Decarbonising the automotive industry: the future for Irish motorists.

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Decarbonising the Automotive Industry: The Future for Irish Motorists

Robert Maher
Decarbonising the Automotive Industry: The Future for Irish Motorists

By

Robert Maher

A Thesis submitted in the fulfilment of the requirements of:

Master of Business, MBS

Research Supervisor: Dr. Angela Wright

June 2019
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Declaration

I declare that this thesis, which I submit to Cork Institute of Technology for examination in consideration of the award of a Master of Business Degree has been composed solely by myself. It has not been submitted, in whole or in part, in any previous application for a degree. Where I have consulted the published work of others, this is always clearly attributed. Except where stated otherwise by reference or acknowledgment, the work presented is entirely my own.

Signed

Student Number

Date
This research study is an examination of the current state of the Irish automotive industry, which is being reshaped by the imminent shift to electric vehicles. This transition is designed to assist in solving Ireland’s air quality and environmental challenges in line with the worldwide move to combat climate change. The research topic of the decarbonisation of the automotive industry determined the research question: “Decarbonising the Automotive Industry: The Future for Irish Motorists”. This inquiry focuses on private cars owned for social, pleasure and domestic use.

Secondary research was completed to verify the most prevalent and current existing information. A qualitative approach was applied to investigate gaps in observed literature to discover new, empirical findings and answer the research question in this study. In-depth interviews were conducted with industry experts to reveal new views and perspectives from principal authorities impacted by changes in the Irish private transport sector.

A key finding of this study is the challenge of ensuring that the residual values of current vehicles are not negatively impacted by the transition to electric vehicles. It is shown that some Irish motorists should not currently adopt an electric vehicle, where such a vehicle would not meet their range needs. Additionally, the Irish government should focus on reducing the quantity of pre-Euro 6 petrol and diesel vehicles on Irish roads, rather than pushing the increased adoption of electric vehicles, as the most effective method of reducing carbon emissions from the Irish motor industry. This study will be of benefit to Irish motorists, car dealers, members of the Irish automotive industry and government policymakers.
Chapter 1

1.0 Introduction

You look at the challenge facing Ireland and other countries, which is to move from current fossil fuel-based transport and mobility to one where it is entirely zero emissions. We all need to be champions of that if we are to protect the planet. We are really compelled to make sure that the industry policies in the short term actually bring us to the place where we need to be, which is a zero-emitting situation.

Alan Nolan,
Outgoing Director General, SIMI

This chapter outlines the motivation, approach and major stages of the research undertaken and reported in this thesis. Since the turn of the century, focus has increased on the damage caused to the environment, and to human health by the automotive industry. This damage is central to a larger climate problem caused by the use of carbon worldwide. The decarbonisation of the motor industry is seen as a fundamental activity in sustaining the long-term health of the planet and its occupants. This chapter describes the background, context, justification and objectives of this research and introduces each subsequent chapter with a short summary.

1.1 Research Background

Climate change is recognised as the most serious and threatening global environmental problem and the transport sector accounts for one third of the energy we use in Ireland (Department of Communications, Climate Action & Environment, 2019). This research focused on investigating the imminent decarbonisation of the automotive industry in Ireland. Decarbonisation is defined as “the reduction or removal of carbon dioxide from energy sources” (lexicon.ft.com).
Despite the original uptake of electric vehicles (EVs) in Ireland being much slower than anticipated, it remains a priority for the Government in its ambitions to decarbonise the transport sector (eolasmagazine.ie). The Irish Government has set an ambitious target that by 2030 all new cars and vans sold in Ireland will be zero emissions (or zero emissions capable) (Department of Communications, Climate Action & Environment, 2019). O’Doherty (2019) suggests that EVs offer immediate and long-term carbon savings. Additionally, EVs offer an increasingly realistic solution to the challenge of reducing the transport sector’s Greenhouse Gas Emissions, increasing the use of renewable energy in transport and reducing reliance on imported fossil fuels (Department of Communications, Climate Action & Environment, 2019).

The Paris Agreement was signed in 2016 in which member States committed to taking measures in dealing with Greenhouse Gas Emissions mitigation. Its central aim is to strengthen the global response to the threat of climate change through nationally determined contributions (United Nations). The EU is concerned that an eighty percent reduction on 1990 carbon levels by 2050 will not meet the objectives of the Paris agreement (Electricity Association of Ireland, 2019). Nevertheless, to meet EU targets, sixty percent of new car sales will be EVs by 2030 (O’Doherty, 2019).

1.2 Context and Justification

Vehicle electrification is now seen as the main decarbonization pathway for nearly all road-based transportation (Cano et al. 2018). Weiss et al. (2019) indicates that EVs are becoming economically more efficient in mitigating the negative impacts of road transport. Governments are aware of this and in recent years have been creating and applying a variety of policies and regulations with the aim of promoting the uptake of EVs (Mazur et al., 2018).
Worsening urban air quality has also led several countries to announce intentions to ban sales of internal combustion engine vehicles (Cano et al. 2018).

Meeting Ireland’s emissions targets is only possible with an almost complete move to electricity (Mazur et al., 2018). On the other hand, it is suggested that Ireland is in danger of coming up short on its renewable energy targets and paying millions in penalties to the EU (IIEA, 2018). A previous investigation by Ortar & Ryghaug (2019) demonstrates that transitions towards sustainable energy and transport systems will be wide-ranging and challenging, requiring extensive public support. Mazur et al. (2018) suggests that influencing car buyer’s preferences is the single most important measure on its own in the current paradigm and alleviating the EV infrastructure availability improves the position of EVs (Mazur et al., 2018). Public investment will have to play an important role in achieving sustainable, low-carbon economic growth; in particular, supporting infrastructure for low-carbon private transport (European Commission, 2018).

The issue of EVs poses a strategic and economic challenge in many areas for policymakers, and it is becoming an increasingly relevant consideration for the future of the automotive industry (Ortar & Ryghaug, 2019). Fernandes (2019) previously reported that Ireland is making progress towards the decarbonisation of its energy system, however the use of electric vehicles must be accelerated. Tsakalidis & Thiel (2018) conveys that various government authorities, organisations, companies and research entities have produced multiple estimations and projections relevant to the evolution of the EV market evolution and penetration, however, this researcher was unable to find studies of this nature grounded in an Irish context. Additionally, the best course of action for the Irish motorist has yet to be determined.
Mulholland *et al.* (2018) modelled the intangible costs from model availability, risk related disutility, range anxiety, and recharging infrastructure availability, but recognized that there are other preferences which consumers may have when purchasing a vehicle that are outside of this scope. This new research considers the impact of the Irish motorist’s decision to purchase a vehicle in the near future and demonstrates that the perceived future residual value of private cars will likely be altered by a shift to EVs.

Tsakalidis & Thiel (2018) reveals that support measures stimulating EV demand in the EU Member States are not harmonised and this has led to a certain market fragmentation both in terms of EVs on the road and availability of publicly accessible recharging infrastructure. In Norway, where EV adoption has been extremely successful, this inquiry reports that there have been negative impacts to policies and attitudes here also. The case in Norway shows that over-incentivising EV adoption can lead to an increase in car use, which may increase carbon emissions in countries with a high reliance on fossil fuelled energy sources. Therefore, it is critical that the Irish motorist, as well as other stakeholders in the Irish motor industry, are informed and can prepare appropriately for the transition from fossil fuelled vehicles.

This research compares the views of a range of stakeholders in the Irish motor industry, each with different perspectives and views. The broad span of interview respondents was chosen for the purpose of ensuring the findings and recommendations presented are not at odds with a particular stakeholder or group of stakeholders.

This researcher has centred the study around private cars in Ireland, i.e. cars owned for social, pleasure and domestic use. As an Irish motorist, the researcher is a key stakeholder in the outcome of this current investigation. This research includes the comments of some key
stakeholders in the imminent shift to EVs in Ireland. The research techniques and methodologies are discussed in detail in Chapter 3.

Interview respondents have been selected based on their unique knowledge and experience. All respondents are Irish citizens with a unique interest or involvement in the motor industry. This includes management level car dealers, a representative of a key government department, key stakeholders in the development of Irish EV infrastructure, and climate experts with unique knowledge of the environmental impact of the motor industry and the rationale for decarbonisation. This allows the researcher to build an informed, accurate prediction with regard to the next decade in the Irish motor industry, and what it will mean for the Irish motorist. The shift to EVs is expected to change how Irish motorists use their private vehicles, how they refuel them, as well as alter their purchase behaviour.
1.3 Aims and Objectives

The overall aim of this new research is to investigate the current state of the transition to zero-emission private transport in Ireland. Existing literature and articles relevant to the electrification of private vehicles and the reasoning behind it is a fundamental base for this research. Additionally, examining policies and trends around the world in order to compare against the Irish context is crucial.

The main objectives are as follows:

- to gather and review existing data relevant to the subject area and present a wholistic analysis of the secondary data
- to identify knowledge gaps and limitations in existing research
- to collect and analyse the views of key stakeholders in the decarbonisation of the Irish motor industry
- to evaluate the findings and provide future recommendations for Irish motorists, the Irish automotive industry and government policymakers
- to discover recommendations for practice and develop solutions for Irish stakeholders in the automotive industry
- to identify potential areas for future research
1.4 Research Focus

Chapter 1
This Chapter has outlined the background, context and justification of this research. It indicates that further investigation into the decarbonisation of the private car industry in Ireland is relevant and necessary.

Chapter 2
Chapter 2 presents the theoretical perspective. This research relates to the motor industry and its worldwide impact on public health and the environment. It continues with an investigation into sustainable replacements for fossil fuels in the industry and details the impacts and requirements of electrifying private cars. Existing trends in the adoption and cost of EVs are discussed and policies in different regions are compared. Chapter 2 presents the existing research that forms the basis for this new study.

Chapter 3
Chapter 3 describes the techniques and methodology involved to answer the research question and achieve the aims and objectives set out in this new study. Elements of the research are defined and justified in detail. The interview respondents are also introduced in Chapter 3.

Chapter 4
Chapter 4 comprises the primary data gathered for this new examination. The interview respondent's comments are organised, and common themes are demonstrated.

Chapter 5
Chapter 5 expands on the main findings of this research. The themes discussed in Chapter 4 are further analysed and key recommendations for practice are outlined, together with conclusions and summaries.
2.0 Introduction

This chapter will review the literature in relation to the decarbonisation of the Irish automotive industry. The literature review is used to provide evidence for the purpose of the study and to identify the underlying problem that will be addressed by the inquiry (Soiferman, 2010, p.8). Relevant sources were studied in order to identify gaps in the literature. The researcher consults and references peer reviewed sources where possible, yet, many relevant articles pertaining to the topic came from non-peer reviewed articles. This is due to the novel nature of the topic under review (see 3.4 for further details). It is conveyed that damage to public health and the environment are key underlying factors driving the need for change, however transitioning to electric powered vehicles will bring about a variety of new challenges. The review of the literature reveals why there is a need to shift from fossil fuelled transportation and concludes that electric vehicles (EVs) are the most suitable replacement.

2.1 Internal Combustion Engines (ICEs) and Public Health

2.1.1 Lead Fuel and Public Health

Throughout the twentieth century, the use of lead as a petrol additive proved catastrophic for public health (Landrigan, 2002). Gavaghan (2002) condemned leaded petrol as one of the worst offenders against public health. Soon after the production of leaded petrol began in the 1920s, an outbreak of acute neuropsychiatric disease appeared among workers, resulting in five deaths (Rosner & Markowitz, 1985). Landrigan (2002) listed consequences of lead exposure such as loss of intelligence and disruption of behaviour, and because the brain has little capacity for repair, these effects are permanent and untreatable.
Lead was first added to petrol in 1922 to improve engine performance, and by the 1970s, almost all petrol produced around the world contained lead (Landrigan, 2002). In Western Europe, the removal of lead from petrol between 1976 and 1995 saw close to a ninety percent reduction in mean blood lead level (Thomas, 1995). In 1994, the UN commission called on governments worldwide to switch from leaded to unleaded petrol, yet by the end of 2000, only 42 countries, including China, New Zealand, the US, and some European countries, had phased out, or, were phasing out lead from petrol (Gavaghan, 2002). Nevertheless, the worldwide spread of leaded fuel is an example of willingness to adopt a promising but unproven new technology without heed to its possible consequences (Landrigan, 2002).

2.1.2 Unleaded Petrol and Diesel and Public Health

“Eighty percent of increases in carbon dioxide emissions in the past 45 years have come from road transport” (Bjerkan et al., 2016, p.170). This echoes the analysis of Verhoef (1994) who proposed that road traffic entails considerable social costs and at the same time, places a significant burden on the public purse. Ristovski et al. (2012) showed that particulate matter emissions from diesel engines are a major contributor to the ambient air pollution problem. Additionally, per travelled distance, diesel has been estimated to be over ten times higher than the emission from petrol engines of equivalent power running on unleaded petrol (Nauss, 1995).

While Hennessy & Tol (2011, p.1) argued that carbon dioxide emissions may be lower per distance travelled because “diesel engines are more fuel efficient than petrol engines”, Sydbom et al. (2001) previously showed that they give rise to a greater amount of nitrogen oxides and aldehydes, which are particularly prone to cause irritation of the lung. Studies have verified that long-term exposure to diesel exhaust particles (DEPs) induces tumour formation in lungs (Singh et al., 2017). Analysis of the lung after DEP exposure has demonstrated
increases in lung weight, and an increased number of particles in the lung (Sydbom et al., 2001). Sjögren (1998) also found that long-term inhalation of DEPs retained in the lung induces an inflammation which elevates the risk for blood clotting and heart disease. This is evident from observations made in Japan which suggest that children living close to roads with heavy traffic are more likely to develop allergies (D’Amato et al., 1998). Gupta (2018) emphasizes that public transportation in India is already responsible for substantial polluting emissions and is predicted to double by 2030. The World Health Organization revealed that fourteen of the twenty most polluted cities in the world are in India and as a result, the Indian government aim to phase out private internal combustion engine (ICE) vehicles by 2022 (Pradhan, 2018). That said, Ghosh (2018) contends that India’s obsession with affordable small cars could delay the government’s plan to phase out new sales of ICES, even by 2030. Elsewhere, Italy carries the heaviest burden in Europe in terms of number of premature deaths due to small particle pollution from diesel cars (Nosi et al., 2017). In Ireland, the “major contributor to greenhouse gas (GHG) emissions is agriculture” (Browne et al., 2011, p.23). Acquaye & Duffy (2010, p.3) “assumed that all fuel used was diesel since the vast majority of plant and construction machinery in Ireland operates on diesel fuel”.

2.1.3 Unleaded Petrol and Diesel and the Environment
Despite the health concerns, in the early 2000s, replacing petrol fuelled cars with diesel ones was viewed as an efficient way to decrease carbon dioxide emissions (Zervas, 2006). In Ireland, shifting vehicle registration and motor taxes from engine size to potential emissions, as introduced in July 2008, “has led to a substantial shift to diesel cars, particularly for larger engines”, and this has led to a reduction in tax revenue of half a billion euro per year (Hennessy & Tol, 2011, p.15). This contradicts the requirement for the government to collect
“considerable revenues through fuel taxes, road taxes and turnpike tolls” to support the significant burden road traffic places on the public purse (Holtsmark & Skonhoft, 2014, p.160).

“To tackle the environmental problems associated with individual motorization, two paths are conventionally considered; improvements in the technical fuel efficiency of the car fleet, or alternatively, reducing the number of car trips” (Klockner et al., 2013, p.1). The former is answered with catalysers fitted to modern engines, which emit harmful substances in relatively moderate quantities (Ji et al., 2012). At over 100 million, Europe now has twice as many diesel cars as the rest of the world (Nosi et al., 2017, p.3). Walmsley (2015) recommended the introduction of a more sustainable biofuel however, as an alternative to conventional petrol and diesel, and as a possible step for decreasing carbon emissions from transport.

2.2 Biofuel

2.2.1 Advantages of Biofuel

Biofuel is a common name given to an alternative fuel that is produced from vegetable oils and animal fats (Ramadhas et al., 2005). Up to forty years ago, Velguth (1983) saw vegetable oils as a useable fuel alternative for diesel engines. It is recommended to shift incentives for private cars from diesel to biofuel blends in order to tackle climate change (Mansson et al., 2014). Unfortunately, the production cost of biofuel is nearly double that of diesel (Franco et al., 2010). Among the advantages however, is a reduction of GHG emissions and increased sustainability (Sundvor & Lopez-Aparicio, 2014). Zah et al. (2007) showed that biofuels can reduce GHG emissions by thirty percent when compared to fossil fuels. Additionally, biofuels are “in the cost range of petroleum derived transport fuels at the service station” (Browne et al., 2011, p.21).
The Irish Minister for Communications, Climate Action and the Environment Richard Bruton TD promises that from January 2019, the level of Biofuel will increase from eight percent to ten percent, increasing to eleven percent from January 2020 (O’Brien, 2018). This would mean replacing an estimated seventy million litres of fossil fuel with biofuel and is estimated to save almost 200,000 tonnes of carbon each year (O’Brien, 2018).

2.2.2 Biofuel Production
Biofuel is produced in various countries worldwide and each country has allocated a certain percent of land for cultivating crops for producing biofuel, and poses their own biofuel policy (Avinash et al., 2014). The EU Renewable Energy Directive promotes biofuel production and sets GHG savings targets compared to conventional fuels such as petrol and diesel (European Commission, 2009). Ireland currently produces 17.5 percent of the biofuels that are used domestically; however, no Irish farmers are producing biofuels at present as it is all derived from used cooking oil and animal fat (McCormack, 2018). The Irish Cattle and Sheep Farmer’s Association (ICSA) president Patrick Kent said farmers should be part of the solution on climate change, but this requires a positive policy framework to allow farmers to grow more renewable energy crops in Europe (Phelan, 2018).

The biofuel policy aims to achieve twenty percent of energy used in the EU and almost ten percent of each member state’s transport fuel coming from the renewable energy sources by 2020 (Franco et al., 2010). Despite this, McCormack (2018) is concerned that the Irish Government is supporting moves that minimise the use of biofuels. Ireland’s arable land is already fully utilised for food and beverage production, and the conversion of permanent pastureland to arable required by most energy crops is restricted by EU agricultural policy, resulting in most transport fuel being imported (Browne et al., 2011, p.22). Ireland imports more than sixty-six percent of its transport fuel from the UK (Smyth et al., 2009). It was
recently revealed that Ireland accounts for 12.4 percent of all UK exports to the EU, with fuel as the single largest export (Flanagan, 2019).

Therefore, due to less availability, land use competition and underdeveloped technologies, biofuels currently can only replace fossil fuels to a very limited extent (Raslavičius et al., 2014). Moreover, Walmsley et al. (2015) warned that converting unconventional energy resources into transport fuels, even after considerable research effort, remains a technical challenge and struggles to economically compete with oil-derived liquid fuels. Therefore, "electric vehicles (EVs) are recognized as one of the most promising avenues to materially reduce automobile contributions to petroleum dependency, air pollution and carbon dioxide emissions" (Nanaki & Koroneos, 2013, p.261).

2.3 Electric Vehicles (EVs)

2.3.1 Trends in EVs

Gupta (2018) expects forty percent of private vehicles and public transportation to go completely electric by 2030. Jones (2018a) agrees, commenting that half of new car sales will be ultra-low emission models by 2030; either plug-in hybrid cars with a petrol motor to extend their range, or pure electric vehicles. Certainly, it is expected that by 2040, more than half of all new cars will be electric (Bloomberg, 2018). Tokyo-based market research specialist Fuji Keizai forecasts sales of 11.25 million EVs globally in 2035, nearly 15 times the number sold in 2017 (Furukawa, 2018). Before that, the International Energy Agency’s Electric Vehicles Initiative, which includes fifteen countries, aimed to reach combined annual EV sales of 5.9 million by 2020 (International Energy Agency, 2013). Yet, in 2017, just 760,000 EVs were sold worldwide, with the largest demand in China, followed by Europe, the US and Japan respectively (Furukawa, 2018). It is now believed that EV sales in 2020 will be closer to four million, but this figure is expected to triple by 2025 (Schmidt, 2019). Pyper (2019) reports an
eighty-one percent increase in US EV sales in 2018. EV sales in Europe grew thirty-one percent in 2018 (Sigal, 2019).

EVs are predicted to achieve cost parity with ICEs in the next five years, which will trigger a momentous shift in car sales (Bloomberg, 2018). Jones (2018a) outlines that Nicholas Lynes, Head of Roads Policy at RAC stated that “cheaper purchase costs and a superior charging infrastructure should provide the tipping point for a transition to zero-emission vehicles”. By 2040, 559 million EVs are forecasted to replace one third of the worldwide fleet of ICEs (Bloomberg, 2018).

2.3.2 EVs vs ICEs

Wu et al.’s (2015) depiction of a key difference between EVs and ICE vehicles is supported by Vatanparvar et al.’s (2018) suggestion that EV energy consumption depends on the route travelled and each individual car driver’s driving style. “The EV user tries to balance the trade-off between travel time and energy consumption, which is different from traditional ICE vehicle drivers, whose travel time is the dominant factor in determining their selection” (Wu et al., 2015, p.7). A study by Ryghaug & Toftaker (2014) highlighted that driving an EV seems to make transportation needs and habits more visible to the users. “This is due to the material features of the electric car, which in many cases forces one to think about the range and capacity of the car in daily life” (Ryghaug & Toftaker, 2014, p.162). In parallel, Palmer et al. (2018, p.116) concluded that “the incremental cost of an EV depends largely on the style of driving”.

Wu et al. (2015) described one of the most advanced features of an EV as the regenerative braking system (RBS), which uses the electric motor to recharge the battery by applying negative torque to the drive wheels and converting kinetic energy to electrical energy.
(Vatanparvar et al., 2018: Wu et al., 2015). It is argued that “by providing information or feedback on the EV energy consumption, EV users may consciously adjust their driving behaviours in order to improve energy efficiency” (Wu et al., 2015, p.9). In fact, the “accuracy of the EV power consumption estimation has been at stake due to lack of driving behaviour consideration” (Vatanparvar et al., 2018, p.2). Al Faruque & Vatanparvar (2016) considered that other accessories in EVs, such as the heating and ventilation, system, have proved to be another major contributor to battery energy consumption, and will also have a behavioural impact with EVs.

Simons (2016, p.2) considered that “passenger cars fulfil a very high diversity of transport demands on a broad range of road types and according to different driving styles”. Reactions and adjustments to vehicle progress, based on the driver’s perception of the route and vehicle condition are described as driving behaviour (Vatanparvar et al., 2018). For example, EVs are much more efficient when driving on interrupted urban routes than uninterrupted freeway; this characteristic could significantly change driving behaviours and travel behaviours in order to save energy (Wu et al., 2015).

2.4 EVs and the Environment

It is well documented that the use of EVs “substantially reduces emissions” (Klockner et al., 2013, p.4). This is because EVs can achieve better fuel economy and lower exhaust emissions than ICEs, and as a result, they form a viable solution to the environmental pollution problem and the energy crisis caused by urban transportation (Gong et al., 2008). The EU intends to reduce GHG emissions by more than eighty percent below 1990 levels by 2050 (Welsch et al., 2014, p.601). Zeman (2018) notes that the rise in economic growth and the rise in electricity consumption has made it harder for the goal to be achieved.
Holtsmark & Skonhoft (2014, p.162) argued that, "when assessing the possible GHG net benefit of EVs, we also need to take into account whether EVs replace or come as an addition to conventional cars" (Holtsmark & Skonhoft, 2014, p.162). Klockner et al. (2013) demonstrated that nearly fifty percent of normal car buyers only have one car per household, whereas for EV buyers, only 9.5 percent have it as their only car, which corresponds to a need for an additional car. Additionally, Holtsmark & Skonhoft (2014, p.165) noted the potential negative impact of EVs on the environment resulting from the fact that "EV driving may replace journeys otherwise taken by train, bus or bicycle".

Therefore, Hickey (2018) warns against hurrying towards an EV society because a dramatically increased demand for electricity may not be met by an adequate supply of green electricity. By 2040, EVs will draw 1,900 terawatt-hours of electricity, according to Bloomberg, which equates to ten percent of humanity’s electricity produced in 2015 (Randall, 2016). Moreover, the power sources used for electricity generation, infrastructure conditions, and regional energy demand profiles may vary the carbon dioxide emissions and operation costs of EVs, which questions the perceived economic and environmental benefits (Noori et al., 2016).

2.4.1 Electricity Generation

Levinson (2014) advised that EVs can cause significant emissions when the generation and transmission of the electricity is considered. Huo et al. (2015) agreed that the benefit to urban air quality depends highly on the cleanliness of the regional electricity generation mixes and the urban share of electricity generation. “Two-thirds of the world’s electricity, feeding EV batteries, is currently generated from fossil sources, so, if EVs are to contribute significantly to solving the world’s carbon dioxide problem, there needs to be a fundamental revision of electricity production” (Holtsmark & Skonhoft, 2014, p.162). Comparably, “electricity generation is responsible for more carbon dioxide emissions and other air pollutants than any
other sector in the US economy” (Zivin et al., 2014, p.24). Accounting for more than forty percent of emissions in the US alone, electricity generation is the primary source of carbon dioxide emissions worldwide (EPA, 2016).

Carbon dioxide emissions depend on the source of the electricity, the electricity mix and the production efficiency (Holtsmark & Skonhoft, 2014, p.163). Furthermore, Huo et al. (2015) argued that in regions where coal dominates in the generation mix, EVs can actually increase the total urban emissions of air pollutants. What’s more, Hickey (2018) outlines that the Swedish Environment Institute found that carbon dioxide emissions from EVs are comparable to those of ICEs, despite the promises of zero emissions by the car industry. Holtsmark & Skonhoft (2014, p.161) concluded that “the reduction in health-damaging pollutants due to a shift to EV driving should therefore not be exaggerated”.

2.4.2 EV Life Cycle Emissions
Nanaki & Koroneos (2013, p.265) clarified that “while electricity consumption does not emit carbon dioxide at the point of use, the GHG intensity of electricity used to charge an EV is a key parameter in estimating the life cycle GHG impact”. “Life cycle emissions means that both the GHG emission related to the production of the vehicle and its components and the driving over the whole lifetime of the car are taken into account” (Holtsmark & Skonhoft, 2014, p.162). As well as this, the post-EV market must be considered, which includes battery re-sale and recycling, and EV recycling (Du & Ouyang, 2017). “The operation phase of EVs includes electricity generation, maintenance, repairs, and the upstream impacts of each of these processes” (Onat et al., 2017, p.633).

Still, there is hope that the expected market diffusion of EVs may mitigate sustainability concerns like GHG emissions or urban smog (Font Vivianco et al., 2014). Considering that EVs
transfer a significant proportion of vehicle life cycle emissions from near-ground tailpipes in populated cities, to high chimneys that are usually far from people, EVs may be able to reduce the urban pollutant concentrations and benefit human health (Huo et al., 2015). Additionally, it is evident that “a switch from ICEs to EVs offers up to a twenty-five percent reduction in the total lifetime GHS emissions for cars of comparable sizes” (Holtsmark & Skonhoft, 2014, p.164). Wu et al. (2015, p.3) argued that “EVs can reduce GHG emissions by about thirty-three percent, compared to today’s ICE powered vehicles”.

“The EVs’ environmental impacts stem mainly from two life cycle phases: well-to-tank, which covers upstream impacts such as those connected to the vehicle’s fuel supply, and tank-to-wheel, which covers tailpipe emissions” (Onat et al., 2017, p.632). While EVs do not emit as much emissions from tailpipes, they can still cause particulate matter emissions from brake and tire wear, which are assumed to be the same as those of ICEs (Huo et al., 2015). Studies estimate that micro particles from tyres make up 5-10 percent of microplastics deposited in the oceans (UK Department for Environment, Food and Rural Affairs, 2018). Holtsmark & Skonhoft (2014) described it as paradoxical that the use of spike tyres, for example, during the winter driving season in Norway, and the associated asphalt particle pollutants, is encouraged. Also, “it is important to improve the well-to-tank impact” (Nanaki & Koroneos, 2013, p.265). Huo et al. (2015) agreed that the well-to-tank stage accounts for the majority of GHG and air pollutant emissions.

