Ireland

As stated by esb.ie (2016b), there are currently 1,200 public charge points available across the island of Ireland, comprising of standard charge points and fast charge points, where of the total of 1,200, 300 are in Northern Ireland. The charge points are accessed by a single charge point access card and charging time for a full charge can range from one to eight hours using the standard points, (esb.ie, 2016b). On the other hand, with the fast charge points, an EV can be charged up to 80% in as little as 25 minutes, (esb.ie, 2016b). There are 70 fast chargers in the Republic of Ireland, and 15 in Northern Ireland; these are usually located at service stations, to facilitate long journeys between towns and cities, (esb.ie, 2016b).

Contrary to Blythe et al., (Chapter 2.2.6:33), Esb.ie (2016a) explains that trials to date have indicated that most charging takes place at night in a convenient place, such as a home charge point, which are being installed free of charge by the ESB for EV purchasers for the moment at least. Esb.ie (2016a) estimates that charging at home at night can cost as little as €2 if charging on the night rate.

Briscoe, (2015) notes that to date, charging of EVs at the public charge points in Ireland has been free of charge; that the only requirement has been to register for an ESB charging card. The ESB announced in November 2015 that they would start charging a €16.99 per month flat fee for all new customers from January 2016, allowing unlimited access to the standard charging points, and an additional
30 cents per minute for the fast chargers, (Briscoe, 2015). Davis, (in Briscoe, 2015) states that the current EV owners would not be affected by the new pricing until April 2016. Cunningham (2016b) notes that all plans to introduce charging are currently on hold, for the moment at least.

2.5.4 Electric Vehicle Usage in Ireland

Rochford (2016) states that 405 of the 466 electric cars sold in Ireland in 2015 were the Nissan Leaf brand, and the Nissan Leaf will this year introduce a new battery option, offering a driving range of up to 150km per charge.

Weldon et al., (2016:223) observe reluctance across all EV users monitored to drive their vehicle beyond a considerable buffer before charging. The users were found to travel on average 30km between charges, compared to the available range of 130km. Weldon et al., (2016:212) also note that there was a peak in charge usage between 7.30am and 9am for the EV users they have polled over a three year period, (contrary to esb.ie, Chapter 2.5.3:43) and observe that the charging pattern is somewhat frequent and irregular, which may become a problem if the need develops to properly manage the charging of EVs on the electrical grid.

2.5.5 Electric Vehicle Behaviour in Ireland

Smith (2010:4516) deems the electric vehicle to be extremely beneficial in an urban context in Ireland, but finds that the benefits decrease rapidly on extra-urban journeys. Smith (2010:4517) also finds that the reduction in CO$_2$ emissions in an urban context is significant, but feels that the majority of Irish journeys are extra-urban.
Accenture (2014:2) suggest that to succeed in the EV market it will be important to integrate and collaborate with a group of diverse players, including utilities, charging infrastructure suppliers and mobility providers.

2.6 Key Players in the Irish Electric Vehicle Market

The ESB (2011:5) consider the following entities as key players in establishing the EV market: the government, consumers, green business and a smarter travel workplace, the IDA and Enterprise Ireland, SEAI, the motor industry, universities and the ESB.

2.6.1 The Role of the European Union

The ESB (2011:4) explain that Ireland has an obligation to reduce GHG pollution levels by around nine million tonnes before 2020. McCarthy (2014) explains that the EU’s 2009 Renewable Energy Directive has set a binding target to all member states to ensure that by 2020, at least 10% of the energy used in the transport sector must be from renewable energy sources. According to Scheer et al., (2016:18) any under compliance by Ireland with the agreement for 2020 will result in fines at EU level, and possibly lead to a more arduous trajectory in post 2020 targets.

According to O’Halloran (2016) Ireland’s commitment for 2020 was 20%, and 20.4% by 2030, which is half of what other European countries were committed to.

2.6.2 The Role of the Government

As outlined by the Department of Communications, Energy and Natural Resources (DCENR) (2015b), there is a plan to support the
uptake of electric vehicles through the supply of grants, and/or tax relief (DCENR, 2015b:66), and the introduction of a scrappage type scheme to encourage the replacement of older taxis by EVs. The government is also involved in funding a number of community-based projects, through the Better Energy Programme, (DCENR: 2015b:43).

Minister Simon Coveney was involved in announcing the Drive4Zero project in Cork, along with Drive4Zero ambassador Donal Óg Cusack, representatives from the ESB, the SEAI, Allied Irish Bank (AIB), Renault, Nissan, BMWi, Mitsubishi and Qpark\(^\text{10}\), (English, 2014). The Drive4Zero project involves incentives such as free parking for EVs, doubling the number of charge points available, grant-aid to fund the installation of home charging points, and attractive car finance deals, (English, 2014).

According to O’Mahony & Wright (2010:134) only six out of twelve candidates interviewed felt that governments would reach their objectives for 10 per cent of all cars in Ireland to be electric by 2020.

2.6.3 The Role of SEAI

SEAI has been involved in providing 45% support to a number of private and public sector bodies to test EVs in a commercial environment, in 2010, (SEAI, 2010).

2.6.4 The Role of the ESB

O’Mahony & Wright (2012:4) explain that most interviewees had confidence in the capability of the ESB to commit to and build the infrastructure for the EV, meeting and possibly exceeding any commitments.

\(^{10}\) A car park chain
Gorey (2015) states that the ESB are heavily committed to the development of EVs, as evidenced by the fact that it has arranged and maintained the charging points across Ireland. Weldon et al., (2016:209) describe the efforts of the ESB to develop a nationwide infrastructure, aiming to fully support the EVs on Irish roads. Developing this network will be achieved by installing publicly accessible charging points, fast charge points, and ensuring that every town with over 1,500 inhabitants will have at least one charging point, (Weldon et al., 2016:209).

Cunningham (2016b) notes that the ESB were to introduce charges of €16.99 per month for new EV owners to have unlimited access to low speed charges, from or in January 2016, but this is currently on hold, so charging for all EV users remains, for the moment at least, free of charge. Briscoe (2015) advises that many EV users are not happy with the ESB's plan to introduce charges, with one user organizing a petition in protest. O'Reilly (in Briscoe, 2015) clarifies that the problem may be related to the proposed flat rate for any use, and the high premium on fast charging, further to poor communication of the message, and suggests that EV users might be happier with the charges if they were closer to the rates for home charging, with a small premium for fast charging.

Herraghty (in Gorey, 2015) notes that if Ireland were to have more EVs in use there would be a need for promotion not just by the ESB, but also by other companies and the people themselves.

2.6.5 The Role of Communities

DCENR (2015:43) describes a community project undertaken on the Aran Islands where 30 residents took part in a trial of 8 EVs over a period of 3 years. DCENR (2015:43) explain that the results of the trial showed a 78% reduction in transport energy cost, along with a 68%
reduction in energy imports, when compared to a new diesel car. During the trial, around 20% of the energy used to run the vehicles came from wind energy, (DCENR, 2015:43).

"Under the Drive4Zero project, several large employers, including EMC\textsuperscript{11} and Apple, as well as healthcare and pharma giants based in Ringaskiddy, have agreed to install EV charge points at their plants to encourage their employees to make the switch to plug-in cars", (English, 2014).

Irish EV Owners Association (IEVOA) was established for EV owners and drivers in Ireland, and represents its members in its involvement with government bodies and companies such as ESB Ecars, EcarsNI, Drive4Zero, County Councils, Nissan Corp and Limerick Smarter Travel, (irishevowners.ie, 2016). IEVOA is intended to represent the interests of EV owners and drivers in Ireland, to encourage widespread uptake of EVs in Ireland, to work with the various companies, government bodies, vehicle manufacturers, and to promote and hold events for EV Owners/Drivers, (irishevowners.ie, 2016).

DCENR (2015b: 40) notes that every citizen has a role to play in the energy transition, through the choices they make.

\section*{2.7 Summary}

Although the introduction of EVs to the marketplace, both in Ireland and globally was slow to take off, vehicle electrification now appears to be gaining some momentum, with improved interest, and a gradual increase in EV purchase since the economic recession. It has been suggested that this recent increase in EV ownership may have been influenced by incentives and promotions from government and other

\textsuperscript{11} A large company based in Cork, Ireland.
interested parties. To date, however, there is limited data regarding the Irish EV users views on this point, and in general.

‘Range anxiety’ remains a key barrier in the uptake of EVs, and previous research suggests that some users prefer to make a start with the PHEV to eliminate this barrier.

Most arguments indicate that the EV is better for the environment long term, although there is still a question about the effect of EVs on the environment in the manufacturing stage.

One of the main questions outstanding is in relation to charging for EVs in Ireland. Some concerns have been highlighted regarding home charging, such as the limited ability to install or use chargers in certain sites such as multi dwelling units and shared apartment complexes. Regarding public charging, the ESB have worked on their goal to establish a range of slow and fast charging points across Ireland, and seem to have been successful so far. It is currently unknown whether consumers will have to pay for public charging in the near future and, if so, what impact this may have on future EV sales. Charges were to be introduced earlier this year (2016), but this plan remains on hold.

Finally, overall knowledge of EVs, and of the needs of EV users across Ireland remains quite limited and such knowledge and experience as there is remains confined to a small community of users as well as manufacturers, dealers and some others with a particular interest. What knowledge there is does suggest the likelihood of benefit in relief of pollution and emissions from increased use of EVs with corresponding reduction in use of ICEs.

This chapter concludes an extensive literature review of the topics relevant to this research, and chapter three will present the
methodology used by the researcher to perform further empirical research.
Chapter 3: Methodology

3.0 Introduction

Methodology is "the theory of how research should be undertaken, including the theoretical and philosophical assumptions upon which research is based and the implications of these for the method or methods adopted," Saunders et al., (2009:595).

This chapter outlines the methodology used to carry out this study. The review of the literature in chapter two revealed that there is some literature available on the subject of Electric Vehicles (EVs), but the topic is relatively new in an Irish context, and more research is required in order to determine the situation for existing EV users in Ireland, and to predict an outcome for the future.

This chapter will present the detailed theoretical material concerning the selection of what, in the judgment of the researcher, is the correct research methodology to be used. The researcher will also present the process and journey involved in collecting and analysing the primary data for this study.

3.1 The Research Question

Before settling on the research question, the researcher must firstly choose a research topic, and from reading previous work in the area, the research problem will be identified, in turn leading to the development of the research question, (Collis & Hussey, 2009:10). The process just mentioned was completed by way of the literature review in Chapter Two.
The literature review contains a critical evaluation of the existing knowledge on a topic, which then guides the research and shows that the appropriate literature has been found and analysed, (Collis & Hussey, 2009:100). “Like a compass, a literature review gives the researcher a bearing on what has been done”, (Balnaves & Caputi, 2001:24).

3.1.1 The Research Question Identified

The research question for this thesis is “Electric Vehicles in Ireland: the past, the present and the future?”

3.1.2 Justification

There are three elements to the research question: the past, the present, and the future of EVs in Ireland. It is, this researcher considers, difficult to understand the present without some understanding of what has gone before, and perhaps more difficult to attempt to see what may lie ahead without first enquiring and undertaking some analysis as to the present position in relation to EVs and how that position has been achieved. For this reason the research question is posed so as to embrace the past, the present and the future.

In relation to the past, the researcher needed to review briefly the history of EVs in order to set the scene; this is done primarily in the introduction and the literature review. Regarding the present, the researcher sought to determine who exactly are the current EV users in Ireland, and what were their motivations to join the EV community, and what have been their experiences so far. This was achieved by way of the literature review of secondary sources, but mostly from the primary data obtained by the researcher, as documented in Chapter Four. Concerning the future, the researcher will attempt to determine whether there is a future for EVs in Ireland, and if so how to develop
and encourage this, and make appropriate recommendations for practice and for future research, based on all secondary and primary data reviewed.

The researcher has reviewed literature on the subject of EVs both globally to a limited extent, and extensively in an Irish context, and reached the conclusion that more up to date research was required on EVs in an Irish context, with particular concentration on EV owners and users in Ireland.

Having reached this conclusion, the researcher sought to obtain as much data as possible from a selection of EV users in Ireland. The researcher concluded that it would be worthwhile in the context of this research to explore the topic further by issuing a survey to Irish EV owners and users to obtain more up to date information on EV use and experience of EV users in Ireland, and also by giving the participants the opportunity to comment in parts of the survey on their experience and to make suggestions.

### 3.2 Data Collection

"Much research starts out from asking questions, considering and trying to solve problems, or constructing a hypothesis about how someone or something behaves or could behave, and then testing out, trying out, working on these problems (... ) using research methodologies and methods", (Wisker, 2005:55). Saunders et al., (2009: 258) note that the majority of research questions are answered using a combination of both secondary and primary data.

#### 3.2.1 Non Empirical Data

Non-empirical or secondary literature includes sources such as books and journals, and is the subsequent publication of primary literature,
and is usually aimed at a wide audience, (Saunders et al., 2009:69). Secondary data can include both qualitative and quantitative data, and is used primarily in both explanatory and descriptive research, (Saunders et al., 2009:258).

The research process can be likened to detective work, where a multiple-source data set can be built by the researcher using a variety of secondary data sources, and possibly linked to primary data collected by the researcher, (Saunders et al., 2009:261). Some advantages of secondary data are that such data can be less expensive to collect, it provides an unobtrusive way of collecting the data, can provide some comparative data, can often result in some unforeseen discoveries, and is usually permanent and easy to re-check, (Saunders et al., 2009:268-269). There are also some disadvantages; such as that the data may not have been collected with the right purpose in mind for the research question, thus rendering it invaluable for use, so that the researcher would need to find alternative data, or collect primary data and use a combination of both, (Saunders et al., 2009:269).

The secondary sources used by the researcher were books and journals from the CIT library, and online database. In addition, some literature was obtained from car manufacturers such as Nissan and BMW. Some other company or government publications were also consulted such as DCENR publications, SEAI publications, ESB information, and more. Some statistical information was also obtained from the CSO, in relation to transportation, and other relevant topics. Finally, some more recent secondary data was obtained from newspaper articles. According to Saunders et al., (2009:263) quality newspapers are often a good source, and can often report summary findings of recent government reports.
3.2.2 Empirical Data

The majority of research questions are answered using a combination of secondary and primary data, and where limited secondary data are available, researchers will have to rely mainly on the primary data collected, (Saunders et al., 2009:258). Empirical data (or primary data) is data obtained first hand by the researcher. Primary data is collected specifically for the research project being undertaken, (Saunders et al., 2009:598).

Primary research was conducted by the researcher after completing the literature review in Chapter two, as the main gaps in the knowledge of previous research had been identified through this review. In order to conduct the primary research, the researcher needed to identify suitable participants for the research, and the appropriate instrument to use to gather data. The process of selecting suitable participants for the research and choosing the appropriate instrument will be discussed in further detail in Section 3.5, from page 59.

3.3 Research Design

The first point in the research design is to determine the research paradigm, which is a framework that guides how research should be conducted, (Collis & Hussey, 2009:11). "A good research design reduces the risk of bias and of ‘jumping the gun’ on conclusions", (Balnaves & Caputi, 2001:65).

3.3.1 Research Paradigm

Positivism is a paradigm that originated from the natural sciences, and assumes that social reality is singular and objective, and is not affected by the act of investigating it, (Collis & Hussey, 2009:56). This type of research is usually deductive in nature, and provides
explanatory theories to understand social phenomena, (Collis & Hussey, 2009:56).

Interpretivism is a paradigm that appeared in response to criticisms of positivism, and maintains the assumption that social reality is in our minds, and is subjective and multiple, therefore social reality is affected by the act of investigating it, (Collis & Hussey, 2009:57). "Interpretivism advocates that it is necessary for the researcher to understand differences between humans in our role as social actors", (Saunders et al., 2009:116). This type of research is inductive in nature, with a view to providing interpretive understanding of social phenomena within a particular context, (Collis & Hussey, 2009:57).

This current research will be positivistic in nature. Positivistic studies usually lay emphasis on "quantifiable observations that lend themselves to statistical analysis", (Saunders et al., 2009:114). The data collected by the researcher will primarily be quantifiable.

3.3.2 Research Approach: Inductive versus Deductive

It is important to consider whether to follow a deductive approach, where a theory is developed and a hypothesis is designed and tested, or an inductive theory, where data is collected and a theory developed as a result of data analysis, (Saunders et al., 2000:87).

"With research into a topic that is new and exciting much debate, and on which there is little existing literature, it may be more appropriate to generate data and analyse and reflect on what theoretical themes the data are suggesting", (Saunders et al., 2000:91). A topic on which there is a wealth of information from which a hypothesis can be designed would work best with a deductive approach, (Saunders et al., 2000:91).
Deductive and inductive methods are compared in Saunders et al., 2009:127) as follows: deduction usually involves scientific principles, moving from theory to data, the need to explain causal relationships between variables, the collection of quantitative data, the application of controls to ensure validity of data, the operationalisation of concepts to ensure clarity of definition, a highly structured approach, researcher independence of what is being researched, and the necessity to select samples of sufficient size in order to generalise conclusions. Induction usually involves gaining an understanding of the meanings humans attach to events, a close understanding of the research context, the collection of qualitative data, a more flexible structure to permit changes of research emphasis, a realisation that the researcher is part of the research process, and less concerned with the need to generalise.

