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Electric Car Cultures: An ethnography of the everyday  
use of electric vehicles in the UK



**Joanne Brady**

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use of electric vehicles in the UK

**Abstract**

This study uses ethnographic methods to study drivers of electric vehicles (EVs) in the UK to add a user perspective to current knowledge of the developing technology of EVs. EVs have had a revival in popularity since their near extinction in the early twentieth century. There is interest from support industries in how a further resurgence in popularity will affect demand for support services, and how increased EV use could re-shape the infrastructure and the landscapes that have been written by decades of combustion-engine vehicle use. Some ethnographic studies of EV drivers have been done, although these are small in number and on a limited scale. This study will look closely at a number of UK based EV drivers and their households, and use ethnographic methods to document patterns of use and driving styles, as well as discuss the attitudes and values of current EV drivers. EV drivers today are an informal collective of innovators and early adopters who form communities to facilitate social learning, and this forming of, and use of networks will be explored. This study will provide an insight into how EV drivers use their EVs on an everyday basis, and find out if there are any problems which EV drivers currently face, which need to be addressed before EVs can become a mass market product.

Electric Car Cultures: An ethnography of the everyday  
use of electric vehicles in the UK

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Year: 2010

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## Statement of Copyright

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## Chapter One - Introduction

In March 2010, residents of Brighton, a popular tourist city on the south coast of England, received letters from the local council informing them of the upcoming installation of two electric car recharging points in the city. People who come to pass by these items of street furniture probably will not even notice them, let alone consider their significance. After all, the oversight of everyday, mundane occurrences going on around us is not unusual; but they will indeed exist and they will be significant. At the very basic level, they signify the start of a progressive transformation of a niche and marginal product into the mainstream.

### **1.1 Introduction to Electric Vehicles (EVs)**

Electric Vehicles, or EVs as they will be referred to throughout this study, are not a new technology. Indeed EVs have been around since the early days of motoring, but were all but eradicated by the rising popularity of combustion engine technology during the era of Henry Ford. In the UK in 2010, electric vehicles remain a niche product.

In 2008, there were an estimated 7000 pure-electric vehicles registered in the UK (including electric mopeds and commercial vehicles) out of around 33 million vehicles on the road in total. While this is not a huge figure by any measure, many car manufacturers are gearing up for an expected growth in electric vehicle use with many new models due for mass release in 2010 or shortly after.

*“Electric cars have remained a niche product. If the publicity and the policymakers are to be believed, all that will change over the next two or three years. Almost every car maker now has active electric car development projects, with the majority of these cars scheduled to appear between now and 2015.”* (Boxwell, 2010:7)



Fig 1.1 – A driver with his on-trial Mitsubishi iMiev

The only fully electric vehicle to have any impact in the way of numbers is the Reva G-Wiz, which number around 1000, with the majority of these being in and around London - this is still a minority product, even in the UK's so-called 'electric car capital'. Electric vehicles are few and far between and the electricity used to recharge them barely registers as a blip on the UK's National Grid.

Currently, there are very few EVs available to buy on the mass-market. Many EVs which are on the road in the UK today are vehicles the owners have converted themselves, or discontinued trial models from the 1990s and 2000s. There are notable exceptions, for example the Tesla Roadster - a two-seater sports car that currently costs upwards of £85,000. There is a strong and growing community comprising of EV enthusiasts and early adopters, some of which have driven EVs for many years. They are slowly being joined by



Fig 1.2 – A Tesla Roadster. One of the more well-known EVs available to buy today.  
(Photo courtesy of Tesla Motors)



Fig 1.3 – A Reva G-Wiz. The biggest selling EV in the UK up to 2010.  
It is legally a 'quadricycle'.

new-generation EV enthusiasts, excited by the new technology but still frustrated at the lack of affordable EVs on the open market.

From 2010, UK major car manufacturers are getting ready to launch production electric cars on a relatively large scale. Some manufacturers have already started trials of their production vehicles, and intensive research is being carried out on all aspects of EV use, for example the trial being done for EVs in the West Midlands (Cabled, 2010a). The upcoming launches of the first mass-market EVs are hotly anticipated by many people, and an increasing number of media items about EVs have been noted. Preliminary results of the first phases of ongoing EV field trials have started to be released (see Cabled 2010 and CENEX 2010).

The effects of a century of combustion engine motoring have become apparent in recent years. These effects include air pollution, resource degradation, road accidents with loss of life and limb, noise pollution, loss of habitat, un-walk-ability of our cities, dependence on oil, and increasing car dependence - although there are many positive effects too, such as increasing individual mobility and freedom. Alternatives to the combustion engine vehicle have been sought with limited success. Many explanations for the dominance of the combustion engine vehicle have been put forward, and encompass technical, social, and cultural theories.

The advantages of EVs over combustion engine vehicles include less noise, a smoother drive, lower running costs, and zero local emissions, although production of the electricity to power the EVs is not necessarily emission free. The features of an EV that are perceived as disadvantages are slower speeds, a higher initial purchase price, and a lower range coupled with a lengthy recharge time, as well as a lack of public 're-fuelling' facilities. The range of an EV is much lower than that of a combustion engine vehicle. While a petrol or diesel powered vehicle can go upwards of 200 miles before the need to re-fuel arises, EVs

that go more than 50 miles between recharges are, at the moment, relatively uncommon. A much used term is *range anxiety*, which describes the apprehension arising from the relatively high likelihood that the vehicle will run out of power before reaching a destination, and is described as being similar to the anxiety experienced when driving a combustion engine vehicle which is low on fuel with the nearest fuel station a significant or unknown distance away.

While there are some new-generation models of EV due to be released that are being marketed as able to travel in excess of 100 miles between charges, these will not be available until 2011 at the earliest, and will be priced much higher than an equivalent combustion engine vehicle for quite some time to come.

## **1.2 Concerns of industry**

Electricity companies are concerned that a rising number of vehicles using electricity as a power source will increase demand for electricity, especially at times of already high-demand, for example in the evening, particularly in the winter months. This could put extra strain on the National Grid and increase potential for local grid failure. The relatively unknown everyday use of EVs and habits of current EV drivers means that companies concerned with the generation and distribution of electricity can only make assumptions in order to help them predict future opportunities and threats.

The assumption is that if EVs are to be used as a substitute for combustion engine vehicles, the habits of using an EV will mirror current driving habits. Electricity companies fear that a lot of drivers, assuming a normal 9-5 working day, will recharge their vehicle immediately upon returning home, causing a spike in demand from 5pm onwards – a time when the National Grid is already under pressure. It is hoped that using Demand Side Management (DSM) techniques will help reduce this risk by encouraging drivers to put off their

recharging until times of lower demand, for example after midnight. One of the aims of this study is to find out when current EV drivers tend to carry out recharging, and why.

The belief that EVs are a threat to the stability of the National Grid does not go uncontested. A recent report to the Climate Change Committee shows how, using data from the National Travel Survey as well as other sources, the predicted uptake of EVs in the UK could indeed be a threat to the stability of the National Grid, but that DSM techniques can be employed to facilitate high penetration levels of both battery-electric vehicles and plug-in hybrid vehicles without the need for network reinforcement (Element Energy, 2009:57). These network reinforcements could cost in the region of £2.6bn - £3.9bn (2009:58) so it makes sense that the potential of using DSM techniques with respect to EV technology should be explored. It must also be pointed out that EVs can also be an opportunity to electricity companies as it will result in extra custom (Ford, 1994).

### **1.3 EV Recharging Infrastructure**

Like petrol stations to combustion engine cars, an easy and accessible way of 're-fuelling' an EV is important to the success of mass EV adoption. Re-fuelling an EV is done by way of a lead between the vehicle and an electrical source. However EVs take several hours to recharge from flat to a full-charge, and it is assumed that a lot of EV drivers will charge their vehicles overnight at home, using an ordinary three-pin 13-amp domestic supply. Although this will mean enhanced convenience in one sense, it also means that journeys (round trips from home or another base) will have to be made that are within the range of the vehicle. This is seen as a major barrier to EV adoption, if not for EV use on a daily basis. A way of overcoming this issue is by providing public re-fuelling facilities.



Fig 1.4 An Elektrobay recharging pillar. (By kind permission of Elektromotive Ltd)

Element Energy (2009) understand that while a '*...dense and widespread publically available recharging infrastructure needs to be in place to encourage EV adoption...*', that the.....

*'....necessity for this recharging solution is questionable, especially given the high cost of this solution (per kWh delivered) when compared to alternatives such as residential and workplace charging.'* (2009:12)

Indeed, they estimate the cost of a public slow-charging point to be between £2,500 to £5,500, and a fast-charging point to be upwards of £40,000 - compared to a slow-charge point at a workplace of as little as £50 to £2,500, and a domestic slow-charge installation of £50 (Element Energy, 2009:68). The availability of public fast-charging facilities is likely to have a bigger utility to the end user than public slow-charging facilities, yet fast-charging technology poses a bigger threat to the stability of the National Grid and would necessitate further reinforcement (Element Energy, 2009:58). However, the provision of any public recharging infrastructure ultimately depends on the drivers' demand for use of and

willingness-to-pay for the facility and, if willingness-to-pay is low, deployment will depend on who is willing to bear the cost of installation and the electricity used. The Royal Academy of Engineering recognise that the debate over the provision of EV recharging infrastructure is reminiscent of the familiar 'chicken and egg' situation (RAE, 2010;44).

#### **1.4 EV Drivers**

An understanding of future EV use is essential in predicting demand for electricity and for planning for potential problems. However –

*'Predicting consumer behaviour in the EV market is challenging as the technology is very distinct from the incumbent, and uptake to date is limited to a very small group of early adopters.'* (Element Energy, 2009:16)

Several assumptions, based on data from various sources, have been made about current EV drivers, with regard to personal characteristics, travel habits, attitudes, and household make-up. It is assumed, that because EVs have different characteristics from combustion engine vehicles, and because of the barriers to mass-market adoption, that EVs are currently adopted by members of society with very specific characteristics who are not representative of society as a whole. In agreement, Kurani et al (1994:247) critique the traditional methods of market research into a potential EV market as they can focus on *'...average consumers [who] are not, by definition, the first buyers of something new.'*

Element Energy (2009:7) have found that the overwhelming majority of EV drivers are multi-car families with off-street parking. This is due to the limited range of the EV which creates a desire for access to an alternative vehicle for longer journeys, and the need to recharge the EV using domestic electricity sources. This is contrary to the image of the EV as a city-car, but does make sense with the consideration that city-dwellers tend to own

less vehicles and are less likely to have access to off-street parking (See Element Energy, 2009:7/8 and 19).

Currently, the initial purchase price of EVs is high, so it is assumed that EV drivers will have reasons for adopting EVs that go beyond financial benefits. Element Energy assume that early adopters of EVs will....

*'...place a higher value on green motoring, will pay to support new technology, will be much less sensitive to higher capital costs and are more likely to account for lower running costs when deciding on a purchase.'*

(2009:16)

### **1.5 Models of ownership**

Element Energy (2009:16) using attitude surveys of potential adopters of EV technology found that the high purchase price of an EV was the biggest barrier to adoption. While early adopters may be willing to pay a premium for a new technology, and low running costs of an EV should go some way to mitigate the high initial purchase price, most people do not consider the total life-cycle cost at point of purchase. This is especially acute where the more expensive EV also has inherent disutilities such as lower range and speed, as well as the mass-market aversion to the purchase of new, unproven technology. Element Energy (2009:17) discuss how different ownership models will need to be considered, such as leasing or pay-per-mile, which may need to be undertaken by a third party.

### **1.6 Alternatives to the EV**

As well as alternative vehicle technology such as hybrid-vehicles, hydrogen fuel-cell vehicles, and the incumbent combustion engine car, critics of EV technology believe that as a society, we should be looking for an alternative to private transport, rather than just simply trying to alleviate the negative effects.

The literature review in this study will discuss how years of private motoring, whether this is in the form of using combustion engine vehicles or otherwise, has led to the development and reinforcement of a car-dependent society which will be hard to overturn. This development process is called 'lock-in', and the physical embodiment of the *sociotechnical* system of the UK's private motoring network – the roads, garages, and other motoring support services that are ubiquitous today – will not be simple to redesign and reshape. The literature on transport networks and public transport will go some way to explaining our everyday dependence on private vehicles, and the study will use evidence to explore how even drivers with environmental sensibilities find it difficult to reject their private vehicles completely in favour of public transport.

### **1.7 Introduction to this study**

This study will try to discover what has compelled a minority of motorists to shift a proportion of their driving miles from a combustion-engine vehicle to an EV. The study will provide an insight into how EV technology could be adopted, or could be made to be adopted in the future, if it is decided that making small incremental changes to a locked-in system is a more workable solution than complete system re-design. The research will help electric companies and other interested policy makers view the use of electric vehicles through the eyes of their drivers.

Qualitative research methods will be used to provide insight into the everyday use of EVs in the UK, and will investigate issues including the reasons for adoption, the characteristics of innovators and early adopters, use of eco-driving techniques, recharging habits, patterns of use, and the potential for the use of DSM techniques. I will explore the habits of current EV drivers and observe if the assumptions made by electricity companies and engineers are correct. The study will provide a very person-oriented interpretation of how EVs are domesticated into the everyday lives of their users, and provide an insight into the

attitudes, beliefs and values which encourage some people to adopt EV technology earlier than others.

Using Gjoen and Hard's (2002) small scale ethnography of EV drivers in Scandinavia as a starting point for my research, I will expect that the EV drivers I study will have environmental concerns high up their personal agendas, will do a lot of short-distance driving, will be disciplined in planning their personal travel and have fairly predictable daily routines. They will drive their cars more prudently and defensively and take notice of how the car performs and preserves power. Personally, they do not mind attention from strangers, will see the recharging of the car as a minor issue, and will not see EVs as an inferior technology despite their obvious limitations. I expect that any drivers with families will not rely totally on the EV, and the EV will likely be one of a household fleet – the sign of a 'hybrid household' (Kurani et al, 1994).