2.5 The Energy System

At the macro level, because of the ways electricity is generated, the global environmental impact may be worse with more EVs, than with modern, fuel efficient ICE vehicles (Hawkins et al., 2012). Carbon is emitted in the manufacture of EVs and in generating electricity to
charge batteries (Hickey, 2018). Both China and the US have significant coal shares in their national generation mixes, which makes electricity generation a significant contributor to their national pollutant emissions and can negatively influence the GHG emission performances of EVs (Huo et al., 2015). Tamayo et al. (2015) characterized regional life-cycle carbon dioxide emissions of EVs across the US and showed that regional variations can significantly change the carbon dioxide emission factors in different regions. Dependency on fossil energy sources also creates a dilemma because the economic growth dependent on energy inputs, which are currently largely provided by fossil energy sources, are not easily replaceable currently, and by nature, they face extinction in the foreseeable future (Halicioglu & Ketenci, 2018).

It is reported however, that “low carbon energy production, such as renewable energy production is a key to realize carbon dioxide savings potential” (Nanaki & Koroneos, 2013, p.265). Gass et al. (2014, p.3525) asserted that “EVs can clearly contribute to a decarbonization of the transportation system if renewable electricity is used”. In 2025, as the share of coal-based electricity decreases and emissions from power plants are controlled further, EVs could offer greater reductions in GHG and air pollutant emissions (Huo et al., 2015). For now, “when electricity comes from fossil fuels, the EV remains competitive only if the electricity is generated on-board”, as with hybrid vehicles (Nanaki & Koroneos, 2013, p.265). Nevertheless, it is evident that production should be redefined with new inputs of energy such as renewable resources of hydroelectricity, wind energy, and solar energy (Halicioglu & Ketenci, 2018).

2.5.1 Renewable Energy
If EVs are charged with eighty percent renewable electricity, they could reduce GHG emissions by more than eighty-five percent, reduce sulphur and nitrous oxide emissions by more than
seventy-five percent, and reduce particulate matter emissions by more than forty percent (Huo et al., 2015). Deane (2018) reports that in theory, with enough wind turbines, solar panels and smart storage solutions, enough electricity could be produced at any one point in time to meet all public energy needs, however, the wider balance of evidence shows that Ireland’s future energy needs are more likely to be met with a mix of fuels and technologies including fossil fuels.

Haicioglu & Ketenci (2018) infer that EU countries are going in the right direction to transform their production function as such that more renewable energy inputs compared to non-renewable energy inputs will be used in the near future. Nevertheless, Malekmian (2018) finds that it is unlikely that fossil fuels will be significantly reduced by 2050 due to the complexity in changing over certain industries, such as aviation, and equipment to run off renewable electricity. Air quality, climate change, and electricity deregulation drives renewable electricity policy (Stokes & Breetz, 2018). “In the EU, wind and solar stood for more than half of all new power investments in 2013” (Lund et al., 2015, p.2). Correspondingly, EVs will offer better environmental benefit as power plants become cleaner in the future (Huo et al., 2015). Marriott (2018) notes that countries like Norway and New Zealand have high electricity generation from renewable sources, making adoption of EVs particularly attractive for reducing emissions. In 2014, 97 percent of imported energy in Ireland came from fossil fuels (Joshi et al., 2018). Similarly, the decision by Germany’s Federal Council to phase out petrol and diesel vehicles by 2030 is at odds with the government’s investment in renewable energy, which is not enough to produce the extra power that electric cars will need (Csala, 2017). Germany has as a goal to meet 80 percent of the power demand through renewables
by 2050, however, tariffs on renewable energy have increased the electricity price by over 20 percent since 2008 (Lund et al., 2015).

2.5.2 Climate Policies

"The European Renewable Energy Directive aims to achieve twenty percent renewable energy by 2020 and a minimum target of ten percent of the energy to be used for transport" (Sundvor & Lopez-Aparicio, 2014, p.100). Csala (2017) notes that while making up the deficit with electricity generated by burning natural gas would create 131 million tonnes of carbon dioxide, this would still save thirty million tonnes on 2014 road-transport emissions. Between 1990 and 2009, Ireland experienced substantial expansion of the transport sector with an increase in final energy consumption of approximately 150 percent over the period (Howley & Holland, 2016). "The target set for Ireland is twenty percent less emissions by 2020 relative to 2005" (Browne et al., 2011, p.23). The country exceeded its 13.2 percent 2010 target with 14.8 percent (Cleary et al., 2016). "Ireland is committed to limiting its GHG emissions to 84 percent of 2005 levels by 2020 under the EU’s ‘20 20’ initiative" (Acquaye & Duffy, 2010, p.1). It is shown that the Irish government is keen to promote wind turbines in order to decarbonise its energy system, with a major push for wind penetration to increase as part of new incentives (Kealy, 2017, p.418).

In an attempt to promote a switch to EVs, the recent focus on climate policies aims to increase demand for electricity (Zivin et al., 2014). For example, the Chinese government has issued a series of policies and standards in order to accelerate the construction of charging infrastructure, and also intend to improve the utilization rate (Du & Ouyang, 2017). It is generally accepted that there are two ways to influence better energy usage; using less energy to do the same job or seek to implement alternative natural energy sources (Kealy, 2017, p.418). Stokes & Breetz (2018) contend that in the early stages of policy adoption, there
is high uncertainty, and renewable energy potential is often overestimated or underestimated. Previously, Stern (2004) argued that the impact of positive policy changes on environmental quality will be limited due to the fact that there are limits to substitution and technological change, and noted that innovations that reduce one type of hazardous emission (for example, flare gas desulfurization) often produce a different type of waste that must be disposed of, as well as other disruption required to implement the technology.

Ireland aims for forty percent of electricity demand to come from renewable sources, mainly wind by 2020, and Ireland has sufficient onshore indigenous wind energy resources to exceed this (Cleary et al., 2016). In 2015, 22.8 percent of Ireland’s energy was generated from wind power (Mason et al., 2018). Zaman (2018) asserts that an instantaneous wind penetration level of 60-80 percent is technically feasible. This has prompted increased interest in wind farm development, with the potential for Ireland to become one of the world’s largest power-from-wind producers as a percentage of total supply (Kealy, 2017).

Previously, Browne et al. (2011, p.21) considered that allowing for a realistic collection of organic residues and grass silage from 2.5 percent of pasture land would allow Ireland to surpass its ten percent target for renewable transport energy by 2020, reducing the dependence on imported fossil fuels, allow compliance with the EU Landfill Directive, and reduce pollution of waterways.

It must be considered however that “introducing variable power generation such as wind and solar power may increase the need of energy system flexibility” (Lund et al., 2015, p.3). Mallig et al. (2016) showed that the concept of introducing EVs to reduce total carbon dioxide emissions can only succeed if combined with appropriate, intelligent charging strategies, that make use of electric energy only when a surplus of renewable energy is available.
2.5.3 Energy System Flexibility

The performance of an EV depends significantly on the efficiency of the employed energy management strategy (Shabbir & Evangelou, 2014). Whether EVs become the most sustainable alternative to ICEs depends on whether, and how quickly, the world succeeds in changing from fossil-sourced power to power generation from other sources, such as wind, sun and water (Hickey, 2018). Moreover, “the growing reliance on renewable power sources requires a high degree of flexibility in the power system” (Welsch et al., 2014, p.601). It is noted that wind characteristics in winter are significantly different from other seasons, altering the potential availability of the energy (Ren et al., 2018). Lund et al. (2015) agreed that improving the flexibility of the energy system in parallel with increasing the renewable energy power share would be highly important. Stokes & Breetz (2018, p.3) conclude that sustained political support for emerging technologies will be necessary to complete the renewable energy transition.

Di Cosmo et al. (2014, p.15) showed that “time-of-use (TOU) tariffs and information stimuli are effective in influencing electricity consumption”. “The availability of domestic electricity is not an issue so long as vehicles are charged at night, when excess electric generating capacity is available” (Wu et al., 2015, p.3). “Smart meters, in conjunction with TOU pricing, can facilitate an improvement in energy efficiency by providing consumers with enhanced information about electricity consumption and costs, and thereby encourage a shift away from consumption during peak hours” (Di Cosmo et al., 2014, p.1).

2.5.4 Energy Storage

“In the US, efforts have been made to enable incentives to store energy, through opening electricity markets to energy storage and permitting companies other than large utilities to sell ancillary services” (Lund et al., 2015, p.29). With the newly introduced Vehicle-to-Grid
(V2G) system, EVs can serve as a storage means for the electric power grid (Noori et al., 2016). For example, some applications of solar energy utilization are currently being explored such that excess solar energy can be sold to the grid and withdrawn as needed (Noori et al., 2016). The EV user can use grid electricity when the sun is not shining (Crabtree, 2015). In general, emerging technologies such as V2G can help to mitigate the on-peak environmental emissions of electricity generation and can also provide benefits to consumers that will in turn enhance the market adoption of EVs (Onat et al., 2017). It is hypothesised that, in the future, power from solar panels could be stored locally and used later, so the homeowner might rely much less on the main grid, instead relying on their own ‘microgrid’ (Crabtree, 2015). EVs could “provide a distributed, moving energy storage service” (Lund et al., 2015, p.24). We will have a ‘bank’ for electricity that can accept deposits and withdrawals at any time (Crabtree, 2015). Still, charging during the recommended hours at night implies that EVs generate more emissions per mile than the average car currently on the road (Zivin et al., 2014).

Holtsmark & Skonhoft (2014, p.163) noted that the possible breakthrough of capture and storage technology (CCS) from fossil-fuel-based power stations may lead to a significant efficiency improvement in fossil power stations. Although energy storage was recognized as a high potential technology for energy system flexibility, its role on the market is somewhat complex as it has both a demand and supply function and therefore, it does not fit well into existing regulatory frameworks (Lund et al., 2015, p.29). Consequently, “in some cases, energy storage may increase the overall carbon dioxide emission levels, like in the Irish power system, where energy storage allows storing power from cheap coal plants, substituting expensive gas during peak demand” (Lund et al., 2015, p.16). As a result, an adequate
charging infrastructure is a fundamental requirement and an appropriate approach for optimizing public and private investments in EVs (Arias & Bae, 2016).

2.5.5 EV Charging Infrastructure

Du & Ouyang (2017) discussed how the charging infrastructure is one of the most important factors influencing EV industrialization. It is currently “a major barrier to EV adoption” (Palmer et al., 2018, p.116). The charging infrastructure construction progress is very slow, lagging behind the rapid development of EVs and hindering their mass penetration (Du & Ouyang, 2017). ‘ecars’ was established in 2010 by ESB to roll out the charging infrastructure for electric vehicles across Ireland and to support the introduction and demand for electric vehicles nationally (ESB, 2019).

Haugneland & Kvisle (2015) found that the typical EV owner has a charging outlet at home and sometimes also at work, and therefore, uses public charging stations less frequently. Yet, one Irish EV owner describes how their home charger broke after four years, which the supplier argued is an acceptable lifetime for an outdoor charger and had to be replaced at a cost of €1,000, adding significantly to the running costs of the car (The Irish Times, 2018). Moreover, while the production of EVs is still in its infancy, the lithium-ion battery technology was developed in the 1990s and, although further improvements can be expected, many advancements at cell chemistry level have already been realized (Nykvst & Nilsson, 2017). In Ireland, government departments have installed just six EV chargers to be shared by their 35,000 staff, which is an indication of lack of leadership and a failure to act on its own policies (The Irish Times, 2018).

“In the UK, EV charging infrastructure has been installed strategically in dozens of cities” (Palmer et al., 2018, p.116). Despite this, the interfaces and protocols of existing charging
poles are not always compatible, locations tend not to be reasonable, and billing systems are not unified, all of which means that the present charging infrastructure operates with a low utilization rate (Du & Ouyang, 2017).

In Ireland, Sadlier (2016) found that further investment in public charging facilities was required for future needs. The lack of adequate charging infrastructure makes EVs unattractive, due to the increased risk that a vehicle is not fully charged when needed spontaneously, and thus, amplifies the problem of limited range and the resulting slow adoption of EVs (Mallig et al., 2016). ESB ecars operate and maintain 1,100 public charge points across the island of Ireland (ESB, 2019).

2.6 Adoption of EVs

Before 2012, the penetration of electric cars was very low owing to their poor performance and few models available (Du & Ouyang, 2017). Nevertheless, Randall (2016) argues that by 2022, EVs will cost the same as their ICE counterparts, encouraging the point ‘liftoff’ for sales of EVs. The Editorial Director at Auto Trader, Erin Baker argues that despite EVs having only proven popular among first-generation early adaptors so far, as soon as 2020, there will be an explosion of choice on the market which will hopefully bring the price down (Campbell, 2018). To date, the biggest catalyst for growth in EV purchases has come from battery costs declining (Pradhan, 2018). Still, eighty percent of EVs on the road worldwide are in the US, China, Japan and Norway (Du & Ouyang, 2017).

“As an increasing number of people drive EVs, it demonstrates that it could be a reasonable choice for others” (Ryghaug & Toftaker, 2014, p.162). Ziefle et al. (2014) show that female users and the elderly, for example, show a higher level of acceptance of EV’s, due to a higher environmental consciousness in contrast to male persons and younger participants, whose
level of self-reported domain knowledge is significantly higher. In contrast, “an early study of travel behaviour among Norwegian EV owners found that the typical owner is a man between thirty and sixty years of age, with high education and high income, living in multi-person and multicar households” (Bjerkan et al., 2016, p.171).

In China, for example, annual sales of EVs were 210,000 in 2015, accounting for a one percent market share of new sale passenger cars for the first time (Du & Ouyang, 2017). In contrast, around the same time, Americans bought only 48,000 EVs out of the fourteen million cars and light trucks sold in the country every year (Levinson, 2014). Similarly, in Italy, only 0.3 percent of the entire country car fleet were electric or hybrid in 2016 (Nosi et al., 2017). By the end of 2015, China had become the world’s largest EV market with 500,000 EVs sold and more than 2000 EV models from more than a hundred companies on the Chinese market by 2017 (Du & Ouyang, 2017). In Ireland, one thousand EVs were registered by May of 2018, compared to 972 for all of 2017 (The Irish Times, 2018). By the end of 2017, there were only 3,800 in Ireland, but registrations of new and imported EVs were up by forty percent in 2018 (Hickey, 2018).

It is demonstrated that the main barriers for EV adoption include immature key technologies, such as batteries and insufficient charging infrastructure, and imperfect government policies and regulations (Du & Ouyang, 2017). Sadlier (2016) also found that the distribution and availability of charging points may be an issue for some potential EV owners and users in Ireland.

Schuijtema et al. (2013, p.2) discovered “higher intentions to adopt plug-in hybrid electric vehicles (PHEVs) than battery-electric vehicles (EVs)”, as PHEVs have an on-board petrol motor. Without this motor, restricted energy stored in the EV cannot be recharged, thus
"limiting the driving range" (Vatanparvar et al., 2018, p.1). In the near future, new technologies such as V2G charging and electricity storage could "yield benefits for consumers, eventually leading to more widespread market adoption of EVs" (Onat et al., 2017, p.639). Jones (2018a) conveys that the UK plans to phase out all new petrol and diesel car sales by 2040, and by 2050 the UK should be 100 percent electric. Currently, the UK government is actively supporting new energy technologies, by investing £177 million to further reduce the cost of renewables such as offshore wind, and £265 million for smart electricity systems and storage (Department for Environment, Food and Rural Affairs, 2018). In spite of all this, customers are currently unwilling to pay substantial premiums for EVs (Larson et al., 2014).

2.7 Cost of EVs

EVs have a "higher manufacturing cost than conventional vehicles" (Palmer et al., 2018, p.109). Industry experts have estimated that battery packs in general make up twenty-five percent of vehicle prices and this cost needs to fall to below $150 per kWh in order for EVs to become cost-competitive on par with ICE vehicles; and this depends on the successful implementation of large-scale battery production facilities and on continued public support through economic incentive schemes in key EV markets (Nykvst & Nilsson, 2017).

A high front-end price has combined to deter many would-be buyers (Fleet Industry News, 2018). Yet, the greatest cost to the consumer is vehicle depreciation (Palmer et al., 2018). The e-Golf is reported to lose £15,790 of its value after three years, against £10,135 for the petrol version (Jones, 2018a). This is due to battery capacity diminishing over time, degrading the battery lifetime (Millner, 2010). Campbell (2018) illustrates that if a battery that once offered 100 miles of range can only reach 85, the potential uses for the car diminish greatly, although there is no agreement on how to calculate the depreciation of the battery. Regardless, while
a three-year old EV is cheaper to purchase, many motorists remain reluctant to buy used EVs because of concerns over battery longevity (Jones, 2018a).

Despite the purchase price remaining substantially higher than that of ICEs, the running costs of EVs are far lower, which result in the requirement to consider the total cost of ownership (TCO) rather than the initial price (Campbell, 2018). A study by Sadlier (2016) discovered that EV owners felt that the burden of the initial cost would be compensated for in fuel savings. TCO combines these purchase and operating expenses to identify the most economical choice of vehicle, given that the price premium of EVs can often be offset by lower running costs (Palmer et al., 2018, p.108). Wu et al. (2015, p.3) suggested that the cost of driving EVs is “almost one fourth of the cost of driving a similarly equipped ICE vehicle”, and Campbell (2018) outlines that the cost of home charging is shown to be almost one third of the AA’s estimated annual petrol costs.

Additionally, Palmer et al. (2018, p.116) contend that the TCO of EVs without government subsidies is still greater than that of ICEs and show that the TCO of EVs is closer to cost parity with ICEs in the UK than in the US. For example, while the e-Golf costs £31,090, against just £18,785 for the petrol-fuelled Golf 1.2L, the Government-funded plug-in car grant cuts £4,500 off (Jones, 2018a). Palmer et al. (2018, p.117) say that purchasers should be able to “assess their fuel saving against depreciation costs given their annual mileage and share of urban/motorway driving”.

When you combine rising taxes with the comparatively high list price of EVs, which is measured before the impact of any government grant for company car tax purposes, it doesn’t make financial sense to choose an electric car in 2019 rather than a petrol or diesel equivalent (Fleet Industry News, 2018). Also, insurance costs are slightly higher for electrics,
mostly because they cost more to buy (Jones, 2018a). Despite this, Schmidt (2019) suggests that the TCO of EVs in the UK could be on par with ICEs as soon as 2021. Rather contradictory, Campbell (2018) discovered that most car brands deliberately exclude electric options from their retailers’ bonus schemes, meaning aspiring electric motorists are likely to be steered towards petrol models by salespeople. This highlights another important consideration by the potential EV user; the predictability of EV policy going forward (Haugneland & Kvisle, 2015).

2.8 EV Policy

The Electric Vehicle Initiative is a multi-government policy forum established in 2009 to promote policies and programs for EV technology and is dedicated to accelerating the deployment of EVs worldwide, with the goal of a global deployment of twenty million electric cars by 2020 (Du & Ouyang, 2017). Onat et al. (2017, p.641) distinguished between “long-term planning for both upstream improvements, like shifting to a cleaner electric power generation, and downstream improvements, such as stimulating EV adoption”. “Most measures for increasing use and adoption of EVs are so-called pull measures, encouraging EV purchase rather than disincentives discouraging use and purchase of ICEs” (Bjerkan et al., 2016, p.171). Furthermore, the lack of decision-making or transparency by carmakers in relation to producing large volumes of EVs is causing major problems for legislators (intelligenttransport.com). Onat et al. (2017) argued that although California has a great deal of environmental and economic potential for EVs, policies are not yet aligned in such a way as to help it reach its full potential. On the other hand, the utilization in New Jersey indicates that its future EV market penetration is well aligned with its EV suitability, meaning the policies currently in place in New Jersey to support EVs are sufficiently economically viable and environmentally friendly to help realize its full potential (Onat et al., 2017).
In New Zealand, for example, the government has set the goal of “reducing carbon emissions to 1990 levels in 2050” (Walmsley, 2015, p.7). Marriott (2018) later suggested that in order for New Zealand to meet its zero-carbon pledge, all the country’s cars will have to be zero emission by 2050. Although New Zealand has active initiatives to encourage innovation and investment to speed up adoption of EVs, the $7 million co-contribution to industry is unlikely to result in a noticeable difference in EV purchasing patterns, which resulted in the average emissions of light vehicles registered in New Zealand in 2017 being 179.3g CO2/km, compared to the average emissions level of a new car sold in the EU of 118.5g CO2/km for the same year (Marriott, 2018).

2.8.1 EV Grants and Incentives

Gupta (2018) advises that a key issue for EV adoption is the nature and quantity of incentives. It is argued that offering higher levels of incentives could move more effectively toward a more sustainable vehicle fleet and has been shown to promote EV sales in the US, Japan, and China (Du & Ouyang, 2017: Onat et al., 2017). EV motorists enjoy “certain tax exemptions as well as various driving privileges, like the use of bus and collective lanes in cities, exemption from parking fees in city centres and often battery charging at zero cost” (Holtsmark & Skonhoft, 2014, p.160). Holtsmark & Skonhoft (2014) continued that in many countries, EVs are exempt from certain purchase taxes, enjoy free public parking, use toll roads for free, and fund charging stations that provide free EV charging. Jin et al. (2014) determined that not all types of incentives affect EV sales equally and highlight, for example, that consumer carpool lane access is more cost-effective for EV owners than purchasing subsidies. Yet, “up-front price support systems like direct financial support and exemption from registration tax, seem to be favourable” (Gass et al., 2014, p.3531). In China, the industrialization of EVs relied heavily on national subsidy policies (Du & Ouyang, 2017).
Fleet Industry News (2018) argue that EV sales would be higher but for ‘irrational’ government intervention over taxes. For example, private cars are the focus in developed countries because these are the principal means of transport, however, in places like India, remedies in private transport lie elsewhere, including making the shift towards public transportation and shared transport easier (Gupta, 2018). “The failure to consider heterogeneous needs of different travellers reduces the effectiveness of the policies” (Wolf et al., 2015, p.32). In India, the attempt to subsidize private cars with inadequate charging infrastructure will lead to wasteful expenditure and not reduce oil consumption and emissions, because primarily, there is a need to electrify vehicles which travel long distances every day, and in places like India, two-wheelers must be prioritized since India has one of the largest two-wheeler markets in the world (Gupta, 2018).

UK government grants will pay for 35 percent of the purchase price for vehicles like the e-Golf, Tesla, and BMW i3 with CO2 emissions of less than 50g/km and can travel at least 112km without any CO2 emissions at all, up to a maximum of £4,500 (gov.uk). The UK is spending nearly £1.5 billion supporting the take-up of ultra-low emission vehicles, including EVs (Department for Environment, Food and Rural Affairs, 2018). Fleet Industry News (2018) welcome the two percent benefit-in-kind rate in 2021 as it is a measure that is expected to increase demand for EVs by 400 percent.

Huo et al. (2015) outlined that California, for example, have an aggressive goal of putting 1.5 million EVs on the roads by 2025. To achieve this, buyers of zero-emission vehicles are entitled to a tax rebate of up to $5000 (California Air Resources Board, 2018). In Japan, the EV consumer is eligible for up to a $2,500 subsidy (Japan Automobile Manufacturers Association, 2016). Similarly, in Ireland, there are government grants to help pay for electric cars ranging
from €2,000 to €5,000, depending on the price of the vehicle, and of up to €600 for the installation of a home charger (The Irish Times, 2018). One Irish EV owner confirmed that it was government incentives such as the zero-purchase tax and VAT, as well as free toll roads and access to bus lanes, that convinced him to buy his EV (Haugneland & Kvisle, 2015). It is noted however, that France, for example, provides a bonus of up to $10,000 for purchases of very low-emission vehicles (below 20g CO2/km), which tapers off to around $4,000 when the vehicle emissions are around 110g CO2/km (Marriott, 2018).

Du & Ouyang (2017) argued that the influence of fiscal subsidy is fading, so to solve the problems of the market being exclusively subsidy-driven, a more scientific policy system is required. It is also validated that “if the purpose of the EV subsidy policy is to mitigate local environmental problems, promoting a switch from diesel vehicles to gasoline models is possibly both a simpler and a cheaper expedient” (Holtsmark & Skonhoft, 2014, p.161). Soon, the average purchase incentive per EV may be lowered by more than a third from the 2018 levels (Bloomberg, 2018). Sweden has effectively the same taxes on EVs as on ICEs, and here, EVs represented well below one per cent of the new car sales in 2013 (Holtsmark & Skonhoft, 2014). Yet, Swedish policymakers have the ambition to increase the use of renewables further and make the Swedish road transport sector ‘independent of fossil fuel’ by 2030 (Mansson et al., 2014, p.350).

In New Delhi, for example, it is revealed that the cash incentives for private cars neither makes a substantial difference in promoting sales, nor serves the purpose of a clean environment, and New Delhi plans to scrap cash incentives currently offered to private buyers of EVs, and only apply the subsidies for operators like Uber as their vehicles run much more than private cars (Doval, 2017). The Chinese government is also scaling back subsidies to place more
emphasis on the need for technological improvements to ensure the industry’s long-term success (Bloomberg, 2018). From 2013, EVs in the Chinese market received national subsidies according to their all-electric range (Du & Ouyang, 2017). In 2017, the Chinese government spent $1 billion funding consumers’ purchases of EVs (Bloomberg, 2018). China’s subsidy policy 2.0 has favoured small-sized EVs over large models, mainly because the former requires smaller installed traction battery packs to attain the same range (Du & Ouyang, 2017). The Chinese government is considering a further reduction in electric-vehicle subsidies next year as the government pushes automakers to innovate rather than rely on fiscal policy to spur demand for alternative-energy cars (Bloomberg, 2018). Accordingly, they have invested more than $1.4 billion to promote the technological research and development, especially for the traction battery (Du & Ouyang, 2017). Palmer et al. (2018) conclude that without government support for EVs, they are significantly more expensive to purchase than ICE vehicles.

2.8.2 EVs and Norway

Norway is racing ahead of other countries, setting a target of phasing out all new petrol and diesel sales by 2025, backed by substantial tax incentives (Jones, 2018a). Haugneland & Kvisle (2015) reported that Norway has the highest number of EVs per capita in the world and has set a goal of 100,000 electric cars by 2020. The stock of EVs doubled almost five times from 2011 to 2013 (Holtsmark & Skonhoft, 2014, p.160). In 2015, seventy thousand EVs were registered in Norway, accounting for approximately eighteen percent of new car sales (Bjerkan et al., 2016, p.170). Over half of new car registrations in Norway in 2017 were electric or hybrid cars (Mariott, 2018). Lambert (2019) reports that EV sales grew by forty percent in Norway to over 46,000, and one third of new vehicles sold in the market were zero-emission vehicles. “The high number of EVs in Norway is the result of the generous policy for purchasing and using EVs” (Holtsmark & Skonhoft, 2014, p.161). EVs, for example, are exempt from
purchase taxes, benefit from free parking in public car parks, are exempt from tolls and
domestic ferry fees, and are also exempt from the annual motor vehicle tax (Marriott, 2018).
Additionally, “as Norway has the highest purchase taxes on new cars in the world, heavy
financial incentives bring the purchase cost of an EV to the same level as a comparable ICES”
(Bjerkan et al., 2016, p.171). According to Jones (2018b), Erik Figenbaum, chief research
gineer at Norway’s Institute of Transport Economics, showed how an e-Golf costs £28,285
before taxes, with the petrol-fuelled Golf 1.2L only costing £19,867, however after the
Norwegian tax system is applied, the petrol version incurs £5,866 in registration tax, with VAT
at 25 percent, adding another £4,966 and raising the purchase price to £30,699, making the
petrol car £2,414 dearer.
Holtsmark & Skonhoft (2014, p.160) showed that data from Norway indicates that EVs may
often be purchased as an additional car “because most EVs driving range is low, the policy
gives Norwegian households incentives to purchase a second car, again stimulating the use of
private cars instead of public transport and cycling”. Moreover, the incentive structure in
Norway means EV owners use their car more, as EV ownership reduces attitudes, intentions
and perceived moral obligation to reduce car use (Klockner et al., 2013, p.5). Therefore, the
Norwegian EV policy is evidently encouraging families to adopt travel patterns that harm the
that the Norwegian EV subsidy policy should be ended as soon as possible and should not be
implemented by other countries because the solution to the GHG problem of the
transportation sector is not to offer subsidies making it cheaper to buy and run EVs, but to
introduce more taxes and restrictions on car use. On the other hand, Scottish climate change
policy gives more attention to demand-side measures to reduce total kilometres travelled or shift to less carbon intensive modes of transport than other countries (Brand et al., 2017).

2.9 Conclusion

The literature review has demonstrated that private car ownership, while necessary, has been detrimental to the planet and public health alike. It is evident that the shift from fossil fuelled transportation has begun, however, what is not clear is what needs to happen to successfully complete the transition in Ireland.