The researcher was able to determine that this current research is primarily deductive in nature, as it involved quantitative data, it required researcher independence of what was being studied, and required the researcher to attempt to determine a sample size. There are some elements of this study that could be considered to lean towards the inductive approach, such as the personal experiences of the researcher discussed in Chapter One, but the primary research used to complete Chapter Four was deductive in nature. The visits to the car dealerships discussed in Chapter One took place after the design and collection of the survey data, so to avoid personal bias in relation to the primary data collection process.

3.4 Qualitative Research Versus Quantitative Research

"Qualitative data are normally transient, understood within context and are associated with an interpretive methodology that usually
results in findings with a high degree of validity”, (Collis & Hussey, 2009:143). In contrast, quantitative data are normally precise, captured at various points in time, and usually associated with a high level of reliability, (Collis & Hussey, 2009:143). Validity and reliability will be discussed in further detail on page 72.

3.4.1 Qualitative Research

Qualitative research involves attempting to gain insight into the perceptions, attitudes and motives of respondents. Possible techniques are interviews, focus groups, and projective techniques. Qualitative data requires a degree of contextualization, i.e. the researcher must collect some background information on the research, (Collis & Hussey, 2009:143).

Interviews are one way of gathering qualitative data, and can take place with individuals or groups, face-to-face, on the telephone, via email or by videoconference, (Collis & Hussey, 2009:144). Interviews can take place in an unstructured format, where the questions have not been prepared in advance and are formed during the interview, which can be advantageous as it leads to open discovery, but is also flawed as it can be time consuming, and difficult to record the different themes and analyse the data, (Collis & Hussey, 2009:144).

Focus groups can also be used to collect qualitative data; these involve selected participants discussing their reactions and feelings about a product, service, situation or concept, guided by a group leader, (Collis & Hussey, 2009:155).

3.4.2 Quantitative Research

Virtually all research contains some element of data to be quantified, such as a frequency of occurrence of test scores and prices, (Saunders et al., 2000:326). Quantitative is primarily used as a synonym for a
data collection procedure that generates or uses numerical data, (Saunders et al., 2009:151).

In their raw form, quantitative data mean relatively little to most people, and need to be processed and analysed to convert them to information, (Saunders et al., 2009:414). Techniques such as charts, graphs and statistics allow analysis of quantitative data, and exploration, presentation, description and examination of relationships and trends within the data, (Saunders et al., 2009:414).

In the current study, for empirical research, the researcher will be using quantitative methods, as using these will allow the researcher to collect the most recent statistics regarding the present status, and the future of EV owners and users in Ireland. The use of quantitative methods appears to be the most appropriate in the context of this research as the researcher will need to collect information from as many EV users as possible, in a situation where the data from the perspective of EV users in Ireland has been quite limited until now.

3.4.3 Mixed Methods

"Mixed methods approach is the general term for when both quantitative and qualitative data collection techniques and analysis procedures are used in a research design," (Saunders et al., 2009:152). According to Balnaves & Caputi (2001:17) it is sometimes necessary to use more than one research method. This study, however, will use primarily a quantitative approach.

3.5 Research Strategy

This section outlines the strategy taken by the researcher to obtain and process the empirical data.
3.5.1 Data Collection Method: Survey

Primary data were collected using surveys as the research instrument. According to Saunders et al., (2009:144), surveys are usually associated with the deductive approach to research, as they are most frequently used to answer who, what, where, how much and how many type questions. This type of question was best suited to eliciting the data required by the researcher, in performing the survey. Surveys also tend to be associated with exploratory and descriptive research, (Saunders et al., 2009:144).

The questionnaire is one of the most frequently used data collection techniques, as each person will respond to exactly the same set of questions, thus providing an efficient way of collecting data from a large number of participants, (Saunders et al., 2000:279).

According to Balnaves & Caputi (2001:75), surveys are best used when direct observation is not possible of what is to be studied. It would not be possible for the researcher to observe EV use and preference amongst all or indeed more than a few Irish EV users. Therefore issuing a survey allows the researcher to collect responses from a significant number of EV users within the timeframe available and thus collect more accurate data.

"Using a survey strategy should give you more control over the research process and, when sampling is used, it is possible to generate findings that are representative of the whole population at a lower cost than collecting the data for the whole population," (Saunders et al., 2009:144). The use of surveys involved the collection of primary data from a representative sample of EV owners and users.
3.5.2 Population and Sample

If data is collected from every possible case or member of possible relevance, this is referred to as a 'census', however, for many research questions it can be impossible to seek data on such a broad basis due to time restrictions, money required and access to the relevant participants, so sampling techniques will allow researchers to limit the data needed by choosing only a sub-group, (Saunders et al., 2000:150).

A sample is a subset of a population: a precisely defined body of people under consideration for statistical purposes, (Collis & Hussey, 2009:62). Selecting a sample is not required if it is feasible to study the entire population, (Collis & Hussey, 2009:62). Populations must be accessible and quantifiable and related to the purpose of the research, (Balnaves & Caputi, 2001:91). For the purpose of this research, the population is all available EV owners or users in Ireland. Potential EV users will not be targeted specifically in this study.

The researcher must assume that the entire population of BEVs and PHEVs in Ireland, at the time of the study, is between 1,300 and 1,500 according to CSO, (2016) and beepbeep.ie, (2016). As it would not be possible to conduct a census of the users of these vehicles, a sample will be used for this research. Sampling techniques provide a number of methods that enable researchers to reduce the amount of data needed, by considering data only from a sub-group, rather than all possible cases, (Saunders et al., 2009:210).

The researcher considered that the most suitable way to reach significant numbers of EV users would be to approach potential participants through some online communities. As advised by the administrators at the Irish EV owners Association, the most active channel for Irish EV users is the Facebook ‘groups’ in which these are
involved. The researcher has found that there are two such groups, Irish EV Owners Association (consisting of 329 members on May 21st 2016) and Irish EV Owners (consisting of 769 members on the same date).

The total for the groups combined is 1,098 members (on May 21st 2016), which was a significant proportion of the total population of EV owners and users in Ireland at the time. When determining the sample size required it was important to consider a number of factors including the possibility of many members being associated with both groups, and the presence of non EV users in the groups. This was demonstrated by the fact that the researcher was able to join both groups easily for research purposes.

Using the sample size calculator provided by survey monkey\(^\text{12}\), and shown in Appendix E, the researcher was able to input the available population size, presumed to be approximately 1,098, based on the total members of the facebook groups discussed in the previous paragraph, along with a confidence level and margin of error. The confidence level shows the precision of the researcher’s estimates of the population as a percentage within a certain range or margin of error, (Saunders et al., 2009:218-219). Researchers usually work to a 95 per cent level of certainty, meaning that if the sample was selected 100 times, at least 95 of these samples would be sure to represent the characteristics of this population, (Saunders et al., 2009:218).

By entering the estimated population size of 1,098, a confidence level of 95%, which is the advised standard to use, and a margin of error of 5% the recommended sample size was 285, whereas by entering a population size of 1,098, a confidence level of 90% and a margin of error of 8% the recommended sample size was 96. In this particular

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case, the researcher had initially sought to understand and follow the rules of probability sampling, by using the sample size calculator, but finally, the researcher chose instead to gather the sample using self-selection sampling.

Self-selection sampling involves publicising the need for cases through appropriate media, and collecting data from those who respond, (Saunders et al., 2009:241). Publicity for samples can take place using articles in magazines, postings in Internet discussion groups, or sending letters and emails, (Saunders et al., 2009:241). For this study the researcher opted to advertise the need for cases on Internet groups used by EV users in Ireland, as this was considered by the researcher to be the most accessible channel to reach these potential participants.

The researcher considered that trying to approach participants using solely online means may introduce bias, so it was necessary to consider the feasibility of reaching a representative sample online. Where appropriate data were not available in an Irish context, the researcher has reviewed the statistics in a U.K setting as a benchmark. For example, Ipsos (2015:3) states that 85% of adults are accessing the Internet in the U.K. Similarly, in Ireland 85% of households had Internet access, (CSO, 2015b). 62% of U.K adults claim to access social network sites, and facebook is the most visited social network among them, (Ipsos, 2015:3). Similarly, 66% of Irish adults are using their Internet access for social networking, including 70% of females and 61% of males, (CSO, 2015b). Furthermore, 60% of Irish people had facebook accounts between March and May 2015, (Ipsos, in Rte.ie, 2015). These figures indicate that facebook is widely used among the general population of the United Kingdom and in Ireland.
It was also important to verify that using this channel would not introduce bias in favour of any age category or gender. By age profile, Ipsos (2015:14) shows that 49% of the U.K facebook population is male, and 51% is female. Furthermore, 16% of users are aged 15-24, 17% are aged 25-34, 16% are aged 35-44, 17% are aged 45-54 and 35% are 55 and over, (Ipsos, 2015:14). The researcher was unable to locate the official statistics showing facebook users by age profile for Ireland, so assuming that the figures will not be dramatically different for Ireland, it was considered by the researcher to be safe to assume that facebook is not particularly biased towards a particular age group.

Following this investigation, the researcher concluded that approaching EV users online would be a reliable way to reach a sufficient number of the Irish EV users. The researcher also attempted to make contact with EV users outside of these online groups, via word of mouth, and by visiting some of the local charge points in Cork, but it was only possible to reach a handful of additional participants by these methods. The participants that were contacted by the researcher outside of the online groups have completed the pilot survey, which was not included in the main findings of Chapter 4, but is available upon request.

3.5.3 Questionnaire Design

For the purpose of this study, questions were formulated to fill gaps in information available after the literature review and other research detailed above. Questions can be either open-ended or closed-ended, where the participant responds using a fixed choice, (Balnaves & Caputi, 2001:78). The survey contains both open-ended questions, to allow the participants to respond using their own words, and closed-ended questions, to allow for ease of analysis. The researcher included
a number of questions where the participants could make comments, in their own words, to clarify the responses.

There are different types of questions that can be asked in a survey. Nominal level questions are questions that take categorical form, (Balnaves & Caputi, 2001:77). An example is a question such as 'Are you male or female' where participants can answer male or female, (Balnaves & Caputi, 2001:77). The researcher used nominal level questions to gather information about the participant demographics.

Scales can also be used in a survey and one example is the 'likert scale' which is a form of summative scale, (Balnaves & Caputi, 2001:80). The researcher found that the likert scale was extremely useful to gather information about the experiences of participants with EVs, and it was used in multiple questions for this purpose.

The survey consists of 19 questions, of which 2 are optional to the participant. The survey was compiled using an online tool called survey monkey which is available at www.surveymonkey.com. Some pages from the final survey have been documented in Appendix F.

3.5.4 Testing the Survey

Thomas (1997:4) recommends the following order of developing and testing the survey questionnaire: Initial interviews or brainstorming sessions to discuss the information required; creating a first draft of the questionnaire; internal testing to ensure that the survey is understandable and answerable; a pilot survey to a small number of participants; producing a final survey based on the results of the testing and the pilot survey; and finally conducting the final survey.

The recommendations just mentioned of Thomas (1997) were followed before issuing the final version of the survey to the sample. The initial
testing phase will be discussed in detail in section 3.5.5, where the survey was issued to road users at random, regardless of the type of vehicle they used. The pilot survey phase will be described in detail in section 3.5.6, where the researcher has issued the survey to a small selection of EV users before sending out the final survey.

### 3.5.5 Testing Process Employed

Despite the availability of contacts through the user groups mentioned at 3.5.2 the researcher considered that the safest option was initially to test the survey on a sample from the general population containing EV users, HEV users and ICE users. The purpose of conducting an initial test in advance of the pilot survey was to identify any usability issues or areas of confusion with the survey questions. The researcher found that it would be better to test these basic issues using direct contacts, as given the indirect relationship with the potential participants in the online groups, the researcher simply could not be sure of the response rate from these participants and felt that it was best to save this important channel for the final survey. The researcher observed the results, and some of the persons surveyed also provided direct feedback. An example of one batch of the test survey results is shown in Appendix G: Test Survey Example.

The initial tests identified a number of changes required. Certain questions required a formatting change, wording change, or a logic change, and some additional options were required. For example, Question 2, “Please explain briefly in your own words what influenced you to buy/use the vehicle type your have chosen? (e.g brand reputation, efficiency, etc)”, was originally set as a ranking option with nine ranking options, numbered from one to nine. Participants were having difficulty with this question, as it was not clear that each ranking option could be used only once. The researcher attempted to add a line of explanation to the question, and also to cut down the
options available from nine to six, and tested this approach. The researcher eventually opted for a free text area where the participants could explain the answer in their own words, and this worked well.

Then, question 5 “In what area do you currently live?” was changed to “In which county do you currently live?” because the researcher found that the term ‘area’ was too vague, and would be difficult to quantify if each participant had a different interpretation of what was expected. During the testing process, the researcher also found that if the question just mentioned required an answer, allowing the respondent to submit an answer using the “other, please specify” option was not accepted by the survey monkey tool as a ‘required’ answer, due to some limitations in the software, so these participants would still have to select a county in order to proceed, even if for any reason, they did not identify with any of the counties on the list. Two approaches were tested to address this problem. First, the researcher tried adding an option to the drop-down menu of counties as “other – please specify in the comment box”, but this was thought to be very difficult to find on the long scrolling list of available options. The second option chosen was to make sure that the “county” question discussed above was not a required question, as the answer was helpful, but not essential to the research, and it was the simplest solution to cater for any responses in the “other” category. The majority of the participants (97.8%) completed this question, although it was not mandatory.

Finally, in question 11, “Please rate the following aspects of driving an EV/PHEV in Ireland with 1 meaning most satisfactory and 5 meaning least satisfactory”, the option “Overall awareness of Electric Vehicle requirements” was removed, as it was found on reflection to be unrelated to the question. It was then posed as a separate question in the final draft of the survey. Some wording changes were also required in parts. For example, in some cases it was found that the full description of terms such as EV, PHEV and HEV was required.
3.5.6 Pilot

Prior to issuing the questionnaire, the survey must be pilot tested to ensure that respondents will not have any difficulty in answering the questions and there will not be any issues in recording the data, (Saunders et al., 2000:305). The number of people required to pilot test the questionnaire will depend on the research question and the scale of the research, but it is strongly advised that a pilot test be completed; no matter how much the researcher is pressed for time, (Saunders et al., 2000:306).

The researcher opted to test thoroughly the survey with other road users, as discussed in section 3.5.5, before issuing the revised pilot survey to three EV users who were identified directly by the researcher. The pilot survey was successful, as all three participants responded in full, which allowed the researcher to review a number of key areas. An extract from the opening pages of the pilot survey is shown in Appendix H: Pilot Survey Example.

One pilot participant selected “N/A” when asked to rate the NCT (National Car Test) facilities for EVs. On noting this response, the researcher was prompted to review the process around the NCT, to make sure it was in fact required for EVs. Upon further research of this particular respondent’s answers it was found that the vehicle in question was registered in 2014, therefore it was possible that it had not yet undergone an NCT, and was possibly due for NCT later in the year. The researcher decided to keep the NCT option for the final questionnaire, as it was clear from some of the discussions on the Irish EV owners facebook groups that the NCT was in fact required for EVs, and the researcher felt that it might be important to understand the participants’ experiences with the NCT.
Another survey participant showed a positive attitude to EV driving in the majority of the questions, but in question 11, “Please rate the following aspects of driving an EV/PHEV in Ireland with 1 meaning most satisfactory and 5 meaning least satisfactory”, the responses were somewhat negative. The option 5, (or least satisfactory) was chosen for level of safety, level of comfort, cost of battery charging, ability to drive short distances, NCT facilities, ease of servicing, cost of purchase, long-term cost and environmental friendliness. On the other hand when asked if purchasing an EV would be considered in the future, the respondent answered “yes, definitely”. It is possible that the options 1-5 may have been misunderstood and reversed, so the researcher changed the question to “Please rate the following aspects of driving an EV/PHEV in Ireland”, with the options of excellent, good, fair, poor, and very poor from which to choose. This change was applied for the final survey, without any notable issues.

3.5.7 Final Adjustments

The final survey was issued on April 13th 2016. On the day of issue of the survey, 34 responses were received, and 33 were received the next day. The response rate started to slow down a little over the following days. The survey was closed after sending a reminder to potential participants allowing a further three days for response. The researcher considered that it would not be appropriate to send any further reminders to the potential participants, as survey participation must be voluntary.

The researcher was able to monitor the responses and comments as soon as they were completed, using the survey monkey account, and found that there was a need for a couple of small adjustments that would not affect the responses that had already been collected.
For example, one issue was that in question 6 "Which of the following categories best describes your current employment status", the option "self-employed" was missing. A few participants remarked on this point in the comments portion of this question. The option for "self-employed" was added after reviewing these comments, as it was considered that if the previous respondents were to be re-categorized into that category, it would be easy to identify those who were self-employed from the options selected previously and adjust the findings. Unfortunately, this issue was not picked up during the pilot, in response a participant who was known to be self-employed selected "employed, working full-time", but offered no comment.