From Rogers' work *Diffusion of Innovations*, I will expect that the EV drivers I study will show a lot of the traits of typical innovators and early adopters. I expect to find a mix of Innovators and Early Adopters, as described by Rogers (1995:263/4) - *Innovators* tend to know other innovators and form cliques, even though they may be geographically dispersed. Innovators tend to have substantial resources to be able to handle the odd failure, desire risk and are venturesome. They may not be respected by other members of society but they launch the technology into a social system and play a gate-keeping role. *Early Adopters* are respected for their advice and information about a technology. This group is seen as important in the diffusion process as they reduce uncertainty about a new technology by adopting it.

Ultimately, the use of a critical, person-oriented approach will enable an analysis to be made of the people who drive EVs today, and facilitate an assessment of how representative current drivers are of the population likely to adopt EVs in the future. From

this assessment, policy makers can make more informed judgements as to whether the lifestyles, habits and practices of current EV drivers will illustrate how EVs and EV technology will be interpreted and used in the long-term, and whether practices carried out today can indeed pose a threat to energy security if replicated on a mass scale.

## **Chapter Two – Methods**

This study of EV use will be focussing on drivers of cars, vans and scooters. There are other electric-powered transport sources in the UK, such as buses and trains, and also electrically-assisted pedal cycles (EAPCs). I will be focussing on studying the use of those vehicles which are used as personal transport, rather than public transport - which is an extensive study in itself.

Currently, there are studies going on, both academically and by industry, into EV use. The industry studies are, in the main, trials of specific models of vehicles in defined geographic areas of the U.K, such as the EV trial in the West Midlands (Cabled, 2010a). This, and similar studies, consist of the collection of real-time 'black box' data, quantitative attitude surveys and in-depth qualitative work. These studies tend to involve drivers who have limited previous experience of using an EV, and for many, the EV they are trialling will be their very first direct experience of using an EV in their daily lives. There is some evidence to suggest that this novelty value can produce various biases which are not so prevalent among long-term drivers (Golob and Gould, 1998).

### **2.1 Use of the Discipline of Anthropology**

The effectiveness of using the discipline of anthropology to gain a better understanding of EV use in the real world has not really been tested in the academic sense. There are few anthropological studies of EV users, and those that exist are small in scale and scope.

Anthropologists can be useful in helping to provide an alternative perspective on everyday EV use as.....

*'Anthropologists are committed to achieving an in-depth and holistic understanding of the contexts from which observations about human activities, behaviours, and values are derived.....'* (Chambers, 1985:3)

This is where the discipline of anthropology can be used to great advantage over more 'value-free' quantitative methods. The holistic approach allows human events to be.....

*'...viewed in the larger contexts in which they naturally occur, and that much of the meaning which people attribute to their lives is specific to their cultural surrounding'* (Chambers, 1985:3)

Traditional anthropological enquiry involves a long-term fieldwork approach, with the emphasis on being '*where the action is*' and the observation of human behaviour in natural contexts (Chambers, 1985:5). One method used to undertake this type of enquiry is ethnography. Ethnography is a detailed description of the lifestyle and patterns of behaviour of a culture-sharing group and involves studying people in their everyday lives. This can involve techniques such as participant observation and in-depth interviews. Often the researcher will live among their study group for a prolonged period of time, whatever form this may take, and observe them from within. Ethnographic study has the advantage of being able to "*...study individuals in their natural setting.*" (Cresswell, 2007:17). Ethnographic research is a very good way of seeing many issues from someone else's perspective. As Cook (2005:167) states -

*"...ethnographic research has developed out of a concern to understand the world-views and ways of life of actual people from the 'inside', in the context of their everyday, lived experiences".* (Cook, 2005:167).

The living-within-the-community approach can be criticised for making the study subjective, rather than objective. Crang and Cook (2007) acknowledge that ethnographic research methods involve subjectivity to some degree, but do not see this as a bad thing. Moreover, they argue that subjectivity is not a weakness in research, as it can provide a position out of '*..which more rigorous understandings can be built.*' (Crang and Cook, 2007:15).

## 2.2 Making Contact

Crang and Cook (2007:2) criticise the traditional academic '*three-stage model*' of conducting research. They say the three stages of the '*read-then-do-then-write*' model can be restrictive, and that the boundaries of the three stages should be fluid and permeable. Researchers are encouraged to mix reading, doing and writing, and to rethink research plans as they go along. Crang and Cook (2007:17/18) recommend making early contacts in the community to find out what research is possible and also assess the feasibility of access to individuals.

Deciding who to contact as potential participants is termed by Crang and Cook (2007:14) as '*theoretical sampling*'. They argue that for a good ethnographic study, participants need to be able to tell the researcher something useful about the research topic and be able to provide insight, wisdom and experience. For an ethnographic study, '*representativeness*' does not matter so much. I decided I needed to study people who had used an EV for some time, and who had taken the decision to adopt on their own; i.e. an EV is not something that was put upon them by their employer. I also needed willing participants, as their involvement would be in-depth and may go on for some time. I decided to start recruiting by finding out if there are any EV fan-clubs or user groups. I anticipated that, if such groups existed, they would likely have an online presence. By using the internet and a few strategic search terms, it did not take me very long to find an active online EV community.

Whilst my official fieldwork period did not start for some weeks, I made my first steps into the online EV community whilst I was still reading, and had many contacts already set up before the fieldwork stage of my study. My first experiences of the EV community were through the forums of the Battery Vehicle Society and the Reva Car Club.

The Battery Vehicle Society is an established interest group run by its own members on a committee basis. The society has traditionally attracted people who enjoy building their own battery vehicles, and it provides a way of contacting other like-minded people in the way of a regular newsletter, and also events and conferences. The traditional Battery Vehicle Society meet consists of members bringing their home-made or converted EVs and racing them in various competitions, including home-made adapted bicycles, and electric go-karts. More recently the society has embraced the internet and has also attracted newer members such as drivers of factory produced electric vehicles. The online forums provide a way for drivers to converse and share information about their vehicles, such as the best battery management techniques, and where to get much needed spares and other paraphernalia.

The Reva Car Club is somewhat more of an owners club than an enthusiasts club that has been set up for owners of the Reva G-Wiz to share stories and best practice. Some members of the Reva Car Club are also members of the Battery Vehicle Society.

The societies are an informal network of individuals, rather than a group with a gatekeeper. While there are clearly leaders in the groups, individual EV drivers have not needed to go through any one individual to express an interest in my research. What is clear about the EV enthusiast community is that they form a network regardless of the obstacle of geographical distance, and the online nature of the groups facilitates this. It was a rare moment that I converse with a driver and they do not know of another EV driver, and do not have some contact with them, although they may be at the other end of the country.

The knowledge and insight I gained from the public conversations of the online EV community helped shaped the literature I read. It meant that by the time I reached my official fieldwork phase, I already had a good idea that environmental concerns and a desire for cost saving would be popular motivations for EV adoption, and I was able to direct my

reading more to the study of the environment, and of energy conservation than I would have done otherwise. This insight and background reading enabled me to compose more relevant questions, and to anticipate the kind of answers I would get in the field.

Gaining access to electric car drivers would have been very difficult without using the internet. As one of my participants observed, it's not really "*...like there's some jazz club somewhere full of electric vehicle users...*". However, once I found the online resources, gaining access to individual electric car drivers was delightfully easy. My first action was to sign up to a Yahoo! user group for EV drivers, and I promptly sent a group email about my research. This method worked very well as it went directly to the inboxes of individuals, and within only a few minutes I received a reply. During the first 24 hours alone, I received emails from four individuals living in different parts of the UK, which were followed by more over the coming days.

My next step was to create new threads on the forums informing EV drivers of my study and asking them to get in touch. I worried for a short time that this was going to prove to be an ineffective way of recruiting people, but in only a matter of hours I received an email. This was followed by more interest over the following weeks, and soon I had built up a list of potential participants.

I was in contact by email with some individuals for many months before I met them in person. This early contact enabled other contacts to be found, through snowballing and other methods. For example, one contact I made very early on helped by putting an article in a publication which is prominent among the EV community, which found me more participants, some of which would not have contacted me through the online requests due to relatively low personal use of the internet and email.

Through email and phone conversations I had with the contacts, I was able to identify other resources that I could use to help me broaden the study group. For example, one contact sent me a link to a website which featured his EV, which I noticed was an international EV enthusiast website. From this, I obtained email contact details of other UK-based EV owners. One speculative, group email later, and I had recruited another six EV drivers.

I was concerned that by concentrating on recruiting through EV enthusiast resources that my study would be limited in scope. I felt that having perspectives from EV drivers outside the enthusiast community would add greatly to the rigour of the study. Crang and Cook (2007:15) term this as '*theoretical adequacy*', which is the process of giving the researcher confidence that the study is rigorous by exploring other perspectives. To give my study an alternative perspective, I contacted Going Green, who are the distributor of the biggest selling EV in the UK – the Reva G-Wiz. They helped me by including information about my study in their regular customer e-newsletter. The response to this was quite disappointing, probably a result of Going Green forgetting to include my email address. However, two tenacious G-Wiz drivers were able to track me down through alternative means, and one of these made it into the final study group.

Crang and Cook (2007:21) warn about rejection from potential participants. However, I found that very few drivers refused to take part, and those that did were apologetic about it. Using a self-selection sampling method meant that most of the participants approached me and, after I gave them more details about the study, decided whether they were willing to participate. I did approach some EV drivers directly after finding a little about them on internet forums; none of these refused. I had to 'lose' around a quarter of the volunteers for various reasons; the most common because of travel distance and time constraints, either on their part or mine. However I was able to conduct more limited interviews by email with some of these.

### 2.3 Conducting the Research

The aim of the research is to provide an in-depth look into the everyday use of electric vehicles in the UK today. Due to the nature of the technology and because it is not yet mainstream, the people that I recruited are not your average UK citizen, however, in a lot of respects they are perfectly normal; they have normal jobs, and live in normal places. These are not people who live outside of society in some secret hideaway. As Crang and Cook (2007:11) explain - no culture is a *'pure culture'*; all cultures are affected by outside influences and do not have a defined boundary. In respect to EV drivers, although they may be part of an EV culture and a community, the individual drivers are also part of other communities and part of other diverse cultures. Driving an EV does not make the drivers in the study different to their neighbours in all respects.

After having corresponded with the individual participants for varying lengths of time, I arranged to go out and meet each one to talk about them and their EVs. Whilst arranging times to go and meet the EV drivers, it became clear that I was not going to be able to get to meet everyone who had volunteered, due to large distances or the participant not being available in the same time frame as others in the same geographic area. Fortunately, three of those households I could not visit were willing to answer questions by email. The use of email as a research tool has increased over the years and is now a viable research tool. This popularity is increasing because *'...email allows the researcher to interview groups or communities that would not and could not have been studied otherwise'*. (Meho, 2006:1288).

In this study, email allowed me to hear the opinions of EV drivers that I did not have the time to visit in person. I found that email interviewing was a good way of getting information from and about EV drivers. All drivers in the study who were interviewed by email understood all of the questions, and the answers were clear and concise if not a little

shorter than similar answers from the face-to-face interviews. I followed with more questions to elaborate on the answers given, though no interviewee was sent more than three separate lots of questions, avoiding '*frustration*' (Meho, 2006:1288). The drop out rate was zero.

For the households I was able to visit, I asked them to keep a seven day travel diary prior to my visit. I asked them to record all of their journeys in a seven day period of their choosing whether these journeys were in the EV or another vehicle. They were asked to record date and time of journey, purpose of journey, and mileage, as well as record when they recharged the EV.

The visit to each household consisted of a ride-out in the EV, where it was operational, to observe how the EV was driven in a real life situation, and a semi-structured interview with the main driver(s) of the EV to gain an insight into real-world use and related issues. The semi-structured nature of the interview allowed topics to be discussed which were not initially raised by myself, but also meant that not all households were asked all of the same questions, and not all in the same way. This helped to provide an insight into what is considered important by each individual driver, but at the same time care must be taken with interpretation because the fact that a certain topic has not been discussed with one driver does not signify that another driver does not have an opinion on that topic, or that their opinion is represented by that of others. The semi-structured nature also means that some interviews are longer than others. The ride-out and interviews vary in length between one hour and three hours in total.

#### **2.4 Profile of the Study Group**

In total, my study includes 23 households – twenty of which I met in person and conducted face-to-face interviews, and three of which I carried out a more limited interview by email.

Three of the households are 'couples' (married or co-habiting) where both are regular drivers of the EV, or part of the EV enthusiasm. In the other twenty households there was one main EV driver – a '*single driver*' household - sixteen of which were married or co-habiting, and in which the partners are involved with the EVs in varying degrees. For these households, only the main EV driver was interviewed, though this was through choice of the household. Out of the twenty '*single driver*' households, only one of the EV drivers in the study is female. Most interviews took place within the drivers' homes and one was conducted at a place of work. The drivers ranged in age from 34 to over 80 years old.

In the study there are many different types of EV. The most common EV in the study is the Citroen Berlingo (owned by 8 households), followed by Reva G-Wiz (3 households), Elcat vans (2 households) and Peugeot 106e (2 households). Other factory built EVs in the study include a Toyota RAV4-E, an Aixam Mega City, a Mitsubishi iMiev, and an Oxygen electric motorcycle. Conversions and 'prototype' EVs were owned by seven households. In one of the households the EV was currently off the road, and in another the EV was a 'work-in-progress'. In some households, more than one EV is owned alongside other combustion engine vehicles. This array of vehicles is not representative of EVs in the UK today. The most popular EV on the road in the UK is the Reva G-Wiz, which is proportionately under-represented in my study. As insight is more important to the study than representativeness, I am not concerned that having a bias towards 'enthusiast' vehicles will harm the study in any way.