While EVs have been identified as the way forward, focus is now turning to increasing EV adoption and developing the supporting infrastructure. Literature shows that the infrastructure in Ireland is decades from allowing for a full transition to an alternative fuel, yet pressures on governments around the world aim to reduce the dependency on carbon sources as soon as possible.
3.0 Introduction

This chapter presents the research approach taken by the researcher in this study and the frameworks and methods that underlie the collection and analysis of the data. This chapter outlines how and why the data is gathered and the strategy employed to analyze it.

3.1 The Research Problem

Research is the search for knowledge through objectively and systematically of finding solution to a problem (Kothari, 2004). The research problem represents “the need for the study” (Lewis, 2015, p. 102). It is what the researcher aims to find out about during the research endeavor (Khan, 2011). The first phase in any review method is a clear identification of the problem that the review is addressing, which is essential to provide focus and boundaries to the review (Whittemore & Knaff, 2005).

3.1.1 The Research Question

The success of any research process relies on how well investigators are able to translate a clinical problem into a research question (Thabane et al., 2009). The research question for this thesis is “Decarbonising the Automotive Industry: The Future for the Irish motorist”.

3.2.2 Justification

As discovered in Chapter 2, there is an urgent need to reduce the dependency on fossil fueled transport. Although this is the case worldwide, the researcher focuses this investigation on Ireland. Ireland is home to a sporadic population, resulting in a critical dependency on private cars. For the purpose of this research, private cars are defined as cars owned and used for social, pleasure and domestic use. Chapter 2 includes a number of studies that focus on the Irish context; however, there are still gaps in the research. It is difficult to propose
how best to bridge the gap between conventional internal combustion engine (ICE) vehicle and electric vehicle (EV) ownership, given the fundamental differences between the two. Specifically, range and refuel/recharge capabilities still favor ICE vehicles. Additionally, the environmental impact of EVs is currently similar to that of ICEs, owing to the way the electricity is generated.

There are many stakeholders responsible for the transition from fossil fueled transport in Ireland. Government policymakers, energy and climate agencies, car manufacturers, and car owners all need to be considered. The researcher found that most studies take just one or two of these stakeholders into consideration and feels that a review which involves experts from each of these groups would generate a comprehensive conclusion. This conclusion intends to offer guidance with regard to the measures required, and expected consequences, of the shift from fossil fueled private transportation in Ireland.

3.2 Research Methodology
Mackenzie & Knipe (2006) defined research as a systematic investigation used to understand, describe, predict or control a phenomenon through the collection, analysis and interpretation of data. It is an original contribution to the existing stock of knowledge (Kothari, 2004). Methodology is the collection of rules that underpin a particular piece of research, and the theories, values and principals by which a particular approach to research is undertaken (Mackenzie & Knipe, 2006).

Every researcher has their own views that guide their thinking, beliefs, and assumptions, framing how they see the world, which is what social scientists call a paradigm (Chilisa & Kawulich, 2012). Methodology is the frame of reference for the research and is influenced
by the paradigm in which our theoretical perspective is placed or developed (Mackenzie & Knipe, 2006).

The methodology summarizes how the research will proceed, and it starts with a choice of the research paradigm that informs the study (Chilisa & Kawulich, 2012). Mackenzie & Knipe (2006) concluded that methodology is the overall approach to research, while the method refers to systematic modes, procedures or tools used for the collection and analysis of data.

3.2.1 The Research Paradigm
The theoretical framework is referred to as the paradigm (Mackenzie & Knipe, 2006). A paradigm guides how problems are solved as it represents a shared world view of the beliefs and values in a discipline (Schwandt & Schwandt, 2001). Bogdan & Biklen (1998) defined the paradigm as a loose collection of logically related assumptions, concepts, or propositions that orient thinking and research. Mackenzie & Knipe (2006) argued that without first determining a paradigm, there is no basis for subsequent choices regarding methodology, methods, literature or research design. For example, a positivistic paradigm typically assumes a quantitative methodology, while an interpretative paradigm typically utilizes a qualitative methodology (Chilisa & Kawulich, 2012). The paradigm represents the motivation for undertaking a study (Cohen & Manion, 1994).

3.2.2 Positivistic and Postpositivistic Paradigms
Positivism is known as the scientific method and is associated with cause and effect philosophy (Mackenzie & Knipe, 2006). It is closely related with the quantitative method of analysis (Noor, 2008). The aim of positivism is to test a theory or describe an experience through observation and measurement (O'Leary, 2004). Chilisa & Kawulich (2012) reported that positivists and postpositivists view reality as being objective and knowable. Postpositivism can be distinguished from positivism with the former describing theory
verification, and the latter describing theory falsification (Chilisa & Kawulich, 2012). Both positivist and postpositivist research are commonly aligned with quantitative methods of data collection and analysis (Mackenzie & Knipe, 2006). Quantitative researchers begin with ideas, theories or concepts that are defined as they are used in the study to point to the variables of interest (Chilisa & Kawulich, 2012). Nevertheless, postpositivism is about a socially constructed reality rather than scientifically determined, and therefore often requires a qualitative approach (Noor, 2008). This is because postpositivists work from the assumption that any piece of research is influenced by previously developed theories (Hymen, 1982). O’Leary (2004) also suggests that postpositivism findings are qualitative in nature.

3.2.3 Interpretative Paradigm

Interpretivists do not generally begin with a theory but generate a theory throughout the research process (Mackenzie & Knipe, 2006). Moreover, interpretivists differ from positivists on assumptions about the nature of reality (Chilisa & Kawulich, 2012). Interpretivist approaches to research suggest that reality is socially constructed (Cohen & Manion, 1994). Interpretivists hold that there are multiple realities because knowledge is subjective, and truth depends on the context (Chilisa & Kawulich, 2012). While the interpretivist researcher relies on the participants views of the situation being studied, they also recognize the impact of their own background and experiences on the research (Mackenzie & Knipe, 2006).

The purpose of interpretative research is to understand people’s experiences (Chilisa & Kawulich, 2012). The interpretivist paradigm operates using predominantly qualitative data collection methods and analysis but can also employ a combination of both qualitative and quantitative methods (Mackenzie & Knipe, 2006). The research questions are not always established before the study begins and can develop as the study progresses (Chilisa & Kawulich, 2012). In this context, the research questions are usually open-ended, descriptive
and non-directional (Creswell, 2003). Creswell (2003) described a typical model where a 'grand tour' question is followed by a small number of sub-questions. The grand tour question is a statement of the problem in its broadest form that is posed as a general issue to avoid limiting the discussion (Creswell, 2003). The sub-questions are used as guides for the methodology and methods used to enable the researcher to answer the broad-based grand tour question (Chilisa & Kawulich, 2012). In recognition of the subjective nature of interpretivist research, Denzin et al. (2008) emphasized that the researcher should note their values, biases, relationship to the participants and closeness to the research topic.

3.2.4 Inductive Research
Trochim & Donnelly (2006) refers to two broad methods of reasoning as the inductive and deductive approaches. The deductive researcher works from the 'top down', from a theory to hypotheses to data to add to or contradict the theory (Soiferman, 2010). Lewis (2005) described how the inductive process involves the researcher working back and forth between the themes until a comprehensive set of themes is established. It may also involve collaborating with the participants interactively, so that they have a chance to shape the themes or abstractions that emerge from the process (Lewis, 2015). The procedures of qualitative research, or its methodology, are characterized as inductive, emerging, and shaped by the researcher's experience in collecting and analyzing the data (Lewis, 2015).

3.2.5 Applications of Methodology in this New Study
Sadlier (2016) previously undertook a positivistic approach to EV ownership in Ireland through quantitative data collection methods. This research intends to incorporate the interpretations of different industry experts to map the uncertain shift from fossil fueled private transportation. "A flexible research design which provides opportunity for considering many different aspects of a problem is considered appropriate if the purpose of the research study
is that of exploration” (Kothari, 2004, p.14). This new examination involves qualitative data collection methods and is guided by the interpretative paradigm and an inductive approach. The exploration of the respondent’s perceptions allows the researcher to compile the views of key respondents from different areas of expertise, develop themes and conclusive expectations for the future of the automotive industry in Ireland, and generate a theory throughout the process.

3.3 Research Design

A research design is a procedural plan that is adopted by the researcher to answer questions validly, objectively, accurately, and economically (Khan, 2011). With the research problem having been formulated in clear cut terms, the researcher states the conceptual structure within which research would be conducted (Kothari, 2004). Focus now turns to the framework and methods involved in this research. Methods are the means used for gathering data and are an important part of the methodology (Chilisa & Kawulich, 2012). Research methods may be understood as the techniques that are used for conduction of research (Kothari, 2004, p.7).

The choice of which research method to employ is dependent on the nature of the research problem (Noor, 2008). Moreover, research methodology, encompasses not only the research methods, but also the logic behind the methods used in the context of the research study and explain why a particular method or technique is used (Kothari, 2004). Having a well-specified review purpose and variables of interest will facilitate all other stages of the review, particularly, the ability to differentiate between pertinent and extraneous information in the data extraction stage (Whittemore & KnafI, 2005). The research continues with data collection and analysis before concluding with the empirical findings.
3.3.1 Primary Research Approach

Qualitative research is associated with a naturalistic philosophy while quantitative research has philosophical roots in the positivistic philosophy (Newman & Benz, 1998). While qualitative research prioritizes depth and quality of data collected, quantitative research maintains premium on the number and volume of data collected (Anyan, 2013). Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (Johnson et al., 2007).

3.3.2 Quantitative Research

The quantitative approach is used when one begins with a theory and tests for confirmation or disconfirmation of it (Newman & Benz, 1998). It involves the generation of data in quantitative form which can be subjected to rigorous quantitative analysis in a formal and rigid fashion (Kothari, 2004). Quantitative research makes use of numerical statistical analysis which allows researchers to either reject the hypotheses or to determine the effect size (Soiferman, 2010, p.9). Quantitative designs include experimental studies (Newman & Benz, 1998). Analysis of quantitative data is formal and rigid (Kothari, 2004).

3.3.3 Qualitative Research

Qualitative research begins with assumptions, a worldview, the possible use of a theoretical lens, and the study of research problems inquiring into the meaning individuals or groups ascribe to a social or human problem (Lewis, 2015, p.37). It is used when observing and interpreting reality with the aim of developing a theory that will explain what was experienced (Newman & Benz, 1998, p.3). We conduct qualitative research because we want to understand the contexts or settings in which participants in a study address a problem or issue (Lewis, 2015). Techniques include focus group interviews, projective techniques and depth interviews (Kothari, 2004). Qualitative research follows an unstructured, flexible and
open approach to enquiry, aiming more towards description than measurement, and believing in in-depth understanding and small samples, and is closer associated with the exploration of perceptions and feelings than facts and figures (Khan, 2011). Qualitative research is a form of inquiry in which the researcher makes an interpretation of what they see, hear, and understand (Lewis, 2015). It is concerned with subjective assessment of attitudes, opinions and behavior (Kothari, 2004). Qualitative research has been identified as the most appropriate method to answer this research question.

3.4 Data Collection

3.4.1 Secondary Data Collection
The methods of collecting primary and secondary data differ since primary data are to be originally collected, while in case of secondary data the nature of data collection work is merely that of compilation (Kothari, 2004). Secondary data is data which already exists but is extracted for the purpose of the study (Khan, 2011). Secondary analysis is the re-analysis of data for the purpose of answering the original research question with better statistical techniques, or answering new questions with old data (Glass, 1976). Kothari (2004) refers to secondary data as data which has already been collected and analyzed by someone else. Ideally, all of the relevant literature on the problem or topic of interest is included in the literature review (Jadad et al., 1998). The literature review is the process of searching the existing literature relating to the research problem to develop theoretical and conceptual frameworks for the study (Khan, 2011). Defined literature search strategies are critical for enhancing the accuracy because incomplete searches result in an inadequate database and the potential for inaccurate results (Whittemore & KnafI, 2005). Kothari (2004) noted that if the data relates to an area which may be either narrower or wider than the area of the present enquiry, it should not be used by the researcher.
This researcher began with the collection of secondary data in October 2017. The purpose of this investigation was to contribute to the research proposal presented to the research supervisor in December 2017. Secondary research resumed in the summer of 2018. A Microsoft Excel spreadsheet was created in order to code and organize collected data. After each periodic reading session, several reference quotes were added to the spreadsheet and a selection of categories were designed and linked to each reference quote. These reading sessions were unstructured and flexible. In January 2019, over 500 reference quotes had been added to the spreadsheet, each with a number of categories assigned. The literature review was generated by category, with every quote used highlighted in yellow until all required quotes were included in Chapter 2. The first draft literature review was submitted to the research supervisor in February 2019 for review.

The researcher used online sources ranging from peer reviewed studies to articles written by experts in the field of EVs, environmental pollution and electricity production. The Cork Institute of Technology library database was also the source of some reviewed literature. Areas researched included the impact of transportation on public health and the environment, recent trends in private transportation, electricity generation and energy strategies, government policies with regard to vehicle emissions and EV adoption, as well as EV adoption in different locations around the world. These areas were researched periodically to encapsulate the latest facts and figures as required by the fast pace of changes in the industry.

3.4.2 Primary Data Collection

Primary data is data that is collected for the specific research problem at hand (Hox & Boeije, 2005). Sources that provide primary data such as interviews, observations, and questionnaires are called primary sources (Khan, 2011). For the purpose of this study, the
researcher has chosen a number of interview respondents with expertise in key areas relating to the Irish automotive industry, the environmental impact of private motorization, and government policymaking. The researcher has noted that studies in the Irish context have not yet included empirical research from all three areas, and that this may prove to be critical in setting future expectations for the industry.

3.5 Research Strategy
This section outlines the research strategy used to obtain and process the primary data. As previously outlined, this researcher selected the qualitative research approach as the most appropriate method of data collection to answer the research question.

3.5.1 Data Collection Method
The interview method of collecting data involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses (Kothari, 2004). Unstructured interviews are characterized by a flexibility of approach to questioning that results in lack of comparability of one interview with another and thus the analysis of unstructured responses becomes much more difficult (Kothari, 2004). On the other hand, the rigid design of structured interviews often produces quantitative data (DiCicco-Bloom & Crabtree, 2006). A semi-structured interview offers sufficient flexibility to approach different respondents differently while still covering the same areas of data collection (Noor, 2008). For the purpose of this analysis, the semi-structured interview is selected as the most appropriate method of data collection. This decision came as a consequence of the pilot interview and discussion with the research supervisor.

3.5.2 Interview Schedule
An interview schedule is a written list of questions, open ended or closed, prepared for use by an interviewer in a person-to-person interaction (Khan, 2011). The questions are developed from gaps identified in the secondary research undertaken as part of this study.
A draft list of questions was developed and resulted in 32 questions. This original list was then screened and ordered which resulted in 17 questions, the 17th being directed only at interview respondents who own (or have owned) an electric vehicle. This interview schedule was used for the pilot interview.

3.5.3 Pilot Interview
Pilot work is invaluable in conducting ethnographic, as well as other forms of qualitative research (Sampson, 2004). The respondent selected for the pilot interview is Professor John Sodeau. Professor John Sodeau is a Professor Emeritus of Chemistry at UCC with research interests in Atmospheric Chemistry and Aerobiology. He has shared his views through articles in the Irish Times and an rte.ie opinion piece. His expertise in the field of air pollution is particularly relevant with respect to fossil fueled cars and electricity policy. The pilot interview was conducted on February 25th, 2019 at the Environmental Research Institute building on the Lee Road, Cork. The purpose of this interview is for the researcher to rehearse the role of the interviewer, and to also collect the initial primary data. A number of adjustments to the interview schedule were required. Together with the research supervisor, it was discovered that the first question was leading, which may have skewed the response in a biased manner. It was also determined that two of the questions, 6 and 10, were similar, and the decision was made to combine these into one question.

After a meeting with the research supervisor, the decision was made to use probing questions and a semi-structured interview technique to improve the quality of the response and increase the quantity of rich data. Probing questions help to “clarify, support or expand initial responses” (Wilen & Clegg Jr, 1986, p.158). Adjustments to the interview schedule and process were completed before the second interview was undertaken.
3.5.4 Interview Respondents

The researcher aimed to include contributions from different stakeholders in the Irish transport industry. Research stakeholders are groups who are likely to be affected by a research activity or its findings (Khan, 2011). The researcher aims to close gaps in research with regard to recent variations in the industry and their impact on Irish car owners. It is also noted that experts in the field of environmental and energy research provide insight that is critical to the validity of the results of this study. Similarly, governmental departments are key to understanding initiatives that are designed to support the transition from fossil fueled private transportation. Similarly, the views of management level car dealers are key from the perspective of EV production and development. The interview respondents in this research as listed as follows:

1. Professor John Sodeau (pilot interview).
2. Pio Cafferkey is a Managing Director at Mallow Road Motors, Ireland's longest serving Kia dealership. The researcher conducted the interview at Mallow Road Motors' Kia showroom in Blarney Business Park on Friday, March 8\(^{th}\), 2019.
3. James McCarthy is the Chief Executive of Nissan Ireland. The researcher conducted a phone interview on Monday, March 11\(^{th}\), 2019.
4. The researcher was eager to include feedback from the Climate Change Unit in the Department of Transport, Tourism and Sport, which has responsibility for policies in relation to alternatively fueled vehicles including electric vehicles. A face to face interview was declined and the group was unable to facilitate a phone interview, however a representative of the group, who chose to remain anonymous, prepared responses to the interview schedule and shared via
email. This response was received by the researcher on Thursday, March 14th, 2019.

5. Conor O' Brien is a Public Policy and Regulation Manager at ESB ecars. The researcher conducted a phone interview on Tuesday, March 19th, 2019.

6. Fay Clohessey is a representative of the committee of the Energy and Environmental Society in Cork Institute of Technology. The researcher conducted a face to face interview in the CIT campus on Wednesday, March 20th, 2019.

7. Tomasz Waliwander is a Managing Partner at Farran Technology and completed the Master of Business degree in Cork Institute of Technology in 2018 with a thesis titled “Autonomous Vehicles as a Disruptive Innovation: Economic and Social Impact”. The researcher conducted a face to face interview in the CIT campus on Friday, March 22nd, 2019.

8. Michael Sheridan is a motoring journalist. He is Editor of Motorhub.ie and has previously presented the motoring show ‘Drive!’ on RTE television, as well as amassing numerous radio program credits. He has been a Car of the Year Judge for over 18 years and is a former Chairperson of the Association of Professional Motoring Press (Motorhub.ie). The researcher conducted a phone interview on April 12th, 2019.

9. Shane Prendergast is a Programme Executive of the EV Grant Programme developed by the Sustainable Energy Authority of Ireland (SEAI). The SEAI intends to play a key role in helping Ireland to achieve its climate targets. The researcher conducted a phone interview on May 2nd, 2019.
10. Alan Nolan is the Director General of the Society of the Irish Motor Industry (SIMI). SIMI is a member's organisation which consists of Dealers, Repairers, Vehicle Distributors, Wholesalers, Retailers, Vehicle Testers and many more important operators within the industry in Ireland. Their role is to represent the views of the motor industry by campaigning to the Government, state bodies, the media and the motoring public (simi.ie, 2019). The researcher conducted a phone interview on May 3rd, 2019.

3.6 Data Analysis

The goal of the data analysis stage is a thorough, unbiased interpretation of primary sources, (Whittemore & Knaf, 2005). Throughout the interview process, the researcher transcribed each interview, highlighting key points from each. Transcripts provide a descriptive record of the research, but they cannot provide explanations, therefore the researcher has to make sense of the data (Pope et al., 2000). The questions from the interview schedule provided a structure for presenting the findings as outlined in Chapter 4. After the final interview, analysis of the interview transcripts began. It is shown that data analysis in research reviews requires that the data from primary sources are ordered, coded, categorized, and summarized into a unified and integrated conclusion about the research problem (Cooper, 1998).

3.6.1 Analysing Qualitative Data

The qualitative analysis begins with transcribing the interview, then immersing oneself within the data to gain detailed insights, developing a data coding system, and linking codes or units of data to form overarching themes which may lead to the development of theory (Smith & Firth, 2011). Often, the analytical process begins during data collection, because the data already gathered shapes the ongoing data collection by allowing the researcher to go back.
and refine questions, develop hypotheses, and pursue emerging avenues of inquiry in further depth (Pope et al., 2000). This was experienced during the primary research phase of this new research. Some participants noted trends and areas of interest that were not previously discussed within the scope of the interview schedule. The researcher did not formally amend the interview schedule to account for these but did note some keywords to discuss with subsequent interview respondents.

The approach to writing up the findings of qualitative research is to report key discoveries under each main theme or category using appropriate verbatim quotes to illustrate those findings, and then incorporate a linking discussion section in which the results are discussed in relation to existing research (Burnard et al., 2008). Grounded theory is a general methodology for developing theory that is grounded in data systematically gathered and analyzed (Strauss & Corbin, 1994). The inductive nature of grounded theory methods assumes an openness and flexibility of approach (Charmaz & Belgrave, 2007). As described in 3.2.5, the current study has used the inductive approach. The primary purpose of the inductive approach is to allow research findings to emerge from the frequent, dominant or significant themes inherent in raw data, without the restraints imposed by structured methodologies (Thomas, 2003).

3.7 Reporting Research Findings
The research findings are reported in Chapter 4, and analysed in further detail throughout Chapter 5.

3.8 Reliability and Validity
The extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability (Golafshani, 2003). The changing
landscape in the automotive industry, led by the imminent shift to electrically powered vehicles, presents a challenge in presenting reliable conclusions. The researcher continued seeking secondary resources of data throughout the primary phase, to ensure discussions with participants were based on the most recent developments in the industry.

Reliability and validity are conceptualized as trustworthiness, rigor and quality in the qualitative paradigm (Golafshani, 2003). Morse et al. (2002) suggested reliability and validity have been replaced by criteria for evaluation of the overall significance, relevance and credibility of completed research. Noble & Smith (2015) argue that it is imperative that all qualitative researchers incorporate strategies to enhance the credibility of a study during research design and implementation. The topic of the current study is of particular relevance to current trends in the automotive industry. To ensure valid findings, the researcher sought the input of key experts in the Irish automotive industry. Golafshani (2003) reported that the quality of a research is related to the validity of the research. The pilot interview enhanced the reliability and validity of this research.

3.9 Limitations

The researcher is engaged in full time employment which resulted in significant time constraints in which to complete this research. Conducting the primary research was impacted as many contributors could only meet during work hours, which meant several interviews were conducted over the phone.

This researcher does not work in the motor industry and had limited knowledge and expertise in the area before conducting this investigation.

A critical source of this study is the perspective of government policymakers; however, the researcher was unable to secure a face-to-face interview with a member or members of the
government. Other potential interview participants also declined, and several did not respond.

3.10 Ethical Considerations

Ethical considerations are paramount in all research from its design to conclusion (Fossey et al., 2002). The researcher provided an informed consent form for the interview respondents to review. This form is included in appendix 1. The researcher ensured this form was agreed to either by signature, or verbally during phone interviews.

Open-ended interviews give discretion to the person doing the interview and to the respondent, which may prompt particular responses or direct the answers (Jacobsen & Landau, 2003). The researcher made relevant adjustments to the interview schedule questions to ensure there was no bias or prompts that would encourage a swayed view. This encouraged honest responses during the interview process.

3.11 Summary

In this chapter, the researcher has reviewed different research approaches and selected those best suited to address the research question. The researcher chose the qualitative method of data collection, through in-depth, semi-structured interviews. The findings of the empirical data collected throughout the interview process are reported in Chapter 4.
Chapter 4

4.0 Introduction

This chapter presents the main findings from the empirical data gathered from the ten participants in this research study. It is shown that petrol and diesel car sales will continue in Ireland for the next ten years, despite the strong viewpoint of climate experts to eradicate the carbon emissions from internal combustion engine (ICEs). This is because electric vehicles (EVs) are significantly more expensive to purchase than ICEs and the charging infrastructure in Ireland is inadequate to meet the requirements of most motorists. This chapter introduces expert’s advice for Irish motorists and Irish policymakers.

4.1 The Sustainability of Fossil Fuelled Cars in Ireland

This research has found that the transition to an alternative fuel source for Irish cars will be a lengthy period. While some participants promote the continuation of the fossil fuelled motor industry, others describe an urgency to eliminate fossil fuelled motorisation. For example, the first contributor suggests that fossil fuelled cars will continue to be bought and sold in Ireland at least until 2030:

*I think at the moment, there’s no substitute, especially for diesel for economy. People are going to be selfish if you’re driving daily from Mallow into Cork city, you’re not going to be paying extra for an electric car or to purchase the car over diesel until the technology gets better. So, I think there is a future for fossil fuels, definitely as far as I’m concerned, for a minimum of ten years.*

Pio Cafferkey, Managing Director, Mallow Road Motors
Still, one expert believes Ireland’s 2030 goal of eliminating the sale of non-zero emission vehicles is achievable:

*By 2030, if fossil fuelled cars are not gone, I'd say they’ll be on the verge of exiting from the market.*

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland

The next participant is concerned as to the viability of this goal:

*What will people do about buying cars after that date if their existing car is an internal combustion engine car and they are being penalised by the State. How do they manage to change to a new, zero-emitting car that’s going to be expensive and their own car has been devalued?*

Alan Nolan,
Outgoing Director General, SIMI

Depending on the driver’s requirements, EVs are not suggested to suit most drivers currently:

*It’s circumstance all the time. If anybody is doing over 15,000 kilometres, they need to think about staying in a diesel car, because it will deliver much better fuel consumption. If they’re not doing particularly high mileage, a petrol-hybrid will be fine. If they’re doing low mileage, say 10,000 kilometres or less, they should be in a petrol. If they’re in a small city car, that whole sector is still dominated by petrol anyway. Superminis like the Fiesta and the Polo are best used as petrol.*

Michael Sheridan,
Motoring Journalist
The next contributor agrees that fossil fuelled cars will still have a place in the Irish market for the foreseeable future, and does not agree that eliminating them from Irish roads is justified:

They represent a very viable and sustainable offering for certain driver types. If you’re putting up high mileage or if you’re carrying a load, diesel is probably your best option. If you look at how clean the euro 6 diesel engine is, a lot of the concerns about the pollution associated with those engines is no longer valid and that engine is only going to get cleaner. The problem is, it’s also going to get more expensive, and is going to get rarer because fewer and fewer manufacturers are going to follow the ever-increasing standards that would be required under European legislation.

There are obviously very serious issues regarding our utilization of fossil fuelled engines at the moment. But that’s not the engine that’s produced today; that’s the engine that was produced five and ten years ago. Those engines are causing significant pollution. If you look at the euro 6 standard petrol or diesel engines, they are extremely clean engines and have addressed a lot of the concerns relating to the CO2 and other pollutants coming from diesel and petrol engines. So, in terms of current standards, I don’t really see a huge issue and if every car that was driven in Ireland was driven to euro 6 standard, the level of CO2 that would be coming from our fleet would be a fraction of what they are today. Unfortunately, we have a policy of almost incentivising people to drive cars that have highly polluting engines, and they are problematic.

James McCarthy,
Chief Executive, Nissan Ireland

The next participant notes that fossil fuelled vehicles will continue to be a popular choice during what is expected to be a lengthy transition period:

The EV industry isn’t quite there yet. I know the Irish government have put in a 2030 deadline to say that from then on you can’t buy an internal combustion engine vehicle, but even that is going to be tricky. There’s going to be a long transition period to get to EVs. Even if you look at today, EV sales have increased substantially this year, but are still quite small. If you talk to any car manufacturers, they’ll say we can’t get supply because there are not enough vehicles being produced.