3.6 Data Analysis

After closing the survey, the researcher began an initial data analysis. Using survey monkey, the survey tool used, it was possible to identify how many participants had fully completed the survey (87) and how many participants had partially completed the survey (4). As discussed on page 63, this survey sample was set using self-selection methods, meaning that the survey was issued to the groups by way of a web link on the Internet that the participants could choose to click on and complete the survey, or choose not to click on the link. It is not possible to know how many potential participants saw the link, versus how many completed the survey, so it is not feasible to estimate an overall response rate, only to note the actual number of responses.

It was also possible to review the individual responses of participants and reach a conclusion as to whether any should be removed from the count for any reason. The researcher concluded that the four unfinished responses could be included in the findings, as they each
contained some basic information that allowed the researcher to categorise Irish EV users in terms of gender, location, make, model and year of the EV.

An additional observation made was that five participants chose the "other, please specify" option when asked if driving an EV or a PHEV. Out of these, two were potential buyers, or in the process of purchasing an EV and one was driving an EV on a daily basis, but it is not the primary method of transport used. A further of these five participants had selected the "other" category due to owning both an EV and a PHEV and the fifth user stated that he or she was a BMW i3 REX user, this is a BMWi3, which is a pure EV, but "REX" refers to the fact that it has a range extender, to allow the car to hold a limited amount of petrol or diesel. This type of vehicle could be classified as a PHEV.

The researcher was required to analyse the data closely and cleanse the data to remove any responses that were unnecessary, or unrelated to the questions asked. These were removed from the findings reported in Chapter Four. For example, the researcher has removed answers such as "no comment".

3.6.1 Analysing Quantitative Data

Quantitative data can be analysed using simple techniques such as creating tables and diagrams, which show the frequency of occurrence, or more complex methods such as statistical modeling, (Saunders et al., 2000:326). As a general rule, researchers should analyse survey data by computer if it has been collected from 30 or more recipients, (Saunders et al., 2009:365). For this research, the survey was completed using the survey monkey tool, but the graphs shown in Chapter Four were created by the researcher using Microsoft Word, as this was the tool used to type the research paper, and the
graphs would be more consistent with the format used for the text if created using the same tool.

Thomas (1997:10-16) recommends a number of methods of simplifying the raw data including the use of a graph or chart, for example, a histogram, bar chart, line chart or a pie graph. The researcher was able to create bar charts, pie charts, and tables to illustrate the data documented in detail in Chapter Four.

3.7 Reporting Research Findings

The research findings will be reported in Chapter Four, and analysed in further detail throughout Chapter Five.

3.8 Validity and Reliability

"Reducing the possibility of getting the answer wrong means that attention has to be paid to two particular emphases on research design: reliability and validity", (Saunders et al., 2000:100). "Validity is the extent to which the research findings accurately reflect the phenomena under study", (Collis & Hussey, 2009:65). "Reliability refers to the extent to which your data collection techniques or analysis procedures will yield consistent findings," (Saunders et al., 2009:156).

For a research result to be reliable, a repeat study should show the same result, (Collis & Hussey, 2009:64). Reliability can be assessed by posing two questions: Will the measure show the same results on different occasions, and will similar observations be made by different researchers on different occasions?" (Saunders et al., 2000:100).
A good way to test for reliability in a questionnaire is to survey the respondents twice, although this may be difficult as respondents may not wish to complete the same set of questions twice, (Saunders et al., 2000:307). It may be possible for the researcher to test and re-test with a sub-set of the participants. In this case of this survey, one respondent was able to perform both the initial test surveys, and the pilot.

In terms or validity, the researcher was able to make a number of comparisons between the survey responses and secondary research regarding EVs. For example, Rochford (2016) states that out of the 466 EVs sold in Ireland in 2015, 405 of them were of the Nissan Leaf brand. Similarly, in the current research, the researcher found that almost 78% of the EVs reported in the survey were a Nissan Leaf model.

3.9 Ethical Considerations

Ethical concerns will emerge during research planning, while seeking access to organisations and individuals, and while collecting, analyzing and reporting data, (Saunders et al., 2000:130). Ethics, in the context of research refers to the appropriateness of the researcher's behaviour in relation to the rights of those who are affected by the researchers work, or the subject of that work, (Saunders et al., 2000:130). The research design should not subject the research population to embarrassment, harm, or any other material disadvantage, (Saunders et al., 2009:160).

Coercion must not be used to force people to participate in the research, and it is not advisable to offer financial or other material rewards to induce people to take part in the research, as the offer of such rewards may lead to biased results, (Collis & Hussey, 2009:45).
Ethical issues have been avoided, as the researcher has made contact with the administrators at the 'Irish EV Owners Association' seeking permission to distribute a survey among its members. On March 2\textsuperscript{nd} 2016, the association responded confirming that its members would be happy to help, and advised the researcher to distribute the survey via two facebook groups, where members of the association could participate if desired. No financial reward was offered in return for participation.

The Internet can provide an easier way to contact participants, but ethical considerations still apply, (Saunders \textit{et al.}, 2009:187). The term 'netiquette' has been developed to describe the guidelines around acting ethically on the Internet, (Saunders \textit{et al.}, 2009:187).

Collis & Hussey (2009:45), state that potential participants in a survey must be given information as to what is required if they participate and how much time is required. This point has been addressed by a thorough testing of the survey in terms of time required. The required time to complete the survey was communicated clearly on the opening page of the survey, along with some details about the nature of the research.

Another point raised by Collis & Hussey (2009:45-46) is the subject of anonymity; the researcher should offer anonymity to the participants. This was achieved by providing an optional contact field in the survey that enabled a participant who so wished to be contacted at a later date. Confidentiality can also be achieved by identifying the participants in the research only by a generic number or letter, for example respondent 1, 2, 3. In the case of this research, the participants were never referred to by name, or by any other recognizable identifier. Some responses have been quoted in this study, but always in a way that prevented identification of respondents.
3.10 Limitations

The most significant limitation encountered during this study was in relation to the time available to complete the project. As an element of a part-time masters programme, the research required the allocation of an appropriate amount of time, while maintaining the normal workload of a full time job and dealing with the usual commitments that arise in non-working time.

Another limitation was that although the number of EV owners and users has risen over recent years in Ireland, EV use is still not widespread, so it was difficult to access a large sample of participants directly, to participate in the survey.

In addition to this, the researcher was not working in the motor industry, and did not know many people, directly or indirectly, who used an EV. Although in the context of the methodology chosen, it was beneficial to the researcher to be uninfluenced in advance of the research by any such contacts, it may have been easier to reach a larger number of participants if the researcher had some direct connections in the EV industry or in the motor industry.

Finally, because there is an element of technology in the subject of EVs, the industry is ever changing and advancing, so it was important to keep up to date with recent changes and updates in the industry. This meant that the researcher needed to keep the literature under review, while advancing on the later chapters, to ensure that the latest developments were not missed.

3.11 Summary

In this chapter, the researcher has reviewed the different research approaches, and selected what appeared to be the most suitable
approach to enable the research question to be addressed and conclusions to be drawn, which is the aim of this study. The research approach chosen was quantitative methodology, and the research tool selected was a survey questionnaire.

The findings of the empirical data collected in the survey are reported in the next chapter, chapter four.
Chapter 4: Research Findings and Analysis

4.0 Introduction

This chapter documents the main findings of the primary research undertaken in this study. The findings have been abstracted from a survey questionnaire issued to Electric Vehicle (EV) users in Ireland. The survey was completed in full by 87 participants, and partially completed by 4 participants, meaning that four participants have completed only the basic data regarding their sex, age, type of EV owned, and reasons for choosing an EV. The remaining 87 participants have completed all questions.

The statistical findings in this chapter will be set out exactly as recorded in the survey monkey tool, to two decimal places. Throughout the survey, the participants have used abbreviations specific to EV related terminology. The meaning of these abbreviations will be found in the glossary on page 144.

Throughout this chapter, any text or extracts from participant responses included are as far as possible verbatim, but some adjustments have been made in relation to spelling, syntax and the use of abbreviations to ensure clarity, while maintaining the intent of the author.

4.1 Gender of Participants

This research reveals that 67.03% of the survey participants were male, and 32.97% of participants were female, as shown in Fig. 4-1.
4.2 Age of Participants

The age profile of participants ranged widely, as displayed in table 4-2. A sizeable majority of participants was found to be between aged 35 and 54, with 42.86% aged 35-44 and 29.67% aged 45-54. The lowest proportion of participants was aged 18-24 (1.10%).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Age Category</th>
<th>Percentage of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>18-24</td>
<td>1.10%</td>
</tr>
<tr>
<td>4</td>
<td>25-34</td>
<td>4.40%</td>
</tr>
<tr>
<td>1</td>
<td>35-44</td>
<td>42.86%</td>
</tr>
<tr>
<td>2</td>
<td>45-54</td>
<td>29.67%</td>
</tr>
<tr>
<td>3</td>
<td>55-64</td>
<td>15.38%</td>
</tr>
<tr>
<td>4</td>
<td>65-74</td>
<td>4.40%</td>
</tr>
<tr>
<td>5</td>
<td>75 or older</td>
<td>2.20%</td>
</tr>
</tbody>
</table>

Table 4-2: Participant Age

The age profile of participants is also demonstrated in a graph, as shown in Fig. 4-2.
4.3 Location of Participants

This study shows that the participants were distributed across a range of counties, as shown in Table 4-3. Fig. 4-3 also highlights the geographical distribution in the form of a pie chart.

The highest proportion of participants was in Dublin (28.09%), followed by Kildare (14.61%), Cork (12.36%), Galway (5.62%), Meath (5.62%) and Wexford (5.62%). There were nine counties without any participants, being Cavan, Donegal, Kilkenny, Laois, Leitrim, Longford, Roscommon, Sligo, and Tipperary.
<table>
<thead>
<tr>
<th>Location</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down</td>
<td>2.25%</td>
</tr>
<tr>
<td>Dublin</td>
<td>28.09%</td>
</tr>
<tr>
<td>Fermanagh</td>
<td>1.12%</td>
</tr>
<tr>
<td>Galway</td>
<td>5.62%</td>
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<tr>
<td>Kerry</td>
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<tr>
<td>Kildare</td>
<td>14.61%</td>
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<td>Kilkenny</td>
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<tr>
<td>Laois</td>
<td>0.00%</td>
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<tr>
<td>Leitrim</td>
<td>0.00%</td>
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<tr>
<td>Limerick</td>
<td>1.12%</td>
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<tr>
<td>Longford</td>
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<td>Louth</td>
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<td>Mayo</td>
<td>1.12%</td>
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<td>Meath</td>
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<td>1.12%</td>
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<td>Offaly</td>
<td>1.12%</td>
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<tr>
<td>Roscommon</td>
<td>0.00%</td>
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<tr>
<td>Sligo</td>
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<tr>
<td>Tipperary</td>
<td>0.00%</td>
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<tr>
<td>Tyrone</td>
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<tr>
<td>Waterford</td>
<td>1.12%</td>
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<tr>
<td>Westmeath</td>
<td>2.25%</td>
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<tr>
<td>Wexford</td>
<td>5.62%</td>
</tr>
<tr>
<td>Wicklow</td>
<td>3.37%</td>
</tr>
</tbody>
</table>

Table 4-3: Participant Location
4.4 Participant Employment Status

The survey found that 81.32% of participants were employed and working full-time, or self employed. The study also revealed that...
5.49% of participants were employed and working part-time, 2.20% of participants were not employed but were looking for work, while 6.59% responded that they were not employed and not looking for work. There were no full-time students among the participants, but 1.10% of participants were studying part time. 6.59% of participants were retired. The details are shown in Table 4-4, and figure 4-4.

<table>
<thead>
<tr>
<th>Status</th>
<th>Percentage of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employed, working full-time</td>
<td>80.22%</td>
</tr>
<tr>
<td>Employed, working part-time</td>
<td>5.49%</td>
</tr>
<tr>
<td>Not employed, looking for work</td>
<td>2.20%</td>
</tr>
<tr>
<td>Not employed, NOT looking for work</td>
<td>6.59%</td>
</tr>
<tr>
<td>Student, full-time</td>
<td>0%</td>
</tr>
<tr>
<td>Student, part-time</td>
<td>1.10%</td>
</tr>
<tr>
<td>Retired</td>
<td>6.59%</td>
</tr>
<tr>
<td>Self-Employed</td>
<td>1.10%</td>
</tr>
</tbody>
</table>

Table 4-4: Participant Employment Status

![Pie chart showing employment status](image)

Fig. 4-4: Participant Employment Status
4.5 Connection of Participants to Electric Vehicles

This research found that 91.21% of the participants were BEV users, 3.30% were PHEV users, and 5.49% responded to being in the “other” category, as demonstrated in Fig. 4-5.

Participants in the “other” category included those who owned both a BEV and a PHEV, and some who were considering buying, or were in the process of buying an EV.

4.6 Reasons for Purchasing an EV

The participants were presented with a text field to allow them to comment on their reasons for purchasing an EV, using their own words. All participants responded to this question. The responses received by each participant are documented in table 4-6. The
responses from this section will be analysed in further detail in section 5.6 from page 118.

<table>
<thead>
<tr>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
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<td>4</td>
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<tr>
<td>5</td>
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<tr>
<td>6</td>
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<td>7</td>
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<td>11</td>
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<td>12</td>
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<td>13</td>
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<td>14</td>
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<td>15</td>
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<td>16</td>
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<td>21</td>
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<td>22</td>
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<td>23</td>
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<tr>
<td>25</td>
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<tr>
<td>26</td>
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<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>27</td>
</tr>
<tr>
<td>28</td>
</tr>
<tr>
<td>29</td>
</tr>
<tr>
<td>30</td>
</tr>
</tbody>
</table>
| 31 | Existing sales of the nissan leaf  
Main dealer actively selling the Leaf  
Technology  
Range  
Charging network  
Environment reduced co2  
Reduced cost of running car |
| 32 | Nissan Leaf as it was at the time the only widespread EV to be designed from the ground up as an EV |
| 33 | Speed, fun to drive, cheap, high-tech. I'm an early adapter in general so it fits in with my personality |
| 34 | Interesting Technology and help towards lowering our dependency on oil.  
On windy nights, the leaf is charged by over 56% renewable energy. |
| 35 | Environment, cost effective |
| 36 | Cheap commuting to/from golf club (80km). |
| 37 | Low fuel costs, superior driving environment |
| 38 | Cost efficiency |
| 39 | Zero emissions, less mechanical maintenance, cheaper to run, safer car on the road, have to plan your journey and tend to slow you down and thus relaxes you more in this fast paced world. |
| 40 | Low running costs |
| 41 | Economical and ecological |
| 42 | After paying it fully getting almost free running car |
| 43 | Environmental reasons. Chose Zoe because I prefer to lease the battery |
| 44 | Efficiency, cost to run, new technology |
| 45 | Very good value secondhand and costs very little to run. |
| 46 | Had a nissan x trail went to look in nissan garage to change it for something more efficent sale guy presuaded me to test drive leaf. |
| 47 | Reliability, user and trade reviews |
| 48 | Efficiency |
| 49 | Daily commute to work was 70km when I bought the car. Gas savings were paying for the cost of the car. Since then pollution and using renewable energy is my priority, not savings on the car anymore. Eg I'm desperate every morning during the school run by the car pollution next to my kids school. |
| 50 | Brand and cost |
| 51 | Cost savings and comfort |
| 52 | Environmental reasons, I needed a large ev, lots of head and leg room, I needed to fit a wheelchair for disabled son, I needed space to carry loads, I wanted technology cleaner and more reliable than internal combustion. I wanted quiet drive as I am noise intolerant. I produce electrical fuel for ev, by clean solar electricity. |
| 53 | I liked the novelty of the EV and then found great economical advantages. |
Efficient cleaner on the environment saves money. I have a Nissan Leaf.

Running costs and environmentally friendly - No emissions

I have two different brand EVs. I bought a Tesla for awesomeness and a Nissan for utility.

Interested in new technology, greener, alternative to fossil fuel, low running cost

Eco friendly, fuel savings

Efficiency. Possible to spend more and buy newer as you essentially have no fuel costs.

Never having to go to a petrol station in the cold and rain again.

Zero emissions at the tailpipe, cheaper roadtax, refined drive.

Infrastructure ready to be used

Cost

Silent, cheap, power, environment friendly, adventurous

Cost savings, nice driving experience, low/zero emissions, no noise

Greener energy, cheaper, novelty factor, fun.

Most popular mass market EV. Cheap to run, great driving experience and kind to the environment.

Efficiency and low running costs.

Efficiency, value for money, cheaper running cost & environmental reasons.

Environmental impact, cost savings, Nissan trade-in allowance and government grant. Also the fact that much of my driving is short journeys around city and that we have an ICE car as a backup for longer journeys.

Nissan were the only creditable manufacturer selling the type of vehicle I wanted. I bought a LEAF and am now on my 3rd one.

I wanted a 5 seater EV, and liked the reputation and reliability of the one I chose.