As well as the EVs detailed above, the households also own a variety of other vehicles. These household vehicle fleets include vehicles ranging from small, economical runabouts such as Ford Fiestas and Smart Cars, through MPV type cars for journeys which require more passenger capacity, larger vehicles for practical tasks like towing caravans, to more fun-type cars like a Porsche or a classic Triumph. All drivers in the study have at least one

other non-EV they can use, whether it belongs to them, or someone else in the household such as a spouse, or a grown-up son or daughter.

Most of the drivers in the study have been driving EVs for more than a year. Some have had many years of involvement in EVs and the EV community. A major criticism that could be levied at the study is that the focus on EV enthusiasts and EVs that have been on the road for many years will not help to predict future behaviour of drivers of the next generation of EVs, such as the Nissan Leaf. However, the lack of 'next generation' EVs on the road in 2010 and the short time they have been in any practical use means that a study of them would be very limited and not provide enough insight to be useful. There are also many studies and trials ongoing in the UK using the next generation of EVs which can be compared to this and other academic studies. A good example of this is the Cabled project (Cabled, 2010a).

My research has taken me to all corners of Britain, from a sheep farm in the Welsh valleys, to the suburbs of Newcastle-on-Tyne, and to the hills of rural Dorset. I have met several EV drivers' wives and children, and have made friends with several cats, dogs and a whole shed full of guinea pigs. I have seen a variety of different electric vehicles; some factory built, some converted by their owners, some imported, and some bought and adapted, but all loved and well cared for by their owners.

## Chapter Three - Literature Review

### **3.1 Introduction to EVs**

In the USA and Europe, cars have been around throughout the 20<sup>th</sup> century, and have brought tremendous benefits to individuals and to society, yet also produce many undesirable side-effects, which include greenhouse gases, local emissions, deterioration of air quality, lead pollution, noise, destruction of landscape and wildlife habitats, solid waste and scrap, accidents and death (Huby, 1998:103-110). EVs are touted as a more environmentally friendly alternative to the conventional, internal combustion engine car.

EVs are not a new technology, indeed the *"..idea of electric cars has been around since the 1920s and they have been manufactured in small quantities since that time."* (Marsh and Collet, 1986), although as Scharff (1992) explains, EVs were popular much earlier in the 20<sup>th</sup> century and, at one point, were more commonly used than combustion-engine vehicles. EVs are popular in other countries, for example the use of electric scooters by tourists in Taiwan (Wang, 2007, 2008).

The technology for EVs has been talked about for some years, with a lot of technology and engineering literature available from the 1970's and 1980's (for a good example of this see Unnewehr and Nasar, 1982). There is a large amount of literature in the engineering and technology disciplines about battery capability, such as that by Shukla et al (2001). The focus of design has been on the vehicle part of the technology, and little attention has been paid to the recharging and the human use of the vehicle. Indeed, Unnewehr and Nasar's (1982) large and detailed book on EV technology summarises the recharging aspect in less than one page, with most of the words being devoted to the concerns over the electricity grid's capacity to cope, rather than with how drivers would actually go about recharging.

In an academic sense, more notice is starting to be taken of EVs and of EV users. In a recent study of EV use in Norway, Gjoen and Hard (2002) show how a worms-eye view of EVs can add much to knowledge. They explain that users can become engineers by using technology and appropriating it in their own way. The EV drivers in their study used the technology to the developers' 'script' in some ways but not all, and by using the EVs the users are *"..in some respects constructing a new artefact and deconstructing an existing infrastructure."* (2002:266). By narrating the everyday movements of just a very small handful of people, Gjoen and Hard have illustrated a great deal about EV use, driving styles, and recharging practice in the real world. They relate their findings of just a few drivers to with what other researchers have found out through more numerous, quantitative work, such as done in Hamburg and Berlin, and argue that more research in an ethnographic style could add much to knowledge of EV use.

### **3.2 Energy, electricity and the environment**

The modern British transport system is the embodiment of many years of technological development, political interference and policy-making (Winner, 1985), economic progress and socio-cultural history. Systems, such as one for transport, are used and re-designed by users, and are subject to ongoing development and re-negotiation.

Electricity systems are a good example of systems that were initially designed and developed as a whole, but then re-negotiated and changed over the years. The development of the early western electric systems were built by engineer-entrepreneurs, such as Thomas Edison, and were designed around the existing political and topographical landscapes, as well as taking into consideration the end users of the product (Hughes, 1983). A sufficient numbers of customers were needed to pay for the huge economies of scale required by power generation, and these customers were seen as a vital part of the

system. The customers were designed by the engineer-entrepreneur as much as the customers influenced the design of the technology.

As in any large industry that has fluctuating demand, huge efforts are expended in smoothing out peaks and troughs. A large demand peak necessitates a large available capacity, even if the technology is idle or under-capacity for much of the period. Hughes (1983:219) explains how this is pertinent in electricity generation in particular as *"...electricity cannot readily be stored: it must be used when generated."* A key component of smoothing out the peaks and troughs is customer diversity (Hughes, 1983:219).

Electricity generation and distribution has consequences for the environment, but as Mees points out, the power plants tend to be located *"...in remote areas where the concentration of local air pollutants rarely cause problems..."* (Mees, 2000:19). Indeed, it is argued that the public are so far removed, both geographically and mentally, from electricity generating facilities that electricity becomes taken for granted. This mentality is slowly changing. Keirstead (2007:4133) found that installation of domestic solar panels increased peoples' awareness of energy issues and yielded a net reduction in overall energy use.

Peoples' understanding of how their energy consumption can contribute to climate change is increasing and citizens can be engaged in managing and reducing their energy use. One technique particularly pertinent to cars is that of *eco-driving*.

*"The characteristics of eco-driving are generally well defined and easily characterized. They involve such things as accelerating moderately.....anticipating traffic flow and signals, thereby avoiding sudden starts and stops: maintaining an even driving pace....driving at or safely below the speed limit; and eliminating excessive idling."* (Barkenbus, 2010:763).

Eco-driving should be distinguished from '*hyper-miling*'. Hyper-miling trades off safety for fuel economy, while eco-driving does not. Eco-driving can be encouraged by good, instant feedback from the vehicle which shows you real-time fuel economy, such as that found in the Toyota Prius (Barkenbus, 2010:763).

Maxwell (2001) has shown, using his focus group research into car driving, that people do understand that car and travel consumption can damage the environment and deplete resources, yet consumption persists with the justification that environmental degradation is the price that society pays for convenience. It is the necessity of travel and the convenience of the private car over all other methods of transport that make the car difficult to give up. Webber (1992) agrees –

*“The auto – or its successor with comparable traits – is here to stay. We obviously need to do something about its negative effects, and we need to find effective fuel substitutes and other means for stemming its horrendous appetite for petroleum products.”* (Webber, 1992:283)

Since around the 1980s, environmental concerns have led to demand for more fuel efficient vehicles. However, Mees (2000:60) explains that critics of improved vehicle technology point out that as vehicles get more efficient, people shift to larger vehicles, neutralising any efficiency gains. While EVs may produce zero local emissions and be quieter than traditional motor cars, they still can do little to mitigate other negative effects such as road accidents, community disruption or social inequity (Mees, 2000:66, Whitelegg, 1997:178).

Demand for electricity is increasing in the UK. Electricity supply companies have implemented demand-side management (DSM) programmes, where rather than making large investments in increased capacity, they have worked with their customers to reduce

and manage demand. DSM can take the form of giving grants for insulation (Van Vliet et al, 2005:99), giving away energy-efficient light-bulbs (p106) or managing customers' expectations of the service by asking them to accept the odd interruption to supply (p105). DSM puts more obligations on customers, but customers do not have to accept DSM and for one reason or another, may not play the part that is expected of them. For this reason, utility managers may be uneasy with DSM as it is unpredictable (Van Vliet et al, 2005:106).

While environmental policy has concerned itself with reducing the consumption of natural resources, Shove (2003:3/4) argues that seeing a resource as directly consumed ignores "*....the services and experiences they make possible.*" In other words, consumers do not consume fuel such as electricity or petrol, they consume a service, such as freshly laundered clothes by using technology (a washing machine) which uses the fuel. It may be argued that people do not understand the full extent of the fuel consumption required for the service they are consuming, but this is likely an oversimplification.

Van Vliet et al (2005:49) recognise four types of customer - 1) the captive customer, 2) the customer, 3) the citizen-consumer, and 4) the co-providers. In the UK, the move over time has been from a captive customer with no choice over who provides their energy, to a citizen-consumer, who takes responsibility for where they buy their products and will pay a premium for something that is better for society (such as fair-trade, or FSC products).

The emerging customer is that of co-provider. In the electricity market this customer generates some electricity themselves by way of windmills or solar panels, and sells their surplus back to the grid as well as buy from it. Some customers have co-provision imposed on them by companies keen to smooth out their demand peaks (Van Vliet et al, 2005:60/1). This method of co-production using small-scale generation technologies is blurring the boundaries between supply and demand (Keirstead, 2007:4128).

There is some concern over the potential increase in demand for electricity that any increase in the number of EVs will cause. Webster (1999) discusses the four key factors that will determine whether the electricity distribution network will be able to cope or not; the profile of the existing distribution network, the battery charger used, the EV itself, and the user profile. She separates users into three categories (domestic, fleet and public transport) and predicts that domestic and fleet users will have the biggest impact on the electricity distribution network. She also predicts that for the majority of these users, charging the EV will take place overnight at home with some provision at the work place, and other public points such as at shopping centres and train stations.

EVs can be used as a source of power for electricity utility companies, where the large amount of storage capacity in an EV – which is idle for most of the day – can be used to store excess electricity at off-peak periods and sold back to the grid at peak times, smoothing out the peaks and troughs of demand that utility companies face, allowing them to make better use of power generated through renewable means, such as wind power or solar power (Kempton and Letendre, 1997). This technology is termed Vehicle-to-Grid (V2G) and has huge potential to play a large part in energy management (Barkenbus, 2009:406).

### **3.3 Technology and society**

Technology is an immense part of our society in the twenty-first century to the end that our lives seem to be:-

*“..dominated by systems of machines that encroach upon our day-to-day rhythms. They are often a source of anxiety, as well as a source of success, and the means whereby to accomplish many of our daily projects.”* (Mazis, 2008:1)

Technology can refer to a physical product, such as a loom, or to the skills required to use it. Innovations can be a new technology, or an adaptation to an existing technology. There is much academic work on technology and innovation, including sociology of technology (Hickman, 1990), technology diffusion (Rogers, 1995), and the social shaping of technology (Mackenzie and Wajcman, 1985). More recently, Boczkowski (2004) has advocated another way: the mutual shaping of technology and society approach. This looks at technology as a human process that shows that the construction and adoption of artefacts are not separate processes. The complexity of society's relationship with technology is recognised by many academics.

*“Technology, defined anthropologically, is not material culture but rather.....a phenomenon that marries the material, the social and the symbolic in a complex web of associations.” (Pfaffenberger, 1988: 249)*

Pfaffenberger (1988) argues that technology, as a topic of anthropological study, is more complex and nuanced than the *somnambulistic* and *deterministic* views put forward over the years. Technology can neither be *somnambulistic*; the idea that an individual has nothing more than a manufacturing and utility relationships with an object, nor can it be *deterministic*; the idea that technology is a given which unquestionably shapes society. Technology is far more than fetishised material objects. Items of technology are created out of a complex web of desire, politics, social relations, design, manufacturing, interpretation, use and re-interpretation.

In academic circles at least, technology is now seen as a two-way, open-ended, negotiable process with technologies that can be rejected or accepted by society. The notion of technology has moved from a technological deterministic perspective, to a more nuanced,

very human activity -

*“Machines are not like meteors that come unbidden from the outside and have impacts. Rather each is an extension of human lives: someone makes its components, someone markets it, some oppose it, many use it, and all interpret it.” (Nye, 1998:5)*

Lots of technologies started life as toys or were passed over as a toy, such as the telephone. Many people love technology for its own sake, and are excited by technology and its capabilities, and not necessarily by what the technology makes possible. Innovators of film-making technology made films to demonstrate the capabilities of the technology with little regard to the artistic content (Levinson, 1990:295/9). Drenegson (1990) describes ‘*technophilia*’ -

*“Humans become enamoured with their own mechanical cleverness, with their techniques and tricks, their technical devices and processes. The products of our technology become not only productive instruments but also our toys. Technology becomes our life game.” (Drenegson, 1990:29).*

Loving technology can mean one is unable to see it objectively and the technology becomes an extension of ourselves. Drenegson (1990:29) says how our love of the car has meant that any insult to the car becomes an insult to us as we are unable to separate ourselves from it psychologically and culturally. However, our love for the car does not mean that we necessarily love the system that the car is a part of (Urry, 2000:193).

Different social groups or individuals will accept or reject technology in different measures, such as in the case of women’s differing take-up levels of the bicycle (Pinch and Bijker, 1987). Technology can be negotiated by users, taking time for problems to be rectified and

the technology to reach closure and stabilization (Pinch and Bijker, 1987). Not all technology has these issues. As Scharff's (1992) history of the electric car shows, in the early-twentieth century, EVs were seen as suitable for women because they were easy to use, and were ideal as small runabouts for shopping trips and visiting. The limited range was not considered a problem for housewives and mothers and it was noted that even Henry Ford, the pioneer of the mass-produced combustion engine motor-car, bought an electric car for his wife. It was a myth, however, that women accepted the EV unquestionably, and many preferred the combustion-engine car. The rising popularity, and falling prices, of the combustion-engine car meant it only took a few 'feminising' modifications such as an electric start and extra leg-room (or skirt room) for the combustion-engine car to condemn the EV to the margins of motoring (Scharff, 1992). Although EVs were seen by designers and producers as cars for women, the users of EVs rejected this notion by swapping their EVs for re-designed combustion-engine cars as soon as developers and society deemed that the cars were now suitable for female use.