Conor O’Brien,
Public Policy and Regulation Manager at ESB ecars
Similarly, the next contributor reassures that diesel vehicles are still a sound choice:

*I would have no fears in buying a diesel in the reasonable period ahead, because in rural Ireland, they will remain at good value because the flow of such vehicles from the UK will reduce down to a much smaller number, so city people will be buying less diesels, so that will work okay.*

Alan Nolan,
Outgoing Director General, SIMI

This is echoed by the next participant who notes the investment of the manufacturers in internal combustion technology:

*It will be at least another ten years before we see fossil fuelled cars being phased out. The motor industry has invested billions in developing engines and is going to continue to build them because they’ve got this massive financial interest in them. We’ll see a gradual decline, but we’ll only see the shift when the motor industry decides it wants to shift, and when it’s economically viable to do it.*

Michael Sheridan,
Motoring Journalist

One interviewee suggests that the shift to electric vehicles is notably slower in the Irish context:

*The sales of fossil fuelled cars will continue going forward. You see some effects worldwide, in China and the US and other European countries, but in Ireland, the change is to a much smaller degree. The road infrastructure in Ireland is not very well developed compared to other countries. In China, they are making strides in R&D in universities and infrastructure is one of them. China is a major market for electric vehicles. You look at where the demand and the need and the infrastructure are. In Ireland, this is not a priority. It’s not just about manufacturing the cars; it’s about seeing the benefits of them and having the right infrastructure.*

Tomasz Waliwander,
Chief Technology Officer, Farran Technology
A climate expert strongly believes that there is an urgency to rid Irish roads of fossil fuelled cars, but changing the behaviour and attitude of car owners is a challenge:

_Burning fossil fuels of any sort poses problems with climate change and air pollution. Although climate change and air pollution are often treated separately, are actually from the same source - carbon. We know the damage that air pollution can do to your immediate health – asthma, diabetes, cardio, lung, Alzheimer’s, all of these things and more. A lot of people immediately take that on board. They don’t however understand the things about climate change that fossil fuels do, because it’s a more difficult concept to explain. It’s not just like do this and you die, which is the case with air pollution. With climate change, the planet is going to have a problem in fifty year’s time, and even though people say, okay, our kids and our grandkids are going to suffer, it’s not really affecting them directly. And because it’s a difficult concept to explain to people, the climate change is more difficult to argue._

Prof. John Sodeau,  
Environmental Researcher, UCC

The next contributor agrees that key stakeholders in the automotive industry are too indifferent towards the effects of continuing to sell fossil fuelled cars:

_I think, it's negligence on the part of the government, and on companies who continue to make and sell these cars. When the planet is at stake, I think they should be doing everything possible. To continue to sell and to make and to market fossil fuelled vehicles is a show of indifference._

Fay Clohessy,  
Chairperson, CIT Energy and Environmental Society
The next participant notes that Ireland’s high dependence on fossil fuels and endorses the diversification of the Irish fuel industry:

The use of fossil fuels is firmly embedded in the private car driving culture of Ireland. In 2017, petrol consumption in transport totalled approximately 18%, which is lower than 1990 levels. With a very high dependence on oil, greater diversification of fuels in the Irish transport sector is highly desirable from an energy security perspective; in fact the transport sector is considered the least secure energy sector and has the greatest need of increased fuel diversity. Diversification of the fuel mix by increasing indigenous renewable electricity and biogas production would reduce the demand for imported fossil fuels and the associated exposure to price variations. In order to see an adequate decrease in emissions, we need to see a high take-up of electric vehicles in Ireland constituting a substantial transition away from traditional fossil fuels.

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport

4.1.1 Petrol vs. Diesel Cars
This investigation found that modern petrol and diesel cars have a similar effect on the environment. Nevertheless, recent media coverage is beginning to encourage car buyers towards petrol models. This research shows a clear distinction between experts in the automotive industry and participants with a more environmentally conscious perspective. For example, an automotive expert notes that the impact of diesel emissions is causing a shift in car purchase behaviour, but argues that diesel is still the most economical choice for the Irish motorist who travels more than 25,000 kilometres per year:

People are being browbeaten into petrol at the moment. I’d be a fan of diesel for the economy. There is just no substitute for diesel at the moment. I was reading up about technology coming in diesel that can get the emissions down to 10% of what it is today, which would be better than petrol. In 2008, the Kia slogan was “thinking diesel, think Kia”. People were then being browbeaten into diesel because they thought diesel was more environmentally friendly, and allegedly it’s not now. People that would normally buy diesel are trying to buy petrol now because they hear about the environmental stuff and because it’s in the media to buy them. If people say to me, “I’m doing 25000 kilometres a year. What will I buy?” You can most certainly buy petrol but it just will not be as economical as diesel. I would say it would be half the fuel consumption.

Pio Cafferkey, Managing Director, Mallow Road Motors
This opinion is shared by the next participant:

> From an environmental point of view, it would make more sense for people with a current diesel car, who are in rural Ireland for instance and benefit from the diesel car, to continue to change to that because environmentally, from a CO2 point of view it makes much more sense. Instead, we're seeing those people moving to buy petrol cars, or buy hybrid cars, which are much more polluting of CO2.

Alan Nolan,  
Outgoing Director General, SIMI

A number of contributors assert that, regardless of whether people may choose diesel over petrol, its place in the Irish market is coming to an end:

> You're going to see the end of the diesel engine. It will become a niche product. A lot of these are self-fulfilling prophecies, so, you see many manufacturers, including Nissan, coming out and saying they're going to stop making diesel engines. One of the reasons they're stopping is that it's becoming increasingly expensive to produce diesel engines that meet the emission standards that are required. So, they're getting priced out of the market as well.

James McCarthy,  
Chief Executive, Nissan Ireland

The biggest catalyst came from the 'dieselgate' scandal. That moved forward the whole debate over what is actually coming out of the cars. Now, with the change in testing regimes with this new WLTP system and real-world testing, the car companies have had to get their house in order in terms of meeting the future regulations. Certain models of cars have been discontinued because the specific engine doesn't meet WLTP and it's too expensive to get to that standard, so it becomes uneconomical. When we have the full shift over, next year, to WLTP, everything will be dearer because all values for emissions will go up. The only values for emissions that won't go up will be the pure EVs.

Michael Sheridan,  
Motoring Journalist
The next interviewee is concerned with the attitudes of the motor industry with respect to the fossil fuel options:

*My grandfather recently bought a diesel vehicle. I suggested he get an electric vehicle. I was disappointed to hear that the dealer had dissuaded him when he was thinking about it.*

Fay Clohessy,  
Chairperson, CIT Energy and Environmental Society

The next contributor comments that there is no need to distinguish between petrol and diesel models, as both must be eliminated:

*Petrol is better from an air quality perspective. It doesn’t have the same level of nitrous oxides and sulphur oxides, but at the end of the day, if you come from the climate perspective, then you need to get rid of both of them. We have to get rid of fossil fuels completely. That might take a while, but it’s clear that neither are any good.*

Conor O' Brien,  
Public Policy and Regulation Manager at ESB ecars

A climate expert illustrates the impact of both fuel types to urban health and condemns government policy for giving rise to a more health damaging cars on Irish roads:

*You should stop burning fossil fuels, whether petrol or diesel. There are bigger arguments against diesel though, because of the nitrogen oxides and particulates that they throw out to a greater extent than petrol does. There was nothing worse done by the Green Party than when they introduced the differential in prices in 2008 because of what they described as climate change reasons – less carbon dioxide. But despite knowing about the health problems with the nitrogen oxides and particulates, they gave this rather large, ten cent per litre difference between buying petrol and buying diesel that pushed people towards buying diesel cars. If you go to the forecourt, in the UK compared to over here, you’ll see currently it’s a ten pence per litre difference between diesel and petrol, but diesel is much more expensive. Over here it’s at ten cent cheaper the other way around.*

Prof. John Sodeau,  
Environmental Researcher, UCC
The next contributor discourages the use of fossil fuelled private motorization where possible:

In recent years air quality concerns have reduced the public’s appetite for diesel-powered vehicles, according to CSO statistics 16,814 fewer new diesel private cars were registered in 2017 compared to 2016 while petrol numbers remained relatively constant over the same time period. Diesel continues to be the most dominant fuel used accounting for 58% of all energy use in transport. It is the policy of the Government to encourage, where use of public transport is not a viable option, a move away from conventionally fossil-fuelled vehicles, including petrol or diesel, to alternatively fuelled vehicles including electric vehicles.

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport

One participant notes the Irish government’s previous intention to adopt biofuel technology in order to sustain the use of internal combustion engines:

Back around 2004, we had biofuels being seen as the saviour of the world, from an environmental point of view. Something that we could produce in Ireland, something that was totally renewable, and was far better from an emissions performance, as well as having a lifecycle benefit. The government put in policies to support it. We’ve had some of the fuel companies putting infrastructure in place to deliver it, at millions in cost. The world turned against it. There were very good reasons, in that the challenge of food production in the third world, and some productive land being switched over to biofuel for export for cash was a concern.

Alan Nolan, Outgoing Director General, SIMI

4.2 Vehicle Pollution in Ireland

There is a common theme among the participants in this study which reveals that Irish transport pollution is low relative to other countries around the world:

Dublin and Cork are low-rise cities. There isn’t the same problem with air being trapped within corridors of tall buildings, like you have in London and other mega cities. We’ve got less blatantly obvious pollution issues than there are in the rest of the world.

Michael Sheridan, Motoring Journalist
Most participants are however in agreement that there is an air quality problem that needs to be solved by cleaning up the cars on Irish roads. The next contributor lists factors that are contributing to a negative impact on Ireland’s air quality:

Transport accounts for almost 20% of Ireland’s greenhouse gas emissions. Road traffic exhaust emissions are a major source of urban air pollutants. Traffic emissions are on the rise due to the marked dieselisation of the national fleet, increased driven kilometres, greater congestion and subsequent increased idling times. The European Environment Agency (EEA) estimated that in 2013 approximately 1,600 premature deaths in Ireland were attributable to air pollutants, with urban NOx levels (mainly from traffic sources) highlighted as being a key concern.

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport

They continue that there have been recent trends which appear more positive:

2017 was the first year of decreased transport emissions after four successive years of increases, with a 2.4% reduction compared to 2016. Since peak levels in 2007, transport emissions have decreased by 16.6% primarily due to the economic downturn, improving vehicle standards, and the increased use of biofuels. Projections suggest that CO2 emissions from cars alone will decrease by an additional 40% by 2050. This progress is, however, likely to be cancelled out by a significant increase in transport demand.

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport

The next interviewees agree that while Ireland is less polluted than other regions, it is evident that there is an air quality problem:

It’s not as bad as other places. Our infrastructure isn’t fantastic, so, people mostly need a car. You see the vehicle concentration in China. Ireland is somewhere in the middle. You look at the Netherlands where they have a lot of bikes. I cycle everywhere and it’s not fun sitting in traffic in Cork city with all the particles. You can feel the heat. It’s surprisingly warm in traffic. The smaller the particulate, the worse it is because it gets stuck in your alveoli in your lungs. People would think two microns would be better than ten microns, but actually it’s the other way around. The ten microns will only get so far. It’s the two-micron size which are the diameter of particulates.

Fay Clohessy, Chairperson, CIT Energy and Environmental Society
I cycle in and out of work and you can feel the toxic emissions coming out of the cars and buses and trucks. It doesn’t make for pleasant breathing in and around it. If you look at more rural areas, [vehicle pollution] is present, but to a much smaller degree.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland

The next contributor does not believe vehicle pollution is an issue in Ireland but still proposes that there should be a focus on improving the air quality:

No, I don’t think it’s an issue in Ireland. If you compare Ireland to other industrialized countries across Europe and China and the US. If you look at air quality in Ireland, you’ll find it’s a very high quality, because it’s not an overly populated country. I’ve been to China a couple of times and you can actually taste the air in your mouth. The issue is that, for the past ten or fifteen years, we haven’t been able to improve the air quality even though we’ve moved so much technologically and with our understanding in dealing with air pollution. Ideally, you’d like to eradicate premature deaths caused by air pollution. A significant number of people die of air quality related diseases every year, but there are a lot more deaths in other countries relative to Ireland.

Tomasz Waliwander,
Chief Technology Officer, Farran Technology

The next participant offers a solution to the pollution problem associated with fossil fuelled cars:

If you did an analysis of the imports, I’d say the vast majority are diesel from the UK. They’re mainly older vehicles that have worse emissions than newer diesel or petrol cars, so I would think that there is a problem with emissions of cars at the moment. I think the age profile of the vehicles would be an issue as well. It is improving but I would say there’s probably a load of older cars there as well that are not as clean as the newer ones. Of course, I’m going to tell you to buy new cars.

Pio Cafferkey,
Managing Director, Mallow Road Motors
The next contributor agrees that reducing the number of older, less efficient vehicles with greater emissions, would achieve the goal of reducing our carbon footprint, but maintains that current policy measures in Ireland do not encourage this appropriately due to policy that encourages importing older cars from countries such as the UK:

"I think we are emitting way too much CO2 from our national fleet. I think the reason for that is we have a policy that encourages us to import older cars that have a higher polluting dimension to them. We have to clean up our fleet and we’re doing nothing about it."

James McCarthy,
Chief Executive, Nissan Ireland

This year, we will drop our proportion of new car sales to below 50% diesel for the first time since 2008. At the same time, 70% of the imported cars coming in are diesel. They will be pushing the age profile of cars in the wrong direction. In other countries, enforcement of things like particulate filters and AdBlue aren’t enforced. We’ll see vehicles coming in that have had those systems disabled. When the UK is out of the EU, then Ireland can introduce rules to stop this.

Alan Nolan,
Outgoing Director General, SIMI

The next contributor promotes more air monitoring in Ireland and warns that cities like Dublin should be considered similarly to some of the more renowned polluting cities around Europe:

"Ireland has a high proportion of diesel vehicles and an aging vehicle fleet. There’s loads of traffic going through Dublin surrounded by high buildings so why wouldn’t we have the same problem as the bigger cities. I think part of that is we don’t monitor to the same degree as countries where they have a lot more monitoring stations. We definitely do, in some of our urban areas, have air quality issues."

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars
4.2.1 Impact of EVs on Air Quality

Several participants highlight the environmental benefits of replacing fossil fuelled cars with EVs:

*I think there will be a very, very positive impact of vastly reduced emissions and vastly reduced noise pollution. You have zero emissions if you can source your energy from renewables.*

James McCarthy,  
Chief Executive, Nissan Ireland

*The main advantage is not having direct by the roadside air pollution of nitrogen oxides and particles. Once Ireland moves over to non-fossil fuel electricity generation, you'll have better air quality and fewer problems with climate change. Still, it's moving the pollution away from the roadside.*

Prof. John Sodeau,  
Environmental Researcher, UCC

*They don't produce the same emissions via an exhaust. We won't be breathing in particulates from diesels.*

Fay Clohessy,  
Chairperson, CIT Energy and Environmental Society

*Full battery-electric vehicles emit zero CO₂ emissions, which has a number of benefits including enhanced air quality.*

Representative of the Climate Change Unit,  
Department of Transport, Tourism and Sport
One participant suggests that a shift to electric vehicles is a valid solution to Ireland’s air quality problem:

*It should be stressed that currently, Ireland has better air quality than most countries in Europe but in larger towns and cities, where prevailing winds are disrupted, and harmful pollutants are confined by densely built-up infrastructures, negative impacts on local ambient air quality and on public health and wellbeing are exacerbated. Given the disproportionate influence of traffic pollutants on ambient air quality in urban areas it can be argued that a reduction of these harmful emissions is equally as important as mitigating CO₂ emissions; therefore, new policy measures should consider potential impacts on both air quality and carbon emission reductions. For instance, mitigation measures that promote electric vehicles not only result in considerably lower CO₂ emissions but also significantly reduce NOₓ and PM.*

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport

This participant continues that a shift to electric vehicles will have a positive impact on the environment:

*The European Environment Agency confirmed in 2018 that battery electric cars emit less greenhouse gases and air pollutants over their entire life cycle than petrol and diesel cars by around 17-30%. As the carbon intensity of the EU energy mix is projected to decrease, the life-cycle emissions of a typical electric vehicle could be cut by at least 73% by 2050. In addition, electric vehicles have clear benefits for air quality, due to zero exhaust emissions at street level, however even electric vehicles emit particulate matter from road, tyre and break wear. Electric vehicles also reduce noise pollution, particularly in urban areas.*

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport
Likewise, the next respondent is optimistic about the impact of EVs on the carbon intensity factor in Ireland:

No tailpipe emissions. The key thing is by plugging into the national grid to charge your vehicle, you’re plugging into renewably generated electricity. I know it’s not 100% renewably generated but a proportion comes from wind and wave energy. This reduces the CO2 intensity factor that can be associated with the electricity generated. So, by using an EV, there’s no tailpipe emissions, but also, you’re ‘plugging into the wind’. If we were to increase the level of renewable sources in our national grid, we’re reducing the carbon emissions that are associated with the EV.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland

Another contributor contends that EVs have not yet realised their potential benefits to help counter climate change and air pollution:

What I can’t understand is this whole thing about there being rose petals coming out the back of EVs, when there’s mines out in Africa, getting iron out of the ground for the batteries, and then for the electricity, there’s a peat burning plant twenty miles down the road burning coal. And the other thing is, when electric cars get old, the disposal of them. When they’re being scrapped, there’s a lot of environmentally hazardous material in them. When you take EVs as a package, from the manufacture of the batteries through mining, and how the electricity is generated, I’d be pessimistic about it. If the electricity was all generated with clean energies like wave energy and wind turbines, then obviously that would be a far better job, but how far off that is, I don’t know.

Pio Cafferkey,
Managing Director, Mallow Road Motors

A previous respondent explains a new renewable energy initiative:

Over the next four or five years, they’re going to be putting out floating wind turbines off the coast of Mayo. If you’re going to be putting up more wind turbines, you’re always going to get push back from locals who don’t want changes to their landscape, but if you work with the floating wind turbines and put it a few miles off coast where no one can see, it’s not interfering with wildlife in the area, it will generate a lot more renewable energy that we can put onto our national grid and reduce the carbon intensity factor of our electricity.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland
The next interviewee is sceptical about the expected benefits of shifting to electric powered vehicles but accepts that EVs are the future in spite of this:

_The environmental debate is very nuanced because the CO₂ emissions coming from diesel are lower than those coming from petrol, and yet, diesel is a dying technology because, while they are good in CO₂, there are other pollutants they are emitting into the atmosphere, like the NOx that weren’t being measured with regard to our carbon footprint. Still, if every car on the road was a euro 6 diesel engine, we wouldn’t have a CO₂ problem from our transport fleet. It’s an interesting debate, but there’s no point in having it because the decision has already been made as the motor industry is already moving lock, stock and barrel to EVs._

James McCarthy,
Chief Executive, Nissan Ireland

The next three contributors support the elimination of fossil fuelled vehicles as soon as possible to improve public health:

_It doesn’t matter if modern fossil fuelled cars have lower emissions. Mitigation of the effects still means that there are effects. We’re up to about 418ppm (parts per million) carbon dioxide in the atmosphere. We used to have between 270-300ppm. And carbon dioxide is not all we’re worried about with vehicles. It’s more about the NOx and SOx. Contributing a smaller amount doesn’t mean that you’re doing something good; it just means you’re doing less bad._

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society

_It’s no good just reducing emissions; you have to eliminate. The problem is the source. If you stop it at source, you stop it. That’s the real key. You’ve got to educate people so they understand. People don’t understand air pollution, but they do understand the effects. They do understand the health problems. They don’t really understand either the effects or what happens with climate change. The carbon economy has got to change._

Prof. John Sodeau,
Environmental Researcher, UCC
[Modern fossil fuelled vehicles] are still emitting toxic emissions. I think EVs should still be pushed in that regard, especially in urban areas. You had ‘dieselgate’ with Volkswagen and you’d wonder are these manufacturers still trying to cheat the system?

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland

One expert warns that, while a decline in diesel cars is good for air quality, the impact would be less beneficial to the environment:

The issue on diesel cars is air quality, which is a city focus issue. What the previous government policy encouraged was for people living in cities who do low mileage to buy diesel cars, which were the wrong car for them. The average C02 figure for new cars sold at the moment is going upwards because we’re moving away from the lower emitting cars, which are the diesel cars, to petrol and hybrid cars for air quality reasons as opposed to environmental reasons.

Alan Nolan,
Outgoing Director General, SIMI

4.3 The Future of Private Car Use in Ireland

From the interviews conducted, it is clear that the future for the Irish cars will consist of cleaner cars and fewer journeys. Nevertheless, it is once again revealed that any notable change to the industry will take time. A number of participants deduce that electrification will be the solution for private cars:

We need to find a situation where you move from selling the majority of cars being internal combustion engine cars, and a very small proportion being electric, to a situation where it moves completely in the opposite direction until the internal combustion ones are down to nothing.

Alan Nolan,
Outgoing Director General, SIMI
Advances in battery technology, increasing competition in the market and falling vehicle costs would suggest that electrification will be the predominant low carbon choice for private car, taxis and commercial vans in the short to medium term.

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport

Encouraging people to move to EVs is good because cars of the future will have their wheels turned by electric motors. What might change is how that electricity is generated. Hydrogen is far more efficient than getting electricity from the grid. You can fill up your tank with hydrogen and use that to generate electricity in the fuel cells to turn the electric motors. That’s the greenest of all. You’ve only got water vapour coming out the tailpipe.

Michael Sheridan, Motoring Journalist

The following contributors agree that zero emission technologies will replace fossil fuelled cars, but expect that this is a long way in the future:

I think that the long-term technology is hydrogen. I would speculate that the oil companies probably have their claws stuck into that somewhere because the technology is very slow coming. That technology won’t be coming into the mainstream for years, until fossil fuels are exhausted.

Pio Cafferkey, Managing Director, Mallow Road Motors

Autonomous electric vehicles are the future. In the end, I think the answer will be when cars are built out of materials that are effectively solar panels so that you have power from the sun and good enough batteries that can store it. Also, as jobs become more technical and you don’t need people quite so much, encourage working from home, so you don’t have to go on the roads.

Prof. John Sodeau, Environmental Researcher, UCC
One expert admits that battery technology may not be the future solution:

What we should be conscious of is the fact that batteries are made up of really bad stuff. They're not healthy in the making or the dismantling. When you look at the electric car, you look at the weight of the battery and consider what proportion of the energy is required just to drive the additional weight of the battery. So, there is an efficiency challenge. Are we eventually going to see hydrogen fuel cells or something else coming aboard as a more acceptable or longer-term answer or partial answer with regard electric cars?

Alan Nolan,
Outgoing Director General, SIMI

The next interviewee recommends reducing the number of vehicles in urban areas, while increasing the number of clean vehicles in rural areas:

In cities and in towns, we can definitely reduce the amount of personal car ownership. I was all for the banning of privately-owned vehicles in St Patrick’s Street. A lot of other cities have done similar things to a much greater degree and have had much success. It means there’s less congestion and people have to find another way to travel. In the countryside, we need more of an increase in electric vehicle ownership.

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society

The next contributor describes autonomous systems of transportation:

The future for the motorist is not to own a car. I don’t see a reason why anyone would want to own an asset that is used only 4-6% of the time. We need a mobility system that allows you to get from where you are to where you want to go, at any time, in the most convenient way. Whether that’s by car, bus, train, scooter is irrelevant. You assume the systems will have to be autonomous to a degree because it will be too expensive to meet this need in rural areas. Studies have found that the greatest opportunities for these systems are people living in the countryside and outside towns where there is already an infrastructure. We won’t have to own a car to secure our mobility. If the paradigm of the ownership of the car changes to a point where we don’t need to own a car, then the electric cars will be owned by fleets and charged at their site.

Tomasz Waliwander,
Chief Technology Officer, Farran Technology
A popular theme among respondents is a focus on improving the public transport infrastructure in Ireland:

*Part of the answer is to do with far better public transport.*

Prof. John Sodeau,  
Environmental Researcher, UCC

A big problem I can see as well from my own experience of living in the country, I would happily jump on a bus to go into town, but I can't. In Ireland, the settlements are so sporadic, public transport isn't good enough to use to stop our reliance on cars.

Pio Cafferkey,  
Managing Director, Mallow Road Motors

An important strand to reduce transport emissions is, where possible, modal shift away from private car use and towards public transport.

Representative of the Climate Change Unit,  
Department of Transport, Tourism and Sport

This contributor continues to describe plans to develop the infrastructure that would enable this:

The National Development Plan has committed €8.6 billion to public transport over the period to 2027. Improving public transport services and infrastructure is central to providing an alternative to the private car, not only to reduce congestion and emissions but also to enable the transport sector to cater, in an environmentally sustainable way, for the increasing demands associated with growing population and employment.

Major projects planned include: BusConnects, which will transform the bus network in our cities with new and expanded bus routes, greatly improved bus access, designated segregated cycle lanes and park and ride facilities; investment in the DART Expansion Programme; and the MetroLink. In addition, multi-annual urban Cycling and Walking Infrastructure underway for our main cities is underway. The Government has also committed in the National Development Plan to stop purchasing diesel-only buses for our urban bus fleet from July 2019, and research is underway to prepare for this transition away from traditional fossil fuels in our public transport sector.

Representative of the Climate Change Unit,  
Department of Transport, Tourism and Sport
Despite this, the next contributor argues that private car ownership is critical in Ireland:

*I think that personal car ownership will continue to be a feature of our society. I think you’ll see, looking at population trends, that there’s about two million cars owned in the country and I think that figure will only go up as our population increases. You will see models like car sharing and all this sort of stuff. Particularly people living in the centre of urban areas. You’re really talking about people living in central Dublin and being able to exist without a car, but I’m working in the outskirts of Dublin, and really every single family who lives in suburban, greater Dublin area, and this applies even more when you get outside Dublin, have to have a car to survive, and I don’t see that changing. So, I see car ownership growing as the population grows.*

James McCarthy,
Chief Executive, Nissan Ireland

The next interviewee suggests that while private car use will remain a trend, the model will likely change:

*I definitely think car ownership is going to change and that’s something we’ll have to understand. You can see the car share model taking off with companies like Go Car. The idea of a second car for most people is becoming unnecessary. When you look at it from a purely economic point of view, it doesn’t make sense. I think the whole model is going to change over the coming years. You’ll probably just rent a vehicle for the type of driving that you want to do.*

Conor O’Brien,
Public Policy and Regulation Manager at ESB ecars

4.3.1 Hybrid Technology

Hybrid technology is popular among early adopters; however, industry experts do not expect this technology to succeed long-term:

*I think hybrid is a transitional technology, and I think the expression ‘self-charging hybrid’ is absolute nonsense. It’s not a self-charging hybrid. It’s charged by a petrol engine mostly, so that is not a valid term at all. I think there is a role for hybrid cars in the medium term, but I really don’t see them being a long-term solution.*

James McCarthy,
Chief Executive, Nissan Ireland
I know Toyota is going down the line of doing purely hybrid and I think that’s the wrong move as well. I think self-charging hybrids are very short term. If you have a plug-in hybrid, it might be a better fit. You can charge it for 2 hours and it’ll give you 55 kilometres of range. Most people are only in and out to work every day. But electric cars going mainstream in Ireland is a way off.

Pio Cafferkey,
Managing Director, Mallow Road Motors

Hybrids are more likely to be a short term, interim solution, or they may have a place focused on areas where air quality is the key issue, and you’re prepared to make some trade-off on the CO2 and the environmental side in return for the better air quality contribution.

Alan Nolan,
Outgoing Director General, SIMI

A motoring journalist describes ‘mild hybrids’:

What we’ve seen most recently is the rise of mild hybrids; these 48-volt systems that are very cheap to add onto an internal combustion engine to give you savings in CO2 emissions. Everybody is shifting to mild hybrids with their internal combustion engine.

Michael Sheridan,
Motoring Journalist

One participant indicates that the potential benefits to the environment from hybrid technology are dependent on the type of car use:

Hybrids have the benefit of being able to drive when they’re in very built up areas or around schools and children to run on zero emissions, which is where air quality is very important. The issue at present is that the range of the electricity is actually quite small and in many cases they have a petrol engine that’s actually bigger than the petrol engine in a standard car, and when they’re running on motorways, or for people in rural Ireland where there’s much less braking and re-accelerating, their performance as a zero emitting vehicle reduces, and you’re running it as a petrol vehicle, but not perhaps as efficient as a diesel or a conventional petrol car that’s low emitting.

Alan Nolan,
Outgoing Director General, SIMI
Another contributor argues that hybrid technology could solve challenges faced by commuters in the future:

You see more and more hybrids on the road now and I think that’s a good thing. It’s a bridge between electric and the internal combustion engine, until the infrastructure is in place. You’ll still have remote locations where people will want to rely on fossil fuels for mobility. It will still be a very good alternative to an electric car in thirty years’ time.

Tomasz Waliwander,
Chief Technology Officer, Farran Technology

4.3.2 The Environmental Impact of a Shift to EVs

Some contributors note benefits of vehicle electrification for the driver and for society:

The pleasure of driving the car is fantastic. It’s absolutely silent, great performance.