The reason I bought an e-golf was to invest in the future of sustainable transport and Volkswagens version is the best bar the Teslas of course which is out of my price range now

It’s the only vehicle tech that’s exciting me at the moment it’s become affordable, and still offers fun driving.

Car fan wanted to try something different

Efficiency, environmental concern.

Spending too much money on petrol

Low cost way forward

Saving the planet etc.

We have 2 Zoe’s nice size and fast to charge our other ev is the fluence... good size family car longer charge time only drawback!!

I bought a Nissan Leaf. I went looking at ICE vehicles & realised the distances I was commuting an ICE vehicle wasn’t necessary & an electric vehicle was more suitable.

Market leader

Zero emissions, low running cost

—

13 Assumed to be Renault Fluence Z.E as described at the following location: https://www.renault.ie/vehicles/new-vehicles/fluence-ze.html on August 6th 2016
| 83 | It made financial sense. Cheaper to run the car. 50 euro a month in electricity vs 320 in petrol. Plus the cheap road tax and the government grant off the car. |
| 84 | Running costs |
| 85 | Running costs significantly less. Friendly on the environment. |
| 86 | Low running costs. |
| 87 | Cost effective |
| 88 | No gears as my husband had severe arthritis but did not have high running cost. Leaf was only option when buying |
| 89 | Was looking for a petrol automatic and saw an ad for the Nissan Leaf with an estimated petrol cost savings of €1,500/year. I calculated that a new but basic model would self finance compared to my 12 year old mazda when considering all costs. I mentioned this to a family contact who offered me a Fluence ZE at a price I couldn't say no to. |
| 90 | The drive4zero advertising campaign first brought it to our attention when we were changing our car. We did a weekend test drive from the garage, which gave us the reassurance that it would work for us. We were concerned about things like hills, heating etc. None of those are an issue for EV's, but we wanted reassurance anyway. We analysed the data from the location services on our phones, and as we had travelled outside the single-charge range of the car only twice in the previous year, we decided it would be a good fit for our family. |
| 91 | Green credentials, brand |

| Table 4-6: Participant Reasons for Purchasing |

4.7 Vehicle Details

The present study reports the year, make, model, and ownership status (first owner or second hand) of the vehicles used by the survey participants.

The most common make and model of vehicle in use by survey participants is the Nissan Leaf, as it was used by 77.53% of participants. The majority (75%) of vehicles in this survey were new vehicles. The responses are displayed in table 4-7. Figure 4-7-1 summarises the vehicle make and model in the form of a pie chart and Figure 4-7-2 demonstrates the ownership status of the vehicles reported, also in a pie chart.
<table>
<thead>
<tr>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2011</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2013</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2011</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>132</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>132</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2012</td>
<td>Renault</td>
<td>FluenceZE</td>
<td>First Owner but bought from garage in 2015</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>161</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2013</td>
<td>Toyota</td>
<td>Plug-in Prius</td>
<td>First [retail] owner. It was a garage – registered demo car</td>
</tr>
<tr>
<td>2012</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand from dealer in UK</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2012</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2016</td>
<td>Volkswagen</td>
<td>e-Golf</td>
<td>First Owner</td>
</tr>
<tr>
<td>161</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner (when acquired)</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2011</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2014</td>
<td>Renault</td>
<td>Zoe</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>BMW i3</td>
<td>REX</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>BMW</td>
<td>i3 REX</td>
<td>Owner&lt;sup&gt;14&lt;/sup&gt;</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>New&lt;sup&gt;15&lt;/sup&gt;</td>
</tr>
<tr>
<td>2011</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
</tbody>
</table>

<sup>14</sup> Assumed to mean First Owner  
<sup>15</sup> Assumed to mean First Owner
<table>
<thead>
<tr>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Owner Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Participant did not respond</td>
</tr>
<tr>
<td>2013</td>
<td>NISSAN</td>
<td>LEAF</td>
<td>Second Owner</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>BMW</td>
<td>I3</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Pcp finance over 3 years</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>No response provided</td>
<td>No response provided</td>
</tr>
<tr>
<td>2015</td>
<td>Renault</td>
<td>Zoe</td>
<td>First Owner</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Owner</td>
</tr>
<tr>
<td>2012</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2011</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2012</td>
<td>Renault</td>
<td>Kangoo ev multi crew cab van, 5 seater, long wheel base</td>
<td>First Owner</td>
</tr>
<tr>
<td></td>
<td>Leaf</td>
<td>Sve</td>
<td>Secondhand it's a UK import</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015, 2013</td>
<td>Tesla, Nissan</td>
<td>S, Leaf</td>
<td>First, Second</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
</tbody>
</table>

16 PCP Finance is a personal contract plan offered by car dealerships and involves the purchaser buying the car from the dealer using low monthly repayments

17 Assumed to mean first owner
<table>
<thead>
<tr>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Owner Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Renault</td>
<td>Fluence</td>
<td>First Owner (employer)</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2013</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>2014</td>
<td>Renault</td>
<td>Zoe</td>
<td>First Owner</td>
</tr>
<tr>
<td>131</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>20142</td>
<td>Nissan and</td>
<td>Leaf and outlander</td>
<td>First Owner</td>
</tr>
<tr>
<td></td>
<td>Mitsubishi</td>
<td>phev</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2014</td>
<td>Renault</td>
<td>Zoe</td>
<td>First Owner</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>LEAF</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Volkswagen</td>
<td>E-golf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Renault</td>
<td>Zoe</td>
<td>First Owner (dealer Demo)</td>
</tr>
<tr>
<td>2015</td>
<td>BMW</td>
<td>13 bev</td>
<td>New</td>
</tr>
<tr>
<td>2014</td>
<td>Renault</td>
<td>Zoe</td>
<td>Second Hand</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>New</td>
</tr>
<tr>
<td>2015</td>
<td>Renault</td>
<td>Zoe</td>
<td>First Owner</td>
</tr>
<tr>
<td>2014</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2016</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>131</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2012</td>
<td>Renault</td>
<td>Fluence ZE</td>
<td>Second Hand but first user. Only had delivery mileage</td>
</tr>
<tr>
<td>2012</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2011</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>151</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>2011</td>
<td>Nissan</td>
<td>Leaf</td>
<td>Second Hand</td>
</tr>
<tr>
<td>2015</td>
<td>Nissan</td>
<td>Leaf</td>
<td>First Owner</td>
</tr>
<tr>
<td>2015</td>
<td>Renault</td>
<td>Zoe</td>
<td>First Owner</td>
</tr>
</tbody>
</table>

*Table 4-7: Vehicle Details*
Vehicle Make and Model

- Nissan Leaf
- Renault Zoe
- BMW i3
- Renault Fluence ZE
- Toyota Prius
- VW e-Golf
- Tesla Model S
- Mitsubishi Outlander
- Renault Kangoo

Fig. 4-7-1: Vehicle Make and Model

EV ownership

- First Owner - 75%
- Second Hand Vehicle - 25%

Fig 4-7-2: EV Ownership

4.8 Vehicle Status
This study shows, as presented in Fig. 4-8, that 5.75% of participants were using company vehicles whereas the vast majority of 94.25%
were not. One participant added a comment that he or she had two vehicles, where one was a personal vehicle and one was a company vehicle.

![Is your vehicle a company vehicle?](image)

**Fig. 4-8: Company Vehicle**

### 4.9 Previous Vehicle Ownership

The responses to the survey showed that 1.15% of participants did not previously have a car. None of the participants previously had a vehicle that was of the PHEV variety, but 11.49% of participants previously had an EV. 35.63% of participants previously had a diesel-fuelled vehicle, whereas 49.43% previously had a petrol-fuelled vehicle. 2.30% of participants stated that their previous vehicle was a hybrid. This breakdown is demonstrated in Fig. 4-9.
4.10 Second Vehicle Status

This research found that 29.89% of survey participants did not have a second vehicle in their household. The research also found that 37.93% of participants have a second vehicle in their household and it is a diesel model, whereas 27.59% have a second vehicle in their household and it is a petrol model. The study shows that 1.15% of participants have a PHEV as a second vehicle in the household. Finally, 3.45% of participants have a BEV as the second car in their household. Figure 4-10 and table 4-10 display these figures in detail.
Second Vehicle

![Pie chart showing vehicle types](chart.png)

Fig. 4-10: Second Vehicle

<table>
<thead>
<tr>
<th>Do you currently have a second vehicle in your household?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, it is an EV</td>
</tr>
<tr>
<td>Yes, it is a PHEV</td>
</tr>
<tr>
<td>Yes, it is a HEV</td>
</tr>
<tr>
<td>Yes, it is a regular ICE, petrol</td>
</tr>
<tr>
<td>Yes, it is a regular ICE, diesel</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

Table. 4-10: Second Vehicle

4.11 Driving an Electric Vehicle

The participants were asked to rate a number of aspects of driving an EV, being the level of safety, level of comfort, battery-charging availability, the cost of battery charging, the ability to drive long distances, the ability to drive short distances, parking facilities, insurance facilities, NCT facilities, ease of servicing, cost of purchase, long term cost, environmental friendliness and convenience.
The results are set out in detail in Table. 4-11-1. In summary, the level of safety, the level of comfort, the ability to drive short distances, and vehicle environmental friendliness were extremely highly rated. The long term cost, convenience, ease of servicing, and cost of battery charging were reasonably well rated. The main areas poorly rated and suggesting a need for improvement were the battery charging availability, ability to drive long distances, cost of purchase, and insurance facilities.

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very Poor</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Safety</strong></td>
<td>71.26%</td>
<td>26.44%</td>
<td>1.15%</td>
<td>1.15%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Level of Comfort</strong></td>
<td>72.41%</td>
<td>22.9%</td>
<td>3.45%</td>
<td>0%</td>
<td>1.15%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Battery Charging Availability</strong></td>
<td>8.05%</td>
<td>22.99%</td>
<td>47.13%</td>
<td>17.24%</td>
<td>4.60%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Cost of Battery Charging</strong></td>
<td>51.76%</td>
<td>29.41%</td>
<td>10.59%</td>
<td>0%</td>
<td>1.18%</td>
<td>7.06%</td>
</tr>
<tr>
<td><strong>Ability to drive long distances</strong></td>
<td>8.14%</td>
<td>16.28%</td>
<td>46.51%</td>
<td>17.44%</td>
<td>9.30%</td>
<td>2.33%</td>
</tr>
<tr>
<td><strong>Ability to drive short distances</strong></td>
<td>81.40%</td>
<td>13.95%</td>
<td>2.33%</td>
<td>1.16%</td>
<td>1.16%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Parking facilities</strong></td>
<td>16.47%</td>
<td>40%</td>
<td>24.71%</td>
<td>11.76%</td>
<td>1.18%</td>
<td>5.88%</td>
</tr>
<tr>
<td><strong>Insurance facilities</strong></td>
<td>14.94%</td>
<td>36.78%</td>
<td>33.33%</td>
<td>10.34%</td>
<td>3.45%</td>
<td>1.15%</td>
</tr>
<tr>
<td><strong>NCT / MOT facilities</strong></td>
<td>14.46%</td>
<td>19.28%</td>
<td>18.07%</td>
<td>4.82%</td>
<td>1.20%</td>
<td>42.17%</td>
</tr>
<tr>
<td><strong>Ease of Servicing</strong></td>
<td>43.68%</td>
<td>39.08%</td>
<td>12.64%</td>
<td>1.15%</td>
<td>0%</td>
<td>3.45%</td>
</tr>
<tr>
<td><strong>Cost of purchase</strong></td>
<td>14.34%</td>
<td>42.53%</td>
<td>29.89%</td>
<td>11.49%</td>
<td>1.15%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Long Term</strong></td>
<td>47.13%</td>
<td>39.08%</td>
<td>12.64%</td>
<td>1.15%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
As mentioned above, the participants were presented with a rating scale to assess their experiences of driving an EV, and the detailed findings have been shown in Table 4-11-1. In the same question, the participants were also given the opportunity to provide additional information in a comment box, if desired. The comments provided are stated in Table 4-11-2.

### Table 4-11-1: Driving an Electric Vehicle

<table>
<thead>
<tr>
<th>Cost</th>
<th>Environmental</th>
<th>Friendliness</th>
<th>Convenience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>74.42%</td>
<td>20.93%</td>
<td>2.33%</td>
</tr>
<tr>
<td></td>
<td>1.16%</td>
<td>0%</td>
<td>1.16%</td>
</tr>
<tr>
<td></td>
<td>20.93%</td>
<td>32.56%</td>
<td>25.58%</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>1.16%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>2.33%</td>
<td>1.16%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>1.16%</td>
<td>0%</td>
<td>1.16%</td>
</tr>
</tbody>
</table>

### 4.11.1 Driving an Electric Vehicle - Comments

1. I charge at home and 2 provided places without hassle – but other places are always taken over by non electric cars

2. The public charging infrastructure is patchy and extremely unreliable. We avoid journeys that will require us to rely on it. Obviously, that is very restrictive. It is ludicrous to propose charging for public charge-points in their current state as, at the moment, it is primarily the economy of an EV that offsets the not insignificant inconvenience that users endure. If you eliminate cost saving, there will remain very little incentive to put up with the inconvenience.

3. Fast charge network is just about at minimal standard. One FCP out of service means a big detour plus additional charging stops.

4. Fast acceleration and very quiet

5. Not enough fast charging stations around the country, spaces being ICE’d

6. Quietness

7. Safety- public charger points not always 24/7 availability, some geographically positioned in dark, lonely places, as a female it's more dangerous than refuelling at petrol stations. Plus more risk of vandalism or theft. An ev driver, may be required to drive slow on motorway if on slow power, could be a hasard. Comfort is in the eye and purse strings of the purchaser. But torque in evs and no engine noise increase comfort levels, many owners bedazzled by the
tech, but most new-same priced ice cars already have this facility. Battery charging facility – cheap and easy to charge from home at night rate, but as public charge points remain free, the ev driver will avail of any chance of free public charging and often free parking, and the availability of cps can influence their choice of journey destination, shopping and dining, hotel or leisure destinations. Cost of battery charging, free public cps because the Utility Regulator is currently reviewing that ESB cannot charge use of cps by the minite but by the kW like residential and business users. Ability to drive long distances, it you want to add 2 hours to a three hour journey, love spending more time in your car, than in your bed, and want to do it for free, please start gambling on the non live report faulty cp system of ESB, then you would really be an ev addict. Many ev owners would use a second family car an ice, unless you’re single or retired without young kids. Ability to drive short distances, In respect of the intitial high purchase cost of ev compared to ice, and falling fuel prices, short instance driving costs comparable to ice car costs. Poor road surfaces, and few inter city incentives for free ev parking and available cps, free use of bus lanes, free toll and few programmes to encourage matching ev driving with public transport use, to reduce traffic in our city centres. Parking facilities, many cps on private land, not monitored by landowner, ev cp bays blocked by ice cars, ev drivers will so overstay these cps, as there are few, frustrating others who have urgent need to charge, insurance ev drivers think they should have incentives for cheaper insurance but the evs are expensive to buy and just the same as ice if insurer needs to pay out to a third party vehicle ev driver has damaged. NCT – just the same as ice, but simple to prepare for NCT. Ease of servicing – less complexity of mechanical parts so should be less labour costs, but computer technology required in advanced form in respect of electrical battery function. Cost of purchase, depends on your financial circumstances and how much of your money you prioritise on spending on a transport vehicle, or a luxury status symbol. New technology will always cost more, many ev owners import from uk, as cheaper and, therefore question why ROI is so expensive to buy evs? Long term cost – high depreciation, except use of public cp charges remain free to use, most evs purchased on hire purchase, pcp, confidence levels maybe poor, as some waiting for next longer range model, or higher tech. Environmental friendliness – better than poisonous diesel fumes, but electricity must be renewably sourced. Evs have environmental footprint because, imported not manufactured locally, the production of electric vehicle battery, questionable, mined non sustainable essential cored minerals, metals, world media confirmed child labour in ev battery mineral mines in South America. Poor response from world car
industry to adapt existing ice model to full ev batter models. Convenience –
depends on the interest and decathlon of ev driver, to remember to charge
battery, understand the technical functions of the car, and plan trips to
include public charging venues, and time spent charging, and accept the poor
service from ESB in sustaining an up to date cp map of operational and
unoperational cps, plus the risk of queing behind charging evs pat cp, or no
access to cp because blocked by ice car.

Range could be better compared to ice cars.

Tesla is company car. Leaf is private car.

Range Anxiety

We need more FCPs. We also need councils to enforce no parking in EV bays
by ICE cars. In many European cities, parking is free for EVs, perhaps a
cheaper rate could be applied for EVs that use payzone. Go Cars get free
parking but are not environmentally friendly. Cost of public charging at
present is great because it's free but that will change and needs to be managed
fairly. Cost of charging at home is good and can be controlled as there’s
competition in the market. Insurance is a rip-off no matter what you drive. In
terms of NCT and servicing and long-term factors I am not sure yet as car is
only a few months old.

Public charging infrastructure is challenging.