A new technology goes through three development stages - which Gradwell (1999) calls 'Eureka', 'Spaghetti' and 'Black Box'. Spaghetti is where "*..the general public becomes involved in using, selecting, trying-out and modifying the invention.*" (p.257). The technology is used, re-designed and negotiated, and in the process, develops into something that becomes accepted and widely-used, before becoming a black-box technology – that is, one where the intricate workings (physical or intangible) are hidden from the naked eye, and the technology becomes a taken-for-granted part of our society. The spaghetti stage then, is an important process which helps the technology to develop in ways appropriate to its users. As Gradwell points out, the questions of any design flaws "*...cannot be at the point when a product is in full use in society because in spite of any shortcomings it may have, people will be depending on it.*" (p255).

New technologies diffuse through society in a fairly predictable pattern, as Rogers' (1995) explains....

*"The individuals in a social system do not adopt an innovation at the same time. Rather they adopt in an over-time sequence, so that individuals can be classified into adopter categories on the basis of when they first began using a new idea" (Rogers, 1995:252)*

Rogers' adopter categories are Innovators (who account for about 2.5% of the individuals who use a given technology), Early Adopters (around 13.5%), Early Majority (34%), Late Majority (34%), and Laggards (16%). The individuals at the earlier stage of adoption tend to be better educated, more literate, and have higher social status than the individuals at the later stages. They also show different personality traits such as empathy, are more open-minded and are less fatalistic, with a higher exposure to mass media and who actively seek information.

Moore (1999) elaborates on Rogers' innovation diffusion model by discussing the marketing of technology. He explains the significant differences between the different consumer groups, with the 'chasm' between Early Adopters and Early Majority being the biggest and the hardest to cross. He argues that in order for a product to be diffused past the Early Adopter stage, a product needs good management, as later adopters will not be so forgiving of technical deficiencies than earlier adopters and will need re-assurance that they are buying a sound product with sufficient support infrastructure in place. Moore argues that a technology will not diffuse itself through society and the technology must be adapted to appeal to each separate consumer group as it is diffused.

Individuals within a society also have different reasons for adopting a technology. These can include economic reasons, as well as social processes such as peer pressure and the

desire for prestige (Rogers, 1995:110/1). In a study of PHEV adoption practices, Axsen and Kurani (2009) found social contact encourages alternative vehicle adoption through different methods, which they classify as – *Contagion, Conformity, Dissemination, Translation, and Reflexivity*. Adoption can be influenced by contact with others in our social networks, and depends on how we see ourselves as individuals in relation to others.

Failure to adopt a technology is sometimes blamed on the individual when it may be that the system that supports the technology is inappropriate to the user or deficient in some way (Rogers, 1995:114-118). That is not to say that the adoption of a product is always a good thing. Technologies can be socially divisive, and whether the technology is a good thing or a bad thing depends on the social context in place, and is culturally-bound (Rogers, 1995:429).

Pelto (1973), writing about the diffusion of the snowmobile through Skolt Lapp society, describes how the new technology displaced the reindeer economy the society was based on and left many Skolt Lapps unemployed and in debt. Ruth Schwartz Cowan (1985b:190) explains how the diffusion of domestic technology made many domestic servants unemployed, and although the adoption of household appliances meant that household chores involved less drudgery, it did not mean any less time was spent on work overall for the housewife.

Hard and Jamison (1997) discuss the topic of alternative technology, and argue that the history of technology is a story of successes, and that much can be learned by looking at the technological failures. They use the history of the steam car and the diesel car to show how one technology was a relative success, and how the other was a relative failure. They argue that an alternative technology is likely to be unsuccessful if it poses too much of an alternative on three levels; *symbolic, organizational, and behavioural*. They suggest that

the relative failure (so far) of EVs is because they mean something different to a conventional car, they do not have the infrastructure in place to support them, and because they mean people have to modify their behaviour (Hard and Jamison, 1997;147/8).

Some societies adopt technologies faster than others because of political intervention, such as with the Clean Air Act in California which legally compelled car-manufacturers to produce EVs as an increasing proportion of their total car output – 10% by 2003 (Rogers, 1995). This meant a rapid adoption of EVs which made California the area most heavily populated by EVs in the world. Other political interventions can be less regulatory, and more in the way of economic incentives. This has been suggested as a way forward for faster diffusion of EVs. In 2009 the British government announced plans to offer subsidies for EV purchase to help Britain meet its commitment to promoting low carbon transport (BBC, 2009a), though a change of government in 2010 means that the subsidy is now under threat. Political intervention can also hold back technological progress, such as the case in South Africa with AIDS prevention measures (Robbins, 2005).

Some technologies are used in the real world differently to how they were intended by the designer or engineer. A designer creates a 'script' – that is an idea of how the technology will be used. However, users can modify or totally reject this idea and create a script of their own (Rohracher, 2005;14). Looking at user scripts is important as it can show how best to adapt and develop a technology.

In their study of EV drivers in Norway, Gjoen and Hard (2002) perform ethnographic studies to show how EV drivers use their vehicles, sometimes in contrast to how the vehicle was intended to be of use, which shows how ethnographic research is a valuable resource in technology studies and is of use when studying car drivers. Richards (2005:199) calls this

*'technography'* – a process which “..describes technologies from the point of view of how they are actually used, and not from the perspective of how they are supposed to work.”

### **3.4 A car is not just a car**

To anthropologists the car is more than just a method of transport. It is an embodiment of cultural practice, a 'totem' (Latour, 2005:37), a status symbol, a member of the family (or tribe if you take a developing world context), or even an extension of your own physical space.

*“Car consumption is never simply about rational economic choices, but is as much about aesthetic, emotional and sensory responses to driving, as well as patterns of kinship, sociability, habitation and work.”* (Sheller, 2004:222)

Cars are more than just a way of travel, whether for work or for fun. People can customize their cars, give them a personality, and also a name (like Sylvia's car in Gjoen and Hard, 2002). The car can be decorated, such as using car upholstery (Miller, 2001), or given bumper stickers or body modifications (Marsh and Collett, 1986:82). Taking a 'symbolist' perspective, the car can become a symbol of who you are, and what you want others to think of you.

Car manufacturers are familiar with the concept of *symbolism*. Product differentiation is something that manufacturers actively do before and during the production process to make their companies' products as attractive to as many markets as possible, and which car you buy and drive says something about you to wider society, whether you want it to or not. Society associates certain types of car with certain people and this symbolism of cars is

so embedded in us that...

*"It is almost impossible to look seriously at a car without making an unconscious thumbnail sketch of the kind of person who would own it."*

(Marsh and Collett, 1986:45)

People are categorized into stereotyped life-styles by the vehicle that they drive, such as the 1990's 'White-van man', or the much-maligned 'school-run mum' (Moran, 2005:67). The 'Mondeo Man' was a 1990's characterization of a middle-Englander whose opinion was valuable in predicting election results in the political heartlands – the Ford Mondeo being a family-sized, average priced, fairly mundane car associated with sales reps (Moran, 2005:102/3).

This symbolism of cars is represented and reinforced with advertising. (Marsh and Collett, 1986:121, Heffner et al, 2007b:24), with Scharff (1992:77) noting how early twentieth-century EVs were marketed to women with adverts containing images of other women going about their daily women's business in the EV. Simmons (1997) notices a common theme in modern car advertising imagery:-

*"Cars pass undamaged through curtains of fire that are sweeping the roadside landscapes, for example, or they may successfully negotiate a mountain pass with poor surfaces and precipitous drops. In extreme cases, cars are driven without problems on ski slopes or glaciers, all of this intensified where four-wheel-drive vehicles are being sold, even if mounting the kerb of a Chelsea sidewalk is likely to be their hairiest off-road experience."* (Simmons, 1997:265).

Symbolism is something that has been found to exist in the consumption of hybrid-electric vehicles, where what the car meant to the drivers themselves and what they thought it meant to others was a large decision-making factor in the purchase, surpassing even the fuel-economy savings associated with hybrid-electric cars (Heffner et al, 2007a). Because cars have a high symbolic value, they have been appropriated by sub-cultural groups as an outward symbol, such as the beatnik culture of the 1960s manifesting itself in the consumption of alternative cars like a beat-up van or a VW Beetle (Marsh and Collett, 1986).

Car culture is not exclusively an American, or even a western phenomenon. There are examples of car-culture from all over the world, including 'The Raggare' sub-culture in Scandinavia (O'Dell, 2001), aboriginal Australia (Young, 2001; Stotz, 2001), and Ghana (Verrips and Meyer, 2001), as well as in modern western cultures such as African-Americans (Gilroy, 2001). Cars can be part of sub-cultures that exist on the fringes of society, such as the 'bo-so-kuzu' of 1970's Japan - a socio-cultural group consisting of academically underachieving, under-educated young males (Marsh and Collett, 1986:102).

The car having its own personality and soul implicates it in the act of road-rage. Road-rage can be brought on by the frustration of traffic jams and road conditions, and be in the form of shootings, stabbings, beatings, verbal nastiness, and antagonistic driving behaviour (Novaco, 1992). The concept of road-rage is explored further by Michael (2001). Michael develops Actor-Network-Theory (see Latour, 2005) to illustrate how the car is partly to blame for the violent act of road-rage as the driver or the car cannot commit road-rage alone. Road-rage is committed by a human-car hybrid, where the car influences how the human acts, and the human controls where and how the car is driven. Dant (2004:74) describes this hybrid as *"...neither a thing nor a person; it is an assembled social being that takes on properties of both and cannot exist without both."*

The human-car hybrid idea is a recurring theme in the auto-mobility literature. This strange hybrid of a 'driver-car' is "...not a species resulting from chance mating but a product of human design, manufacture and choice." (Dant, 2004). Together the car and driver form a whole that acts to achieve the end and "bring about the impact of the automobile on modern societies." (Dant, 2004:62).

Michael (2001) suggests that the very look of the car, with its imposing eye-like headlights, makes a car look like it is aggressive in its own right. This notion works the other way for cars such as EVs, where driving a smaller, lighter car with less safety features causes the driver to adapt using less aggressive and more prudent driving styles (Gjoen and Hard, 2002:271). This shows how the design and technology of the car has actively influenced how people use it and supports Actor-Network-Theory.

The car is embedded in our psyche and our imagination. The car has become a symbol of who we are and how we identify others. The car is almost human and has taken on a life of its own, as well as influencing our own driving styles and habits. Yet not everyone agrees that the socialization of the car is the reason for its popularity.

*"The real reason for the automobile explosion should be clear, yet the commonplace explanation for the cars popularity is wrong. People everywhere are attracted to cars not because they are lovable or because they are prestigious, but because they offer better transport services than does any other mode."* (Webber, 1992:274).

### **3.5 Cars, transport infrastructure and society**

Cars are just one part of a sociotechnical system which has, so far, resisted *dissociation* (Pfaffenberger, 1992:498), that is has not yet succumbed to system failure and has been

relatively stable, barring the odd reverse salient characteristic of large, dynamic systems (see Hughes, 1983). The continued development of the private transport system has manifested itself in our physical and economic landscape.

*“Automobiles are not isolated objects; they are only the most salient parts of a complex energy-consuming system that includes production lines, roads, parking lots, oil wells, pipelines, service stations, and the redesign of urban spaces to accommodate drivers.” (Nye, 1998:177)*

As a technology, cars do not exist alone. Cars did not appear and fit straight into our lives seamlessly. The car system created a network of not just cars, but garages and petrol stations, road signs, showrooms to sell them and, above all, a network of roads on which to drive them. An artefact which is part of a larger system depends on other artefacts within the system (Hughes, 1987:51). This is shown very obviously in the case of roads and transport.

The support system for the motor vehicle has evolved over time in conjunction with the car itself, and this support system cannot easily be remade. This is known as system ‘lock-in’ where the system becomes significant in society and it is difficult to switch to another. Social life has become “...locked into the modes of mobility that automobility generates and presupposes.” (Featherstone, 2004). For a history of the path to ‘lock-in’ for the conventional car and how the switch to electric motoring will not be a quick and easy process, see Cowan and Hulton (1996).

Michael Callon (1987) illustrates how EDF designed an EV programme (VEL) in 1970s France. EDF designed the VEL system, designed how each of the actors, including car manufacturers and retailers, would play a part, and then ‘sold’ it to the public – using neo-Marxist Tourainian theory – in a way that required all the actors to play the part that was

assigned to them for the programme to work. This also took a degree of redesigning French society in order to make the VEL acceptable, and required the car to be a socially-neutral and banal object of function over form. The programme failed. Callon explains, using Bordieu's theory, that redesigning the automobile to make it acceptable failed because the....

*"...total banalization of an object of consumption, which plays a central role in struggles for distinction seems highly improbable. Social movements that protest against the symbol automobile are without doubt quite right to see in it one of the cornerstones of our societies.." (Callon, 1987:89)*

The redesigning of locked-in systems to accommodate new technologies, Callon argues, is a step too far. In the case of the car, just taking the car and replacing it with a radical alternative in a society that is so auto-centric is nigh on impossible.

*"The automobile is at the centre of society, so socially embedded that it can be modified only with great care. It must undergo evolution, but this is not purely and simply a case of making it disappear so that it can be replaced with a radically new technology; the only realistic strategy is to transform it gradually through progressive introduction of technical improvements enabling it to respond to new user demands. The best answer that can be given to social movements is to introduce yet more differentiation, not make a tabula rasa of the past." (Callon, 1987:89)*

Callon is not saying that Touraine was wrong when he saw the re-design of society and systems as the answer, just that it did not work in the case of the VEL in France in the 1970s/80s. What Callon is saying essentially is that gradual changes may be better for some systems, and that total re-design is difficult to do when there are established technologies

in place. In the case of cars, which are only part of a larger, established transport, geographic and social system, gradual change with technological fixes may be a more successful approach to the introduction of more environmentally-friendly transportation technology, rather than trying to re-write society and space.