James McCarthy,
Chief Executive, Nissan Ireland

It’s a much nicer driving experience. The battery range is becoming a lot more useable for people. If you electrified vehicles, you get a much quieter city, and there’d be much better air quality. From an Ireland perspective, there’s an opportunity if you increase renewable energy to actually harness that. They’re much more economical for drivers as well, they’re a lot cheaper to run.

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars

Still, the silence of the EV is not preferred by all contributors:

I hadn’t realised they’d be so quiet. That would be a huge disadvantage for cyclists.

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society
Some contributors question the actual environmental advantage posed by the EV:

Electric vehicles have got to be part of the mix but the way that we generate electricity in Ireland is mainly through coal plants, which is not good for the environment. You’re just moving the air pollution problems to somewhere maybe in the middle of nowhere. But you don’t get rid of the climate change problems from burning fossil fuels. Even then, electric vehicles are of course not totally pollution free. You get particulate pollution from tyre and brake wear.

Prof. John Sodeau,
Environmental Researcher, UCC

The next interviewee questions the environmental impact of the manufacture and disposal of new EVs:

I’ve heard that the carbon emission is greater for the manufacture of electric vehicles. Another problem is how you dispose of the cells of the electric vehicles. The grid is a disadvantage at the moment. We might be sponging off fossil fuels for another while yet.

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society
4.3.3 Driving Behaviour

It is noted that currently, the EV charging infrastructure in Ireland requires much more involvement of the driver:

Not everybody has access to a parking spot, or a dedicated charge post. Even if you do find a public charger when you’re out of charge, there’s no guarantee it’ll be free. You have to be actively involved in the whole driving element of it and not everybody is that interested. People have to treat it as a hobby now.

Michael Sheridan,
Motoring Journalist

There’s going to be a massive impact, even in the way people think about fuelling their cars. It’s like when you go home and plug in your mobile phone to charge. Your car will be like your phone. It’s a ‘charge it when you can’ kind of thing. If you’re at work and there’s a charge point there, you plug in. If you’re going shopping and there’s a charge point there, you plug in. If you’re looking at solar panels and generating electricity and selling that back to the grid, you can actually utilize your EV battery as well. Motorists will be more involved in the grid.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland

Nevertheless, an interesting finding of these interviews is the affect EV driving has on the individual’s driving behaviour. It is found that EVs, by their nature, lead to more economical and safer driving:

Certain driving practices can have an impact on the battery range of an electric vehicle e.g. driving with the radio or heating on, or with extra weight in the car. In addition, eco-driving, which is a term used to describe the energy efficient use of vehicles through smooth and safe driving practices in order to reduce fuel consumption, can have a positive impact on electric vehicle range. As such, in order to prolong battery life, it is likely that drivers would tailor their driving habits. A 2012 study by the University of Lisbon found that the adoption of electric vehicles impacted everyday routines of 36% of participants while 73% changed their driving style.

Representative of the Climate Change Unit,
Department of Transport, Tourism and Sport

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When you drive the EV, there’s a graph of a tree for example, and when you’re driving the car economically, there’s loads of leaves on the tree, but if you drive more aggressively, all the leaves fall off the tree. For the most part it does make you drive more economically. If you’re buying an electric car, you’re conscious of the environment anyway. All these modern electric cars have these graphs and charts on the dash and if you’re driving any way aggressively or uneconomically, you’re looking at them and subconsciously you’re going to drive the car as economically as you can because of what’s in front of you.

Pio Cafferkey,
Managing Director, Mallow Road Motors

You drive much more conservatively because what you’re interested in is range preservation. It’s amazing; the clock you look at is how much kilometres you have left in your battery. I live about 10km from work, so I’ll get into my car when I’m going home this evening and it’ll say I have say 115km left in the battery, and I’ll try to drive home in a conservative way so that when I get home, it might say I have 145km left. It’s incredible how it creates a much safer driving environment for you.

James McCarthy,
Chief Executive, Nissan Ireland

It’s designed to make you think about what you’re doing when you put your foot down. You can see the battery depleting. When you take your foot off you can see the battery charging.

Tomasz Waliwander,
Chief Technology Officer, Farran Technology

Some contributors continue that EV driving is a superior experience:

When you get back into a regular car you can’t believe how noisy they are. You just get used to the relevant silence of the EV. You hear the radio perfectly. You don’t have to shout when you’re talking to someone beside you. It’s just a much more pleasant experience, and I think you’ll find that kind of response from most EV drivers.

James McCarthy,
Chief Executive, Nissan Ireland

That simple engineering side of it, where you only have a single gear, and a go pedal and a stop pedal. They’re so easy to use. The torque is so nice, they’re quiet. The cabins are refined, there’s no stink. They’re absolutely simple and wonderful at the same time.

Michael Sheridan,
Motoring Journalist
4.4 Financial Costs of EVs

Several contributors offer the financial costs of running an EV as a key advantage for the driver:

An advantage would be running costs. You can charge the car at night when it's cheap rates and it's only a couple of cent a night to do it, so it's very good in that respect.

Pio Cafferkey,
Managing Director, Mallow Road Motors

Depending on how you fund your car. For example, for a company car in Ireland, you're probably saving €1200 a year. Then there's the amount of money you save on servicing costs as well. The economics of it speak for themselves.

James McCarthy,
Chief Executive, Nissan Ireland

Driving an electric vehicle can save the driver up to 74% of the fuel costs of a traditionally fossil-fuelled vehicle.

Representative of the Climate Change Unit,
Department of Transport, Tourism and Sport

It's not a choice between saving money or saving the environment. With the EV, it's both. I think that's a message that's often missed.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland
One participant details Government financial incentives designed to increase electric vehicle adoption in Ireland:

In order to expedite the deployment of low carbon technologies, especially the uptake of EVs, the Low Emission Vehicle (LEV) Taskforce published a Progress Report in October 2018 which consists of a suite of continued and new EV supports including;

**Purchase Grant Schemes** – A grant of up to €5,000 towards the purchase of a new Battery Electric Vehicle (BEV) or Plug-in Hybrid Electric Vehicle (PHEV);

**VRT Relief** – VRT Relief of up to €5,000 for BEVs (until end 2021), up to €2,500 for PHEVs (until end 2019) and up to €1,500 for conventional hybrids;

**Domestic Charger Grant** – A grant of up to €600 towards the installation cost of a domestic charge point for new and second-hand BEVs or PHEVs;

**Low Motor Tax** – BEVs qualify for the lowest tax band of motor tax at €120 per annum, while a PHEV is typically taxed at circa €170 per annum;

**Toll Incentive Scheme** – As of July 2018, BEVs and PHEVs qualify for 50% and 25% toll reductions respectively up to a maximum €500 annual threshold for private vehicles and €1,000 for commercial vehicles;

**Lower fuel and maintenance costs** – Studies show that you can save circa 70% annually on fuel costs in comparison with a diesel alternative;

**0% Benefit in Kind Rate** – BEVs qualify for a 0% Benefit in Kind rate up to €50,000 without mileage conditions;

**Accelerated Capital Allowance (ACA)** – BEVs/PHEVs and their associated recharging infrastructure qualify under the ACA scheme. This scheme enables businesses to identify and buy the most energy efficient equipment including electric charging infrastructure and write down the cost of such equipment in the year of purchase rather than over the traditional 8 years;

**eSPSV Grant Scheme** – A grant of up to €7,000 or €3,500 towards the purchase of a BEV or PHEV respectively for vehicles in the taxi/hackney/limousine sector.

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport
It is noted by some participants that EV running costs and tax rates are not sustainable in the long run. One contributor recognizes that the tax incentives will eventually balance out:

As more and more people go into the grid and there’s more demand, the price is going to go up. It probably won’t go up to the same as the price of a litre of fuel, so I still think it would be economical in that respect. At the moment, you get €2500 off in VRT. There’s a limited supply of money in to run the country in taxation and if they’re going to lose it in VRT, we’re going to have to pay for it somewhere else. Or they’ll increase VRT. I know you get SEAL grants and stuff at the moment in our cars, between a VRT break and that, you get about €7500 off the price. But what will happen is, when they become more mainstream, the government won’t be able to sustain the supplements for it.

Pio Cafferkey,
Managing Director, Mallow Road Motors

On the other hand, it is noted that:

If you consider that 80% of EV charging is probably going to be done domestically, there’s not going to be any real change there for charging fees. The government is going to be losing a lot of tax revenue from the petrol and diesel. They’ll be looking for ways that they can recapture that. There could be certain taxes coming in. But I would say the running costs of EVs will always remain lower than the costs of petrol and diesel.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland

Some interviewees emphasise that the tax breaks are only sustainable while the adoption rate is low:

I think initially the taxes and running costs will come down, and as more and more people start getting them they’ll go up again. I think probably in the next five to ten years, they will come down, and then in the next ten, twenty, thirty years they’ll go way up again.

Prof. John Sodeau,
Environmental Researcher, UCC
We are still dealing with a relatively small adoption rate overall and early adopters really do need the encouragement to get there. The other problem is EVs are still very expensive to produce. They’re still investing massive amounts in R&D. They don’t have the economies of scales that they have with regular cars, so EVs are expensive at the moment, but there’s no doubt that they will come down in price.

I think incentives will probably be phased out before we reach two hundred thousand EVs on the road in Ireland. If you had a really big surge in EV sales, the government wouldn’t be able to sustain that loss of revenue from fossil fuelled vehicle taxes. Also, about €2bn in excise duty is taken every year at the petrol pump. So, if in ten years’ time, 50% of the cars on the road are EVs, that’s an awful lot of excise duty forsaken by the state, so they have to find other ways of raising it. They’ll have to design some model for recovering that money. At the moment, the utilization of the EV is low, so it doesn’t really make a dent. If we were to sell 50,000 a year, they might start noticing it.

James McCarthy,
Chief Executive, Nissan Ireland

It is suggested that a key challenge for the Irish government will come in the form of significantly reduced tax income as a greater number of drivers adopt zero emission vehicles:

The other thing is the potential massive loss of revenue to the State from motor taxes. They’ll have to look at the whole model of transport and ask where else they can get that billion Euro per year in tax revenue, which would vanish if everyone shifted to EVs.

Michael Sheridan,
Motoring Journalist

An expert mentions fees that will be introduced for public charge points but notes that the tax policy for EVs will need careful consideration in the future:

At the moment it’s free to use the public network. Later this year, we will introduce fees for the fast charge network. Then on the AC network next year. It’s something that has to be looked at from a tax perspective. There’re all kinds of theories around that. John Fitzgerald of the Irish Times suggested more toll roads, so if you’re using more roads you’re paying more tax. I don’t think it’s possible to tax electricity because consumers in the home will see their bills spike up.

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars
The next participant mentions a time delay they experienced with acquiring a home charger. They voice concerns about the longevity of the battery cells, which are expected to be expensive to replace. Again, the high purchase price is noted, however, the running costs are conveyed as a cost advantage:

*If you’re not a fairly wealthy person, you’re not going to get an electric vehicle at the moment. In terms of charging, you can still slow charge for free at public charging points around the country. They’re bringing in fees for the fast chargers, but it’s still not a huge amount. Costs for charging at home doesn’t cost nearly as much as filling a tank with petrol or diesel. Cells might need to be replaced. That would be more like an investment in the vehicle and not a running cost. You have to have all your papers in order and signed off and sent before you can get your grant for your charging point. That can take a bit of time. We got the car at the start of November, but we got the home charging point in January, probably because of Christmas time.*

Fay Clohessy,  
Chairperson, CIT Energy and Environmental Society

Another interviewee agrees that the purchase cost is too high, even with government grants:

*Electric cars are still expensive because they don’t sell them enough. Today the battery probably costs about twenty percent of what it cost ten years ago. Still, it’s the significant cost keeping the cost of the car very high. Getting a government incentive of €5,000 on a car that’s €40,000 is not really a lot. You still see that for €10,000 less you can get an internal combustion car, and you question the value. Why would someone buy an electric car when they can have a regular car that can be refuelled anywhere? The free electricity won’t last long. More than half of the cost of petrol is tax so that’s a big pool of money that the government will not want to lose. Going forward, owning electric cars will not be as cheap as it is now.*

Tomasz Waliwander,  
Chief Technology Officer, Farran Technology
The purchase price is noted, by one participant, as the key driver in EV adoption:

Nobody argues with zero emissions. That’s fantastic. Nobody argues with a lower price of €15 to fill your electricity, as opposed to €90 to fill your fossil fuel. There’s no arguments there. It does come down to the consumer being able to buy it at a price point, and the manufacturer being able to produce it at a price point that they’ll know they can make money on. What ultimately drives people to shift [to EVs] is the economics of it.

Michael Sheridan,
Motoring Journalist

When asked about when EVs might reach cost parity with fossil fuelled cars, one contributor reflects on the uncertainty surrounding battery production:

The big component is the battery. There’s a concept called Moore’s Law, where technology gets twice as powerful and halve the price every number of years. I wondered would that apply to EVs, where the battery would get twice as powerful, and it would come down in price, but from what I understand is we won’t see this because a significant portion of the battery is lithium ion, which has a fixed cost. Just because you buy in more of it doesn’t mean the price comes down. In fact, if you’re buying more of it, the price is probably going up. So, you don’t get any economies of scale around that. What you might see are technologies developing with things like graphite or hydrogen cell, or something that amalgamates with the conventional battery that will enable the range to go one way and price go the other. The big challenge is to find complimentary technologies that can take the price out of battery production. That will have a significant bearing on the price of the EV. From what I’m reading, I’m not hearing that there is anything immediately coming down the tracks that’s going to tell us that the price of a battery is really going to have that Moore’s law type of impact.

James McCarthy,
Chief Executive, Nissan Ireland

Nevertheless, it is suggested that manufacturing efficiencies are in the pipeline:

It’s like every new technology. It’s not mass produced just yet, so once it gets there, it will start bringing the cost of making these vehicles down so much that it will filter down to the retail price of the vehicles. Volkswagen are bringing in this NEV platform, which I think will bring down the price of the electric cars by about €10,000. Once we get a fully mass-produced market and manufacturing processes up and running in the EV market, that will filter down to a reduction in the actual cost of purchasing one.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland
Meanwhile, another participant suggests the purchase cost of the EV may become cheaper than that of ICE vehicles:

*The running costs are an advantage. Once certain economies of scale are met, when batteries become less expensive, I believe electric vehicles will become much cheaper than internal combustion engine vehicles, because technically, there's less complexity to them.*

Tomasz Waliwander,  
Chief Technology Officer, Farran Technology

4.5 Increasing EV Adoption in Ireland

One contributor details government policy designed to increase electric vehicle adoption in Ireland:

**Comprehensive public and on-street charging network** – ESB eCars rolled out a network of EV charging points throughout Ireland, including almost 80 fast chargers. This network is complimented by charge points provided at locations such as hotels, shopping centres, visitor attractions, places of employment and private car parks;

**Public Engagement Programme** – A National Awareness Campaign was launched in April 2018 as part of a wider public engagement programme which aims to increase awareness and familiarity with the technology of EVs, and;

**Test Driving an Electric Vehicle** – An online interactive map shows the availability of dealers throughout the country and enables a test drive to be booked online.

In response to the introduction of these measures, there has been a recent increase in EV sales; in 2018, a total of 1,972 new EVs were registered, bringing the total number on Irish roads to almost 7,650 by end December 2018. 2019 is seeing a continued rise in EV numbers – in January alone this year, 811 new BEVs were registered compared to 104 for the same period last year, and PHEV sales are also increasing with 301 vehicles registered in January compared to 109 last year.

Representative of the Climate Change Unit,  
Department of Transport, Tourism and Sport
One participant recommends permitting EVs to use bus lanes in order to increase EV adoption:

*We would say if people see people driving in bus lanes in heavy traffic, it actually convinces people that there’s added value to that car to compensate for the extra expense and all the uncertainties that go with it. When you have enough of them on the road where you can no longer accommodate them on the bus lanes, then you change that policy. But it’s about getting enough of them out there.*

Alan Nolan,
Outgoing Director General, SIMI

The next respondent recommends investment in EV charging infrastructure, and also continuing the current media trends that have recently been shown to discourage ICE purchase:

*Building more electric power points I think is important, but also tax incentives and subsidies. Some bad-mouthing petrol and diesel more as well will help people over the line.*

Prof. John Sodeau,
Environmental Researcher, UCC

It is argued that ‘bad-mouthing’ diesel would result in a lack of confidence in government policy:

*Acting negative against the diesel fleet discourages people from following government advice.*

Alan Nolan,
Outgoing Director General, SIMI
Similarly, the next contributor describes how market trends will see a significant take up in EVs in Ireland in the next ten years, but that range anxiety and an insufficient charging infrastructure are barriers that need to be overcome:

"Fewer people are going to be buying fossil fuelled cars, and that will be driven by both market demand, and also supply because you’re going to have fewer manufacturers choosing to produce them. The single biggest issue at the moment is the development of a charging infrastructure. There has got to be a commitment to put a charging infrastructure that gives people the confidence that they will not be constrained by the range on their vehicle. What you’re seeing is technology in the cars that allows larger range. Nissan will have a 60kw Leaf by the summer, so that’ll extend the range up to around 400km. In the following year, we expect to have a car with a range of about 500km. Once you get to that kind of capacity, Ireland is the ideal environment for electro mobility. The size of the island makes this the perfect place for EVs. It wouldn’t surprise me if the Nissan fleet was 50-70% EV in 2030 and our annual sales in 2022 I would expect to be 50% EV sales."

James McCarthy,
Chief Executive, Nissan Ireland

Another participant reports that cost is the single most important factor in attracting the potential EV buyer:

"People will have the environment in their head, but when it comes to money, that will be the definition. If a diesel car is €26000 and a similar electric one is €36000, they’re going to buy the diesel. They’re not going to care about the environment enough to buy an electric over petrol or diesel unless they put tariffs and increase taxes on fossil fuel vehicles. Maybe that will encourage people. Money talks."

Pio Cafferkey,
Managing Director, Mallow Road Motors

This is also noted by another interviewee:

"Also, a bit like the way you got people to go into diesel, was to make it cheaper. I’d like it to be more that people make their own choices because they’re improving climate change and air pollution, but if they also get a big tax break, that’s good too."

Prof. John Sodeau,
Environmental Researcher, UCC
The next contributor is optimistic about the impact of government support given the success of the increase in diesel sales that were encouraged to reduce CO2 emissions from the Irish transport sector in 2008:

Rewarding people for buying very low emitting diesel cars which pushed us from a situation where we had 71% of new cars sold pre-2008 would have been petrol. Within a period of three or four years that percentage had reversed. Based on government policy that was designed to push us in that direction.

Alan Nolan,
Outgoing Director General, SIMI

The next participant emphasizes the need for the purchase prices of EVs to come down significantly in order to encourage EV adoption:

Until we see sub twenty grand EVs, there really won’t be massive jumps towards them. If you think the electric Hyundai Kona is €37,000. The standard Kona starts at €20,000. The running of it is like a false figure, because if you spent €40,000 on an electric car that you could have got a petrol or diesel equivalent for €20,000, and spent €5,000 over its lifetime on fuel, you’re still coming out ahead of the EV.

Michael Sheridan,
Motoring Journalist

It is suggested that there is some onus on the manufacturers to bring the EV purchase price down:

You need the technology to evolve. You need the manufacturers to bring the EVs to markets, and you also need the price of the cars to come down to where they’re more comparable with other vehicles. The incentives that are already there are quite good. If you were to put any more, I think you’d distort the market a bit. But the manufacturers themselves need to bring the prices down. And that will come with producing more vehicles and more R&D. It’s usually around 2024 or 2025 that you read about there being a big fall in the price of EVs. That’s the key. There’s only a handful that are affordable, full electric vehicles, and that’s after the grants.

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars
The next contributor continues to suggest promising trends in the manufacture of EVs:

They’re now able to build EVs on the same production line as their petrol and diesels. So, they can drop in an EV platform and so on and build an electric only car alongside fossil fuelled cars. In the past, they were so specialized that they were built in different production lines, so the economies of scale weren’t there. The companies are now finding ways to slot them into their regular production line and drastically reduce costs. So, we’ll see drops coming in reasonably large chunks in the coming years, as they find better ways to scale it.

Michael Sheridan,
Motoring Journalist

Two interviewees emphasise the requirement to educate potential EV users which aligns with the Public Engagement Program outlined by a previous contributor:

I think the incentives that are present at the moment are one of the best in Europe. From that side of things, I don’t think there’s too much more that can be done by the government. What I think could be done more is an information and education piece because the mass public still don’t really understand how the EV works with regards to its range and how to charge it. People need to be educated around whether an EV has the capability of meeting their driving needs at present.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland

PR campaigns. People think that batteries are something that break easily. After a few years of driving the electric car, you’ll have to replace it. I’m sure you’ll find people who think you have to be careful washing an electric car because it’s electric. People don’t know much about electric cars and educating them is the key to it.

Tomasz Waliwander,
Chief Technology Officer, Farran Technology

A concern is highlighted with regard to regional specific support for EVs:

In Dublin city, which is the area where you would expect the most progress, has been unsupportive of electric cars. It’s probably the only city in the world that will clamp electric cars that are parked at a recharging point in the city. You can imagine the message that sends to the would-be buyer of an electric car.

Alan Nolan,
Outgoing Director General, SIMI
The next contributor suggests that lack of choice in the EV market is a key area that is currently limiting the transition to EVs, but expects this choice to increase dramatically over the next number of years:

If you look at the number of options, it’s probably about thirty plug-in electric and fully electric vehicles on sale now, whereas if you look at the general car market, there’s well over a hundred. That choice for customers to have a range of options for the vehicle to suit them, and to have sufficient driving range. There’s loads of cars in the pipeline. And for those vehicles to reduce in price as well to where they’re comparable to an equivalent ICE vehicle.

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars

Another interviewee notes issues around clean energy production and persuading car owners to choose an electric vehicle as key challenges in the transition to EVs:

We have to find a renewable, sustainable source of electricity. We have that with wind turbines, and wave potential. There’s a company in Cobh that developed a more efficient wave energy converter. Ireland has the biggest wave potential in Europe because we have the Atlantic on the West Coast. I’ve heard that might supply all of Ireland’s energy needs. The other thing is having these solar panels on your roof, so you can charge your car and other items, and it’s a way around the grid. Other challenges include trying to convince people to change their behaviour. They have a campaign for the new face of electric vehicles, where they show an old woman, and an old farmer from down the road. They’re showing that it’s not just cool, hip people who are buying an electric vehicle.

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society

The next participant agrees that:

We need to see more electric cars on the road and normalise them, so they’re not just a car for eco-warriors or for people who count their pennies.

Alan Nolan,
Outgoing Director General, SIMI
The next contributor lists the technical limitations of electric vehicles currently on the market, but describes that these will be overcome through R&D:

*Purchase costs, concerns over the reliability of a new technology, range anxiety, battery life expectancy and charging availability are factors potentially limiting electric vehicle uptake both internationally and in Ireland. It is envisaged that technological advances will alleviate concerns over range, battery life and charging requirements in the near future; market forces and rationalising production has already seen a marked decrease in vehicle costs.*

Representative of the Climate Change Unit, Department of Transport, Tourism and Sport

The next participant also notes the technical limitations, and persuading the public to choose an EV:

*The technology isn’t good enough range-wise for say, a trip from Cork to Dublin. I also think Irish people aren’t conditioned to buy electric vehicles yet. The technology isn’t there for big mileage yet. Range is a big issue.*

Pio Cafferkey, Managing Director, Mallow Road Motors

4.6 EV Charging Infrastructure

The Irish charging infrastructure is a key disadvantage highlighted by participants:

*The compromises in terms of what the car can do for you depend on what you need the car to do for you. If you’re living in an apartment, the infrastructure isn’t there for you at the moment. The target market for the EV is restricted by those issues.*

James McCarthy, Chief Executive, Nissan Ireland

It’s about the lack of charging points and infrastructure for anyone to drive anywhere at any time, knowing that there will be a charging point to charge the vehicle in a reasonably short time. You could drink coffee or read for a few minutes while you wait. You would be connected to experiences, and not wasting your time waiting for your car to charge itself.

Tomasz Waliwander, Chief Technology Officer, Farran Technology
At the moment, only some cars can take fast chargers, and even less can take these ultra-fast ones. There's also an issue with fast charging and batteries and the potential to shorten battery life if you fast charge. A lot of the car companies will only guarantee the batteries for eight years.

Michael Sheridan,
Motoring Journalist

Another problem is charging infrastructure.

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society

Experts in the automotive industry contend that Irish infrastructure is delaying the transition to EVs:

The biggest problem would be range for people to use them in the mainstream with longer commutes. There're not enough charging points around the place, and if there's huge volumes of all electric vehicles, say for example in Cork city, and everyone is going to town and everyone wants their car charged, the infrastructure isn't there. I'm sure it will come when there's demand there, but it's just not there at the moment, and I can't see car parks putting the capital in to do that.

Pio Cafferkey,
Managing Director, Mallow Road Motors

Our job in the motor industry is to deliver the cars that are capable of running at zero emissions and not contributing to damaging the environment. The challenge for the State is ensuring the electricity is generated is also renewable and non-damaging. That's not our challenge. That's too big of a challenge for us to be focused on. We need to ensure that our industry is capable of delivering the cars that are capable of it.

Alan Nolan,
Outgoing Director General, SIMI
The ESB, through their business ESB ecars, need to upgrade infrastructure. If the ESB significantly upgrade the infrastructure, that’ll certainly help EV adoption. The government and local authorities have a huge part to play in this. We could look at the Swedish models, where a lot of soft benefits were given to EV drivers, in particular permission to drive in bus lanes. That incentive has had significant effect in terms of encouraging people to adopt EV driving. As long as the generous financial incentives stay in place until we get to a level of adoption of maybe two hundred thousand plus cars on the road.

James McCarthy,
Chief Executive, Nissan Ireland

Another participant continues with the challenge of solving this ‘range anxiety’:

I think the challenge is partly psychological because people have this thing about running out of electric power in the way that they wouldn’t run out of petrol. So, that does mean a very large investment by the government and by the car manufacturers, and the taxpayer to have a lot more charging stations around.

Prof. John Sodeau,
Environmental Researcher, UCC

One interviewee emphasises the requirement for EV charge points in the home, and refers to the potential flexibility brought to the energy grid by the EV:

With Ireland having such large rural areas, you have to be clever about putting the charging stations around, but in the first place, clearly you make sure every home has one. If every home has a charger, then you charge overnight. And you've probably then got 300 miles to do, so even in rural it’s probably not that much of a disadvantage. People just want to make sure that they don’t run out. You’ve got to get over that problem.

Home charging is essential, and I think there’s a lot more that has to be done with the home. If you have solar panels in your house, that would power the EV, but more than that, if you’re able to feed the electricity that you generate into the network, then you get paid some money for it. I think there’s got to be a lot more clever usage of the electricity.

Prof. John Sodeau,
Environmental Researcher, UCC
Additionally, it is recommended to pre-empt the rise of the EV by installing a home charger now, whether or not the homeowner drives an EV:

*If we’re talking about pure EVs, the infrastructure really isn’t up to it. If you have an average car like a Nissan Leaf. Now, with a 40kw battery it has a useable commutable range, although you still need to top it up. A Kia Niro or a Hyundai Kona will go close to 400km on one charge. The problem is, that charge takes longer to happen because it’s a bigger battery capacity. So, it’s vital that everyone has a home charger. If you don’t have an EV now, you should still look at getting a charge point put into your home. Even for your friends visiting in their EV, it’s important to have the facility there.*

Michael Sheridan,
Motoring Journalist

The importance of home charge points is reiterated by the next contributor, who details the costs involved with installing one. This contributor goes on to suggest home charging alone is insufficient:

*If you have an electric car, you have to have a charge point at home. In fairness, it is quite economical. A charging point might cost over €800 but with the grants, it works out as €200 or €300 when you have all your taxes back. But you need to have charging points where people go. You’re going to have to have a load of them in shopping centres and at the cinema and places like that, which is a load of work to get that level of infrastructure in place.*

Pio Cafferkey,
Managing Director, Mallow Road Motors

Further to the point of public charge points, the next participant questions the sustainability of traditional refuelling stations as the electricity infrastructure for charging EVs develops:

*Fuels stations, like Applegreen and Circle K are going to miss out on a market opportunity if they don’t move quickly. People are not going to be going to their outlets to recharge their cars. They’re well positioned on the motorways but around the cities, you’re seeing supermarkets and other places putting charging points in. If the natural port of call for someone to recharge their car is in a supermarket carpark as opposed to what is currently a fuel station, the long-term viability of those petrol stations might be questionable. The ESB have made statements that they are going to significantly upgrade the infrastructure this year. If they do, that’ll certainly help EV adoption.*

James McCarthy,
Chief Executive, Nissan Ireland
The next interviewee is optimistic about the future of public refuel stations:

There’s actually little profit in retailing fuel. The profit is in the shops while the customer stops for petrol. With an electric car, you’re probably always going to be there for the length of a cup of coffee.