Table 4-11-2: Electric Vehicle Awareness

4.12 Electric Vehicle Awareness

This survey found that 72.41% of participants do not feel that the
majority of people are aware of the presence of EVs in Ireland, while
17.34% of participants feel the opposite and 10.34% were not sure.
These responses are shown in Figure 4-12 below.
Do you feel that the majority of people are aware of Electric Vehicles in Ireland?

![Electric Vehicle Awareness Chart]

**Fig. 4-12: Electric Vehicle Awareness**

### 4.12.1 Electric Vehicle Awareness - Comments

The participants were also given the opportunity to comment on awareness of EVs, in their own words, and the responses have been documented in Table 4-12.

<table>
<thead>
<tr>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
</tbody>
</table>
Evs do not have clear symbols that they are electric

As there is increasing media attention I think awareness is increasing, but still think that the majority of people are not really aware of EVs

Awareness needs to be raised and myths dispelled.

They are aware, but do not necessarily understand

There's an awful lot of misinformation being peddled, a case in point the segment on the Sean O'Rourke show last week.

Most people think the car is dual power as in petrol and electric

Table 4-12: Electric Vehicle Awareness

### 4.13 Electric Vehicle Driving Patterns

Some details and preferences on the driving patterns of participants, as highlighted in Table 4-13 were shown by this research. In summary, EVs are reported to be extremely suitable for driving to and from college and work and for driving short distances. Participants have a preference for driving EVs in urban areas, although driving in rural areas seems to be acceptable as a possibility as well. The view of participants as expressed in their responses is that the ability to drive long distances in an EV could be improved.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find my Electric Vehicle suitable for driving to and from work/college</td>
<td>83.91%</td>
<td>9.20%</td>
<td>1.15%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>I find my Electric Vehicle suitable for driving long distances</td>
<td>10.34%</td>
<td>25.29%</td>
<td>26.44%</td>
<td>28.74%</td>
<td>9.20%</td>
</tr>
<tr>
<td>I find my Electric</td>
<td>90.80%</td>
<td>6.90%</td>
<td>1.15%</td>
<td>0%</td>
<td>1.15%</td>
</tr>
</tbody>
</table>
# 4.14 Electric Vehicle Charging Patterns

The survey explored the EV users charging patterns, and the results showed that the majority of participants (90.80%) can charge their EVs at home, and 62.35% stated that they usually charge their vehicle at home. Of those charging a vehicle in public, a significant number of EV users (40.70%) preferred to use a fast charge point. On the question of whether there is adequate public charging in Ireland for current needs, the majority did not agree with 37.93% opting to strongly disagree, and 39.08% disagreeing. This study also found that 79.31% of participants strongly agreed that further investment is required in charging infrastructure for the future. Finally, if fees were introduced for public charging, the majority of participants would use the public charging points less frequently, with 44.83% choosing to strongly agree that this would be so, and 20.69% choosing to agree.

The detailed results are shown in table 4-14.

<table>
<thead>
<tr>
<th></th>
<th>68.60%</th>
<th>4.65%</th>
<th>20.93%</th>
<th>3.49%</th>
<th>1.16%</th>
<th>1.16%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I prefer driving my Electric Vehicle in urban areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I prefer driving my Electric Vehicle in rural areas</td>
<td>29.89%</td>
<td>24.14%</td>
<td>34.48%</td>
<td>4.60%</td>
<td>4.60%</td>
<td>2.30%</td>
</tr>
</tbody>
</table>

Table 4-13: EV Driving Patterns
<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is possible for me to charge my Electric Vehicle at home</td>
<td>90.80%</td>
<td>6.90%</td>
<td>1.15%</td>
<td>0%</td>
<td>0%</td>
<td>1.15%</td>
</tr>
<tr>
<td>I usually charge my vehicle publicly</td>
<td>5.81%</td>
<td>20.93%</td>
<td>23.26%</td>
<td>37.21%</td>
<td>10.47%</td>
<td>2.33%</td>
</tr>
<tr>
<td>I usually charge my vehicle at home</td>
<td>62.35%</td>
<td>15.29%</td>
<td>7.06%</td>
<td>14.12%</td>
<td>1.18%</td>
<td>0%</td>
</tr>
<tr>
<td>I spend equal time charging my vehicle at home and in public</td>
<td>8.14%</td>
<td>11.63%</td>
<td>15.12%</td>
<td>37.12%</td>
<td>24.42%</td>
<td>3.49%</td>
</tr>
<tr>
<td>When charging in public, I prefer to use fast charge points over regular charge points</td>
<td>40.70%</td>
<td>19.77%</td>
<td>19.77%</td>
<td>11.63%</td>
<td>4.65%</td>
<td>3.49%</td>
</tr>
<tr>
<td>I find that there is adequate public charging available in Ireland for current needs</td>
<td>0%</td>
<td>8.05%</td>
<td>13.79%</td>
<td>39.08%</td>
<td>37.93%</td>
<td>1.15%</td>
</tr>
<tr>
<td>I feel that further investment in charging infrastructure is needed for the future</td>
<td>79.31%</td>
<td>14.94%</td>
<td>1.15%</td>
<td>2.30%</td>
<td>2.30%</td>
<td>0%</td>
</tr>
<tr>
<td>Response</td>
<td>Description</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>I believe fees would negatively affect the uptake of new EV sales.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Depending on the level of the fees it could reduce current users and prevent new owners even considering an ev.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Kill it off as it would be far too expensive if charging is commercialised.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Somewhat diminish the take up.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>It would effectively eliminate any new ev owners.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Limit uptake before critical mass is achieved.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Put people off buying EV's. Would have to be nominal charge. At least in the beginning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>As long as it is fair priced - pay what you use, just as petrol/diesel and not the time you spend as some cars take longer to charge, temperature of car/outside changes charging times.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>It will be cheaper to run Diesel.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Streamline over usage, force more home usage and night rate.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Less owners.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Not great.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>It would completely disincentivise purchase of evs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>None.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>It depends on the fees. In general, there would be a reduction in congestion as it would reduce opportunity charging.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>It depends on Level. Per use would be OK but high fixed charges would put me off even owning a car.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Make us plan to charge at home more.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table. 4-14: EV Charging Patterns

4.15 Impact of Public Charging Fees

Participants were asked to comment regarding what kind of impact the introduction of fees might have for public charging in Ireland. All responses have been collected, and set out in Table 4-15.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Negative... infrastructure is totally unreliable</td>
</tr>
<tr>
<td>19</td>
<td>It will hamper the sale of evs even if the cost is cheaper than fossil fuels</td>
</tr>
<tr>
<td>20</td>
<td>The infrastructure needs to be maintained. As long as it's reasonable it should be alright</td>
</tr>
<tr>
<td>21</td>
<td>If a fair price no impact, If priced higher than the price of running a diesel car, will be the end of EV in Ireland.</td>
</tr>
<tr>
<td>22</td>
<td>A vast reduction in the prospect of EV uptake, keep it free, make it a public good free for all to use, encourage home charging, install smart meters and we will be okay.</td>
</tr>
<tr>
<td>23</td>
<td>Drivers won't leave cars unattended at chargers if paying for the service.</td>
</tr>
<tr>
<td>24</td>
<td>This would effect the cost of ownership in a huge way and ev sales would decrease as incentive scheme's appeal to buyers</td>
</tr>
<tr>
<td>25</td>
<td>Discourage potential customers from investing in EVs</td>
</tr>
<tr>
<td>26</td>
<td>Kill it if not done right</td>
</tr>
<tr>
<td>27</td>
<td>Stupid idea at a time when very little uptake - needs to be when mainstream</td>
</tr>
<tr>
<td>28</td>
<td>Depends on the rate &amp; how it's charged</td>
</tr>
<tr>
<td>29</td>
<td>Reduce the amount of Ev's</td>
</tr>
<tr>
<td>30</td>
<td>Free up fast chargers for those who need them for long journeys, increase home charging but put off new EV purchasers.</td>
</tr>
<tr>
<td>31</td>
<td>Once it's done fairly and rapid chargers capped at 80% or 30 minutes per user per charge with a 10 minute lock out after 30 minutes will stop rapid charger hogging and the problems that go with it</td>
</tr>
<tr>
<td>32</td>
<td>It would be an additional barrier for new users. It would free up chargers and stop users 'hogging' who live locally. Realistic pricing of charges or time limits need to be introduced</td>
</tr>
<tr>
<td>33</td>
<td>Sales of evs would cease</td>
</tr>
<tr>
<td>34</td>
<td>Discourages new drivers</td>
</tr>
<tr>
<td>35</td>
<td>Would go back to diesel as it would be cheaper.</td>
</tr>
<tr>
<td>36</td>
<td>Kill the EV market completely</td>
</tr>
<tr>
<td>37</td>
<td>Would turn people off depending on the cost if high</td>
</tr>
<tr>
<td>38</td>
<td>Depends on the cost</td>
</tr>
<tr>
<td>39</td>
<td>Depending on how expensive charging will be it may drive people away from pure electric vehicles.</td>
</tr>
<tr>
<td>40</td>
<td>Better availability</td>
</tr>
<tr>
<td>41</td>
<td>More hassle. Move to charging at home only.</td>
</tr>
<tr>
<td>42</td>
<td>Standing charge would put people off using evs. A fair pay as you go system would be required using credit card type facility.</td>
</tr>
<tr>
<td>43</td>
<td>It would probably be a disincentive to prospective buyers</td>
</tr>
<tr>
<td>44</td>
<td>Depends entirely on the fee structure.</td>
</tr>
<tr>
<td>45</td>
<td>Little charging is usually done for necessity</td>
</tr>
<tr>
<td>46</td>
<td>Discourage parking by EV's that are not charging in EV bay</td>
</tr>
<tr>
<td>47</td>
<td>Put people away from buying electric cars.</td>
</tr>
<tr>
<td>48</td>
<td>Good impact</td>
</tr>
<tr>
<td>49</td>
<td>More appropriate use rather than abuse</td>
</tr>
</tbody>
</table>
Depends if public cp charging was same as home night rate charge, the rich will buy Teslas to use free upper chargers, the rest will try to find an adaptor to illegally access free electricity from Tesla supercharger, others will charge at home, those who complete infrequent long journeys will pay to charge on their journeys. It also dependent on the price of oil and comparative price of running an ice.

EV owners would switch back to ice car’s electricity is free in other countries for EV cars

Reducing emissions target would not be reached. Fees would put a lot of people off buying an ev in the early stages of ev driving in this country.

It would remove an incentive for buying an EV, and with the take up of EVs very low, we need all the incentives available to encourage EV ownership. Any fees introduced need to be both fair and not end up more expensive than diesel in reality (not just in theory as ESB seem to think it would work)

It would slow down the uptake of EVs

Help reduce charger hogging

Use home or work only

Depends if there is a subscription fee or not

It would put a brake on EV adoption rates

It’s too Early to start charging once a certain percentage is reached then gradual charging should start

Detrimental

It would have a good impact as only those that really need to charge have access to the charge points. The charging network needs to be stabilised first and made more reliable. Bylaws for parking also need to be enforced

Deter people from buying an ev. Depends on how the charges are calculated.

Would reduce queues at charge points, no opportunistic charging.

Impact would depend totally on the fee structure!

Fees are necessary, but need to be fair to reduce impact on EV sales.

If fees are fair and on a per usage basis with perhaps a discount scheme for heavy users then I have no major problem with it. But parking and the enforcement of ICEing is a bigger issue. Also, network needs to be expanded and maintained. Privatisation is perhaps a solution.

Would prevent charger blocking by some owners ‘just topping up’ or leaving the vehicle for hours on end. Under previous suggested price structures, it would make electric driving expensive & not as appealing to new entrants to the market.

Devastating!

Due to the slow take up of electric cars it would have a huge negative impact as the cost of an electric car is greater and there must be as little barriers to entry as possible

I think it would have a negative impact

It would kill it off completely.

Would free up fast chargers used in shopping centres / unnecessary local usage. Needs to be pay as young without subscription.

People would be even less interested in EVs even tho it doesn’t make sense (still cheaper than ICE)

People would revert back to ICE vehicles

Some people would be less likely to buy electric
Great reduce the sale of evs

Negative but would improve usage patterns

Depress the market for electric cars

It would negatively affect future sales. Put people off. It may also help stop people from hogging chargers.

Reserve public charging points for those who genuinely need them and encourage people to charge at home at night when they should be.

Depends on the fees! Not much if fair (eg linked to home electricity account at its rate, plus small premium for fast chargers. Ruinous effect if unfair like ESB proposal.

If it's fair no change. Too Much and you won't persuade people to switch to EV's.

Negative

This would depend on the fairness of said charges

It is a critical period for uptake of EV’s. People are already nervous about new technology without introducing disincentives.

Negatively impact on ev sales

Table 4-15: Impact of Charging

4.16 Future Purchase Prospects for EVs

The findings of this research reveal that 83.91% of participants responded that they would definitely consider purchasing an EV in the future. 11.49% responded that they would perhaps consider purchasing an EV in the future, and 4.60% responded that they didn’t know. None of the participants chose the option “No, definitely not” when considering if they would purchase an EV for their next car. The results are shown in Table. 4-16 and in Figure 4-16.

<table>
<thead>
<tr>
<th>Would you consider purchasing an Electric Vehicle for your next car?</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, definitely</td>
<td>83.91%</td>
</tr>
<tr>
<td>Perhaps</td>
<td>11.49%</td>
</tr>
<tr>
<td>I don’t know</td>
<td>4.60%</td>
</tr>
<tr>
<td>No, definitely not</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table. 4-16: Future Purchasing Prospects of EVs
Would you consider purchasing an Electric Vehicle for your next car?

![Pie chart showing survey results]

- Yes, definitely - 83.91%
- Perhaps - 11.49%
- I don't know - 4.60%
- No, definitely not - 0%

Fig. 4-16: Future Purchasing Prospects of EVs

4.17 Factors Influencing EV Purchase

The survey responses show the main factors influencing the participants when choosing an EV as a vehicle. The primary driving factors were found to be running cost, purchase price, and driving performance, followed closely by environmental efficiency. The ability to fuel the vehicle at home was also a key consideration for some. The least significant factors were the availability of the preferred make and model, the features available, and being among the first to try a new technology. The complete results are documented in Fig. 4-17.
Factors influencing EV purchase

Features available
The possibility of fuelling my vehicle at home
Being among the first to try a new technology
Environmental Efficiency
Financial incentives and grant schemes available
Driving Performance
Availability of preferred make and model
Running Cost
Purchase Price

Factors influencing EV purchase

Fig. 4-17: Factors influencing EV purchase

4.17.1 Factors Influencing EV Purchase - Comments

The main additional comments provided by participants in relation to factors influencing EV purchase are shown in Table 4-17.

<table>
<thead>
<tr>
<th>Response</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The environmental aspect is a bonus. It is a free car for me as it is paid for with what I was spending in diesel.</td>
</tr>
<tr>
<td>3</td>
<td>Range</td>
</tr>
<tr>
<td>5</td>
<td>Driving range</td>
</tr>
<tr>
<td>6</td>
<td>No gear change, urban performance, silence.</td>
</tr>
<tr>
<td>7</td>
<td>Range</td>
</tr>
<tr>
<td>8</td>
<td>The pleasure of driving it! It is quiet, smooth, no juddering. Noiseless at junctions. It is such a joy to pull up to a stop sign and hear birds rather than an engine. Cities and towns would be so much more pleasant if the majority of vehicles were as quiet.</td>
</tr>
</tbody>
</table>

Table 4-17: Factors influencing EV purchase
4.18 Participant Suggestions for EVs

Participants were asked if they had any suggestions or further comments in relation to EVs. The responses are displayed in Table 4-18.

<table>
<thead>
<tr>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
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<td>2</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
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<td>14</td>
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<tr>
<td>15</td>
</tr>
<tr>
<td>16</td>
</tr>
</tbody>
</table>
I'm enjoying my time with an EV!

Public charging network needs to more reliable. When charge points go down, it can be months before they're fixed; Poor reliability/ service has potential to reduce customer confidence

Maintenance of infrastructure is shocking - ICE drivers blocking charging stations big problem

Continue to improve the infrastructure, Government backing, Education the public

At shopping centre locations a lot more 7kw to 22kw charge points are needed as the rapid chargers in those locations are overtaxed to say the least

Public perception on EV's will take a lot to change in a conservative country like Ireland. Real government leadership in positive policy changes needs to happen or Ireland will be left behind our European counterparts. EV's are the future, that is a definitive, whether we become leaders in that move or pay the cost later is up to our government to deal with.

Around one percent of car sales is electric vehicle if there is to be a 1/5 sales by 2020 like the government wants then many more charge points will need to be installed and there is one in naas town but around 50 leads with many of them mooching off the public fast charger

Greater range between charges. More charge points. Greater discourages for icing

Need more incentives if it is to be successful.

Incentives to promote EV take up are needed, 5 year commitment to free public charging, Access to bus lanes, Countrywide free parking while charging, free time limited parking in cities, No tolls

Could have a rollout by EV companies to colleges/workplace to inform people of the benefits

More awareness through government, more fast charging bays

Pay it, don't lease it. After it's paid you just pay a little bit for the charging anymore, except small tax, nct & insurance.

Reliability and access of public charge point is a big issue. Lots of chargepoints are blocked by ICE there are not enough fcps when one is broken it can totally sterilise an area for ev drivers.