Shinnar (2003:s4) argues that it is “*..prohibitively difficult in a developed economy in which there are large investments in the infrastructure of delivery for natural gas, electricity, gasoline and diesel...*” to make a sudden switch to an alternative support infrastructure such as that which would be required to make the move to using alternatives to the EV, for example hydrogen-fuelled vehicles. Shinnar outlines some of the disadvantages of fuelling vehicles with hydrogen, including the inherent danger in giving the use of potentially dangerous hydrogen to an untrained member of the public, although Hawken at al (1999:35) argue that a tank of hydrogen is no more dangerous than a tank of petrol.

Schwoon (2007; 71) recognises the issue of the lack of infrastructure for hydrogen cars as part of a ‘chicken and egg’ problem, where drivers are not willing to invest without an acceptable level of refuelling facilities, and filling station operators are not willing to invest until demand is sufficient. He argues that the hydrogen economy will not grow until some hydrogen stations are provided, and provides a tool to calculate what the optimal distribution of hydrogen stations might be, although he does not identify who might be the first agents to start the ball rolling. In this sense, vehicles fuelled by electric are superior as they depend on the availability of a power supply that is already widely available, accepted and easy to use. There are not very many houses, workplaces, garages, hotels, shops, or leisure facilities that are not linked up to the electricity grid and could not provide the small domestic electric socket that current EVs require for recharging. The development of an EV recharging network could initially be done in very small increments without significant investment in either the generation or distribution of electricity required.

Motor vehicles, together with the network and infrastructure that supports their use, have had a profound and long-lasting effect on our cities. Urban geographers have long concerned themselves with the notion that the car has had a massive influence on the way that our modern cities have developed (see Knox and McCarthy, 2005). The widespread adoption of the car has allowed cities to develop in a sprawling manner, with private interests making the city amenable to the car and often resulting in a city that makes a car a necessity. Those without cars or access to one become marginalised and find the city un-navigable, impractical and dangerous (Mees, 2000:20). In cities built around the capabilities of the motor car, those unable to drive or afford to run a private car find themselves condemned to the urban core or doomed to use public transport.

Wright and Curtis (2005:12) summarise the self-sustaining cycle of car use –

*“Individually, the urban dweller is strongly motivated to buy and use a car, because a car provides access to more places than do other modes of transport. Low-density suburban housing then becomes an attractive proposition, particularly to car-owning families who prefer to bring up their children in quieter and more spacious surroundings while still retaining access to the rich variety of land uses and services that can only be supported in a vibrant city centre. But collectively, low-density suburban housing locks residents into a car-based lifestyle, eroding the demand for public transport and with it, the quality of life for the residual minority (for example, young and elderly dependents within car-owning families) who do not have discretionary use of cars.”*

Much literature is critical of private transportation, and advocates a move back towards a public transport system to end dependence on the car and minimise the negative side-

effects associated with rising car use. Whitelegg (1997) explains that cars are a hazard to non-car drivers, such as cyclists and pedestrians, which tend to be the poor, young, and elderly in society. He explains that most of the traffic in cities consists of “...*affluent commuters who live in rural idylls and drive to work or their park and ride destination..*” (Whitelegg, 1997:130), while imposing noise, air pollution and danger on poorer inner-city groups, who ultimately pay the price for the convenience of richer groups. This is a very good example of how a technology can be socially divisive.

The rising popularity of cars - and no-one can dispute that use of private motorised vehicles has increased continuously since the early 20<sup>th</sup> century - has gone hand-in-hand with falling patronisation of public transport. Perhaps this is not surprising. It is hard to see how public transport can compete with the convenience and flexibility of the private car. Indeed Rosenbloom argues that...

*“Conventional fixed-route transit services are not responsive to the needs of working parents who must link trips, be available on a minute’s notice to pick up sick children, or provide a chauffeur service that can vary daily, weekly, and monthly.”* (Rosenbloom, 1992:53)

Indeed, Bottles (1992) argues how in Los Angeles the rise in the car was a democratic process of individuals protesting against inadequate public transport. The decline in public transport use had already started before the mass adoption of the car (Bottles, 1992:195).

Not all groups in society have access to a car. Children, women, the elderly, the poor, and disabled people are less likely to have access to a car and so depend more heavily on public transport (Mees, 2000:20). Increasingly, public transport, buses in particular have “..*low cultural status because they are disproportionately used by (and just as importantly, are associated with) women, children, students, the elderly and the poor.*” (Moran, 2005:3), and

any decline in public transport services has an adverse effect on the people who rely on them the most – including the elderly who may have lost their driving skills (Webber, 1992:284).

EVs must be prepared to accept blame for future reduction in public transport patronage, as EVs may not only be a substitute for using a combustion-engine vehicle, but also a substitute for buses, walking and cycling (Gjoen and Hard, 2002:273 citing a study by Knie et al, 1997, 44, 86). This goes against the political script of EVs reducing journeys only in a combustion-engine vehicle, and shows how users can apply their own ideas about how often, where and when a technology will be used.

Roads existed before the invention of the motor car, but their growth has been accelerated by increasing car use and road building has been a source of contention in many modern societies. Moran (2005:63/4) talks about the protests over the building of London's Westway in the 1970s – a road which was seen as symbolically separating more deprived areas from the affluent areas of Holland Park and Notting Hill. Road protests have been carried out in Rio de Janeiro and Sao Paulo with different degrees of success, leading Alonso and Costa (2005:182) to explain that success of political mobilization against development projects is place-bound and depends on the social and political context, as well as access to technical and scientific expertise.

Another ubiquitous feature of the modern city is the car park. Most cities in the UK were built before the invention of the motor car and many older homes and neighbourhoods do not have parking facilities that meet the needs of the automobile era (Moran, 2005:79). There is conflict over parking rights and this has led to the innovation of parking wardens to help enforce the rules made to make the best use of limited parking space (Moran, 2005:80-83).

Innovative ideas have been used to battle congestion and parking problems. In 1920 Los Angeles, the council banned parking in the downtown, expecting people to switch to public streetcars instead. After less than thirty days the ban was overturned due to people just abandoning downtown shopping and going out of town (Longstreth, 1992:141/2). The lesson learnt from the Los Angeles experiment is that to *“..remain competitive, retail services must accommodate the motorist.”* (Longstreth, 1992:141).

Jackson (1992) explains that the phenomenon of combustion-engine vehicles marginalising early EVs was not limited to the private car. In the early 20<sup>th</sup> century, many trucks and vans were electric, but the weight of the batteries, and the inconvenience and expense of recharging meant that the electric truck was slow around anything other than the city, and was uneconomical to run. Charging stations were infrequent and expensive, and the operation took time to perform, losing the truck driver money because of downtime. Because of the limited technology, EVs were inconvenient and expensive. As Jackson says –

*“A vehicle like the electric van, which had to stay in the city and abide by a fixed routine, was in a class with the railroad train or the streetcar, confined to pair of rails and a timetable.”*(Jackson, 1992:18).

### **3.6 Cars as a convenience**

So, although cars can have a detrimental effect on the natural environment, can be socially divisive and cause our cities to become sprawling, un-walkable entities, why does the technology of the car not only persist, but continue to become adopted in ever increasing numbers? Mimi Sheller explains that –

*“Cars will not easily be given up just (!) because they are dangerous to health and life, environmentally destructive, based on unsustainable energy*

*consumption, and damaging to public life and civic space. Too many people find them too comfortable, enjoyable, exciting, even enthralling. They are deeply embedded in ways of life, networks of friendship and sociality, and moral commitments to family and care for others.” (Sheller,2004:236)*

The car is the ultimate in convenience for individuals in modern society. As Elizabeth Shove (2003:170) explains, technologies allow people to “...*structure and manage their time around core, non-negotiable activities or injunctions...*” and the car is the technology of choice for personal transportation because people can choose when and where they make their journeys and also what route they take, or as Webber (1992:276) puts it “..*autos permit direct connection from everywhere to everywhere..*”.

Drivers can stop when and where they need to, within the constraints of the road, and can continue for as long as they want to. They are not constrained by time-tables, or by routes. They can take passengers with them, and also other tools and equipment they may need. The car offers flexibility of travel with personal convenience (Huby, 1998:99). Wright and Curtis (2005:18) agree. They say that “*At the individual level, the increasing radius of activity that characterises modern living makes it difficult to contemplate abandoning the automobile as an everyday item of use.*”

This is particularly pertinent for women, especially those with young families. Rosenbloom (1992) agrees with Shove about convenience being a major issue –

*“The car offers the flexibility and convenience essential to working parents, particularly, mothers who often carry the double burden of working at both work and home, Its hard to see how any other option could serve the complex travel needs of such families.” (Rosenbloom, 1992:39)*

According to Rosenbloom (1992), there are three main reasons why a busy family need a car. The first reason is so that the numerous errands (to childcare, shops, the bank etc) can be combined; the second so that children can be taken to various activities that may change on a daily or weekly basis; and so that the family can be prepared for a child-related emergency (p46). Within the family unit too, women are more likely than men to do the chauffeuring of children, and are more likely to combine trips (p47).

Commuting between home and work and back again is a big contributor to road traffic, however Corn (1992:26/27) explains how a vehicle can also be the place of work and *“..essential to the job itself – hauling, collecting, distributing, transporting, and servicing...”*, such as in roles such as a mobile salesman. Laurier (2004) shows how the car can become a place to do work out of necessity, even though the car is not designed to be a work vehicle. Jackson (1992:20) notes how some vehicles have been adapted to work on the move, such as a cement mixer, or an ambulance – which becomes a kind of mobile emergency room. Work vehicles, in whatever form, contribute a lot to congestion and pollution and concentrating study efforts on just private transport would ignore this significant source of everyday traffic.

As Urry (2002) explains, mobility facilitates social relations and is necessary for the development of social relations. Cars have been a big player in sustaining social capital, and reducing car travel for political or economic gain may undermine social capital. This can make any policy which restrict car driving very unpopular.

## **Chapter Four – Technology and Society**

Technology can have different meanings to groups within society, and to individuals within these groups. This chapter will discuss the traits, attitudes and values of the drivers in the study, and compare them to the Technology and Society literature, particularly to the work of Rogers (1995), which discusses the consumer groups in society through which a new technology diffuses.

Although EVs are not a new technology, they have been marginalised by combustion engine technology for the best part of a century. EVs are potentially facing a renaissance in the next few years, and current drivers are characteristic of the ‘innovators’ and ‘early adopters’ discussed by Rogers (1995).

This chapter will explore how innovation and early adoption helps to develop EVs and EV technology. A large area of interest is that of how early adopters are tolerant of technical deficiencies, and a number of technical deficiencies are indeed observed and discussed. These deficiencies, while tolerated by current EV drivers are examples of what may need addressing in order for EVs to become a mass-market product. Technical and systematic deficiencies have prompted some EV drivers in the study to use their advanced knowledge of cars, electronic engineering, and ICT to develop products and systems which have benefitted early adopters of EVs and will continue to be of benefit in the future.

The drivers in the study have a good understanding of electricity production and energy issues and are using this higher level knowledge to become the ‘citizen-consumers’ and ‘co-providers’ discussed by Van Vliet et al (2005). The surprisingly ambivalent attitude to technology in general is discussed, and compared to the actual *technophilic* practices which were observed throughout the study.

## 4.1 TRAITS OF INNOVATORS AND EARLY ADOPTERS

### 4.1.1 Education Levels

Overall, there are 26 individuals in the study group (20 'single drivers' and 3 couples) and as a group, they are relatively very well-educated. The 2001 Census found that 19.8% of all people (aged 16 to 74 years) in England and Wales had a qualification at Level 4 or above (NOMIS, 2001). As per the table below, seventeen of the drivers in this study have at least a level four qualification (which equates to 65% of the sample), of which five drivers are educated well above average; one has a PhD and four others have post-graduate qualifications. A further five drivers in the study have City and Guilds or vocational qualifications, and two studied A-Levels. Only one driver in the study has nothing beyond O-Level (Level 2 qualifications), and one driver did not give their highest qualification levels.

Education Levels	Number in the sample	% of sample	% of general population
Level four or above (including NVQ4, HND/HNC, degrees and postgraduate qualifications)	17	65%	19.8%
Level 3 (A-Levels, NVQ3 and City and Guilds 3)	7	27%	8.3%
Level 2 (CSE/GCSE at grades A-C and above and O-Level)	1	4%	19.4%
Unknown	1	4%	-

Fig 4.1 Education levels of drivers in the study compared to the population as a whole

Of those drivers in the study that have completed post-16 study, five studied Electronic Engineering, and two studied Physics. The subjects studied by other drivers include Metallurgy, Mechanical Engineering, general Engineering, Chemistry, Computing, Medical Practice, and Social Sciences. One driver is currently studying for a master's degree at an evening class, showing that life long learning is valued within the group.

#### 4.1.2 Occupations

Drivers in the study have, or have retired from, successful careers. No drivers in the study are unemployed and most work full-time.

Of the drivers in the study, twelve work (or worked) in engineering related industries. This is half of all drivers in the study. These jobs include, but are not limited to, Product Technical Authority for an engineering company, and Design Engineer for a motor car manufacturer. Two drivers own their own engineering companies. One driver has three different jobs in electrical engineering, one of which is on a self-employed basis. One is an aircraft engineer, and another is an electrician at the local hospital. One driver owns and runs an electric guitar manufacturing company.

Three drivers are employed in the computer, media and software industries. One driver is a self-employed car designer and rally event organiser.