Alan Nolan,
Outgoing Director General, SIMI

This contributor recommends an approach to developing the charge point infrastructure:

I think they could find out where there are most electric vehicles. The same way the State will use the CSO to plan where to put a primary school because there’s a young population nearby, or where to put a nursing home because there’s an aging population there. They have everyone’s registration and address. They can find out where there is a higher concentration of electric vehicles, and they can put more charging points there. And pre-emptively, they could put more charge points in rural Ireland to encourage people to buy the electric vehicles.

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society

The next contributor recommends investment by car manufacturers in the charging infrastructure:

If I wanted to buy an electric car, I wouldn’t buy anything other than Tesla because their strategy is not only to make the cars, but also to roll out the charging network. You see other car manufacturers are shifting towards electric vehicles, but no one is investing in the infrastructure. If I have a Tesla, I have Tesla chargers, but everyone else has to rely on ESB charging points, where there’s only about a thousand in Ireland, and many of those don’t work. I think that’s fundamentally what will keep people from buying an electric vehicle.

Tomasz Waliwander,
Chief Technology Officer, Farran Technology
An expert offered more insight into the development of the EV charging infrastructure in Ireland:

*ESB ecars have a plan over the next four years to roll out charging hubs across the country. They’d be like fuel filling stations. It would be a row of chargers. You’ll be able to charge up to eight vehicles in some locations. There’ll be 150kw chargers as opposed to 50kw, which are the general fast charger standard now. You’ll get about 100km range in about 6 minutes. That will transform the charging experience. We’re also looking at a solution like that for the cities. If you don’t have off street parking, you can use those kinds of facilities as well.

It translates to about four hundred more points. We think, because most of the charging will be done at home, we’ll be able to accommodate five or six hundred thousand vehicles. Maybe other providers will, but we won’t be putting chargers in car parks. You’ll charge at home, and you’ll charge in these hubs, and that’s kind of the way it’s going, particularly with the range of the batteries.

New cars have a 64kw battery and a range of 350-400km. Most people in rural areas don’t cover that kind of distance. They have driveways where they can plug their car in and charge it at home. For the network we’re going to roll out, it doesn’t matter where you live. If I live in Leitrim, I can charge at home for 400km every day. If I wanted to drive further afield, then I’ll use the public network to bring me further than 400km. It shouldn’t make any difference between rural and urban. The network we’re going to roll out is right across the country.*

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars

When asked what impact he thinks this will have on traditional refuel stations, this contributor reassured regarding their sustainability:

*A lot of what we’ll be rolling out will be in partnership with them. We’re going to roll them out on their sites. What they’re looking to do is have pumps for ICE vehicles, and chargers for EVs as well. It will be an extra service. If you look in the UK, Shell and BP are getting involved in developing charging networks as well. Eventually, if the whole car fleet moves over to electric, then I presume they’ll move all their pumps over to electric and have more chargers on site. If you look at petrol, their margin is 2-4%. It’s all about the retail side of it and what you purchase in store.*

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars
The next participant highlights the challenge to be met with regard to developing the public infrastructure, but agrees it will resemble traditional refuel stations:

*Would you buy an electric car if there was no infrastructure in place? Would you invest in infrastructure if there were no electric cars on the road? Recharging at home and recharging at work are two requirements that make it easier for people to change to an electric car. The other infrastructure, you’re probably looking at the same infrastructure as petrol and diesel fuel stations.*

Alan Nolan,
Outgoing Director General, SIMI

When asked about the impact the transition to EVs will have on the energy grid, one expert describes some of the technologies designed to reduce the strain on the network:

*ESB networks can accommodate, without too much major investment, two or three hundred thousand EVs in the first instance. There are a lot of chargers at the moment that will alter the amount of charge coming out of the charge point, based on how much energy is being used in the rest of the house. So, if you turn on your electric shower, it’ll turn down the power going to the car for a while. Even as it is with having night rate metres, you can have a timer on your car which means you can have the car charging start at maybe eleven o’clock at night when you’re getting pretty much half price electricity.*

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars

The next interviewee warns of the potential impact of a large take up in EVs:

*It will put immense pressure on the national grid. If everyone plugged in their EV at eight o’clock at night, the grid would need to have enough smart capabilities within it, and there would need to be enough smart charging equipment out there that can balance the loads. It’s just load balancing and making sure there’s not too much pressure coming on the grid, and too much demand there. At the moment, the grid is in peaks and troughs, so utilizing EVs will balance out that demand on the grid. If you consider battery storage, you can really manage the stability of the grid to keep it at a more consistent level. If there was a massive surge in demand at some stage in the grid, through the use of smart meters and smart chargers, you could take some power back from the vehicles. You can use the power that’s already in the EV to service the spike in demand on the grid. Then, when that demand levels off again, the grid can replace what it took from your vehicle again.*

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland
Experts in the automotive industry are similarly sceptical about the effect increased EV adoption will have on the electricity grid:

I think there will probably be pressure on the grid initially, but that will be a gradual realignment of our power usage. The EV will have a balancing effect on the grid. I think it will move to a kind of virtual circle where more and more homes will look to have their own renewable source, through solar panels and the like, allied to power storage units. The EV will be a power storage unit as much as it will be a car. It can store energy in the battery and release that to the grid as necessary, and people can use that energy to power their house. So, I think you’ll see a rebalancing of the grid and EVs will create a greater opportunity for renewables to form a more significant part of our power usage in the country.

There’s no doubt EVs will put additional strain on the grid, however, the experience in Norway where you now have over two hundred thousand EVs, is that it hasn’t had any material impact on the energy usage. I know we’re looking to go way beyond that in time, but I think as technologies are reliant on renewables and if homes start putting solar panels in and developing their own renewable sources, that won’t have any impact on the grid. In fact, it would be a positive addition to the grid.

James McCarthy,
Chief Executive, Nissan Ireland

I don’t think the national grid could take it.

Pio Cafferkey,
Managing Director, Mallow Road Motors

The next respondent reassures that technologies in the energy sector can complement the EV technology for an overall positive impact on the grid:

It will all come down to artificial intelligence and the algorithms they have that will allow the demand and supply to adapt and meet each other when needed to balance out the grid. It comes down to the smart capabilities and the smart meters allowing the grid to react to high demand in one area and take the energy from elsewhere to meet that demand. If for some reason the grid goes down, because of a hurricane for example, it could come to a point where you can run your house from your vehicle battery if you have solar panels. You would be running your own microgrid.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland
The next contributor describes a current issue with charge point parking:

For the charging points, there's two slots, so two vehicles can charge at a time on every charger. When the car is finished charging, the plug releases and anyone can unplug it, so someone else can come along and charge their car then. So, you can technically have four parking spaces for one charging point and have two parked ready for when the first two are finished. Because the leads are only so long, that space isn't there in most places where there's a charging point. So, there's a limited number of spaces for anyone to charge at. Changing how they plan parking around the charging point would be fantastic.

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society

Participants support fees at EV charging points:

We're expecting fees to come for fast charging and that might stop people from just randomly topping up because it's free. People who even have a home charging point will prefer to park all day at a public spot, to get free electricity. That's how the system gets abused.

Michael Sheridan,
Motoring Journalist

One of the things that we would have had a view on, is that the idea of offering free electricity to electric cars from the beginning as an incentive was very good and you couldn't argue with it. But, the idea that the provider of the service couldn't charge for it was the wrong way to do it. It would have been far more sensible to let the person providing the service to be able to recover some of the cost of the investment by charging for it, and that the State subsidized that piece. We are, thankfully, moving to a situation where the State has changed its policy view to the fact that recharging can be a cost recovery thing.

Alan Nolan,
Outgoing Director General, SIMI
This participant continues to suggest variable charging rates:

*The ability to be able to charge at variable rates for your recharging facilities. If someone is on a slow charge, you’d imaging that it would be at a lower rate of cost than if someone wanted to get in and out at a very quick period of time. It will probably end up being like the fuel price wars that happen from time to time, that on busy roads, where there are lots offering the same service, they actually have to be very competitive, and in other places where you’re lucky just to find one, you’re hardly going to argue about the price because you’re just happy you managed to get the recharge.*

Alan Nolan,
Outgoing Director General, SIMI

4.7 Advice for Motorists

This research reveals a common recommendation for car buyers to choose an EV if it meets their transport requirements. The aforementioned disadvantages of the EV will not impact all potential owners and the importance of crossing the chasm of EV adoption is emphasised. Additionally, the contributors in this study recommend government policies that would reduce the number of fossil fuelled cars on Irish roads. The first contributor recommends reducing the reliance on fossil fuelled personal transport where possible, and warns of imminent policy measures to discourage ICEs:

*Go for an electric car if you can. Get prepared for very large tax increases on their petrol and diesel engines. Wherever possible, use public transport, but make sure that public transport is clean as well. The other thing is to try to stop the necessity for travel by doing more and more online.*

Prof. John Sodeau,
Environmental Researcher, UCC
The next participant recommends the purchase of newer, cleaner vehicles, but not necessarily EVs in the current climate:

*Buy newer vehicles that have cleaner emissions. I think the government should incentivise the manufacturers to come up with cleaner technologies and incentivise car owners to buy newer vehicles. I think the plug-in hybrid is the way to go as of now. I think that’s the best technology available. If you could get the range up to 150 kilometres on one of these plug ins, that you can fall back to the petrol engine, I think that’s the best compromise today. If a person is driving from Cork to Waterford every day, an EV is not for them. You have to go diesel for your economy.*

Pio Cafferkey,  
Managing Director, Mallow Road Motors

Action taken by a car buyer should be determined by their needs. Experts in the industry do not support EV adoption where it would not suit the driver:

*You need to look at what your needs are. If an electric car or hybrid is suitable for the sort of driving you do, then it becomes a real option for you. If you are in rural Ireland and you do high mileage, then the only logical thing for you is a diesel. It is, as it has always been, you need to settle on which works for you and not what you read from the media. We’re in that transition where there isn’t the one answer for everybody yet, if there ever will be.*

Alan Nolan,  
Outgoing Director General, SIMI

At the moment, it’s nonsense to say everyone should be hopping into an EV. It’s always the same advice as before. Buy what suits your needs. If it can work in your life and do what you want of it. The caveat with electric cars is that, when it runs out of electricity, you have to charge. You have no other choice. Does that work for you? It won’t work for a lot of people.

Michael Sheridan,  
Motoring Journalist

Concentrate on your daily driving routine. Look at the range of vehicles on the market. Look at the infrastructure in your locality. Do you have off-street parking? That’s a big question. Understanding your own driving routines, journeys and your driving style is most important when you’re looking to be fully informed with regard to which car is the best fit for you.

Shane Prendergast,  
Programme Executive at Sustainable Energy Association of Ireland
Another contributor describes the worries of potential car buyers currently, who do not have confidence in a new car holding its value as well as it may have done previously. Yet, this contributor proposes that EVs should hold their value, based on earlier generation EVs, and if the specific requirements of the driver can be satisfied by an EV, it is recommended that the car buyer should choose an EV:

At the moment, if you buy a diesel or petrol, which is probably an excellent car with very low emissions, good value and economical to run, when you go to sell that car in four years’ time you worry will there be anyone there to buy it? You have the same question around hybrids and you wonder whether hybrid will be a relevant technology in four- or five-years’ time. With EVs, if you buy a 40kw EV today, in four years’ time when I go to sell that car, and the standard is 80kw, will anyone want to drive my 40kw car? People are deciding to do nothing and continue to drive the car they’re currently driving.

What we’re seeing is that the residual value of EVs is really holding up, so the cars that we originally sold six or seven years ago, which were 24kw cars. We thought that they might not have any great attraction when longer range cars came into the market, but actually the used car values are working out pretty well. My view would be if an EV works for you, buy an EV. It just depends on personal requirements. If you’re somebody who does high mileage, I think diesel is still the right answer. I think it’s an environmentally solid answer as well at the moment. If you’re a city driver I think it’s a petrol car.

James McCarthy,
Chief Executive, Nissan Ireland

The next interviewee is concerned that there are still uncertainties regarding the residual value of EVs:

Other concerns would be what is the lifecycle of the battery on the car when the car is eight or nine years old. Replacing the battery might be a bigger cost than the residual value of the car. Would that mean it’s a write-off? Will a bank give me a loan on a second-hand electric car in the same way? Will they have a poorer view of it? If I’m trading my electric car back in, will they give me as good a price as they would on my petrol or diesel car?

Alan Nolan,
Outgoing Director General, SIMI
This participant continues that the logical solution for many motorists is not the best solution:

If you’re someone living in rural Ireland driving a diesel car, and you would normally change it now, would you see your investment in that new car as something sensible? An electric car isn’t going to work for you, a hybrid car isn’t going to work for you and a petrol car is going to be too expensive for you to run. The most logical thing to do is just keep driving your older car. It’s actually counterproductive.

Alan Nolan,
Outgoing Director General, SIMI

The next interviewee acknowledges the anxiety of many car buyers but suggests that a surge in electric vehicle sales will speed up the development of the industry:

I would say bite the bullet and buy an electric vehicle if you can. The supply will increase when the demand does. If everyone rushes to buy an electric vehicle then suddenly, there’s going to be more investment into electric vehicles. The infrastructure will become better. Investment in technology will only come if it’s a viable market. Of course, down the line electric vehicles are going to be cheaper and more efficient, but you can speed up the efficiency and the development of these vehicles by buying them. No one wants to spend big money on a model that’s going to be out of date in two- or three-years’ time. But someone has to start it. What we need is for the large majority of the population to buy them. We have to talk to our politicians and our manufacturers and tell them that we want electric vehicles and that we want charging infrastructure. It will follow on naturally anyway, but you need a catalyst. Otherwise it’s going to take too long.

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society

The next contributor encourages electric vehicle adoption where appropriate:

There is a wide range of incentives available to drivers who wish to transition to an electric vehicle. As such, when changing your car, it is important to explore all the options available to you and be open to transitioning to an alternative fuel.

Representative of the Climate Change Unit,
Department of Transport, Tourism and Sport
Another participant does not think it’s wise to buy a new car at the moment, but mirrors the opinion that if an electric car suits a person, it is important for those people to adopt them:

*Buying now is not the best solution. Spending a lot of money on a quickly depreciating asset, that is set to depreciate even faster with the new technologies, doesn’t make sense. I think there is merit in buying second hand vehicles now, more so than in the past. But if no one buys electric cars, the adoption is not going to happen. We need to cross the chasm. For the person who needs a regular style commuter, an electric car might make sense. It is ideal for people who wouldn’t have to rely on the public network and can do a week on a single charge by charging the car at home or in work.*

Tomasz Waliwander,
Chief Technology Officer, Farran Technology

### 4.8 Advice for Government

The first participant surmises that the government can have a key role to play in supporting the transition to a new model of transport:

*When you look at how government policy can successfully influence people’s behaviour. Car buying and car usage is driven by behaviour. Your car is not just a means of transport. It’s part of your self-image. When you look at the job that was done with the changeover to emissions based on taxation in 2008, I don’t think there’s a better example anywhere of how the State successfully changed people’s buying behaviour in the way that they set out to do it. What they set out to do may have been misjudged, but there is a huge lesson is how it can be successful.*

Alan Nolan,
Outgoing Director General, SIMI

One contributor makes a case for a carbon tax that would discourage ownership of fossil fuelled cars, but recognises that such a tax would be met with much resistance:

*One thing I said earlier was incentives for electric cars, but there has got to be disincentives for fossil fuels as well. There’s a lot of arguing about the carbon tax. People in rural areas saying they are being screwed because they use a car. Certainly, there are these ideas by putting a really substantial carbon tax per kilogram of carbon to put people off. That’s why they come up with these schemes to say, let’s put the money back in people’s pockets at the end of the year. Give them a cheque for one hundred euro for doing it. The important thing is to get people out of the habit of using carbon. People are afraid they are not going to be compensated for doing that.*

Prof. John Sodeau,
Environmental Researcher, UCC
Resistance to such an initiative meets strong opposition by experts in the automotive industry due to the damage it could potentially do to the Irish motor industry in the short term:

*If you look at it, and obviously I’m biased, but the market is down 14% on last year, which was roughly down 5% on the year before. The motor industry is a huge employer in the country. If you put a carbon tax on new vehicles, it’s going to reduce the amount of vehicles that are sold and it’s going to affect income. Firstly, VRT will be down, which is a big portion of the tax take. Secondly, if dealers aren’t selling as many cars as they’d like to or they should be, they’re going to be laying people off, and that will put an extra strain on social welfare and stuff like that.*

Pio Cafferkey,
Managing Director, Mallow Road Motors

Experts in the automotive industry condemn current policy that is at odds with the goal of meeting Irish emission targets:

*At the moment the policy encourages people to drive older more polluting cars rather than newer cars. For example, if you’re importing an older car in from the UK, you’re paying a lower VRT rate than you do on a newer cleaner car. In most other countries what happens is, as cars reach the end of their life, they’re typically replaced by newer cars that are cleaner. So, that has a natural effect of cleaning up the fleet. Our problem is, we’ve taken so many used cars that our fleet isn’t getting cleaned up. In fact, it’s getting dirtier. That is going to create a big problem for us as we fail to meet our CO2 targets. We won’t solve that problem by converting people into EVs because the pace of conversion would just be too slow.*

James McCarthy,
Chief Executive, Nissan Ireland

A motoring journalist suggests a new model of vehicle running costs:

*Fuel is heavily taxed already but if you tax fuel more and include third party insurance and carbon penalties just in the price of fuel. Let everybody buy whatever car they want and don’t penalise the taxes based on emission. Everybody would naturally go with the cars they can afford to run. If a car was uneconomical, people wouldn’t buy it, because the cost of fuel would be so much. Down the line, if nobody’s buying fossil fuels, then if the government still wants to be able to identify stuff as motor tax, they’ll have to do something like charge for registering a car with either a one-off payment, or an annual subscription.*

Michael Sheridan,
Motoring Journalist
The next participant distinguishes between cleaner, modern ICEs and the older, more polluting cars:

*The biggest challenge in all of that, which nobody has even mentioned, is that the current fleet of cars is like a barrel of oil. The newer cleaner cars at the top and down at the bottom, where sludgy darker oil tends to gather, you have probably a million very old cars, very highly polluting. They’re the cars that are most damaging that we need to work out how we get them replaced. We don’t have any option in the short term because of the supply of electric cars, the infrastructure for electric cars, and the needs of users will not be satisfied by the current range of electric cars available. Therefore, in all environmental sense, we have to continue to buy and sell fossil fuelled cars. The alternative is far worse.*

Alan Nolan,
Outgoing Director General, SIMI

One contributor recommends policies that would reduce the number of older, more polluting fossil fuelled cars in Ireland:

*The biggest emitting vehicles are the older ones. If they introduced some sort of scrappage scheme for older diesel and petrol vehicles, given owners an allowance to take them off the road. If people got into a newer vehicle, even if it wasn’t electric, the CO2 emissions come way down. Also, and Brexit might sort this out, but if they tax dirty UK imports and put a tariff on them coming in. That would stop the rot and we could move forward with newer technologies as well.*

Pio Cafferkey,
Managing Director, Mallow Road Motors

When asked for their thoughts on the introduction of the suggested scrappage scheme for older cars, one participant suggests policy measures that tackle the root of the problem; the import of polluting vehicles into Ireland:

*You would ask yourself why we’re importing cars only to have to scrap them later. The better option is to say the cars that are in our national fleet are left to fall off at the end of their lifespan and maybe introduce policies that encourage people to buy newer, cleaner cars. We are compounding the problem by allowing 100,000 plus cars that don’t meet present day emission standards, into our national fleet. So, we’re allowing those cars to come in, and then we’re going to have to pay some money to get rid of them. These are cars that are being dumped from the UK into Ireland.*

James McCarthy,
Chief Executive, Nissan Ireland
When asked about how the government could discourage the import of these polluting vehicles, this contributor describes a simple solution:

*Very simply by the government just saying they are not allowing any cars into Ireland that don’t meet a particular emissions standard, for example, at least euro 6 compliant. I can only distribute new cars that meet the latest standards, so in our case it’s euro 6. I can’t import a car that from first registration is lower that euro 6. In some countries like Russia, they have cars that don’t meet any environmental standard. I can’t import them; however, if it’s a used car, people can. And it’s going to cost a fortune to try and clean up. To put it in perspective, with regard to EVs, nationally about 1200 EVs were sold in 2018, plus about 800 used EV imports, we took in over 100,000 polluting cars.*

James McCarthy,
Chief Executive, Nissan Ireland

Another interviewee believes the focus should turn to the public transport sector, while sustaining the current incentives for EVs:

*I’d focus on public transport; taxis, electrify the bus fleet. The infrastructure part I think will grow naturally. There’s lots of incentives for customers and I think you need to hold to those incentives for another couple of years so that the market will evolve enough as well.*

Conor O’ Brien,
Public Policy and Regulation Manager at ESB ecars

The next contributor recommends disincentivising the use of fossil fuelled vehicles, and using price reductions to encourage additional public transport utilisation:

*They talked about bringing in the carbon tax. There should be disincentives, whether it’s monetary or just saying we’re banning a certain type of vehicle. You have a huge number of cars being imported into the country. If they were to increase taxes or ban them altogether, it would certainly have an effect. The price of public transport could be reduced to encourage more people to use it.*

Fay Clohessy,
Chairperson, CIT Energy and Environmental Society
The next participant agrees that focusing on reducing the use of polluting cars has been overlooked in Norway, which has seen significant success in EV adoption:

In Norway, the average age of a diesel car is about 12 years old. In Ireland, the average age of a diesel car is between 5 and 6 years old. What those two figures tell you is that, while they've been buying electric cars, people have been holding onto their diesel cars in Norway. So, if you're going a long distance, you can drive your old diesel car. The average diesel car in Norway does not have a diesel particulate filter at that age. The average diesel car in Ireland was fitted originally with diesel particulate filters. Your approach to how you make that transition and still benefit during the period with cleaner cars and better cars has to be much more subtle.

Alan Nolan,
Outgoing Director General, SIMI

The next participant echoes the response of other participants:

According to 2016 emission figures, transport emissions are broken down approximately as follows:

- Around 52% from private car use;
- Just over 18% from the freight sector;
- Just over 8% from light duty vehicles;
- Approximately 4% from fuel tourism – the practice of buying fuel in the State but using it outside the jurisdiction (border fuel sales); and
- Approximately 4% from the public transport fleet.

Maximum impact in emissions savings can therefore be achieved in the private car and freight sectors; as such we are focusing primarily on promoting:

A) Modal shift towards public transport and making public transport more climate friendly;
B) A transition of the private car fleet to alternative fuels; and
C) A reduction in emissions from the heavy-duty vehicle and freight sector.

Representative of the Climate Change Unit,
Department of Transport, Tourism and Sport
One contributor recommends that the government focus on a PR campaign that educates and elicits trust in the public:

> The government need to prove to people that this won’t be another case like with diesel vehicles. About ten years ago they changed the principal of taxing the cars by the virtue of CO2 emissions, and as we recently learned, it probably isn’t the best way to gauge how damaging the car is to the environment. People will feel like they weren’t told the truth and that they are being tricked again into shifting to an electric car. There needs to be a proper PR campaign that shows people that there is a planned strategy and purpose in shifting from ICE’s to electric vehicles. It needs to be completely truthful with regard to the benefits, the constraints and the limitations.

Tomasz Waliwander,
Chief Technology Officer, Farran Technology

The next participant deduces that:

> You can’t mandate people to buy an EV. People don’t like to be forced to do things. You look at policies around infrastructure. If there’s a large company with five hundred employees, they need to have ten or twenty EV charge points on their premises for their staff. Another thread of policy is looking at new residential property, where all new buildings will have to have parking and EV charging. You’re talking carrot and stick, and the carrot seems to work best. It’s about investing and making sure we’re future proofed for the uptake that’s coming.

Shane Prendergast,
Programme Executive at Sustainable Energy Association of Ireland

One expert concludes that:

> I think we need to develop policies that are not based on the certainty that what we’re saying now is the only answer. It is likely not to be the only answer and the correct answer, but it may well be the path to a far better answer and we need to develop policies that have a much wider view with the pathway that we need to get to, and an understanding that everything you do knocks onto something else and there will be other things opening up so trying to watch those things so that our policies can be flexible.

Alan Nolan,
Outgoing Director General, SIMI
4.9 Summary

This chapter presented comments from the interview participants in this research. It reveals some key challenges facing Ireland and conveys the future landscape of the automotive industry with regard to the imminent shift to EVs. The concerns of automotive experts, climate experts, and key stakeholders in the industry are noted. The data that has been collected and presented in this chapter will be further analysed in Chapter 5.
5.0 Introduction

This chapter presents the main discoveries from the empirical research carried out as part of this study. These findings are organised and structured similarly to Chapter 4. Chapter 5 includes new data from secondary sources, while referring to some data collected previously and presented in Chapter 2.

5.1 The Sustainability of Fossil Fuelled Cars in Ireland

As revealed by Sundvor & Lopez-Aparicio (2014), biofuels were previously considered to provide long-term sustainability to the fossil fuel transport industry. Biofuels were viewed as “something that we could produce in Ireland, something that was totally renewable, and was far better from an emissions performance” (Chapter 4: p.62). Findings in this research are coinciding with Zah et al. (2007), who validated the environmental advantage of biofuels. In line with O’Brien (2018), it is reported that “the government put in policies to support it” (Chapter 4: p.62). As previously reported by Browne et al. (2011) and Raslavičius et al. (2014), “The challenge of food production in the third world, and some productive land being switched over to biofuel for export for cash was a concern” (Chapter 4: p.62). The concerns of McCormack (2018) reveal that the use of biofuels in Ireland is minimal, and as such, petrol and diesel cars will continue to impact the environment and urban air quality alike.

This study shows that while fossil fuelled cars have become cleaner, emitting particles and gases into the environment in small amounts, climate experts strongly oppose sustaining the use of fossil fuels in the Irish cars. “Burning fossil fuels of any sort poses problems with climate change and air pollution” (Chapter 4: p.58). This supports the views of Verhoef (1994), who...
described the social costs of road traffic. Electric Vehicles (EVs) are now attributed as the future solution to transport worldwide, with Hughes (2019) suggesting that while EVs are very much the future of motoring, they need to become a larger part of the present as well. This is consistent with one participant who emphasises that “we need to see a high take-up of electric vehicles in Ireland constituting a substantial transition away from traditional fossil fuels” (Chapter 4: p.59).

This research indicates however, that fossil fuelled motorisation will continue to dominate the Irish automotive industry for the next ten years. “We don’t have any option in the short term because of the supply of electric cars, the infrastructure for electric cars, and the needs of users” (Chapter 4: p.107). One automotive expert explains that they “would have no fears in buying a diesel in the reasonable period ahead” (Chapter 4: p.57). The limited range of the EV, as described by Ryghaug & Toftaker (2014, p.162), supports the sustained purchase of diesel models for the foreseeable future.

This new study discovers that a driver’s circumstance determines the appropriate type of car. This is encouraging for fossil fuelled car sales in Ireland. “If anybody is doing over 15,000 kilometres, they need to think about staying in a diesel car, because it will deliver much better fuel consumption” (Chapter 4: p.55). Nevertheless, this research recognises that the transition to zero emissions transport in Ireland has begun. The Irish government aims to eliminate the sale of ICEs by 2030. “By 2030, if fossil fuelled cars are not gone, I’d say they’ll be on the verge of exiting from the market” (Chapter 4, p.55). It is reported that diesel engines now account for less than fifty percent of new car sales (McAleer, 2019a). Additionally, an increasing number of legislative constraints aim to discourage the manufacture and sale of
fossil fuelled cars. “Fewer manufacturers are going to follow the ever-increasing standards that would be required under European legislation” (Chapter 4: p.56).