Need for more incentives, eg lower road tax, retaining free public charge points, improve charge point infrastructure on motorways

There needs to be a much larger network of fast chargers before the general public will embrace the EV. At present you can only charge one car at a time!

Not sure why charging points in train stations in the north as if you have ev i think you would drive. Could do with points at malls in one is good jet centre in coleraine would be nice

Mandatory use of electric cars in Dublin by 2025. The Netherlands are pushing for this in Amsterdam. No road tax. Special plates to recognise ev. Overly incentive EVs over PHeVs. 10x the number of fast charge within 2 years.

Cheaper cost to buy to encourage more users. Extra benefits like zero road tax and ability to use bus lanes.

Government and car manufacturers have to invest in research, and into lowering co2 emissions, Electric cars are only one approach, ESB ECars poor research and handling of public charging infrastructure, has left prospective ev purchasers cautious, of availability and reliability of cps, and unclear of what payment of cps will be. Unlike other countries, there are no other ev charging
infrastructure providers, and ESB has a monopoly, but are not very efficient, effective, or listen to the views of the ev owners. Large funds have been provided by EU, U.K. And ROI governments. Millions spent on poor quality charge point equipment, that is frequently faulty, parts often taking months to arrive from mainland European contractors.

Tens upon thousands or more spent on private call out engineers, an ineffective 24 hour subcontractor helpline service which is expensive to phone, and not always 24 hour, especially Christmas. The ev owner is the first to report a faulty cp, and left stranded for long periods waiting for engineers, or having to call breakdown tow truck. ESB in 5 to six years have not yet installed an interactive communication system between cps and operation centre, not even a cctv installed to monitor operational status of cp. Increasingly there are reports of public cps being vandalised, or the ev charging or its cable, little security considerations in planning the position of cps.

Plus ESB are not running some fcps

Full electrical advertised cp power capacity so cars are taking longer than expected to charge. Some cps are not widely available to accept Specific ev model charging technology, eg Renault Zoe compatible, CSS Regarding BMW.

Also there are increasing numbers of models of vehicles that although have ice engines have electrical plugin technologies therefore more queues at public cps, and there are social media posts of incidents of public cp rage. Incidents.

| 39 | More charging stations |
| 40 | Do not introduce charges yet until the infrastructure is reliable and real time information is provided. |
| 41 | There needs to be a common approach to parking, charging point signage and marking etched by local authorities around the country ... at present it is very confusing, and enforcement of normal cars parking in EV charging bays is poor. |
| 42 | EV owners are awesome |
| 43 | Free road tax |
| 44 | Increased grants scheme in order to try convert more |
| 45 | Range increase and I think everyone would get one. They are great to drive. |
| 46 | The street chargers that are not marked for exclusive use by EVs while charging need to be painted immediately. |
| 47 | More chargers would make the uptake and visibility of evs better. |
| 48 | Great cars but not suitable for long distances as charging network too unstable and q s are too long at fast chargers |
| 49 | As the number of evs on the road increases more charge points, esb fast cp's are needed. Also a lot of black spots for charging outside of Dublin and roads that lead to/from Dublin. Enjoying ours. |
| 50 | Charging network reliability is quite poor currently. While it is almost widespread enough for the number of EVs right now, response times for repair have to improve. |
| 51 | I love the whole new EV driving experience, I never want to go back to an ICE car. |
| 52 | Government should be doing a lot more to incentivise and promote EVs. Particularly for urban dwellers they are a fantastic option and the benefits in terms of air quality would be huge. Hopefully EU directives on CO2 emissions and air quality will force action. |

111
Get Government serious about a long term policy.

Turn the lamp posts into slow charge points extremely cheap to do and would hugely increase access to the network as so many people could charge their car whenever they wanted and wouldn't have to drive around looking for one

More fcp in small towns would be nice

More chargers, from more companies providing chargers.

Decide what type of driving you do as long journeys involve planning. See what type of chargers are available in your locality. Is it possible to install a home charging unit.

They could be used to promote safe driving ... eco driving is at 96km per hour or less... also having to stop to charge means you have to take a break every 2 hours helps prevent tiredness !!

I feel people should be more actively encouraged to try E cars out. There are a lot of misconceptions about range as the latest cars can do 180-220 Kms easily

People are reluctant to risk buying an EV unless they are particularly environmentally or financially motivated

More chargers. Fast chargers at petrol stations are great. People top up and go. Also by location less likely to be iced than on street chargers.

Introduce costs on fast public charging on a pay as you go basis. €5/hour immediately. Free parking everywhere but NOT at charge points. Employers / public car parks to have 5% of parking spaces with low power power points 2-3kw only with regular parking rates applied. Insurance policies need to offer comprehensive cover for driving other cars when electric is not suitable. All cars must have a 3 pin charging cable €800 for an adaptor is ridiculous.

More incentives to switch

More charge maybe in petrol stations. Drive in the bus lanes Free tolls

ESB ecars needs to engage with service users more regarding charger positioning

I would love the public relations of EV's to be pushed. The scare tactics of charging more than a diesel to charge the battery has done huge damage to the public perception. EV's need to be making up at 15% of new sales, in order to build a sustainable consumer base before any disincentives are introduced. The drive4zero iniative in cork was a great success. This should be extended, and rolled out to the rest of the country.

More charging points required and more incentives such as road tax etc

Table 4-18: Suggestions for EVs

4.19 Summary

This chapter presented the details of the primary data gathered from the survey. The next chapter will analyse this data, draw conclusions from this analysis and make suggestions for the future of EVs and for future areas of study.
Chapter 5: Main Findings Recommendations & Conclusions

5.0 Introduction

In this chapter there is an evaluation of the data referred to in earlier chapters and produced by the researcher's primary and secondary research, followed by analysis of that data and conclusions.

Percentages used in relation to survey responses have been rounded to whole numbers, for ease of reading, but more precise results, to two decimal places, have been detailed in Chapter Four.

5.1 Gender of Participants

This research found that the majority (67%) of Electric Vehicle (EV) users surveyed were male, and that females were in the minority (33%).

There are a number of possible explanations. Some researchers observe that typically, the perception is that men are more interested in motoring, and in technology in general. Bonner, (2010:40) believes that despite women's actual use and ownership of cars in the Western world, cars can be labeled as 'masculinist', and this is seen by the prominence of cars in 'lads' magazines' and the lack of car related features in 'womens' magazines'. Similarly, according to Redshaw, (2012:36) "while cars are technologically regarded as neutral they are nevertheless socially framed as essentially masculine and the domain of men, as is much technology".
5.2 Age of Participants

Another finding was that 73% of participants were between age 35 and 54, with 43% between age 35 and 44 and 30% between age 45 and 54. Most of the survey participants discovered the survey on the Irish EV owners groups on facebook. Thus, this researcher sought to analyse the potential reach of this channel, as shown in Chapter 3, page 63. It was found that facebook membership between the ages of 18 and 55 is fairly balanced, and facebook is used heavily across a wide range of age groups in Ireland.

Very few survey participants, however, were in the 25-34 age category, (4%), or in the 18-24 category, (1%), suggesting that affordability is an issue for the younger age category in Ireland, when it comes to purchasing an EV. It can also be assumed that those who belong to the over 35 category have greater job stability and a higher income, and therefore can afford a newer car, or one that involves a little adventure or a novel experience.

The low rate of EV ownership among the under 35 age category may also be related to the lower level of home ownership for this group. One major benefit of EV ownership is the possibility of home charging, which may not be possible for some home renters where for example a landlord may not be willing to install a home charger or the likely duration of the tenancy might not justify the expense. NESC (2014:7) demonstrates that in 2011, 70.8% of households were owner occupied in Ireland, yet in 2011, under 10% of those under the age of 24 were home owners, while approximately 40% of 24 – 34 year olds were homeowners, (NESC: 2014:13).
5.3 Location of Participants

The primary locations for EV users were Dublin (28%), Kildare (15%), Cork (12%), Meath (6%), Galway (6%) and Wexford (6%). This is not surprising, as Power (2016:14) demonstrates that for the first quarter of 2016, the highest numbers of car registrations were in Dublin (30,121), Cork (10,911), Galway (3,472), Kildare (3,447) and Limerick (3,190), implying that the number of EVs purchased is likely to increase based on the number of vehicles purchased per county in total. It is also worth noting that Cork is the home of the Drive4Zero initiative discussed in Chapter 2, page 46, a fact likely to have a strong influence on the rate of EV ownership in Cork.

A number of counties, Cavan, Donegal, Kilkenny, Laois, Leitrim, Longford, Roscommon, Sligo and Tipperary did not have any survey participants. In the first quarter of 2016, the lowest numbers of overall new car registrations were noted in Leitrim (365), Longford (440), Monaghan (740), Sligo (796) and Roscommon (875), (Power, 2016:14). This suggests that car users in counties with lower overall car sales are less likely to purchase an EV.

County Tipperary shows 2,516 new car registrations in the first quarter of 2016, and County Donegal shows 2,091, (Power, 2016:14). This makes Tipperary and Donegal the counties with the 7th and 10th highest numbers of car registrations by county in the Republic of Ireland and raises the question as to why there is not a larger proportion of EVs present in these counties.

There is also a link between the disposable income available per county and the ability to purchase an EV. For example, the average disposable income per person, excluding rent, in Kildare is €17,524, whereas in Donegal it is €14,414, (CSO, 2014). Similarly, the

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18 Only Republic of Ireland counties included
disposable income per person, excluding rent, in Dublin was reported as €19,431, and in Cork as €17,895, whereas in county Roscommon it was reported as €15,564, (CSO, 2014). This suggests that there is a financial barrier to purchasing an EV in areas such as Donegal and Roscommon where lower numbers of EV users are to be found than in Kildare, Cork and Dublin.

The distribution and availability of charging points may also be an issue for some potential EV owners and users. For example, when examining the ESB charge point map: https://www.esb.ie/our-businesses/ecars/charge-point-map, which can also be consulted in Appendix I: eCars Charge Point Map, the number of charge points in County Donegal, quite a large county, can be compared and contrasted with the number in County Kildare, a smaller county. In County Donegal, at present, there are three fast charge points out of a total of 70 available in the Republic of Ireland (as noted in chapter 2, page 43), and 17 standard charge points. In contrast, in County Kildare, a smaller county, there are four fast charge points and 19 standard charge points. This demonstrates that location can be a factor influencing potential EV users, as some more remote areas may not have sufficient access to charging points.

A further finding in this study was that driving EVs is regarded by survey participants as more suited to urban driving, as 69% of them strongly agree that they prefer driving their EVs in urban areas, whereas only 30% of participants strongly agree to a preference for driving their EVs in rural areas, (Chapter 4, page 100). This finding may further explain the difference in EV ownership between counties such as Donegal, and Kildare.
5.4 Participant Employment Status

This research showed that the majority of EV owners (80%) were working full-time. The majority of EV users in the survey were also first owners, or had vehicles registered in 2011 or more recently, (Chapter 4: 87), which suggests that currently it is important to be able to afford to purchase a relatively new car, if considering driving an EV. Even though the savings on fuel are seen to be a major incentive to drive an EV, (Chapter 4: 83), it is important to have enough money to cover the initial purchase price. This may change, as EVs have been present in the Irish market since 2011 (Chapter 1: 15), and the second hand market may get a chance to grow with an increasing population of EVs coming to the market as existing owners trade up.

It is also important to note that there is currently a grant of €5,000 available when purchasing a new EV (Chapter 2: 36), and this factor may also be driving the high level of first-owner EV users, and the current situation as to the grant may change in the next few years, possibly leading to less new EV purchases.

5.5 Connection of Participants to Electric Vehicles

The majority of participants were found in the course of the research to own a BEV (91%) rather than any form of hybrid electric vehicle. The survey was distributed to members of the Irish EV owners group. The researcher was unable to find a similar group, specifically directed towards PHEV owners. As responses included PHEV users it was assumed that PHEV owners are also welcome and active on the EV owners groups and forums, in the absence of any available forum for PHEV owners specifically.
The finding that so many participants were BEV owners, if the assumption just mentioned is true may tend to undermine McCarthy's statement (Chapter 2: 33) that people prefer having the safety of switching between electric and petrol or diesel.

**5.6 Reasons for Purchasing an EV**

This study (see Section 4.6) discovered that from the perspective of participants, the most common reasons for purchasing an EV were cost, environmental reasons, efficiency, technology, and early adaption. It is worth noting that there were two questions in the survey regarding reasons for purchasing an EV, the first, described here, with results documented in section 4.6 was posed in order to determine why, in their own words participants chose to purchase their current EV. The second question (Section 4.17 and 5.17) asked the participants to select from nine different pre-defined reasons for EV purchase, and the result was to determine which were the strongest and weakest factors considered relevant in relation to the possible purchase of an EV in future.

In the question documented in section 4.6, in relation to cost, "low running cost", "fuel savings", and "low maintenance cost" were cited multiple times in the responses. Many respondents felt that the burden of the initial cost would be compensated for in fuel savings. For example, one participant (no 22) explained that the vehicle “will be paid for in three years with what I was paying for diesel”. Similarly, another participant, (no 42) felt “after paying it fully getting almost free running car”.

In relation to the environment, “environmental friendliness”, “environmental considerations”, “reducing Co2”, “zero emissions”, “alternative to fossil fuels” and “green” were mentioned several times.
Efficiency was cited both in relation to the environment, and in relation to fuel efficiency. In relation to technology, one participant (no 73) stated “It’s the only vehicle tech that’s exciting me at the moment (...) and still offers fun driving”.

A number of participants also felt that driving an EV was ‘fun’. For example one participant (no 33) mentioned “Speed, fun to drive, cheap, high-tech”, as reasons for purchasing an EV. Another participant (no 65) stated “Greener energy, cheaper, novelty factor, fun” as some reasons for purchasing an EV.

In addition to the primary motivations, a number of participants had chosen an EV because automatic transmission was necessary for particular reasons, such as (no 88) having arthritis, or in particular one participant (no 21): “I am disabled and needed an efficient automatic car that was easy to drive.” Automatic transmission is not unique to EVs, but is a factor along with others that may tend to influence potential purchasers to choose an EV.

Silence was cited a number of times as a reason for purchasing an EV, and one participant (no 52) chose an EV citing noise intolerance as a reason: “I wanted a quiet drive as I am noise intolerant”. All comments in relation to the silence of EVs were positive, which was noteworthy, as some previous researchers, for example, O’Mahony & Wright, (2012) have raised the question of whether quietness in an EV is unsafe. As discussed in Chapter 2, page 39, it remains to be determined whether silence is truly a hazard in EVs, and this issue is currently under review.

5.7 Vehicle Details

It is clear from this research that the most popular EV among the survey participants was the Nissan Leaf, with 78% of participants
reporting that they used one. The highest numbers of the Nissan Leafs reported were from 2015 (29%), followed by 2016 (22%), 2014 (18%), 2013 and 2011 (12% each) and 2012 (6%). The Renault Zoe model was the second most popular EV among survey participants, holding an 8% share, while BMW i3, Volkswagen e-Golf, Renault FluenceZE, Toyota Prius, Tesla Model S, Mitsubishi Outlander and Renault Kangoo were also in use but by a smaller number of participants.

There are a number of reasons explaining the prominence of the Nissan Leaf in Ireland. For example, it was the first EV promoted aggressively in the Irish market (Chapter 1: 15). The Nissan Leaf is also a more affordable vehicle than some of the other EVs available in Ireland, such as the BMWi3, (see Appendix C).

In section 4.6 Reasons for Purchasing an EV, participants commented in relation to their choice of make and model. For example, one Nissan Leaf user (no 6) explains: “Nissan appear to be committed to ev market. Good penetration in Ireland relative to Renault.” Another participant (no 22) backs the Nissan Leaf: “As for model, I saw the Leaf at a farm show and was surprised that it was a real car. It fit all 5 of us, and seemed to be what we were looking for. I wasn’t aware of any other models.” Similarly, another comment (no 32) explaining the choice of a Nissan Leaf was “Nissan Leaf as it was at the time the only widespread EV to be designed from the ground up as an EV”. These comments and support indicate that the Nissan Leaf currently has gained more traction in the Irish market relative to other models.

It appears, however, that the current dominance of Nissan Leaf cannot be taken for granted. Other models in the market are beginning to make progress. Participants explained their choices in relation to these other models, (see again Section 4.6). For example, one user (no 43) explained the choice of a Renault Zoe: “Chose Zoe because I prefer to lease the battery”. In relation to the Tesla Model S, another user (no
56) stated: “I bought a Tesla for awesomeness and a Nissan for utility”. Finally, in connection with a Volkswagen Golf, a participant (no 72) explained: “The reason I bought an e-golf was to invest in the future of sustainable transport and Volkswagens version is the best bar the teslas of course which is out of my price range now.”

The oldest EVs reported in the study were 2011 models (9% of the overall total). The newest model reported was a 2016 model (18%) of the overall total, but it is important to bear in mind that the survey took place in April 2016, so this figure will almost certainly increase over the year.