Among the more non-technical jobs, there are-

- Two civil servants
- A retired physics professor
- A retired benefits advocate for a charitable organisation
- A sheep farmer
- A GP
- A police officer
- A life coach and tutor
- A publisher and accountant

More than half of the drivers who work are able to manage their own working pattern to an extent; either to a large extent (five drivers), or to some extent (five drivers). Three

drivers have no control over their working hours at all, and three other drivers do have some control but only 'a little'. This shows that a lot of drivers in the study are in jobs which allow them a good degree of flexibility.

#### **4.1.3 Fatalism**

Rogers (1995) found that innovators and early adopters of technology are less *fatalistic* than later adopters. People who are fatalistic believe that events are pre-determined by some unknown force and therefore, inevitable.

When asked if they believe in fate, the drivers in the study, as a whole, reject the notion of fate, and are happier in the belief that you can make your own destiny. Out of the 22 drivers in the study who expressed an opinion on the idea of fate, half say they lean more towards the idea of making your own destiny. Eight say they believe a little in fate and a little that you can make your own destiny, and are of the opinion that fate throws you choices, but you can personally influence which path you choose and how things turn out from there. Only three drivers said they leaned more towards the idea of fate.

Good examples of people who make their own destiny are Mike and Angela. Mike, a media developer in his forties, told me he believed in being able to make your own destiny and His wife Angela agreed. She said –

*I'd say most of what we've achieved is down to us.*

Jonathan, a GP in his sixties, also believes that making your own destiny plays a much bigger part than fate -

*I suppose I, I think one's destiny is obviously affected by things that happen around you. I'm not sure that's the same as fate. Fate is something you can't avoid, isn't it? No, I think I'm in charge of my own destiny. Obviously I have to react to what's happening around, but I'm not one of those people who think it's written so you don't have to take control.....*

On the whole, the drivers in the study are people who do not sit and wait for things to happen to them. They actively take control of their own lives in the belief that you can create your own destiny, and as such, as a group, do not have fatalistic beliefs. Whether this is representative of society as a whole is beyond the scope of my study, but I can say overall, that the notion that fate plays a significant role in life is accepted by only a minority of drivers.

#### **4.1.4 High level of exposure to mass media**

Drivers in the study are, on the whole, a media-savvy group, particularly for new media. All have internet access and at least one email address each, and all are competent in using the applications required. Although two drivers in the study say they do not enjoy using the internet and email, they are both still competent in using it, and were confident enough to be successful in getting in touch with myself via email. One other driver says he struggles with email, but his self-confessed lack of ability does not deter him from using the technology. The oldest driver in the study, Alan a retired physics professor in his eighties, is very competent using the internet and email, having had experience of computers since he bought an early Apple Mac for his family in the 1980s.

Overall, the drivers in the study are big users of ICT, with nearly all confessing they use it *'every day'* or *'continually'*. At least six drivers in the study have bought an EV using auction website EBay, and other drivers use it to buy spares and parts for their vehicles. A lot of drivers are active on the online forums of owners' clubs such as the Battery Vehicle Society, either under their own names or pseudonyms, while others are on EV email circulation lists.

At least two of the drivers in the study run their own websites which have a high profile among other EV drivers. Two other households help to maintain and run the websites and

forums of the Battery Vehicle Society. I recruited some of the drivers in the study group through a multi-national website where EV enthusiasts can post pictures and details of their EV and share the information with others.

Drivers in the study use the internet to carry out research, not only into EVs but also for other matters, including alternative energy technologies, and also in one instance, for spreading information about the care of dogs. Some drivers spend many weeks and months carrying out research on the internet before they make an actual purchase. Chris A, an electrical engineer in his forties and a self-confessed internet addict says -

*I spend far too much time on it and yes I research anything and everything, you know we recently bought a new washing machine, I'd hate to think how many hours I spent on the internet researching the types, who was the best make.....*

#### **4.1.5 Culture and Foreign Travel**

When I started my study into EV drivers I expected to encounter many introverted, engineer-types working away in their sheds. What I actually found was a bunch of people who are familiar with foreign culture and are well travelled, and I was told many stories of worldwide travel and experiences of working abroad. During my fieldwork, I was not looking for evidence to back up some theory of early adopters being highly cultured and well travelled, but it was something that struck me in many of the households that I was fortunate enough to visit.

Alan and his wife taught physics at universities on the continent of Africa for many years, before returning back to England on retirement. Terry, a semi-retired electrician in his sixties, has taken his family on a round the world trip, visiting Australia, Asia and several places in the United States. Andy, a computer engineer in his fifties, has visited almost every continent in the world, and often returns to India to visit his wife's family and so his son can learn a little more about his heritage. David, a Welshman in his forties, says he has

ridden a bus on pretty much every continent in the world, and did a lot of travelling as a student. Martin has lived in a lot of places, both as a child and adult, owing to the travel requirements of his father's job. Martin says –

*I guess because of my childhood flitting about the planet. I'd much more see myself as a citizen of the world, rather than a citizen of the UK*

Other drivers in the study have lived in several places in the UK. Drivers are not averse to moving to pastures new if their current location does not offer what they want from life. Chris C, an engineer in his forties, tried living on the Isle of Wight for a while, but found it stifling and soon moved on again. Belinda, a retiree, was originally from the north of England, but found it was not to her taste and moved to London as soon as she was old enough. Originally from the Midlands, John L, a farmer in his fifties, has lived in several areas of the UK, including London, and now lives in South Wales.

#### **4.1.6 Influencing others**

A feature of early adopters is their ability to influence others. The drivers in the study do this by spreading the word about EVs, by contributing to the mutual shaping of technology and support systems, by advising others on technical matters, and by helping others to make purchasing decisions.

A term I noted on the internet forums was 'ev-angelism', which is a tongue-in-cheek word that refers to spreading the news about EVs. I asked drivers whether they ev-angelised about their EV to others. Five drivers in the study said that they did try and spread the word to others. They do this by giving talks to local groups, writing books on EVs, and organising publicity and information events. Mary, one half of an EV enthusiast couple says -

*I just kind of drop it into conversations, I'll go 'Oh I took my electric vehicle out the other day' and people go 'Ooh, have you got an electric vehicle?' and then I go 'Ha-ha, you're mine now!'*

Thirteen of the drivers said they are happy to talk to others about EVs but don't 'ram it down peoples' throats'. They talk to people at work about EVs when asked, or try and convince selected people that an EV would work for them, but they don't go out of their way to do so. Andy says –

*I do mention it, but I don't go out of the way to make a point out of it. I do make sure people know I've got one, and if they want to ask questions they can.*

Belinda, who drives her G-Wiz to save money, says that she tries to convince other pensioners to switch to an EV –

*Belinda: If it's a pensioner I do.*

*Interviewer: What, you say that they should have one?*

*Belinda: Yes. There's a chap up the allotments who's got the same Rover as me, except his is not fuel-efficient, it's not good. I'm forever saying to him ..... why have you got that car? He's always moaning about money, and I rub his nose in it, but it's just not sensible. He's just being male.*

Three of the drivers said they avoided evangelising about EVs as it was no business of theirs to try and tell others what to do. While this may come from a desire to not appear pushy or from not to set themselves up for ridicule among their peer group, at least one driver admits that he does not really want others to know about the benefits of EV motoring. He can foresee that a large uptake in EVs will mean that the tax breaks that EVs currently receive will be taken away once petrol sales start to fall and with it the high tax revenue that the government currently levy on fuel - this cynical view is one that is also put forward by some other drivers in the study. As he does not really care about the environmental benefits of EV motoring and likes driving something that is a bit different, he would rather EVs were not adopted in mass numbers and so, says he spreads the word as little as possible.

#### 4.1.7 Mutual Shaping of Technology and Systems

Another way in which the drivers in the study try to move EV technology forward is by lobbying government, encouraging businesses to provide EV facilities, and by taking part in technical research conducted by car manufacturers.

Belinda is currently in a battle with her local councillor. The local council decided to make parking for EVs free of charges and permits, but this was withdrawn. Belinda is not happy about this and is emailing her local councillor to get to the bottom of this. She is also not happy about the fact that an MOT for an EV is the same price as for a combustion engine vehicle, although is faster to do because there are fewer components to check. She does not think that this is fair, so she says she—

*.... might email the government department about that because it's just such a rip off.*

Michael, a retired electrician from the north east of England, is not happy that insurance is difficult to get and usually more expensive for an EV (see Chapter Five below), so he has complained to people about it, including former transport minister Lord Adonis. He told Lord Adonis that he believes that more incentives should be put into place, such as free parking and free recharging points.

Some drivers take an interest in developments in EV technology with regard to the provision of recharging infrastructure. Terry has been speaking to his local council to try and get better recharging provision in his city. He thinks that EVs will not be adopted unless recharging points are in place. Michael heard that his local council have installed a recharging point behind one of their buildings for use by their fleet vehicles. He has asked to be able to gain access to the point, and for it to be made available to the general public.

Tim C and Mary, an EV enthusiast couple in their 30s, have persuaded some local businesses to make their existing recharging facilities more readily available to EV users, including their local pub which was already set up with electric hook-up points for lorries. Chris A is part of a committee at the council he works for which is working towards the provision of public recharging facilities in the local area. He was drafted onto the committee when word got round that Chris was already driving an EV on a daily basis.

Some drivers work with private companies to help make improvements. Chris C, an engineer, has found many design faults with the parts he uses in his EV. He has fed back this information to the manufacturers, with mixed results, but takes the time to do so anyway.

Nissan, a major car manufacturer in the UK and producers of the forthcoming all-electric Leaf, have been out to visit Chris C, and also Rob to discuss how they use their EVs and what problems they have found with them. Chris and Rob are happy to contribute their time as it will mean that the next generation of EVs will be an improvement. This participation won Rob and Chris an invite each to the Nissan Leaf launch event, where they were able to preview the new Nissan Leaf and Rob also managed to bag himself a test drive.

Evan, an engineer in his 30s from Scotland, has contacted Nissan to try and find out what sort of recharging points they are planning to install in the north-east of England, but he is still unaware as he keeps getting pointed in the direction of recharging point manufacturing companies.

Mike and Angela have spoken to the Technical Director at a major recharging point manufacturing company to report problems that they have discovered with public recharging points in-situ and to arrange for them to be fixed. They have also mediated with

Going Green, the distributors of G-Wiz cars, to facilitate the servicing and repair of G-Wizzes outside of London, which has been of benefit to themselves and to other G-Wiz drivers.

While there are some drivers in the study who do not 'ev-angelise' to their peers, they are significantly outnumbered by those that do. Drivers in the study play active parts in spreading the word about EVs and also influence the future of EV development. Drivers in the study who say that they do not actively spread the word may still work with companies to develop EV technology, showing that the drivers in the study make the distinction between individual users and EV companies. This 'ev-angelism' is not only a process showing how early adopters bridge the gap between early adoption and mass market adoption, but also shows how the development of artefacts and technologies is influenced by users as well as by engineers and technicians.

#### **4.1.8 Early Adopters are Respected for their Advice**

Early adopters are said to be respected for their knowledge of products and of new technologies (Rogers, 1995). Drivers in the study said that they are often called upon by others to help with technical problems or to help make a purchasing decision.

21 drivers in the study reported that they are consulted for advice on a range of things from EVs to televisions, to computers, to the care of dogs. Only one driver says that no-one really comes to him for advice on technical matters. Chris C explains what people come to him for and why –

*Everything. Anything you could possibly imagine. The guy next door there – boiler not working – 'Fix my boiler'. So anything and everything. What happens is they see you working on your car and they think he must know something.*

John L also has a similar experience. Other people come to him for help with -

*.....electric vehicles, petrol vehicles, heating systems, solar systems, alternative energy systems, people know my background so use me as a general encyclopaedia for technical matters.....*

Has this respect meant that anyone else has adopted EVs as a direct influence? Alan says that his grown-up children are showing interest in the next generation of EVs, and he is sure that at least one of them will buy a Nissan Leaf. Evan has already convinced his parents to drive an EV - a Berlingo van that Evan acquired along the way, and use it regularly as their second vehicle. Terry's son-in-law has bought a Toyota Prius, and Terry admits that he does '*bend their ears about....being greenie*'.

Overall, the drivers in the study have not convinced many people in their family and social circles to go electric, although they have possibly convinced a lot of like-minded strangers to do so, via the internet or through promotional work at car-shows or eco-fairs. At the moment, the majority of EV drivers in the study are islands of innovation who tend to know other EV drivers because of the EV enthusiasm. They keep in touch with each other, despite relatively large geographic distances to form 'cliques' based on make and model of EV, geographic area or just like-minded attitudes (for a full explanation of this, see Chapter Five below).

## **4.2 KNOWLEDGE OF TECHNOLOGY**

Knowledge of technology among the study group is at a high level. Half of the drivers in the study have an engineering background. Those that do not have experience in engineering have a fairly good understanding of related issues, such as energy production.

### **4.2.1 Knowledge of energy production**

The high proportion of drivers in the study with engineering backgrounds means that there is a high level of understanding of energy production and consumption within the group. A

lot of drivers in the study are interested in science and technology, and pay a great deal of attention to developments in energy.