This new examination demonstrates that the concerns surrounding pollution stemming from ICE vehicles are associated with cars that are more than ten years old. “If people got into a newer vehicle, even if it wasn’t electric, the C02 emissions come way down” (Chapter 4: p.107). Therefore, this new review suggests that the purchase of newer, cleaner ICE vehicles will result in significantly reduced emissions. It is argued in this study, that the emissions from modern petrol and diesel models are low enough to create a sufficient decrease in air pollution. “A lot of the concerns about the pollution associated with [internal combustion] engines are no longer valid” (Chapter 4: p.56). This research has identified a key issue in the popular trend of importing cars that are more than ten years old: “seventy percent of the imported cars are diesel. They will be pushing the age profile of cars in the wrong direction” (Chapter 4: p.65).

Industry experts agree that the transition to emission free transport will be a lengthy affair and, although the government deadline for eradicating conventional internal combustion engine vehicle (ICE) sales in Ireland is 2030, the feasibility of this is met with some scepticism. “The Irish government have put in a 2030 deadline to say that from then on you can’t buy an internal combustion engine vehicle, but even that is going to be tricky” (Chapter 4: p.56). This is in line with Cunningham (2019d) who reports that the 2030 deadline has been criticised for being over-ambitious.
This study shows that motorists travelling more than 25,000 kilometres per year should not be encouraged to switch from diesel to petrol models because petrol engines will “not be as economical as diesel” (Chapter 4: p.59). Supporting the findings of Hennessy & Tol (2011, p.1), one expert in the automotive industry reveals that a diesel model would consume as little as half of the fuel consumed by an equivalent petrol model (Chapter 4: p.59). This new inquiry finds that, while EV technology continues to limit driving range, diesel is the clear choice for those travelling more than the average distance. Moreover, it is established that diesel vehicles emit less CO2, which is more beneficial to the environment: “the CO2 emissions coming from diesel are lower than those coming from petrol” (Chapter 4: p.69). Yet, Campbell (2018) showed how salespeople will intentionally steer people towards petrol models. “We’re seeing [diesel car owners] moving to buy petrol cars, or buy hybrid cars, which are much more polluting of CO2” (Chapter 4: p.60). Paradoxically, one participant recounts how “the dealer had dissuaded” a family member from purchasing an EV (Chapter 4: p.61).

This research has found that the pressures being placed on Governments and car manufacturers to eradicate transport fuel emissions will limit the choice of diesel models in the near future. “You’re going to see the end of the diesel engine” (Chapter 4: p.60). The Worldwide Harmonised Light Vehicle Test Procedure (WLTP) laboratory test is used to measure fuel consumption and CO2 emissions from passenger cars, as well as their pollutant emissions (wltpfacts.eu). WLTP aims to provide a much more accurate basis for calculating a car’s fuel consumption and emissions. This study shows that, because of the introduction of WLTP, motor taxes “will be dearer because all values for emissions will go up” (Chapter 4: p.60). This is likely to deter car buyers from choosing to purchase petrol and diesel models and push them towards zero emission vehicles.
In this investigation, climate experts challenge the Government’s pricing strategy of petrol and diesel as it encourages diesel car purchase. Coinciding with the findings of Zervas (2006), “despite knowing about the health problems with the nitrogen oxides and particulates, they gave a ten cent per litre difference between buying petrol and buying diesel that pushed people towards buying diesel cars” (Chapter 4: p.61). Furthermore, it is introduced in this new investigation, that the focus on eradicating diesel models while encouraging petrol fuelled cars appears short-sighted. “We have to get rid of fossil fuels completely” (Chapter 4: p.61). Additionally, this research has shown that “a move away from conventionally fossil-fuelled vehicles, including petrol or diesel” is encouraged by the Irish Government (Chapter 4: p.62).

A critical finding of this thesis demonstrates that “the average CO2 figure for new cars sold at the moment is going upwards because we’re moving away from the lower [CO2] emitting cars, which are the diesel cars, to petrol and hybrid cars for air quality reasons as opposed to environmental reasons” (Chapter 4: p.70). This study reports the distinction between petrol vehicles, which emit harmful levels of CO2 resulting in environmental damage, and diesel vehicles, which emit lower levels of CO2 but emit particulate matter in the form of NOx and SOx which has been detrimental to air quality in cities around the world and has presented the greater immediate challenge to human health.

5.2 Vehicle Pollution in Ireland

This study conveys that transport pollution in Ireland is relatively low when compared with other regions. “Currently, Ireland has better air quality than most countries in Europe” (Chapter 4: p.67) because cities like “Dublin and Cork are low-rise cities” (Chapter 4: p.62). Despite this, “in 2013 approximately 1,600 premature deaths in Ireland were attributable to air pollutants, mainly from traffic sources” (Chapter 4: p.63). Moreover, it is revealed that
“traffic emissions are on the rise” (Chapter 4: p.63). Ristovski et al. (2012) showed that diesel vehicles are the major contributors to the pollution problem. Transport is the biggest contributor to a key air pollutant, ambient nitrogen dioxide levels, in Irish cities, the majority of which is coming from private vehicles (Rock, 2019). This new research also reveals that any decrease in vehicle emissions, due to modern, cleaner engines is “likely to be cancelled out by a significant increase in transport demand” (Chapter 4: p.63). This is evident from one account that “for the past ten or fifteen years, we haven’t been able to improve the air quality even though we’ve moved so much technologically and with our understanding in dealing with air pollution” (Chapter 4: p.64). This study finds that in Ireland, “we don’t monitor [air quality] to the same degree as countries where they have a lot more monitoring stations” (Chapter 4: p.65).

In this examination, automotive industry experts note the relevance of the age profile of vehicles, which is revealed to impact the level of emissions from Irish cars. Additionally, Ireland has “a policy that encourages us to import older cars that have a higher polluting dimension to them” (Chapter 4: p.65). “In other countries, enforcement of things like particulate filters and AdBlue aren’t enforced. We’ll see vehicles coming in that have had those systems disabled” (Chapter 4: p.65). When AdBlue combines with exhaust emissions, it creates harmless nitrogen and oxygen by breaking down the harmful mono-nitrogen oxides inside the diesel exhaust (finol.ie).

5.2.1 Impact of EVs on Air Quality
This new research proposes that replacing ICE vehicles with EVs will result in a considerably positive air quality impact. This supports the findings of Klockner et al. (2013). “The main advantage is not having direct by the roadside air pollution of nitrogen oxides and particles” (Chapter 4: p.66). “Electric vehicles also reduce noise pollution” (Chapter 4: p.67). While it is
conveyed that EVs emit zero carbon emissions, Levinson (2014) previously noted that this is dependent on the source of the electricity used to power the vehicle. “You have zero emissions if you can source your energy from renewables” (Chapter 4: p.66). This investigation shows that offshore wind initiatives “will generate a lot more renewable energy that we can put onto our national grid and reduce the carbon intensity factor of our electricity” (Chapter 4: p.68). Yet, it is argued that, depending on the carbon intensity, EVs can increase the emission of air pollutants (Huo et al., 2015). This research however, finds that EVs “emit less greenhouse gases and air pollutants over their entire life cycle than petrol and diesel cars by between seventeen and thirty percent” (Chapter 4: p.67). This is in line with Wu et al. (2015, p.3), who suggested that EVs can result in a thirty-three percent reduction in emissions. With an increase in renewable sources of electricity generation, “the life-cycle emissions of a typical electric vehicle could be cut by at least seventy-three percent” (Chapter 4: p.67).

It is demonstrated that automotive experts are sceptical “when you take EVs as a package, from the manufacture of the batteries through mining, and how the electricity is generated” (Chapter 4: p.68). Firstly, aside from the manufacture and disposal of EV batteries noted in this examination, this study also conveys the lack of efficiency with battery technology questioning how significant the “proportion of the energy is required just to drive the additional weight of the battery” (Chapter 4: p.72). This may suggest hydrogen fuel cell technology is a more suitable long-term solution. Secondly, the concerns regarding how the electricity is generated supports the findings of Holtsmark & Skonhoft (2014), who previously questioned the electricity mix. On the other hand, it is argued in this investigation that Ireland “wouldn’t have a CO2 problem” from traffic, if every car on Irish roads was a modern, low
emission, Euro 6 model (Chapter 4: p.69). Emission regulation aims to improve air quality by reducing pollutants emitted from the road transport sector, with Euro 6 emission regulations applying to new vehicle registrations from 2015, setting tougher emission limits for nitrogen oxides (rsa.ie).

This new research identifies a clear conflict between environmental experts and automotive experts. While automotive experts strongly support the continued purchase of modern ICE vehicles, environmental experts argue that “it’s no good just reducing emissions; you have to eliminate” (Chapter 4: p.69). The increasing adoption rate in Ireland suggests that the decision to shift from ICEs to EVs on Irish roads has already been made. In Ireland, sales of EVs soared by 470 percent in the first quarter of 2019 (Burke-Kennedy, 2019).

5.3 The Future of Private Car Use in Ireland

This new inquiry reveals two main themes regarding the future of car ownership in Ireland. Firstly, cars will have significantly less pollutant emissions in the future. It has been demonstrated in this study that modern fossil fuelled cars emit polluting gases and matter on in smaller amounts than cars manufactured before the introduction of Euro 6 emissions standards. In accordance with Nanaki & Koroneos (2013), this new research shows that, in the future, “electrification will be the predominant low carbon choice for private car” (Chapter 4: p.71). As a result, “encouraging people to move to EVs is good, because cars of the future will have their wheels turned by electric motors” (Chapter 4: p.71). It is also expected that “autonomous electric vehicles are the future” (Chapter 4: p.71). Indeed, it is predicted that commuters will be able to access autonomous vehicles much the same as they currently do trains and buses (Cunningham, 2019c). One expert suggests that zero emission
technologies “won’t be coming into the mainstream until fossil fuels are exhausted” (Chapter 4: p.71).

Secondly, the use of cars will be discouraged to a greater degree than has been seen before. “The future for the motorist is not to own a car” (Chapter 4: p.72). This will stem from a combination of a “shift away from private car use and towards public transport” (Chapter 4: p.73) and “encourage working from home, so you don’t have to go on the roads” (Chapter 4: p.71). Gupta (2018) revealed a focus on introducing low emission vehicles for the public transportation infrastructure in India. Similarly, this study demonstrates that urban areas present the greatest opportunity to decrease car use. “In cities and in towns, we can definitely reduce the amount of personal car ownership” (Chapter 4: p.72). In Ireland, private cars have already been banned from city centre roads in Dublin and Cork, although the latter restricts car use for just three hours per day. “It means there’s less congestion and people have to find another way to travel” (Chapter 4: p.72). Holtsmark & Skonhoft (2014) previously warned that generous government incentives which encourage EV adoption may stimulate the use of private cars instead of public transport, as seen in Norway.

Increased investment and efficiency in Irish public transport networks is noted by several participants in this study. “Improving public transport services and infrastructure is central to providing an alternative to the private car” (Chapter 4: p.73). It is however shown that Ireland’s National Development Plan, which “has committed €8.6 billion to public transport over the period to 2027”, focuses on urban development. This research concludes that the reliance on private car use will extend beyond this timeframe for rural areas in Ireland. Nevertheless, it is suggested in this study that the model for private car ownership will likely change. “You will see models like car sharing” (Chapter 4: p.74). Contributors in this
investigation hypothesize that drivers will “rent a vehicle for the type of driving that they want to do” (Chapter 4: p.74). “If the paradigm of the ownership of the car changes to a point where we don’t need to own a car, then the electric cars will be owned by fleets” (Chapter 4: p.72). This study concludes that today’s challenge is to “move from selling the majority of cars being internal combustion engine cars, and a very small proportion being electric, to a situation where it moves completely in the opposite direction until the internal combustion ones are down to nothing” (Chapter 4: p.70).

In the short term, this study reports that continued research and development into the technical aspects of the electric motor and its power source will enable a more competitive alternative to ICE transport in terms of driving range. “We’ll only see the shift [from ICE vehicles] when the motor industry decides it wants to shift, and when it’s economically viable to do it” (Chapter 4: p.57). For EVs to achieve a par with ICES in terms of selection and price, manufacturers need demand to increase in order to realize economies of scale similar to ICE production. “Once certain economies of scale are met, when batteries become less expensive” (Chapter 4: p.86). Supporting Fleet Industry News (2018), this study finds that potential EV buyers need the price to decrease for the EV to be a feasible option. “There’s only a handful that are affordable, full electric vehicles, and that’s after the grants” (Chapter 4: p.89). Combined with the inadequate EV charging infrastructure, few Irish car owners are likely to favour an EV over an ICE vehicle under the current conditions. Ireland is the tenth worst of the thirty International Energy Agency countries in terms of integrating EVs into its national fleet (Malekmian, 2019).

In the long term, Ireland needs “a mobility system that allows you to get from where you are to where you want to go, at any time, in the most convenient way” (Chapter 4: p.72). This
research shows that an autonomous system would be most suitable to support the sporadic rural areas in Ireland. “The greatest opportunities for these systems are people living in the countryside and outside towns where there is already an infrastructure” (Chapter 4: p.72). It is revealed that there are many elements that will determine when driverless cars enter the mainstream including the technology itself, consumer attitudes, affordability and public policy (Cunningham, 2019c). Cunningham (2019d) reports that true autonomous driving could be as far away as twenty years.

5.3.1 Hybrid Technology
Hybrid vehicles attempt to strike a balance between the more versatile combustion engine and the more economical electric motor (drivingfast.net). This investigation shows that “hybrids have the benefit of being able to drive around schools and children to run on zero emissions, which is where air quality is very important” (Chapter 4: p.75). Despite this, the low range of the electric motor requires the hybrid vehicle to be driven by the petrol or diesel motor more often in rural areas and on motorways. The petrol and diesel motors in hybrid vehicles are suggested to be less efficient and more polluting than conventional petrol or diesel engines.

Self-charging hybrid vehicles now make up 7.7 percent of the car market against 2.2 percent for EVs, with hybrid volumes growing on an equivalent level to EVs (Leonard, 2019). As indicated by Jones (2018a), manufacturers are now “shifting to mild hybrids with their internal combustion engine” (Chapter 4: p.75). While a traditional hybrid’s electric motor is able to power the car on its own, a mild hybrid’s motor is only able to assist the engine; it isn’t potent enough to drive the car independently (Griffiths, 2017). Hybrid car sales increased by twenty percent in the first two months of 2019, compared with the first two months of 2018 (Leonard, 2019).
Automotive experts call hybrid vehicles a “transitionary technology” (Chapter 4: p.74) during the shift from ICE vehicles to EVs. This study distinguishes between two forms of hybrid vehicles; plug-in hybrid vehicles (PHEVs) and self-charging hybrids. “Self-charging hybrids are very short term” and it is contended that ‘self-charging’ “is not a valid term at all” because the batteries are charged by a fossil fuel motor (Chapter 4: p.74). “It’s a bridge between electric and the internal combustion engine, until the infrastructure is in place” (Chapter 4: p.76). Still, it is noted by Schuitema et al. (2013), that motorists are currently more likely to adopt PHEVs than EVs. The advantage with the hybrid is that it is much closer to what the average consumer is already familiar with and it fends off so-called range anxiety (Leonard, 2019). Self-charging Hybrids are expected to grow to twelve percent, or 1 in 8 of new cars sold in 2020 (Leonard, 2019). This new study finds however, that the imminent shift to fully electric vehicles will eliminate ‘self-charging’ hybrids from the automotive market in the future.

On the other hand, PHEVs can be charged using an EV charge point and are reported in this study as being suitable for certain needs in the future. One participant proposes that people will want to rely on fossil fuels for mobility in thirty years’ time (Chapter 4: p.76) and PHEVs will remain an alternative to fully electric vehicles. McAleer (2019b) reports that, because hybrid vehicles can spend the majority of their time in zero emissions mode, they can support the current focus on decarbonising the Irish national car fleet.

5.3.2 The Environmental Impact of a Shift to EVs

“If you electrify vehicles, you get a much quieter city, and there’d be much better air quality” (Chapter 4: p.76). EV drivers relate the quietness of the electric motor to the pleasurable driving experience; however, this research also shows that silent engines would pose a “huge
disadvantage for cyclists”, due to the potential dangers of not hearing EVs on the road while cycling (Chapter 4: p.76).

In line with the findings of Joshi et al. (2018), this new examination shows that the impact of EVs on air quality is determined by “the way that we generate electricity in Ireland [which] is mainly through coal plants, which is not good for the environment” (Chapter 4: p.77). As noted by the UK Department for Environment, Food and Rural Affairs (2018), this study also considers that there is “particulate pollution from tyre and brake wear” (Chapter 4: p.77) in EVs consistent with ICE vehicles. Similarly, to the verdict of Hickey (2018), this research also exposes concerns with the pollution caused in the manufacture and disposal of EVs, which is argued by some contributors to be greater than that of ICE vehicles.

5.3.3 Driving Behaviour
This study has found that under the current conditions and limitations of the EV charging infrastructure in Ireland, EV use requires more involvement than ICE vehicles. “People have to treat it as a hobby” (Chapter 4: p.78). In accordance with Wu et al. (2015), this new study finds that drivers will need to adjust their current driving behaviour in relation to refuelling their car. This supports the claim of Cunningham (2019b) who expects EV drivers will no longer drive until the tank is empty, but instead treat EVs like mobile phones; you plug in whenever you can. With the introduction of smart energy technologies, such as smart meters and domestic microgrids, “motorists will be more involved in the grid” (Chapter 4: p.78).

Another interesting finding in this research is the impact of the EV on the driver’s driving style. Economical and safe driving results from a focus on battery range preservation. “In order to prolong battery life, it is likely that drivers would tailor their driving habits” (Chapter 4: p.78). Supporting the findings of Al Faruque & Vatanparvar (2016), this study finds that EV drivers
“drive much more conservatively because what you’re interested in is range preservation” (Chapter 4: p.78). There is an emphasis on how EVs are “designed to make you think about what you’re doing when you put your foot down” (Chapter 4: p.79). “Modern electric cars have these graphs and charts on the dash” (Chapter 4: p.79) and “the clock you look at is how much kilometres you have left in your battery” (Chapter 4: p.79). A study of EV drivers showed “seventy-three percent [of drivers] changed their driving style” when driving an EV compared to an ICE vehicle (Chapter 4: p.78). “It creates a much safer driving environment” (Chapter 4: p.78) as a consequence of “eco-driving” (Chapter 4: p.79). This study also shows that EV driving is a superior driving experience than that of ICE vehicles, due to the silence and the “simple engineering” that make EVs “so easy to use” (Chapter 4: p.79).

5.4 Financial Costs of EVs
This new research shows that “what ultimately drives people to shift [to EVs] is the economics of it” (Chapter 4: p.85). This study examines several ways that EVs are considered to be better value for money than ICE vehicles. In terms of fuelling the EV, the user “can charge the car at night when it’s cheap rates and it’s only a couple of cent a night to do it” (Chapter 4: p.80). “Driving an electric vehicle can save the driver up to seventy-four percent of the fuel costs of a traditionally fossil-fuelled vehicle” (Chapter 4: p.80). As shown by Sadlier (2016), this could compensate for the higher purchase price of EVs over equivalent ICE vehicles. Chapter 4 outlines the financial incentives put in place by the Irish government to encourage EV adoption. Among these incentives is a reduction in the purchase price of an EV, the motor tax, the cost of installing a home charger, and toll charges. The financial savings of “€1200 a year” for selecting a zero emissions model for company car use is also noted in this thesis (Chapter 4: p.80).
This analysis shows however, that as EVs “become more mainstream, the government won’t be able to sustain the supplements for it” (Chapter 4: p.82). This study finds that the financial incentives should “stay in place until [Ireland] gets to a level of adoption of maybe two hundred thousand plus cars on the road” (Chapter 4: p.94). “If you had a really big surge in EV sales, the government wouldn’t be able to sustain that loss of revenue from fossil fuelled vehicle taxes” (Chapter 4: p.83). This study reveals an important element to consider as more people shift to zero emission cars. Government motor taxes for ICE vehicles will be foregone and the government will “have to design some model for recovering that money” (Chapter 4: p.83). Some models were suggested including introducing “more toll roads, so if you’re using more roads you’re paying more tax”, regardless of the emissions from your vehicle (Chapter 4: p.83).

While Campbell (2018) argues that the total cost of ownership (TCO) of the EV is lower than an equivalent ICE vehicle, this research, in line with Palmer et al. (2018), reveals that currently, even with the government grants, “electric cars are still expensive” (Chapter 4: p.84) to purchase because they are “still very expensive to produce” (Chapter 4: p.83). It is indicated that “if you’re not a fairly wealthy person, you’re not going to get an electric vehicle at the moment” (Chapter 4: p.84). There is optimism that the production costs of an EV should reach cost parity with ICE vehicles. “When batteries become less expensive, electric vehicles will become much cheaper than internal combustion engine vehicles, because technically, there’s less complexity to them” (Chapter 4: p.86). It is reported that manufacturers are “now able to build EVs on the same production line as their petrol and diesels” in order to “drastically reduce costs” (Chapter 4: p.90). This is expected to significantly reduce the purchase price of EVs.
It is predicted that when fees for EV charge points are introduced in Ireland, the cost of ‘filling up’ at the EV charging network will be comparable or even higher per kilometre than running a conventional petrol or diesel car (Gibbons, 2019). Nevertheless, a study in Norway showed that a substantial eighty percent of EV users said they would not revert to fossil fuel vehicles if all the electric-car incentives were withdrawn (Cunningham, 2019b). This highlights the importance of encouraging initial EV purchase.

5.5 Increasing EV Adoption in Ireland

In line with Du & Ouyang (2017), this new examination discovers that “purchase costs, concerns over the reliability of a new technology, range anxiety, battery life expectancy and charging availability are factors potentially limiting electric vehicle uptake both internationally and in Ireland” (Chapter 4: p.92). Despite this, the fear of running out of battery power is being overtaken by a compelling argument to save money on running costs (Cunningham, 2019b). This new research observes two paths to increase EV adoption; using financial incentives to encourage EV purchase and using financial disincentives to discourage ICE purchase. Bjerkan et al. (2016) previously distinguished between these ‘pull’ and ‘push’ measures and noted that most policies centre on the former. This new investigation reveals that people are “not going to care about the environment enough to buy an electric over petrol or diesel unless they put tariffs and increase taxes on fossil fuel vehicles” (Chapter 4: p.88).

Larson et al. (2014) reported that EVs are still too expensive to encourage the majority of car buyers to adopt them, and this is also presented in 5.4 of this thesis. It is argued that most Irish motorists will not purchase EVs until there are EVs on the market which can be bought for less than €20,000 new. “Until we see sub twenty grand EVs, there really won’t be massive
jumps towards them” (Chapter 4: p.89). This study demonstrates that research and
development by manufacturers is critical to decrease the manufacturing costs of the EV. “The
manufacturers themselves need to bring the prices down” (Chapter 4: p.89). This focus is
evident in China (Bloomberg, 2018). “It is envisaged that technological advances will alleviate
contains over range, battery life and charging requirements” (Chapter 4: p.92). The advent
of more EVs, which are less expensive, alongside the growing perception of serious savings
on running costs will swing buyers to purchase EVs in increasing numbers (Cunningham,
2019b). “There’s probably about thirty plug-in electric and fully electric vehicles on sale now,
whereas if you look at the general car market, there’s well over a hundred” (Chapter 4: p.91).
It is revealed that increasing the selection of EVs which are equal to the price of ICE
alternatives will increase EV adoption.

This study reports that in the coming years, manufacturers will choose to produce less fossil
fuelled cars. EV adoption will be impacted accordingly. Nissan Ireland CEO James McCarthy
expects “annual sales in 2022 to be fifty percent EV sales” (Chapter 4: p.88). The real take-up
surge will come as carmakers move into less expensive vehicles that are mass produced for
smaller families and first-time buyers (Cunningham, 2019b). The Government was recently
urged to offer a special grant or tax relief to first-time drivers in addition to the existing €5,000
fund available for the purchase of EVs because those who buy an EV as their first car are more
likely to continue driving plug-in cars for the rest of their lives (Malekmian, 2019). In
agreement with Holtsmark & Skonhoft (2014), this research warns that “while they’ve been
buying electric cars, people have been holding onto their diesel cars in Norway” (Chapter 4:
p.109). This shows that the focus should be less towards encouraging EV adoption, and more
towards discouraging the use of polluting ICE vehicles.
In line with this, some recent policies have focused on banning certain types of vehicles from certain locations, similar to the St Patrick’s Street car ban, where private vehicles are not permitted to use the street between 3pm and 6pm daily. “A lot of other cities have done similar things to a much greater degree and have had much success” (Chapter 4: p.72). It is demonstrated that a ban on fossil fuelled cars in Oslo led to an increase in EV adoption from one percent of the market in 2011 to thirty-one percent in 2018, with a decline in diesel models from eighty percent to eighteen percent over the same period. (Cunningham, 2019a). This study identifies these bans as an adequate disincentive for certain types of car use. This policy measure can be implemented to encourage EV adoption by giving EV drivers more freedom to use roads unavailable to ICE vehicles. This new research also proposes that permitting EVs to use bus lanes will convince motorists “that there’s added value to that car to compensate for the extra expense and all the uncertainties that go with it” (Chapter 4: p.87). This, in turn, is expected to assist EV adoption in Ireland.

In accordance with Palmer et al. (2018), this new review shows that “the single biggest issue at the moment is the development of a charging infrastructure” (Chapter 4: p.88), supporting Hughes (2019), who quotes a survey of 3,000 motorists which found that forty-eight percent were concerned about the driving range of EVs. “The technology isn’t there for big mileage yet. Range is a big issue” (Chapter 4: p.92). It is argued that “if the ESB significantly upgrade the infrastructure, that’ll certainly help EV adoption” (Chapter 4: p.94).

5.6 EV Charging Infrastructure
This new research supports the findings of Du & Ouyang (2017), reporting that “the biggest problem [with EVs] would be range for people to use them in the mainstream with longer commutes” (Chapter 4: p.93). It is argued that the “challenge is partly psychological, because
people have this thing about running out of electric power in the way that they wouldn’t run out of petrol” (Chapter 4: p.94). It is believed that the way EVs are refuelled will differ significantly from the current model of visiting the refuel station with an ICE vehicle. Current trends show that EV drivers no longer drive until the tank is empty. Instead, you “charge it when you can” (Chapter 4: p.78). This study conveys the need for smart energy technologies to deal with the “immense pressure on the national grid” (Chapter 4: p.98). Yet, it is also revealed in this investigation that EVs can play a role in increasing the flexibility of the energy system by its storage capabilities.

This new research examines how Ireland can more cleverly manage electricity. “If you have solar panels in your house, that would power the EV, but more than that, if you’re able to feed the electricity that you generate into the network, then you get paid some money for it” (Chapter 4: p.94). In line with Onat et al. (2017), “more homes will look to have their own renewable source” (Chapter 4: p.99). Moreover, it is demonstrated that “a rebalancing of the grid and EVs will create a greater opportunity for renewables to form a more significant part of our power usage in the country” (Chapter 4: p.99). The Government has pledged to generate seventy percent of the country’s electricity supply from renewable sources by 2030 (Lehane, 2019). With energy produced from more renewable sources, EVs would be “a positive addition to the grid” (Chapter 4: p.99).

This study notes some of the challenges with public EV charging facilities. As EV charging is more time consuming than refuelling an ICE vehicle, EV charge points need to be positioned where the EV driver can optimize their time while they wait for their vehicle to charge. “You would be connected to experiences, and not wasting your time waiting for your car to charge itself” (Chapter 4: p.92). This suggests that charge points should be near shops or other
amenities to allow the driver to utilise their time while they wait. This study also shows that EVs are clamped while charging in Dublin city: “it’s probably the only city in the world that will clamp electric cars that are parked at a recharging point in the city” (Chapter 4: p.90).

Current plans between ESB ecars and fuelling stations aim to “have pumps for ICE vehicles, and chargers for EVs as well” (Chapter 4: p.97). Additionally, “ESB ecars have a plan over the next four years to roll out charging hubs across the country” (Chapter 4: p.97). The hubs will be able to charge between two to eight vehicles simultaneously and can provide up to 100km of driving range in six minutes (Ni Aodha, 2019). These hubs will consist of 150kw chargers, “which are the general fast charger standard” (Chapter 4: p.97). It is however shown that “only some cars can take fast chargers” (Chapter 4: p.93). This poses concern for older EV models.

This research demonstrates variable EV charge rates at public recharging facilities. “If someone is on a slow charge, you’d imaging that it would be at a lower rate of cost than if someone wanted to get in and out at a very quick period of time” (Chapter 4: p.101). It is also noted in this inquiry that depending on the competition in the surrounding area, some EV charging facilities will vary their rates in a similar way to current petrol and diesel refuel stations, in order to remain competitive.