This research found that 75% of the participants were first owners of their EVs while 25% reported to being subsequent owners. This proportion may change in the coming years as EV use increases and current owners trade up so that more EVs become available for purchase second hand. Redshaw (2012:3) explains the current preference for a newer car. “Many people also prefer to be seen in a newer car than in an older one, unless it is a special older car or they choose to live in an alternative, less consumer oriented world”, (Redshaw, 2012:3). It is also worth noting that there is currently a grant available for purchasing a new EV, as discussed in Chapter 2: 36. This may further explain the apparent inclination for purchasing new EVs.

5.8 Vehicle Status

Interestingly, this research has revealed that only 6% of survey participants were using an EV as a company vehicle. Power (2016:15) states that sales of light commercial vehicles increased by 33.6% in Q1 of 2016, reflecting improved business spending. So it is surprising
that there has not been a corresponding increase in demand for commercial EVs.

One participant (no 4 in section 4.6) commented: “Cheaper than £300/mth in diesel, lower maintenance, no benefit in kind tax charge for company vehicle (Other car cost me £2k/year ) £0 road tax”. It is worth noting that the figures in this statement are reported in pounds, indicating that this user is based in Northern Ireland. In Chapter 2, page 31 it has been suggested that a zero BIK policy should be introduced in Ireland, as has been done in other countries to promote commercial use of EVs.

5.9 Previous Vehicle Ownership

This research found that the majority of survey participants used either a petrol-fuelled vehicle (49%) or a diesel-fuelled vehicle (36%) for transport prior to using an EV. This statistic is interesting, as it shows that a large proportion of diesel and petrol users are switching directly to EVs rather than testing the water first with a HEV.

The survey results also show that only 2% of participants moved from a HEV to a BEV or a PHEV. It was interesting that users did not make a more gradual transition to EVs, starting with a HEV, as suggested by O’Mahony & Wright (2012) in Chapter 2: 28.

5.10 Second Vehicle Status

It was found that the majority of participants had a second vehicle in their household, with 38% of these being diesel models, and 28% being petrol models. Of note, 30% of participants did not have a second vehicle in their household, indicating that in some situations, at least, use of an EV was feasible without an ICE vehicle in support.
5.11 Driving an Electric Vehicle

Participants rated very highly their EVs for: level of safety, level of comfort, environmental friendliness, and the ability to drive short distances. Convenience, long-term cost, and ease of servicing were also rated quite well. The purchase cost is rated good (43%) or fair (30%), so this could be an area for improvement. Many EV purchasers may not see the purchase cost as a barrier, as with the low long-term fuelling costs, the relatively high purchase cost would, in time, be offset.

The survey results indicate that just over 50% of participants rate the cost of battery charging as excellent. This finding may change in the event of introducing battery charging costs, as described in section 4.15. Battery charging availability was not rated favourably, with only 8% of participants rating it as excellent. A number of participants provided further insight on this issue by commenting that charge points are frequently obstructed by the parking of non-electric cars, or that the public charging infrastructure is patchy and unreliable, and possibly not always available 24/7, that there is no way of knowing if a charge point is in use or out of order in advance of arrival there and that repairs, where needed, can be delayed.

The ability to drive long distances was rated "fair" by 47% of participants. Insurance facilities and NCT facilities did not raise any particular concerns. NCT facilities were rated as "N/A" by 42% of participants, but this is explained by the fact that the majority of vehicles in the survey were first owned vehicles, and would not have got to the point of requiring the NCT just yet. For example one participant (no 12, table 4-11) advises that "in terms of NCT and servicing and long-term factors I am not sure yet as car is only a few months old".
5.12 Electric Vehicle Awareness

This survey shows that most of the current Irish EV drivers (72%) feel that the majority of Irish people are not aware of EVs, at all or sufficiently.

Some participants were able to elaborate on their views by providing additional comments. For example, one participant indicated that EVs do not have a clear symbol to show that they are electric. Some participants made comments regarding misinformation and under education regarding EVs. A number of participants felt that awareness is rising, but that the majority of non-EV users remain without knowledge or understanding in relation to the concept of EVs.

5.13 Electric Vehicle Driving Patterns

This research found that the EV is extremely suitable for driving to work or college, and for driving short distances. When asked if EVs were suitable for driving long distances, 29% disagreed and 26% were not able to agree or disagree. It appears that most EV manufacturers are developing batteries (See Chapter 1, section 1.5.4) with a longer range, so this position may improve going forward.

Driving EVs in urban areas was preferred by 69% of participants, whereas only 30% of participants strongly agreed to a preference of driving an EV in rural areas. Driving preferences expressed by participants are set out in Section 4.13.
5.14 Electric Vehicle Charging Patterns

It was also found that for the majority of participants (90.80%) it was possible to charge their vehicle at home. In Section 2.4.2, page 39, O'Brien (2014) made reference to the question of the suitability of certain houses and apartments who for EV users, if there is communal car parking where laying a charging cable across the parking area would create a trip hazard. It was not within the scope of this study to determine the extent of this issue, and in order to determine whether this is a significant factor for potential EV owners, it would be necessary to pose an appropriate question in a future survey.

This research also found that charging at home is preferred by the majority (62%) of EV users, and when charging in public, fast charge points are strongly favoured by 40%. On the subject of the public charging infrastructure, most participants found that it was not adequate for current needs (38%), and 79% of participants strongly agreed that further investment in public charging facilities was required for future needs.

If fees were introduced for public charging, 45% considered that the public charging points would be used less frequently.

5.15 Impact of Public Charging Fees

The participants were given the opportunity to comment in their own words regarding how they feel the potential introduction of charges for public charging would have an impact in Ireland.

After an analysis of all comments provided, the researcher established that 60% of the comments clearly suggested that the introduction of fees for public charging would have a negative impact, 22% clearly
suggested a positive impact, and 18% were unclear or had a mixture of positive and negative thoughts on the matter.

For example, in most cases, the participants who felt that the introduction of charges would have a positive impact, participants felt that it would encourage EV users to use the charging points only when necessary. One participant (no 63, table 4-15) commented: "Would reduce queues at charge points, no opportunistic charging". Similarly, another participant (no 80) stated: "Reserve public charging points for those who genuinely need them and encourage people to charge at home at night when they should be".

For the majority of users who felt that fees for public charging would have a negative impact in Ireland, the main reasons offered were that it was perhaps too early to introduce fees, as the free public charging is a huge incentive for people to buy EVs, and that perhaps there were not enough EV users on the roads yet to justify the introduction of fees, as it may deter new users from moving forward with EVs, and may encourage existing users to revert to driving ICE vehicles. For example, one participant (no 52) commented as follows: "Reducing emissions target would not be reached. Fees would put a lot of people off buying an ev in the early stages of ev driving in this country".

There were a number of participants who had mixed feelings about the potential introduction of fees. One reason for the mixed feelings concerned the uncertainty of what type or level of fees would be introduced. For example, a participant (no 85) responded: "this would depend on the fairness of said charges". A particular level of cost or fees was not specified by the researcher in the question, as the charging scheme previously proposed by the ESB was put on hold and may not be implemented as discussed on page 44, so it was not possible to speculate at this point regarding the structure of possible fees. Other participants who had mixed feelings on the introduction of
public charging fees could see the positive aspect of freeing up the chargers, but also the negative aspect of not trusting the network. For example, a participant (no 66) responded: "If fees are fair and on a per usage basis with perhaps a discount scheme for heavy users then I have no major problem with it. But parking and the enforcement of ICEing is a bigger issue. Also, network needs to be expanded and maintained. Privitisation is perhaps a solution."

5.16 Future Purchasing Potential for EVs

84% of the EV users responding to the survey stated that they would definitely consider purchasing an EV in the future. None of the participants responded that they would definitely not consider purchasing an EV in the future.

This is a positive result indicating that once a user has experienced driving an EV it is unlikely that such a user would revert to using an ICE, under current circumstances, and that the positive attitude of EV users is likely to affect others who may, as a result, be converted to EV use.

5.17 Factors Influencing EV Purchase

The survey responses showed that running cost was the single biggest influencer when it came to considering the purchase of an EV, with 76% of participants choosing this option as an important factor in making the decision to purchase an EV.

The availability of the preferred make and model was relatively unimportant in the context of the decision to purchase an EV, with only 14% of participants choosing this option.
5.18 Participant Suggestions for EVs

The questions posed in the survey allowed participants to have the option to provide their own suggestions for EVs in Ireland, in their own words. A significant number of the suggestions or comments were in relation to awareness and promotion of EVs. For example, one participant (no 35, table 4-18) recommends “special plates to recognize ev”. Another user (no 66) states: “I would love the public relations of EV’s to be pushed”.

Some participants were happy to make suggestions as to how the EV could be marketed. For example, one (no 58) suggests: “they could be used to promote safe driving (...) also having to stop to charge means you have to take a break every 2 hours helps prevent tiredness”. Others would like to see initiatives being pursued more strongly. For example, participant no 66 suggested: “The drive4zero initiaive in cork was a great success. This should be extended, and rolled out to the rest of the country”. Another user (no 35) suggests: “Mandatory use of electric cars in Dublin by 2025 (...) No road tax (...) Overly incentive EVs over PHeVs. 10x the number of fast charge within 2 years.”

The public charging network, and charge point fees were also quite topical. For example, a participant (no 18) replied: “Public charging network needs to be more reliable. When charge points go down, it can be months before they’re fixed”. Some users were quite critical of the work done by the ESB so far in relation to charging points, for example, another participant (no 38) stated: “The ev owner is the first to report a faulty cp, and left stranded for long periods waiting for engineers, or having to call breakdown tow truck. ESB in 5 to six years have not yet installed an interactive communication system between cps and operation centre, not even a cctv installed to monitor operational status of cp”.

128  
R00130868
There were some suggestions that this researcher did not consider acceptable, particularly use of bus lanes suggested by several participants including numbers 1; 6; 8 and 9. This, it is felt, would lead in the long term, and assuming growth in EV use, to undermining the purpose of bus lanes, being to encourage the use of public transport in preference to private vehicle use by ensuring relatively free flow and faster movement for public transport.

5.19 Summary of the Main Empirical Findings

<table>
<thead>
<tr>
<th>Demographical Profile of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
</tr>
<tr>
<td>• The majority of EV users in Ireland (67%) are male, while 33% of the participants are female, based on the responses from survey participants.</td>
</tr>
<tr>
<td><strong>Age Profile</strong></td>
</tr>
<tr>
<td>• The greatest number of EV users in this study are aged 35-44.</td>
</tr>
<tr>
<td>• There were very few EV users aged under 35, or over 64, in this survey.</td>
</tr>
<tr>
<td><strong>Location</strong></td>
</tr>
<tr>
<td>• The primary locations for EV users in Ireland are Dublin, Kildare, Cork, Galway and Meath.</td>
</tr>
<tr>
<td>• The areas most lacking in EV users are Cavan, Donegal, Kilkenny, Laois, Leitrim, Longford, Roscommon, Sligo and Tipperary.</td>
</tr>
<tr>
<td><strong>Employment</strong></td>
</tr>
<tr>
<td>• Most Irish EV users are employed or self-employed</td>
</tr>
</tbody>
</table>

**Vehicle Information**

<table>
<thead>
<tr>
<th>Type of EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pure EVs are currently the preferred model in Ireland among the survey participants.</td>
</tr>
<tr>
<td>• The Nissan Leaf is currently the leading EV in Ireland, followed at a distance by the Renault...</td>
</tr>
</tbody>
</table>
Most of the survey participants are first owners of their EV.

More EV users have moved from petrol or diesel vehicles rather than from any form of EV, including HEV.

In fact, the majority moved from petrol engines.

It was common for EV users to have a second vehicle in their household, and in most cases the second vehicle was a diesel or petrol vehicle.

Almost 30% of EV users did not have a second vehicle in their household, indicating that the EV was their only method of private motor transport.

The primary reasons for purchasing EVs were related to running cost and fuel savings, or environmental concerns.

There were some other interesting motivations, such as the possibility of using automatic transmission, the ‘fun’ of driving the car, or the silence associated with an EV.

The issue that stands out among participant rating for driving an EV is the poor level of charging availability.

Otherwise, most aspects were viewed positively, including the safety, comfort and environmental friendliness of the vehicle.

There is a strong lack of awareness and education in Ireland around EVs, which could be a key barrier to EV adoption.
<table>
<thead>
<tr>
<th>Future Purchasing Potential</th>
<th>The vast majority of EV users in Ireland would be happy to buy an EV again in the future.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A minority of the survey participants did not know, or were not sure, but none of the participants were certain that they would not purchase an EV in the future.</td>
</tr>
<tr>
<td></td>
<td>79% of participants felt strongly that further investment in charging infrastructure is required, so this may become an influencing factor on the future purchasing potential of EVs, if not addressed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fees for Public Charging</th>
<th>A lot of survey participants had mixed feelings about the potential introduction of fees for public charging.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>There were a number of comments referring to the potential for charging fees to deter opportunistic charging, or charging without necessity, so it could be perceived as a benefit.</td>
</tr>
<tr>
<td></td>
<td>Overall the participants were concerned that the introduction of fees for public charging would be premature, and could 'kill off' the take up of EVs in this early stage.</td>
</tr>
<tr>
<td></td>
<td>In general there was a strong preference not to have fees for public charging for now, but many participants are open to charges, if fair and reasonable.</td>
</tr>
<tr>
<td></td>
<td>It would be possible to introduce fees fairly, appropriately, and at the right time.</td>
</tr>
</tbody>
</table>

| Suggestions for EVs | Many of the participants recommended further promotion of EVs, and educating others on their existence. |
- Participants sought further incentives for purchasing EVs, or maintenance of existing incentives until there were more EVs in use on the roads.
- Participants would like to see more done to improve the charging infrastructure, and promote live updates of the status of charging points.

Table 5-19: Summary of Main Research Findings
5.20 Recommendations for the Future of Electric Vehicles

In the course of this research, the researcher found that at times it was difficult to obtain up to date and accurate information regarding EVs. Now that EVs have become more prominent in Ireland, it would be beneficial to have more information about EVs reported in key motoring publications such as the SIMI quarterly reports, or in CSO publications. In addition to this, statistics should distinguish between HEVs, PHEVs and BEVs, to avoid misleading reports, by combining all varieties of EV under the one category.

It is recommended that the government continue offering incentives for new EV drivers, at least for the time being. Within this current research, for example, members of the Irish EV community have expressed strongly their feelings in relation to the proposal to introduce fees for public battery charging. Although fees will most likely become acceptable in the future, it is felt by the majority of EV users that fees just now may be premature, and it would be important to defer any introduction of fees until there are more users on the road, and better control of charging points and information about them. Similarly (SEAI, 2008) have previously urged the need to maintain incentives for a longer period, to allow the market to gain momentum (Chapter 2, page 30).

Awareness continues to be a key issue in relation to EVs in Ireland. It would be valuable, going forward, to create an awareness campaign to inform the general public about the existence, and the benefits of EVs. The Drive4Zero programme in Cork seems to have had some success, but it is important to keep up a momentum on this project. From reviewing the Drive4Zero website\(^{19}\), the “latest news” section comes

\(^{19}\) [http://drive4zero.ie/](http://drive4zero.ie/), available August 14th 2016, 12.25
from April 2015, over one year ago, so visitors to this website may be under the impression that the initiative has expired. The drive4zero team could renew interest by creating some up to date marketing material.

The findings of this study suggest that Dublin might be considered as the most suitable location to launch a project similar to the Drive4Zero campaign. Earlier findings (Chapter 4: page 100) suggest that urban driving; along short distances is the preferred method of transport for EV users. In line with earlier comments from the CSO (2015a), in Chapter 2, page 21, that the average journey in Dublin is typically short, slow-paced, and that most longer journeys take place outside of Dublin, it would seem that Dublin is an ideal location for Drive4Zero type initiatives. One survey participant (no 35, table 4-18) even suggested that EV use in Dublin should be mandatory by 2025.

Although motor dealerships could be involved in the process of generating EV awareness, it seems that more awareness and training could also be helpful within the motor industry itself. For example, participant 10, table 4-18 states “Dealers are not pushing EVs”. Furthermore, this research revealed that there are specific benefits associated with EVs that may not be obvious to the public, such as the lack of gears, and the silence of the vehicle. It may be beneficial to find brand ambassadors in need of these features, to promote them, rather than choosing a more traditional route of choosing individuals who are well known in the media as ambassadors.

Some frustration on the part of current EV users in Ireland was noted in relation to public charging. It is clear that the ESB have worked to create a public charging network across Ireland, but as the number of EV users increases, users are becoming frustrated with the public charging network, in terms of its maintenance, use and obstruction by inappropriate parking. One key recommendation that stands out
would be to invest in some technology that would show the ‘live’ status of charge points across Ireland, this point came up several times in the survey, and through discussions with EV dealers. This development would ease the frustration of EV users arriving at a charge point to find it to be out of order or in use. Perhaps this project could be undertaken in conjunction with one of the universities in Ireland. An analysis by the ESB of the current processes for reporting and fixing charge point failures would also be critical to understand how to move forward, and advance this network.