Tim N, an engineer in his forties, explains why his understanding of energy consumption is better than average –

*....my background is engineering so I guess I'm relatively clued up on how much power different things use, so a light bulb versus a kettle versus a car versus the fridge, I can reasonably rank where those are in terms of power consumption.*

Knowledge can come from education and training, and also from a general interest in science and the environment. Chris C explains that he has always had an interest in power generation. He has visited power stations in different parts of the UK. His first experience was at Didcot power station as a teenager–

*You get an instant feel for the technology and everything, it's an amazing experience, and you can feel it. Lets say you're standing next to the 500 megawatt generator, the alternator thing, the whole thing vibrates, you know what I mean? I mean that sort of thing stirs my..... for some reason I like it.*

Chris regrets that the increased fear of terrorism since 9/11 has meant that these experiences will not be as readily available to the younger generation –

*... if you went to any power station you could turn up and they'd show you round the reactor and the control room but all that's stopped. Sad really.*

David's knowledge has been enhanced by the emergency planning training he has received at work. He says that -

*....one of the exercises we have done, in fact one of the exercises which comes up regularly, is what happens with major failure of the electricity system, so we do stuff like what happens if all the phones go down in the country, or all the electricity, or all the water supply becomes contaminated, you know that sort of thing....*

Two of the drivers in the study have worked for electricity companies in 'the control room' experiencing first hand the challenges faced by energy companies. The high level of knowledge of energy production means that the drivers in the study have a lot of empathy

with electricity generating and distributing companies. They understand the main issues that electricity companies have on a day-to-day basis. Rob, a software engineer in his forties, explains what he understands these issues to be –

*Well we have, I've forgotten what the proper word is now, but we have a number of generating sources and those sources can be split into base load sources where they generate the electricity at a constant rate or a pretty slow changing rate, like nuclear and coal. There's the fast changing generators like gas, yes, and so the gas takes out the fluctuations in the day-to-day, the base load. It's distributed to homes, and you are talking about 20% losses, something like that.*

Alan's view is that the challenges facing energy generation are more acute and long term –

*We are going to run short of electricity in ten years time and it's a tragedy and there's no need for it. We could've built wind farms years ago, instead of closing down that factory on the Isle of Wight, they could've built more nuclear stations, oh they could've done so many things, more mini-micro hydro electric, but they've started too late and we're going to suffer.*

This knowledge and appreciation of electricity and energy generation means that the consumption of electricity is monitored and minimised.

#### **4.2.2 Consumers as active participants**

Some literature on Demand-Side Management (DSM) techniques critique the view of consumers as passive consumers who play no part in energy management. The critics argue that consumers are becoming increasingly aware of, and more involved in managing, their own consumption of energy, and in the process, are making the move from passive consumers, to 'citizen-consumers' and to 'co-providers' (Van Vliet et al, 2005:49).

Drivers in the study are far from the passive consumers that earlier literature describes. Some of the drivers in the study use technological fixes to help them to reduce their energy consumption, and in some cases, to produce their own energy. Eight of the drivers have an energy-use monitor in their houses. Nine of the drivers have installed, or are planning to install very soon, solar panels which are either for the production of hot water or for the

production of electricity. Three drivers have installed, or are planning to install, a windmill. One driver has installed his own ground source heat pump, while another has been researching heat pumps on the internet recently. Five drivers report that they use energy saving light bulbs, and two report that they have power-down switches. Generally, these drivers are attracted to energy saving technology for the same reasons they are attracted to EVs – the environmental benefits and the cost saving (see Chapter 5.1 below).

Martin, an ex-engineer in his forties, is one driver who is seriously looking into installing solar panels. His interest has gained momentum with the introduction of the generous feed-in tariffs that have been announced by the government. Martin is sure that solar panels make sense, even to people who do not have any interest in the environmental benefits. Chris A too is attracted to micro-generating because of the financial incentives –

*....because of the new feed-in rates that they have just given I'm just about to....., we fancy having a go at because I think it would be fantastic because again, it's about saving money....*

Tim C and Mary are a little more sceptical about technical fixes. They say that although using an energy monitor has reduced their consumption a little, it has not reduced it very much. Tim thinks that –

*.....we were conscious before that and that's why we bought the energy monitor in the first place.*

Another way that drivers in the study reduce their energy consumption is by adopting a management approach. Andy, an environmentalist from London says that –

*....we've just got more of an energy saving philosophy. We've got nothing fancy but our energy bills seem to be half of everyone else's..... We have an environmental approach to management, rather than bolt on technology.*

Belinda's main motivation behind saving energy is financial. She understands energy in terms of how much it costs. She explains that –

*I'm a war-baby, I'm from Yorkshire, I watch every penny.....I don't leave lights on.*

Russ, a company owner from the Midlands, has a similar approach –

*....I'm forever shouting at the kids to switch the lights off, and the bloody computers off, yes.*

One way in which consumers can influence where their energy comes from is by buying 'green energy'. The consumer chooses a 'green tariff' and pays a premium over and above the standard rate. The extra money is invested by the electricity companies in renewable energy sources, for example hydro-power or wind power.

Only two drivers state that they are not willing or able to pay the extra. Far more express an interest in moving onto a green tariff. Six of the drivers in the study (more than one-quarter) are already paying extra to be on a green tariff.

There is a culture of 'responsible consumerism' among the group of which the purchase of 'green energy' is a part. Of the 22 households that I asked, 12 said they tried to buy Fair Trade products where possible, and another one favoured local, in-season produce to reduce waste and increase sustainability. One of these households also expressed a preference for buying produce from organic sources as well as Fair Trade goods.

Three of the drivers said they did not buy Fair Trade goods as a rule, but tend to avoid products which were over-packaged to save on waste. One driver buys ethical products, but says it depends what it is he is buying. Five of the drivers in the study (around one-quarter) said they do not buy ethical products as a rule, because of the higher price or because of the difference in quality to regular products.

Three-quarters of the drivers in the study make some effort to consume ethically, and this practice is a conscious decision-making process where products are not bought and consumed simply on the sight of a Fair Trade mark, or because it is sold as 'green'. Drivers in the study are far from consumers who willingly pay anything to ensure their ethical credentials, and can be very selective about where their goods come from, or in Martin's case, who they are giving their custom to. He says –

*Ah well now I was, I was with Eco-tricity and then I think it was to do with electric vehicles, I saw an article somewhere where the boss, whatever his name is, was standing next to his £350,000 Mercedes something or other petrol or diesel car and pontificating about something or other and I suddenly saw where the extra money I paid for my green tariff was going and so I wrote to them to say how delighted I was that Mr Miggins is making a lot of money out of this but sadly I'd like to change my tariff thank-you.*

Martin's comments show that the purchase of 'green energy' or 'good energy' is part of a culture of *responsible consumerism* and that drivers in the study take the time and effort to research where their purchases come from. They do not necessarily buy a product unquestionably, just because it is sold as 'environmentally friendly' or 'ethical'. Just as important though is that drivers in the study are under the same decision-making constraints as their peers. One driver explains

*We lean towards [ethical products] ..... but the only thing I find is that there is a fundamental price increase, which is exactly the same as with electric vehicles, most of the stuff is substantially dearer and being as my finances are the same as a retired persons, we are limited to how much we can use them.*

### **4.2.3 Technophilia**

Technophilia, or an enthusiasm for technology, is something I expected to find in abundance among the study group. I anticipated that because EVs are a niche technology as well as a method of transport, that I would find a widespread enthusiasm for technology in general, especially as a significant number of the drivers in the study have engineering or

technology backgrounds. Although I found a large enthusiasm for EVs and EV technology and a relatively high incidence of enthusiasm for energy efficient technologies, I found little evidence of technophilia in other areas.

I found that two of the drivers in the study had anything more than a very basic mobile phone. While nearly every single driver said they were a lover of technology in general, none talked about other technologies more enthusiastically than about their EV. Overall, the group were pretty ambivalent about new technology.

Tim N talks about the technologies that he likes -

*Some technologies I guess is the answer to that. So, I like computers and I like computer type stuff, we have a hard drive recorder for the telly, that sort of stuff. But other technologies have no appeal to me. I'm not into MP3 players or playing video on the move, my phone is a very basic makes phone calls and sends texts type of phone, I have no interest in surfing the web on the phone, taking photographs on the phone, erm I might play snakes on the phone every so often but it's a phone,*

I found that technophilia within the study group is high, but limited to EVs and to EV technology (for a full discussion of how EV hobbyism can encroach into other areas, see 4.2.4 below). In other areas, such as ICT and home entertainment, the households of drivers in the study do not seem to own significantly more technologies than other households of similar circumstances.

#### **4.2.4 Tolerance of Technical Deficiencies**

A trait of early adopters is that they are more tolerant and forgiving of technical deficiencies than later adopters (Moore, 1999). EV drivers in the study have certainly come across deficiencies when using their EVs but use persists. Ten of the drivers have experienced problems and deficiencies with their EVs that later adopters would probably

not tolerate. None of the drivers in the study reported the deficiencies as a major problem and they generally seem to be accepted as the price of early adoption.

John S and Martin both converted their own EVs. Both decided to have DC drive with gears. The gears in John S's van are '*a bit clunky*' and '*a bit crap*' but it still works, so he does not mind. Martin acknowledges that having no clutch in his van was a mistake, but again, he perseveres. Both drivers forgive their vans for their respective, relatively small technical deficiencies, partly because they themselves made them a little deficient. Russ's computer in his car doesn't record the battery levels properly after a recharge. He has to manually reset the computer himself. As he converted the car himself he is forgiving.

Alan's converted Ford Fiesta has become a two-seater vehicle after having been a four-seater for some time. He needed to surrender use of the back seats to make the battery access easier, but as he does not carry as many passengers as he once did, he is happy to live with this. Tim N hasn't found any technical deficiencies with his G-Wiz but he is not 100% satisfied with the passenger capacity. The car seats two people at best and the 'back seats' are inadequate for anything more than two very small children. As a result, he tends to use the back seats for carriage and storage only. However, the car suits him and his lifestyle and, if he needs to carry more passengers, he will take his bigger car instead. Use of the G-Wiz persists because Tim's motivation of reducing his carbon footprint is important to him; he tolerates the smaller passenger capacity of the G-Wiz to achieve this.

Chris C's wife nearly ran him over with his EV because she did not realise it was active and pressed the accelerator by mistake. Although he tells me this story with some humour, in a more sober tone Chris tell me that he feels that later adopters would dislike this and will need something to inform them when the EV is active.

Mike and Angela have found deficiencies with recharging infrastructure but instead of giving up, they work with the equipment manufacturers to get the problems solved. They see themselves as EV pioneers, and are happy to contribute by sorting out teething problems.

Terry has had some technical problems with his Oxygen motorcycle which he has been able to fix himself; albeit in a way later adopters would not tolerate. Terry's bike is foreign-built so the circuit boards which he needed to fix are printed in French. Terry did persist with fixing his bike, though he had to call on a French-speaking colleague to help him with translation.

Jonathan experienced many obstacles in getting his Finnish Elcat van road-legal for the UK. Besides the only available manual being in Finnish, he has, among other things, had to adapt the headlights so that they dip correctly for UK roads (in Finland, they drive on the right). To do this he had to find UK-legal headlights and adapt them to fit. He used the oven to melt the glue in the casing to take out the Finnish lenses and replace them with the UK lenses. He says –

*I put them in the oven and warmed them up gradually, and eventually was able to pull them apart, so I did the same with the others and put them back in the other way, but this is the sort of caper you get into you see....*

The 'capers' that Jonathan describe are not something that later adopters would likely tolerate, though they seem to be relished by some drivers in the study who enjoy working on their vehicles. The 'capers' also seem to encroach on other areas in the domestic sphere. Where Jonathan used the oven in the kitchen of the house to carry out his modifications, others use their place of work to carry out repairs, such as the workshop of their engineering company, or the company car park. Many drivers have filled their driveways and garages with various parts, and other vehicles in various stage of repair.

More than one home had a permanently sited 'spare' EV from which parts were taken to assist in the upkeep of the regular EV – this was fairly common in households which run the discontinued Citroen Berlingo Electrique. In some houses, I passed various pieces of kit and equipment in the entrance hall or other areas, much of which was unfamiliar to me as a non-engineer. In homes of the more non-engineering type drivers, these items were less common and the vehicle was kept much more separate from the domestic sphere. EV related kit was non-existent in some cases, or limited to the garage in others. I get the impression that behind some of the more enthusiastic EV innovators and early adopters, there are understanding and tolerant families (see Chapter 5.2 for a fuller discussion of EVs and gender).

Deficiencies will need to be fixed for later adopters to consider using an EV. For EV enthusiasts and early adopters, the deficiencies are minor problems that are tolerated because the desire to have an EV is large enough for any deficiencies to become insignificant, and overcoming problems is seen as part of the fun of being a pioneer. The practices that are carried out to enable EV motoring in the household can encroach onto other areas of domestic life, and while spouses and partners of current innovators and early adopters seem to be fairly tolerant of this encroachment, later adopters may not be so easy-going, and the practices which are currently used to overcome deficiencies will become more difficult to sustain.

#### **4.2.5 The Deficiency of Limited Range**

The biggest technical deficiency or biggest disadvantage of an EV is the limitation on range. Eighteen of the drivers stated the limited range of the EV as a potential disadvantage. The drivers in the study appreciate that their EVs can not go too far, however none see this as a major issue. The limited range means that some journeys take more planning and mental effort, and that substitution for other vehicles within the household occurs. On a daily

basis, the EVs tend to be used for short, local journeys and for regular trips, for example commuting to work or doing the school run. Chris A explains how although the limited range of the EV is a deficiency, why an EV suits him fine –

*...[one of] the inadequacies of the electric vehicle, the fact that it won't go further than 25 mile radius, but then equally you're better off remembering that and only using it for those shorter journeys..... It's for all those little journeys that you do out and about, round and about, up to the shops, back to the DIY store, the recycling centre, you know to work which is a sixteen mile jolly that way, you know go to the shops. It's for all those sorts of things*

Evan knows that other people struggle with the idea that an EV can restrict travel distance, but he finds that for himself, it is not an issue with a bit of planning -

*...for me it's not a huge problem – I know where I'm going, my trips are planned and so on – it could you know, it depends on the way the person uses the car to start with. If you're out and you suddenly decide to go somewhere further away then you can't and that would be a disadvantage. You need to think about where you are going before you go.*

There is the recognition that the deficiency of limited range will be less of a problem in the future. David cites range as one of the more obvious disadvantages but–

*that's an issue that's going away. I mean the Mitsubishi ones that are coming out, and the next generation ones, you're talking about 100, 150 miles.*

### **4.3 INNOVATIVE BEHAVIOUR**

Rogers (1995) called the groups in society who adopt a new technology earlier than others 'Innovators' and 'Early Adopters'. Innovators invent, design, and adapt technologies. They form cliques to share information. Early adopters embrace the new technology, help to shape future development, and spread the word to other groups in society.