In line with Haugneland & Kvisle (2015), this new study infers that “you’ll charge at home, and you’ll charge in these [public EV charging] hubs” (Chapter 4: p.97). Du & Ouyang (2017) previously commented that the development of the charging infrastructure is hindering the mass penetration of EVs and this is evident in the contrast between Norway and Ireland. Norway has over 2,800 fast chargers while Ireland has approximately seventy (Cunningham, 2019a). There are 200,000 EVs in Norway and there are 12,000 charging points, yet there are
still queues for public charge points (Cunningham, 2019a). This highlights the importance of home charge points for EVs.

Similar to the variable public charging rates, this research also observes cheaper electricity rates for home charging during the night. “If every home has a charger, then you charge overnight” (Chapter 4: p.94). “New cars have a 64kw battery and a range of 350-400km” (Chapter 4: p.97). This investigation demonstrates that overnight charging at home gives sufficient range for most journeys. Yet, Zivin et al. (2014) reported a potential increase in private car emissions as a result of charging overnight. Additionally, “if you’re living in an apartment, the infrastructure isn’t there for you” (Chapter 4: p.92).

Nevertheless, a significant finding in this research for most homeowners is that “if you don’t have an EV now, you should still look at getting a charge point put into your home” (Chapter 4: p.95). “A charging point might cost over €800 but with the grants, it works out as €200 or €300 when you have all your taxes back” (Chapter 4: p.95). Additionally, “because most of the charging will be done at home, [ESB ecars will] be able to accommodate five or six hundred thousand [electric] vehicles” in Ireland (Chapter 4: p.97).

5.7 Advice for Motorists

This new study discovers that “it’s nonsense to say everyone should be hopping into an EV” (Chapter 4: p.102). In fact, “there isn’t the one answer for everybody yet, if there ever will be” (Chapter 4: p.102). “Understanding your own driving routines, journeys and your driving style is most important when you’re looking to be fully informed with regard to which car is the best fit for you” (Chapter 4: p.102). The range capabilities of the EV and the Irish charging infrastructure are not appropriate for motorists who travel more than 20,000 kilometres annually. It is also presented in this thesis that the price of EVs is too high, despite the grants
and incentives in place to encourage EV adoption. “Once we get a fully mass-produced market and manufacturing processes, that will filter down to a reduction in the actual cost of purchasing one” (Chapter 4: p.85).

This study reveals that the price of EVs should reach parity with equivalent ICE vehicles and, in accordance with Palmer et al. (2018), this raises concerns regarding the depreciation of existing vehicles. This research indicates that motorists should “get prepared for very large tax increases on their petrol and diesel engines” (Chapter 4: p.101). Therefore, it is argued by respondents in this review that current petrol and diesel models may become too expensive to run with rising taxes. On the other hand, hybrids and low watt EVs may not be a relevant technology in five years’ time as a result of developments in EV technology. Motorists investing in new cars “worry will there be anyone there to buy it” when they go to sell it on (Chapter 4: p.103). Additionally, there are concerns regarding the lifecycle of the EV battery and it is suggested that “replacing the battery might be a bigger cost than the residual value of the car” (Chapter 4: p.103). With the Irish government planning to eradicate ICE sales after 2030, one expert questions how the Irish motorist will be able to “change to a new, zero-emitting car that’s going to be expensive and their own car has been devalued” (Chapter 4: p.55).

It is demonstrated that “diesel is still the right answer” for motorists doing high mileage (Chapter 4: p.103). It is recommended that these motorists “buy newer vehicles that have cleaner emissions” (Chapter 4: p.102). For motorists doing lower mileage, plug-in hybrid vehicles are identified as “the best compromise today” (Chapter 4: p.102). “Our fleet isn’t getting cleaned up. In fact, it’s getting dirtier. That is going to create a big problem for us as we fail to meet our CO2 targets. We won’t solve that problem by converting people into EVs
because the pace of conversion would just be too slow” (Chapter 4: p.106). As a consequence of the uncertainty in the industry; the lack of charging infrastructure, and the high costs of EVs, it is suggested that “the most logical thing to do is just keep driving your older car” (Chapter 4: p.104).

Yet, this study demonstrates a relationship between EV adoption and a reduction in EV manufacture costs. “The supply will increase when the demand does” (Chapter 4: p.104). This means the motorist should “bite the bullet and buy an electric vehicle” (Chapter 4: p.104). “If no one buys electric cars, the adoption is not going to happen. We need to cross the chasm” (Chapter 4: p.105). In response to concerns regarding vehicle depreciation, this examination shows that “the residual value of EVs is really holding up” (Chapter 4: p.103). Contradictory to concerns raised by Jones (2018a), this new research reveals that while motor industry experts “thought that they might not have any great attraction when longer range cars came into the market, actually the used [EV] values are working out pretty well” (Chapter 4: p.103). This new study reports the potential economic benefits of the EV to the motorist when the demand and supply of EVs, and renewable energy sources in Ireland all increase. “It’s not a choice between saving money or saving the environment. With the EV, it’s both” (Chapter 4: p.80).

5.8 Advice for Government

There is a huge lesson in how government policy can be successful “when you look at the job that was done with the changeover to emissions based on taxation in 2008” (Chapter 4: p.105). “A transition of the private car fleet to alternative fuels” is a focus of government policymakers currently, and it is noted that fifty-two percent of Irish transport emissions are
This new inquiry considers that “there has got to be disincentives for fossil fuels” (Chapter 4: p.105). A fourfold increase in carbon tax to €80 per tonne is one recommendation being considered by some TDs and senators, but many politicians oppose this (McQuinn, 2019). O’Sullivan (2019) argues that motorists wishing to adopt sustainable practices need to be incentivised to do so before there is any move to increase carbon tax. Additionally, this study reports that motor industry experts expect a tax of this nature would “reduce the amount of vehicles that are sold” and this will result in car dealers “laying people off” (Chapter 4: p.106). This review deduces that “the important thing is to get people out of the habit of using carbon” (Chapter 4: p.105). “It’s about investing and making sure we’re future proofed for the uptake [of EVs] that’s coming” (Chapter 4: p.110).

While there has been disagreement over proposals for carbon tax, a scrappage scheme is believed to have widespread support among members of the Joint Committee on Climate Action (McQuinn, 2019). It is revealed in this research that if the government “introduced some sort of scrappage scheme for older diesel and petrol vehicles”, it would reduce Ireland’s CO2 emissions (Chapter 4: p.107).

A critical trend identified in the Irish context is the current tax policy that encourages the import of older cars, with greater emissions. “If you’re importing an older car in from the UK, you’re paying a lower VRT rate than you do on a newer cleaner car” (Chapter 4: p.106). This had an adverse impact on the “natural effect of cleaning up the [Irish national car] fleet” (Chapter 4: p.106). This study recommends that the Irish government seek to reduce the quantity of older cars imported from other EU countries, most notably the UK, by placing
heavier registration taxes based on emissions. An industry expert in this investigation questions why the Irish government would encourage “importing cars only to have to scrap them later” (Chapter 4: p.107). This study concludes that the focus should be; “cars that are in our national fleet are left to fall off at the end of their lifespan and introduce policies that encourage people to buy newer, cleaner cars” (Chapter 4: p.107). There is hope that a successful Brexit, with the UK leaving the European Union, may naturally lead to higher tariffs on importing cars from the UK, thus reducing the quantity of older imports. “When the UK is out of the EU, then Ireland can introduce rules to stop this” (Chapter 4: p.65). In addition, this new research supports new government policies with the purpose of “not allowing any cars into Ireland that don’t meet a particular emissions standard” (Chapter 4: p.108). It is demonstrated that car dealers in Ireland can only distribute cars which meet the latest Euro 6 emissions standards. This is not the case for the private car buyer who can travel to the UK, import and register an older car in Ireland that does not meet this standard. “We are compounding the problem by allowing 100,000 plus cars [per year] that don’t meet present day emission standards, into our national fleet” (Chapter 4: p.107).

In this new study, it has previously been suggested that a new model for vehicle taxation is required. One possible method to reducing Ireland’s dependency on fossil fuels, as outlined in this research, is including taxes and insurance charges at petrol and diesel pumps. “If a car was uneconomical, people wouldn’t buy it, because the cost of fuel would be so much” (Chapter 4: p.106). This would encourage higher EV adoption rates. In order for the government to avoid losing out on this potential tax revenue from petrol and diesel pumps, the taxation model would need to be adjusted once again to account for users of EVs. This
examination notes a subscription model for annual vehicle registration, although a more comprehensive review of taxation policy is recommended for further investigation.

This study reports that the Irish government should focus on PR and information campaigns regarding EVs in order to encourage EV adoption. "People need to be educated around whether an EV has the capability of meeting their driving needs at present" (Chapter 4: p.90).

The next step for government, as defined in this thesis, turns the focus to public transport. Climate experts call to "electrify the bus fleet" and reduce the price of public transport to encourage more people to use it (Chapter 4: p.108). Future expansion of the public transport infrastructure in Ireland has a critical role to play in the decarbonisation of the country. A more comprehensive review of the development of the public transport infrastructure is recommended by the researcher for further inquiry.
5.9 Summary of Main Empirical Findings

| Internal Combustion Engines Vehicles (ICEs) | • Biofuels were seen as a way to sustain ICEs but concern regarding pasture land use did not support a large enough increase in biofuel production  
• ICE vehicle sales will continue in the Irish automotive industry for the next ten years  
• Ireland is unlikely to meet its 2030 deadline for eradicating ICE sales, but by 2030 ICE vehicles will be on the verge of exiting the market  
• There is uncertainty regarding the residual value of ICEs approaching 2030  
• Ireland is allowing the import of too many vehicles that do not meet sufficient emissions standards  
• If every car on Irish roads met the Euro 6 emissions standard, Ireland would not have a CO2 problem  
• Diesel car sales are diminishing significantly  
• Diesel car sales are still encouraged by dealers for their fuel efficiency  
• Discouraging diesel car sales can harm the environment because diesel engines emit lower levels of CO2 than petrol and hybrid models  
• Legislation is beginning to discourage manufacturers from releasing new ICE only vehicles in favour of hybrid or fully electric models  
• WLTP standards may increase carbon emission taxes on ICEs |

| Air Pollution | • Climate experts assert that there should be a focus on eradicating fossil fuel emissions, no matter how small  
• Irish motorists with ICE vehicles more than 10 years old upgrading to modern ICE vehicles will result in a sufficient decrease in air pollution  
• Transport pollution in Ireland is low relative to other countries  
• Traffic is still attributed as the main cause of 1,600 premature deaths in Ireland in 2013  
• Decreases in emissions from modern, cleaner ICE vehicles are likely to be cancelled out by the significant increase in transport demand in Ireland  
• There is particulate pollution from brake and tyre wear in EVs  
• Most of Ireland’s electricity is generated in coal plants |

| Electric Vehicles (EVs) | • EVs are the solution to future transport  
• Nissan Ireland expects annual car sales in 2022 to be 50% EVs |
- Technological advances and continued research and development is required to alleviate concerns over the range, battery life and charging requirements of EVs
- The weight of batteries raises concerns regarding the efficiency of battery EVs
- The manufacture and disposal of batteries is harmful to the environment and may point towards hydrogen fuel cell technology being a better fit for the transport industry
- The lifecycle of the battery is still unproven and there is concern that replacing the battery might be a bigger cost than the residual value of the car
- Demand for EVs needs to increase in order for manufacturers to meet the economies of scale required for EVs to match the selection and price of ICE vehicles in the market
- Once we get a fully mass-produced market and manufacturing processes up and running in the EV market, that will filter down to a reduction in the actual cost of purchasing one
- Manufacturers are beginning to build EVs and ICES on the same production line in order to reduce manufacture costs
- Ireland ranks in the bottom third of the International Energy Agency countries for EV adoption
- Irish EV sales increased significantly in the first quarter of 2019
- EVs reduce noise pollution and eradicate roadside air pollution
- Renewable energy sources would result in zero emissions from EVs
- Lifetime emissions of EVs are over 70% lower than EVs if renewable sources of energy are used
- EV driving is a more pleasurable experience than ICE driving
- Current recharging infrastructure requires EV drivers to be more involved in the fuel consumption process than ICE drivers
- EVs encourage safer driving in order to prolong battery life
- Over 70% of drivers adjust their driving style for EVs compared to ICES
- Overnight home charging in Ireland is better value than charging during the day
- Silent engines may pose a danger to cyclists on the road

| Motorist purchase behaviour | The motorist’s specific circumstance determines the most suitable type (EV, petrol, diesel, hybrid) of vehicle |
- The sticker price of a vehicle ultimately determines purchase behaviour
- Despite government grants, EVs are still too expensive for many Irish motorists
- Currently, the most logical answer is for the Irish motorist to keep driving their existing car, which is counterproductive
- EVs are expected to achieve cost parity with ICE vehicles in Ireland
- The generous EV incentives in Norway have encouraged motorists to buy an EV as a second car, and so has not succeeded in reducing the number of older, polluting cars sufficiently
- Early generation EVs are a popular choice for a household’s second car
- Motorists need to understand their driving routines, journeys and driving style to be fully informed with regard to whether an EV is a good fit for their requirements

| Future of private car use | • Car use will be discouraged in the future and replaced with investment in public transport systems • Car ownership will be discouraged in the future and drivers will rent vehicles to suit their needs • Public transport will replace private cars in urban areas • Private car use will continue to dominate rural regions in Ireland • An autonomous system of public transport would best suit Ireland’s sporadic population |

| Government policy | • Financial incentives need to stay in place until Ireland achieves over 200,000 EVs on the roads • The Irish government will not be able to sustain EV grants and incentives when EVs become more mainstream • The Irish government must design a new model for taxing vehicles • Ireland’s CO2 targets would be better met by reducing the number of older imports than increasing the number or EV sales because the pace of conversion to EVs is too slow • A significant carbon tax will negatively impact the Irish motorist and the Irish motor industry • The large proportion of diesel cars are a result of government policies, therefore by acting negatively against diesel, motorists will be discouraged from following government advice • A scrappage scheme for older diesel and petrol models would encourage the adoption of newer vehicles with lower emissions |
| The government needs to eliminate the import of petrol and diesel cars that do not meet the Euro 6 emissions standards |
| The government needs to invest in areas to ensure the Irish public is future proofed for the imminent uptake of EVs |
| The government should focus on PR and information campaigns |
| Allowing the use of bus lanes to EV drivers would encourage more EV adoption |
| The government and local councils must support a policy of free parking at EV charge points, while ensuring it is not abused |

<table>
<thead>
<tr>
<th>Hybrid technology</th>
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<tr>
<td>Hybrids spend the majority of their time with zero tailpipe emissions in built up areas where air quality is poor</td>
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<td>The ICE in hybrid vehicles is often less efficient than a conventional ICE which results in more emissions</td>
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<tr>
<td>Mild hybrids and self-charging hybrids are a transitional technology</td>
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<td>Plug-in hybrids (PHEVs) may remain an alternative to fully electric vehicles in 30 years</td>
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<th>EV Charging Infrastructure</th>
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<tr>
<td>EVs will change the way the driver will refuel their vehicle</td>
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<tr>
<td>Increasing EV adoption in Ireland will put an increased strain on the public network and leads to congestion at charge points</td>
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<tr>
<td>Home charging during the night gives sufficient range for most journeys</td>
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<td>Homeowners should invest in an EV charge point whether or not they currently own an EV</td>
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<tr>
<td>A rebalancing of the energy grid in conjunction with EVs will create a greater opportunity for renewables</td>
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<tr>
<td>EVs can be utilized to balance out the load demand on the grid</td>
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<tr>
<td>There will be variable rates for EV charging determined by the location of the charging facility</td>
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5.10 Recommendations for Practice

1. The Irish government should focus less on eradicating fossil fuelled car sales, and more on encouraging the sale of modern, Euro 6 emission standard vehicles. This thesis recommends that the Irish government should focus on ensuring that the residual value of vehicles is not affected by the transition to EVs. The Irish motorist should be encouraged to invest in a newer vehicle. Depending on the specific driving requirements of the motorist, a diesel vehicle may be the best fit to meet their needs. Therefore, it is critical that the motorist can rely on the residual value of that diesel vehicle, given the imminent shift from fossil fuelled car sales. Euro 6 standard diesel vehicles should not be classed equivalent to pre-Euro 6 models. While the eradication of pre-Euro 6 vehicles is supported by this study, modern ICE vehicles that meet this standard should still be encouraged in place of older vehicles. A scrappage scheme may assist with encouraging many motorists to shift to newer models. Additionally, a higher polluting factor in tax policies should distinguish between Euro 6 petrol and diesels and pre-Euro 6 models.

2. It is recommended that the Irish government bans the import of private cars that do not meet Euro 6 emissions standards. With the UK set to leave the European Union, the Irish government can place barriers to used car imports. This is a critical step in ensuring that there are no additional polluting vehicles on Irish roads.

3. Do not mislead Irish motorists towards petrol or hybrid models when diesel is a better fit for their driving style. It is shown in this investigation that many motorists are currently being misled by media publications to switch from diesel to petrol or petrol-hybrid vehicles, regardless of their vehicle requirements. It is demonstrated in this examination that petrol vehicles are less fuel efficient than diesels and emit higher
levels of CO₂. Irish motorists travelling more than 25,000 kilometres per year should drive modern, Euro 6 diesel vehicles. Information campaigns should be run to inform the Irish motorist that the most efficient, economical choice of vehicle is dependent on the driver’s requirements, and there is not currently one type of vehicle to best suit every driver’s needs.

4. This research recommends continued investment in renewable energy sources to decarbonise the electricity generation process. It is demonstrated in this study that the environmental benefits of EVs can only truly be realised if the level of electricity generated by coal plants is significantly reduced. Findings in this investigation reveal that renewable energy sources would result in zero emissions from EVs. Furthermore, EVs can play a key role in energy grid load balancing and optimizing renewable energy efficiency.

5. For policymaking, this analysis proposes taking a long-term view. It is important not to repeat the recent shift from petrol to diesel vehicles; an initiative that is now critical of causing a large proportion of urban air quality issues in Ireland. Policymakers must be aware that battery electric vehicles may not be the only answer for the future of personal travel. In this way, it is critical to ensure Ireland is future proofed for a broad mix of transport capabilities. A key finding in this thesis is the need for investment in the public transport network to decrease the demand for private cars in Ireland.

6. Educate the Irish motorist regarding the experience of using an EV and relieve the fears associated with being ill-informed. Range anxiety and the fear of new, unproven technology has been shown to restrict EV adoption, however, respondents in this investigation strongly advocate the characteristics of the EV. To achieve the required decarbonisation of the Irish transport industry, Irish motorists must be encouraged to
adopt EVs in scenarios where the EV meets the driver's specific needs. Encourage the adoption of an EV to replace a second car in the household which does low mileage journeys. Information campaigns can play a role in promoting the functionality and enjoyment of EV driving while also advising the Irish motorist if an EV will meet their driving requirements.

7. When the motorist is convinced that the EV will meet their requirements, this examination reveals that the cost of purchasing an EV is the principal determinant to EV adoption. Thus, the government should sustain EV incentives until 200,000 EVs are purchased by Irish motorists. Additionally, an interesting finding of this new research is that EV adoption in Ireland would be encouraged if EVs are permitted to use bus lanes while adoption rates remain low.

8. This inquiry shows that while tax incentives for EVs are positively stimulating EV adoption, it is costing the Irish government significant tax income. This cost is guaranteed to increase in parallel with the increased EV adoption in Ireland. Therefore, the Irish government must design a new model for taxing vehicles. It is critical that this new model does not discourage further EV adoption or punish motorists who need to remain using ICE vehicles.

9. A significant finding of this thesis is that all homeowners should be encouraged to install an EV charge point at home, whether or not they currently own an EV. This aligns with the previously mentioned focus on future proofing Ireland for the imminent shift to EVs. This will give rise to opportunities for encouraging the development of domestic microgrids to maintain balance on the energy grid.
5.11 Recommendations for Future Research

1. A key challenge, as outlined in this research, is the future model for motor tax calculation and collection. Currently, EV users enjoy an array of tax breaks which are only sustainable while EV adoption is low. An investigation into possible government taxation policies for EVs is recommended for future study. It is advised that a qualitative review, consisting of in-depth interviews with key government policymakers and other industry stakeholders, is undertaken to discover the most effective short-, medium- and long-term motor taxation policies in Ireland.

2. This thesis has focused on the private car sector in Ireland, although it is noted that vehicles used in the commercial context, such as public transport vehicles, are guilty of a high proportion of polluting emissions. Moreover, the future of personal transport is reported to rely heavily on the development of a more efficient, more flexible public transport system. An exploration into the opportunities and challenges presented to the Irish public transport industry by emerging technologies is recommended for future research. It is advised that this investigation involves in-depth discussions with relevant transport authority and government policymakers with a view to recommending possible initiatives that would decarbonise the public transport sector in Ireland.

3. The researcher notes the fast pace of change in the motor industry resulting from the urgency to decarbonise the transport industry, and the changing attitudes of the Irish motorist accompanying the uptake in EVs. Further investigation into the impact of increasing EV adoption in Ireland is recommended for future examination. It is suggested to monitor the changing perspectives of the Irish motorist through
quantitative survey methods and encouraging the involvement of participants who own and use a car in Ireland.

4. EVs support the imminent development of autonomous vehicles. An in-depth inquiry into developing opportunities and challenges presented by autonomous technology in Ireland is recommended for future analysis. It is suggested to focus the study outside Ireland in order to identify transferrable trends and capabilities of autonomous technology which can be implemented and tested in the Irish context. A qualitative research approach should be implemented to adequately explore the potential of emerging technologies with a view to recommending how these technologies can be most effectively transferred to the Irish motor industry and how stakeholders in Ireland should prepare for such initiatives.

5. The successful decarbonisation of the motor industry is dependent on the source of electricity generation for EVs and the increase in renewable energy sources. An in-depth investigation into the development of the Irish energy mix is recommended for future research, especially considering the heightened concern about the environment and our planet. An investigation of this nature would be best served through qualitative analysis and discussions with key government departments and energy companies to draw from their experience and to deliver meaningful recommendations.
5.12 Conclusion

The environmental impact of the transport industry has long been a topic of discussion. Since the establishment of the private car industry, when motorists around the world first began purchasing motor vehicles for personal, social and domestic use, the planet and public health have fallen victim to the gases and particles that are emitted from engines. One notable development in the transport industry was the eradication of lead from vehicle fuel. This significantly reduced the human health damage caused by motor vehicles. More recently, interest in biofuel production was heavily invested in for its sustainability and emissions benefits. Nevertheless, this research has revealed that biofuel is no longer considered to pose a sustainable solution to the automotive industry.

Continuing with the goal of reducing transport emissions, in 2008 the Irish government successfully encouraged the adoption of diesel vehicles through fiscal policy incentives. Diesel vehicles emit lower CO2 emissions than petrol vehicles. In the early 2000s, a significant majority of Irish motorists drove a petrol vehicle. Now, Ireland is experiencing detrimental consequences to air quality from the particulate emission from diesel engines, which are known to cause damage to the human lung when inhaled. Similar to the challenge of reducing petrol car sales, now Ireland faces the challenge of reducing the sale of all ICE vehicles. Beginning with private cars, the sale of which may be eradicated as soon as 2030, the transition to EVs is underway.

Currently, the EV market is significantly smaller than the selection offered to petrol and diesel vehicle buyers; however, the industry is set to change in the next few years with some manufacturers expecting to sell fifty percent EVs in 2022. Another limiting factor to the adoption of EVs in Ireland is range anxiety, which is expected to be solved by the research and
development of EV manufacturers, and the development of the Irish EV charging infrastructure.

Fundamental to the research problem in this study is whether or not the Irish motorist should purchase an EV. While many of the characteristics of the EV encourage EV purchase, such as its silence and simple driving procedure, its environmental benefits, its cheap running costs, and the financial incentives designed by the government, the specific motorist's circumstance and driving requirements determine the most suitable type of vehicle for them. Given Ireland's sporadic population, and the current challenges to support EV charging, this means that a significant proportion of Irish motorists should not purchase an EV. The best course to reducing transport pollution in Ireland is to significantly reduce the number of vehicles more than ten years old, which do not meet Euro 6 emissions standards. The first step to achieving this is to ban the import of vehicles that do not meet this standard from other countries. Secondly, incentives should be offered to owners of these older vehicles to adopt newer, Euro 6 standard cars. For many motorists, diesel vehicles are still the right choice, and replacing older diesel cars with newer ones would go a long way towards resolving Ireland's transport pollution problem. Where appropriate, and where they meet the requirements of the driver, Irish motorists will adopt EVs.

The introduction and evolution of EVs with range, capabilities, and prices that compete with conventional internal combustion vehicles is the responsibility of car manufacturers, and there is optimism that such offerings are on the horizon. Manufacturers will create the industry that will naturally result in significant EV adoption. Yet, Ireland does not manufacture cars. Ireland's responsibility lies in investing in areas that will ensure the country is prepared for the electric motor industry. Development of the EV charging infrastructure is underway;
however, Ireland’s energy mix needs to be converted to a point where the majority of electricity is generated from renewable sources. This is fundamental to realising the environmental benefits of EVs as the adoption rate increases. Another key requirement to consider is how the Irish government will collect motor taxes when EV sales match those ICE vehicles.

Irish motorists can support the decarbonisation of the motor industry by adopting EVs; however, in many circumstances, trading up to a newer petrol or diesel car can result in adequate reductions in carbon emissions. This research determines that the most ‘logical’ decision for Irish motorists is to keep running their older vehicle due to current uncertainties regarding the residual value of vehicles. Yet, this seems to be counter-productive in the mission to decarbonise the Irish motor industry. Irish motorists changing their car are facing a difficult problem: will they get value for that car when they go to sell it on? With the government aiming to eliminate petrol and diesel cars, is there a point in investing in one now? With car manufacturers improving EV technology and bringing the price of EVs down, would it be better to wait before purchasing an EV? These are among the numerous challenges posed by EVs, but similarly, there are numerous opportunities offered by electric motorisation.

Electrically powered vehicles can provide the answer to a sustainable transport industry. It is proven that autonomous technology is possible, and the reduction of air and atmospheric pollution by EVs is clearly proven. The way the Irish motorist uses their vehicle is set to change with the rise of the EV industry. For example, the way the driver will refuel their car will be different. The roads will be quieter. Travelling by car will be a more pleasant experience as a result of the silence of the motor, and the simple driving procedure of having one forward
gear. Unfortunately, to achieve this, current Irish motorists need to consider shifting to an EV today. There is certainty that EV technology and charging infrastructure will improve, however, to reach environmental targets Irish motorists are encouraged to risk adopting an early technology, with many limitations and uncertainty regarding their residual value. The Irish government and the Irish motor industry need to work together to ensure the motorist is not punished for supporting the decarbonisation of the Irish automotive industry.

Word Count: 46378
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Appendix 1: Informed Consent Form

Informed Consent

MBS Research Thesis

The purpose of this research is to gather data relevant to the future of personal motorization in Ireland.

You are invited to participate because of your expertise and knowledge of the area.

Please sign below to approve that:

- You agree to partake in this research
- You agree for your comments to be included in this study

You may opt out at any stage.

Participant signature _________________________________
Appendix 2: Interview Schedule

**ICEs**

1. What is your view on continuing to buy and sell fossil fuelled cars in Ireland?
2. In your opinion, is Ireland a victim of vehicle pollution?
3. In your view, what is the long-term solution to personal car ownership in Ireland?

**EVs**

4. What do you think would be the impact of replacing the Irish car fleet with electric vehicles?
5. In your opinion, will there be new challenges associated with shifting to electric vehicles?
6. In your view, how can electric vehicle adoption in Ireland be increased?
7. In your opinion, what are key advantages and disadvantages of the electric vehicle?
8. In your opinion, what changes to electric vehicle taxes and running costs are likely to be implemented in the next few years?
9. In your opinion, how can the electric vehicle charging infrastructure in Ireland best compete with traditional petrol and diesel refuel stations? What do you think is the future for conventional refuelling stations?

**Environment**

10. In your view, is there an environmental advantage of electric vehicles, given modern technologies designed to reduce the harmful emissions of petrol and diesel models?
11. In your opinion, what are the most important climate, energy, and transport policies that need to be introduced by the Irish government?
12. What future action would you recommend now, based on your own knowledge and expertise, for car owners today?