In an effort to tackle two key issues, awareness, and the problems around public charging, notably “ICEing” at public charge points, or the issues just mentioned surrounding the lack of knowledge of the live status of charge points, the researcher would recommend making available online to the public a facility for reporting all known issues in relation to EVs. As discussed by the BMW salesperson in Chapter 1, page 12, EV users are relying on one another to report charge point issues, and currently do so via social media. AA roadwatch is a well-known platform in Ireland for reporting issues such as traffic and road closures. The AA roadwatch staff have teamed up with many radio stations to report some of the key information as a radio bulletin, and also make regular updates on the AA roadwatch website, and via social media. Since AA roadwatch is already known and trusted, it may be interesting to trial a partnership with this organization to create a sort of “EV watch” where key issues with charge points are reported on the website, via social media and on the radio. This would help inform EV users of issues in certain areas, and of known alternatives and could even help inform the public of the existence of EVs and of the need to avoid blocking charge points.

Finally, this current research shows that there is very little market in relation to EVs as company vehicles. This might well be changed by 20

20 https://www.theaa.ie/roadwatch/newsroom/ available August 14th 2016, 12.47
the introduction of incentives to make EV models more attractive to companies. It is known that battery operated vehicles have worked well in the past, in the case of bread delivery and laundry services in Dublin, (Chapter 1, page 2). Although these vehicles were displaced after new processes for shopping and laundry became popular, it might be worth considering the use of battery-operated transport for companies operating within the city. Companies should be encouraged to innovate, and to think of new ways to make use of battery operated transport, if it will ultimately lead to the reduction of emissions, something that is desperately needed. Of course, if BEVs are not to be displaced once again for commercial use, the parties involved in re-introducing them would need to keep a close eye on new technology. For example the arrival of self-driving vehicles, as discussed in Chapter 1, is an innovation to be watched and if these become popular the demand for a solution for ease of charging in the case of self-driving vehicles will increase.
5.21 A Model for the Future of Electric Vehicles

In this section, the researcher has sought to present a recommended model for EVs in Ireland, as shown in Table 5-21. The model sets out a role for a number of parties who may have an interest in the success of EVs in Ireland. These are the government, the ESB and car manufacturers.

The model also sets out some recommendations regarding two of the most important findings of the research, the need for attention to the brand, image and awareness around EVs, and the possibility that an issue around public charging fees needs to be considered, planned for and addressed very soon.

Further detailed recommendations have been made in section 5.20 and 5.22.
The Role of Stakeholders

- **Government**: To continue to incentivize the use of EVs at least until more of the potential market is aware of the benefits, and to introduce incentives for use of EVs as company vehicles, and to encourage innovation around EVs.
- To plan, monitor and evaluate the progress of EV promotion, as a contribution towards emissions reduction.

- **ESB**: To work on making the charge point information live, and to maintain the charging point network.
- To analyse and improve the process for reporting failures, and for the maintenance of these.

- **Car Manufacturers**: To seek education in relation to EVs, to work on the promotion of second hand EVs.

Communication, Awareness, and Image

- EVs to be included specifically in key motoring publications such as SIMI reports.
- An awareness campaign should take place in schools, in the media, among car manufacturers, and possibly even with the help of an organization such as "AA Roadwatch".
- More effort should be made to eliminate non EV users parking at charge points, such as painting the spaces, providing informative signage, and awareness campaigns on television, or at least on social media.
- Suitable Brand ambassadors should be selected to promote the key benefits of EVs, e.g silence, ease of use, automatic transmission, and emission reduction.

Public Charging Fees

- Charging infrastructure to be assessed, and potential collaboration involving publishing live data on public chargers.
- Careful planning of any proposed introduction of fees for public EV charging, which, if introduced fairly and appropriately and at the suitable time are less likely to meet with significant opposition.
- A recommended model for fees would be to charge on a basis similar to home charging for slow charging, with a premium for using the fast chargers, as advised by some survey participants.

Fig. 5-21: Recommended Model for EVs in Ireland
5.22 Recommendations for Future Research

The topic of EVs is a very interesting, and relatively new one for discussion in Ireland. To date there has been a reasonably slow uptake of EVs in Ireland, but this has been changing in the past year or so. At this point, the researcher has been able to capture some initial quantitative data from the existing EV users in the country. While this data was informative, and provided some interesting findings for this current study, it also raises some new points that could be researched at a later date.

For example, throughout the literature review, Norway has been cited as the country with the most success in promoting EV use. Some further research could be carried out as a comparative study between Ireland and Norway, to determine what benefits, if any, have arisen from EV use in Norway and best practice in maintaining and promoting EV use in Ireland.

Another area that deserves further examination is the low percentage of EVs being used as company vehicles in Ireland, as discovered in Section 4.8. It would be beneficial to perform a detailed review of the process of registering a vehicle for company use, with the view to making recommendations on how this market could be penetrated by EVs.

There are a number of areas that could benefit from further research in relation to battery charging. For example, in section 2.4.2, the percentage of charge point failures has been reported as 15% in a study in Ireland and the U.K. Furthermore, in Section 4, a large number of EV users have reported issues with the charging infrastructure and behaviour around this in Ireland. A dedicated study in relation to charge point distribution, maintenance and
etiquette would be beneficial in the future, if EVs are to become more widespread.

Furthermore, due to the frequently reported issue of 'range anxiety' that has been discussed throughout the literature review, it is clear that continued research around battery performance would always be beneficial. It is likely that driving range will continue to improve, with technological advancements, but in order for this to happen, the subject must be researched continuously.

The participants in this study have clear opinions on the impact of introducing fees for public charging. At this point, a number of participants were undecided due to the unclear nature of the fees should they be imposed. At this point, there is uncertainty as to the level and nature of charges if introduced by the ESB. It would be interesting to perform a study, and discover EV user views in relation to a variety of charging structures, to determine which structure would be most suited to the Irish market. Fees for public charging are in their infancy in the U.K, but in time, it may be worth analyzing whether a similar structure could work in Ireland, or a more suitable structure, if it proves not to be appropriate, as suggested by Brady (2016) in an earlier section. It may also be possible to consider the experience in Norway as a guideline.

Some researchers, such as O'Brien (2014), chapter 2, page 39 have raised the point that some people do not have the possibility of fitting a charger at home due to on street parking or shared parking areas. This topic was considered to be outside of the scope of this research. The quantitative data were gathered from current EV users, therefore it was difficult to know if this is a barrier to EV purchase, but it would be interesting to research this topic further, and if it was a barrier how that might be overcome.
Another topic of interest is to investigate the longevity of EVs. Unfortunately, it was not possible for the researcher to look into this topic in more detail, as the vehicles have been in the Irish market for a mere six years, but it would be very helpful to generate some further research as to the life expectancy of an EV, and the process for the disposal of the vehicle, its battery and its other parts at the end of life, whenever that might be. This further research will be crucial to establish the true extent of the differential in terms of environmental damage or contribution between EVs and ICEs and to determine policy on this issue.

5.23 Conclusions

This study has set out to examine the issues pertinent to EVs in Ireland. The researcher has reviewed the past, the present, and sought to understand if there is a future for EVs in Ireland.

As with any research, this research began with certain assumptions, mainly that there is a grave problem of environmental damage, contributed to in a significant way by the use of ICEs. The assumption that a switch to EV use would alleviate this problem seems safe, but for the moment its continued acceptance will depend, going forward, on a number of factors. These factors include experience of EV use in Ireland over a longer period, learning from the experience of other countries, particularly Norway, ongoing developments of technology both in relation to EVs and other modes of transportation, and of course further research in respect of which some suggestions have been made within.

Only in the light of these things will it be seen if over the lifetime of an EV, when compared with an ICE, the differential in terms of environmental harm that now appears to favour EV use is real, and if so, whether it can be maintained or perhaps improved. EVs were
successfully used in the past, but at a time when environmental concerns were not an issue. The current revival is clearly related to environmental issues and in this context EV use is encouraged by government policy as referred to within. Current or other government policy favouring the use of EVs is likely to be maintained so long as a significant differential between EV and ICE emissions persists and, of course, so long as no better solution to the problem of environmental degradation emerges. Such policy as well as other factors identified in this research have tended to bring about EV use and those who have become EV users, although pointing to certain issues as set out within, have reacted very favourably to their experience and these factors must surely lead to increased demand for and use of EVs.

Increased demand will in turn lead to increased commercial interest in the production and marketing of EVs with increased research and development resulting in time in a greater variety of EVs, with improved performance including at an environmental level and price competition. Increased use will in turn force efforts to resolve issues causing concern at present. Notably the provision of additional charging points and the maintenance of these, as well as those already in place and of course the issue of access. Thus with the undoubted ingenuity of human beings, advances in technology, increased investment of resources and a will and determination on the part of government, existing issues of concern will be overcome and there is indeed a future in which increased use of EVs of ever greater variety and and sophistication will be a significant part.

This researcher remains mindful, however, that increased EV use is but a step and that the very ingenuity that has led to it may lead to many further steps by way of development and refinement or on the other hand to some entirely new development which in time may consign the EV to history. For the moment, at least for EVs, the conclusion must be that having made a contribution in the past,
experienced a revival in recent years, there are even better times to come for EVs in Ireland.
## Appendix A: Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>BEV</td>
<td>Battery Powered Electric Vehicle powered solely by battery</td>
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<tr>
<td>BIK</td>
<td>Benefit in Kind</td>
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<tr>
<td>CIT</td>
<td>Cork Institute of Technology</td>
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<tr>
<td>CP</td>
<td>Charging Point</td>
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<tr>
<td>CSO</td>
<td>Central Statistics Office</td>
</tr>
<tr>
<td>DCENR</td>
<td>Department of Communications Energy and Natural Resources</td>
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<tr>
<td>ESB</td>
<td>Electricity Supply Board</td>
</tr>
<tr>
<td>EV</td>
<td>Electric Vehicle, includes BEV above and PHEV below</td>
</tr>
<tr>
<td>EVI</td>
<td>Electric Vehicles Initiative</td>
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<tr>
<td>EVSE</td>
<td>Electric Vehicle Supply Equipment</td>
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<tr>
<td>FCEV</td>
<td>Fuel Cell Electric Vehicle</td>
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<tr>
<td>FCP</td>
<td>Fast Charging Point</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GHG</td>
<td>Green House Gas</td>
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<tr>
<td>GNP</td>
<td>Gross National Product</td>
</tr>
<tr>
<td>HEV</td>
<td>Hybrid Electric Vehicle</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
</tr>
<tr>
<td>ICE</td>
<td>Internal Combustion Engine</td>
</tr>
<tr>
<td>KPH</td>
<td>Kilometres Per Hour</td>
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<tr>
<td>MaaS</td>
<td>Mobility as a Service</td>
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<tr>
<td>NCT</td>
<td>National Car Test</td>
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<tr>
<td>PHEV</td>
<td>Plug-in hybrid vehicle</td>
</tr>
<tr>
<td>PR</td>
<td>Public Relations</td>
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<tr>
<td>RES-T</td>
<td>Renewable Energy in Transport</td>
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<tr>
<td>SEAI</td>
<td>Sustainable Energy Authority of Ireland</td>
</tr>
<tr>
<td>SIMI</td>
<td>The Society of the Irish Motor Industry</td>
</tr>
<tr>
<td>SUV</td>
<td>Sports Utility Vehicle</td>
</tr>
<tr>
<td>VIN</td>
<td>Vehicle Identification Number</td>
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<tr>
<td>VRT</td>
<td>Vehicle Registration Tax</td>
</tr>
</tbody>
</table>

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Appendix B: Electric Vehicle Models

Appendix B.1: Laundry Van

![Dartry Laundry Van](image)

Appendix B.2: Toyota Prius

![Toyota Prius](image)
Appendix B.3: BMWi3

BMWi3: Driven by the researcher on June 11th 2016

Appendix B.4: Nissan Leaf

Nissan Leaf: Driven by the researcher on June 13th 2016
Tesla Model S: Driven by the researcher on June 20th 2016

THE TESLA MODEL S IS A QUIET MASTERPIECE

No engine means there is extra space up front for a "trunk."

The door handles pop out when the driver gets near.

The car is packed with cameras and radars that enable Autopilot semi-autonomous driving.

The overall lines are smooth and flowing — and highly aerodynamic.

The rear glass slopes to the trunk line, creating a "fastback" design.

There's a very modest amount of chrome.

On all-wheel-drive models, another electric motor sits atop the front axle.

The large battery is on the car's floor.

A small third-row seat can be installed as an option, creating seating for seven.

On rear-wheel-drive models, there's an electric motor over the rear axle.

## Appendix C: Electric Vehicle Pricing

<table>
<thead>
<tr>
<th>Make</th>
<th>Model</th>
<th>Starting Price</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toyota</td>
<td>Prius</td>
<td>€31,450</td>
<td><a href="https://www.toyota.ie/models/prius/index.json">https://www.toyota.ie/models/prius/index.json</a></td>
<td>HEV</td>
</tr>
<tr>
<td>Tesla</td>
<td>Model S</td>
<td>From €64,300</td>
<td><a href="https://www.tesla.com/en-EU/models/design?redirect=no">https://www.tesla.com/en-EU/models/design?redirect=no</a></td>
<td>BEV</td>
</tr>
</tbody>
</table>

Price depends on features chosen, i.e. battery type, rear wheel or all wheel drive, etc.
Appendix D: Renewable Energy

Average Fuel Mix over one month, on August 7th 2016
Available at http://smartgriddashboard.eirgrid.com/#all/generation?scroll=fuel
August 7th 2016, 15.10

Average Fuel Mix over 24 hours, on August 7th 2016
Available at http://smartgriddashboard.eirgrid.com/#all/generation?scroll=fuel
August 7th 2016, 15.10
Appendix E: Sample Size Calculator

Sample Size Calculator

How many people do you need to take your survey? Even if you're a statistician, determining sample size can be tough. To make it easy, try our sample size calculator. We give you everything you need to calculate how many responses you need to be confident in your results.

Calculate Your Sample Size:

- Population Size: 1098
- Confidence Level (%): 90
- Margin of Error (%): 8

Sample Size: 96

*This sample size calculator uses a normal distribution (50%) to calculate your optimum sample size.

Appendix F: Final Survey

Electric Vehicles Survey

Response Summary

91 Total Responses

Collectors

- Web Link 1

Responses Volume

Since 4/13/2016

CLOSED

Overall Survey Status


Analyte Results
Thank you for participating in this survey. Your feedback is important. The survey is being collected as part of a research masters being undertaken from Cork Institute of Technology.

The survey will take approximately 10 minutes to complete.

Please only complete this survey if you are a PHEV or EV owner/user.

Thank you for your time.

Appendix G: Test Survey Example

Choose the statement that best describes your connection to Electric Vehicles

Answered: 9 - Skipped 0

- I am an EV (Pure Electric)
- I am a PHEV (Plug-in Hybrid)
- I am a Hybrid Vehicle
- I do not own or use an...

Test Survey
Appendix H: Pilot Survey Example

Electric Vehicles Survey (Pilot)

**SUMMARY**

- Electric Vehicles Survey (Pilot)
- Questions: 19 Pages: 3
- Survey language: English
- Theme: Aquila

**SEE HOW YOUR RESULTS STACK UP**

Use benchmarks to see how your results compare to industry leaders and get the context you need to:
- Assess performance metrics more accurately
- Set realistic goals
- Make targeted improvements

**OTHERS LIKE YOU**

- Collectors
- Web Link 1
- Responses: 3
- Since 4/12/2016
- Responses Volume

Pilot Survey Example

Appendix I: eCars Charge Point Map

Map data ©2016 GeoBasis-DE/BKG (G2009), Google Terms of Use

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Appendix J: Number of EVs Registered 2007 - 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of EVs Registered for the first time</th>
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</thead>
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<tr>
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<td>23</td>
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<td>38</td>
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<tr>
<td>2009</td>
<td>59</td>
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<tr>
<td>2010</td>
<td>66</td>
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<tr>
<td>2011</td>
<td>103</td>
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<tr>
<td>2012</td>
<td>215</td>
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<tr>
<td>2013</td>
<td>73</td>
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<tr>
<td>2014</td>
<td>238</td>
</tr>
<tr>
<td>2015</td>
<td>497</td>
</tr>
<tr>
<td>Total</td>
<td><strong>1312</strong></td>
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</tbody>
</table>

(CSO, 2016)

Appendix K: Number of EVs Registered 2008 – 2016 Q1

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of EVs Registered for the first time</th>
<th>Number of PHEVs Registered for the first time</th>
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</thead>
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<td>0</td>
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<tr>
<td>2010</td>
<td>18</td>
<td>0</td>
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<tr>
<td>2011</td>
<td>46</td>
<td>0</td>
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<td>2013</td>
<td>49</td>
<td>0</td>
</tr>
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<td>2014</td>
<td>221</td>
<td>35</td>
</tr>
<tr>
<td>2015</td>
<td>466</td>
<td>117</td>
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<tr>
<td>2016 Q1</td>
<td>273</td>
<td>126</td>
</tr>
<tr>
<td>Total</td>
<td><strong>1218</strong></td>
<td><strong>278</strong></td>
</tr>
</tbody>
</table>

(beepbeep.ie, 2016)
References


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