Users of technology can be an important source of innovation and product improvement, and users form *innovative milieus* through which information and resources are available to

the *user-innovator* (Rohracher, 2005: 25). In the study, there are some good examples of innovative and early adopter behaviour.

Aside from the drivers within the group who take existing technology (motors, batteries, controllers etc) and assemble and adapt them using knowledge they have gained from various sources, there are also drivers in the study who have made innovations for other EV users.

#### **4.3.1 Product innovation**

Evan has invented, and currently manufactures and sells a computer diagnostic device called the EV-Lite, which is a plug-in device that enables owners of Citroen Berlingos and Peugeot 106Es to diagnose faults and carry out their own servicing. Evan created the device for his own purposes after having a costly experience with his local servicing agent. After other EV owners heard of this device, the demand for it was such that Evan started to produce them commercially. He now sells the EV-Lite to other EV owners within the UK, and also exports them to Scandinavia, where EV use is relatively high. This device enables



Fig 4.2 A driver demonstrates the EV-Lite in action

other Berlingo and 106 owners to avoid servicing costs, and in some cases where local dealerships do not provide servicing to EVs, it enables the owners to keep their EVs operational for longer.

#### **4.3.2 Other innovation**

John L started an independent company servicing, fixing and importing EVs because he recognised an unfulfilled demand for EVs in the UK over the last few years. John's company has imported Elcat vans from Finland, as well as converting EVs for other people. He has now expanded into an agency for Aixam Mega cars and vans with London-based, fellow EV enthusiast Andy.

There are intangible innovations which are useful at spreading the word and giving others the confidence to adopt EVs. Tim N devised and runs a website called the EV-Network. This site shows the location of public recharging points, and also private recharging points that registered members are willing to share with others. He created the site while he was researching where his own local public recharging points were, because he observed that there was no single online resource which covered all areas of the UK. Information about the whereabouts of public recharging infrastructure is available online, but is fragmented. Tim's innovation was to put all the information he collated into one place and to encourage others to add to it. This site has enabled EV drivers to have the confidence to make journeys to unfamiliar places, and to meet other like-minded EV drivers.

Mike is a very high profile EV user. His expertise in media development means he runs many online resources, including some for EV users. One development is an online carbon calculator which works out the current carbon output of the national grid using real time data. This raises awareness of how EVs can be environmentally friendlier by being recharged at times of low demand and, as a consequence, lower carbon output.

#### 4.4 SUMMARY

Individuals have diverse and complex relationships with technology. Earlier adopters of a new technology tend to have different traits than later adopters. This is certainly the case for EVs. In this study, it was found that early adopters of EVs are highly educated, have good jobs with high social status, are well travelled and cultured, believe that you make your own destiny rather than believing in fate, actively seek information (particularly online), and have had a little success in influencing other people. Most of the drivers in the study are male, one is female, and three EV households comprise of male-female couples. This suggests the possibility that the early take-up of EVs is gendered. (For a fuller discussion of this, see Chapter 5.2 below).

Drivers in the study actively help shape the future of EVs by lobbying local and national government, helping to design recharging infrastructure, and taking part in consumer research to develop future products. Drivers in the study see this as part of being a 'pioneer'. As such, they are tolerant and forgiving of deficiencies in EV technology as they appreciate that they are using a product in its early stages.

However, the drivers in the study do not present themselves as technophiles. I found evidence of people who enjoy cars, and enjoy the benefits of EVs, yet to my surprise, not too many people who own the latest '*must-have*' gadget. What technology the drivers in the study have tends to be environmental and energy efficient technology. Unsurprisingly, many drivers in the study have solar panels, windmills, energy monitors, and heat source pumps.

Drivers in the study have a relatively high understanding of electricity production and distribution. All think about how electricity is produced, even if this understanding is simply how much electricity costs. No drivers are completely ignorant and uncaring about where

their electricity comes from and how it is produced, though some admit that they still take it for granted. This appreciation of electricity as an energy source does not lead to increased use. On the contrary, electricity use is reduced, either through management techniques or technological fixes.

Innovative behaviour is evident among the group, with innovations both in products and in information sharing. The innovators in the group tend to be those with backgrounds in electronic engineering or media development. These innovations are sidelines which exist outside of the innovator's day job.

The way in which EV drivers in the study relate to technology is as individuals. Overall they appreciate technology, but do not stretch themselves to have anything other than their EVs, which they love and fit into their lives, even if this means making small compromises and living with problems and deficiencies.

## **Chapter Five – EV Relationships**

Drivers in the study have diverse and nuanced relationships with their EVs. This chapter will explore why drivers chose to adopt an EV, who influenced them to adopt, and how they see themselves and others as EV drivers. EV drivers in the study are still in the innovator and early adopter stage, so community and clique-forming will be discussed. What this chapter will find is that motivations for adoption are multiple and varied, and that current drivers are islands of innovation where the relationship with the EV itself is superior to that of other EV relationships.

### **5.1 MOTIVATION FOR ADOPTION**

Evidence from this study reveals that there is no single reason why drivers have adopted EVs. EVs have many differences from their combustion engine counterparts so it is not surprising that most drivers cite more than one reason for choosing to go electric. EVs are marketed by car manufacturers as environmentally friendly alternatives to combustion-engine vehicles, yet drivers in the study cite more than just the environment as a motivating factor, and others cite the environment as a low priority.

Concern for the local and global environment was the most frequently quoted motivation for adoption (seven drivers cited this as their major motivation, and three drivers as a contributory motivation), followed by the cost savings associated with EVs (three drivers cited this as their major motivation, and six drivers as a contributory motivation). Most people have more than one reason for adoption, although there are also some drivers for whom one reason is overwhelmingly the most important. The reasons cited include -

- wanting to be different
- the enjoyment of tinkering and building their own things
- energy saving and lack of dependency on oil and petrol

- the EV is nicer to drive
- they are 'less smelly'
- to preserve and recycle used vehicles
- experimentation.

A typical response consisted of multiple factors, as one driver explains:

*If I broke it down, I would say it was 30% say technology, 30% eco and probably most of the rest is because I'm fed up basically funding these loons in far flung places to blow us up.*

### **5.1.1 The environment**

The environmental benefits of EVs are contested in many places including newspapers. Many people doubt the carbon saving that an EV can deliver over a combustion engine vehicle, and I have noted many examples on general internet forums where the doubters are very vocal. The truth of such assertions is beyond the scope of my study. None of the drivers in the study believed that EVs were worse for the environment than combustion engine vehicles. Many believed that EVs were far better from a local emissions perspective and better overall even taking into account the carbon created by a power station. Four of the drivers compared EVs and combustion engine vehicles in terms of the resources used in the manufacturing process and the disposal of the batteries. While they are undecided as to whether the manufacturing of the EV is significantly more environmentally friendly than the manufacturing of a combustion engine vehicle, these drivers believe that the lower emissions at the point of use gave EVs the edge.

Rob, a software engineer in his 40s, swapped his gas-guzzling sports car for a Toyota Prius (a hybrid car) after becoming more environmentally aware, and became determined to get the maximum economy out of it. He found the experience so satisfying that he decided to take the next step and go fully electric. Rob grew into a true EV enthusiast, owning two

Citroen Berlingos, and a Peugeot 106 electric as well as the Prius. Rob is in the process of making his house more eco-friendly. He has made a system that uses rain water for flushing his toilet and is currently looking into making hot-water solar panels. Rob believes that electric cars are more environmentally friendly than conventional cars especially when powered from green electricity.

For Tim N, a chartered mechanical engineer in his 40s, the main motivation is to reduce his carbon footprint both locally and globally. He describes his G-Wiz as “*not ideal*” but believes it was the best EV available at the time, enabling him to reduce his impact on the environment without making too many changes to his lifestyle. For him, the environment was the most important factor in the decision to adopt.

Overall, the understanding among the drivers in the study is that while EVs are not completely without negative environmental impact, they are cleaner than combustion engine vehicles with the potential for them to be cleaner still, providing progress is made in energy generation and distribution.

### **5.1.2 Cost saving**

The potential cost saving of an EV is the sole motivation for only three drivers in the study, though it is a significant contributory factor for many other drivers. Some drivers admit they initially did not think about potential cost saving as they were interested in having an EV for other reasons. For around half of the drivers in the study the EV is perceived to work out a lot cheaper, while a few other drivers perceive the costs as a little cheaper than a combustion engine vehicle, depending on the lifespan of batteries which relates to how well the batteries are cared for. Most drivers agree that the running costs of an EV are extremely cheap, but that the high initial purchase price and replacement batteries can be more expensive.

The unpredictable nature of petrol or diesel prices is something that has motivated at least three of the drivers in the study to switch to electric, and a further three drivers have been motivated by rising prices in the past. Adopting an EV is seen as an investment; a kind-of insurance policy against unpredictable petrol prices. The relatively low cost of the electricity to power the vehicle is not even thought about as it is currently seen as insignificant compared to the cost of the rest of the vehicle. Tim C, an aircraft engineer in his 30s from Manchester explains the mentality behind the cost difference between EVs and conventional vehicles:

*You don't have to think about petrol stations or how much the fuel is costing this week. Possibly I ought to think about how much the electricity is costing, but I don't, it isn't a great amount because the biggest fraction of the cost is buying the batteries in the first place and I've already done that.*

Chris A explains the difference in the running costs between his EV and his wife's combustion engine car -

*.....in the Vectra, you know you can put £50 or £60 worth of diesel in it and it's gone in about 500 miles, and that's it, it's all gone! And you're thinking crumbs, £60 is nearly six months driving in the electric.*

The low running costs of an EV are often doubted by non-EV drivers. I have spoken to many people about EVs over the last few months and some have asked me how much they cost to run. When I reply that it is about 2p a mile, they don't believe me. Evidence from the study would suggest that disbelief in this claim is not unusual. Chris C is concerned that Nissan, who came to him for research into the Leaf, did not fully take on board just how cheap running an EV can be. He thinks that other people do have the misconception that the running cost can be expensive. He says -

*... I talk to people at work who are non-technical and they say 'There's no point is there, because the electricity bill will just go up to £1000' but no it doesn't, it doesn't change. I haven't even noticed the difference. ....I'll tell you what the [LPG] Range Rover was, it was £5 a day, that's what it worked*

*out and I can tell you it's nothing like that with these things, it's pence per day. I mean the actual number, it depends how far you go because it's cost per mile, but these vans use 200 watt-hours per mile, so from that number you can figure out everything you need to know, it's 0.2 of a kilowatt hour per mile, so if you're doing ten miles, 0.2 x 10 is 2, so it's two units of electricity. How much is two units of electricity?*

Two units of electricity costs between 20p and 40p in total (depending on supplier and region) on a daytime rate, and between 10p and 12p on an Economy 7 tariff overnight. (EDF, 2010). This means that ten miles will cost between 2p and 4p per mile on a standard daytime rate, and between 1p and 1.2p per mile using an Economy 7 overnight rate.

Evan and his partner each do a good amount of mileage in an EV most days, using their EVs for commuting as well as for domestic errands and travelling to social events. He has noticed that both the household EVs together use about 50 units of electricity each day, which is about £2.50 on overnight rates – for both EVs. He has worked out his commute to and from work, a round trip of 44 miles, costs about 70p in electricity.

Belinda, a retired benefits advocate and a G-Wiz driver in London, agrees that the running costs work out to be very low. She says –

*I've kept a careful eye on the electric bill and it's not gone up. It's about £1 a week, come on, you'd lose that with the general increases and decreases that have been going on.*

She reports cost saving as the most important factor in convincing her to adopt. This is partly due to living in London where EVs get free parking and recharging in some boroughs, for example in Westminster, and also pay next to nothing towards the congestion charge. When she retired, Belinda invested some of her lump-sum pension in a G-Wiz after speaking to her neighbour about the cost savings on his G-Wiz. It was enough to convince her that the G-Wiz was the car for her.

For a few drivers in the study, the EV is not a cost saving. The higher initial purchase cost of the EV, coupled with a set of replacement batteries means, for some drivers, that the cheaper cost per mile alone has not been enough to make the EV cheaper overall. However, as these drivers see other factors as more important than cost saving, use of the EV persists. In all cases, the EV is used in preference to the other vehicles owned within the household, and this is partly due to the fact that the more the EV is used, the more economical it works out per mile, and the quicker the investment in the high initial purchase price is recouped.

Most drivers in the study obtained their EV second-hand from private individuals either directly or through second-hand websites, the most popular being eBay, or from companies selling off EVs from their fleets. For these drivers, the cost savings are more pronounced. For those who have paid for a newer vehicle, or for a brand new conversion of an older vehicle, the cost savings are less or non-existent.

Mike and Angela, who are currently trialling a brand new iMiev in the West Midlands, said that the high purchase price of the new all-EVs coming onto the market over the coming years will make EVs much more expensive than an equivalent combustion engine car. Indeed, the car they are trialling is, at the moment, out of their price range. However, they believe that prices will drop in time, and that new models of ownership will emerge, such as leasing, or cars on a per mile contract.

The relative lack of servicing and maintenance of EVs is seen as a major contributor to the lower cost. Most of the drivers do a lot of the maintenance work themselves, saving money on repair bills. Knowledge and expertise is shared among members of the EV community, and members often help each other out with spare parts or just lending a hand.

Road tax in Britain is currently free for an EV, and not all of the vehicles I looked at required an MOT, so there are some savings to be made here. However, six drivers in the study reported that their insurance was sometimes difficult to get, and five drivers reported that the insurance is more expensive than for their combustion engine car. This compares with three drivers who reported that getting insurance was no problem at all and only one driver who said it was cheaper. Some drivers can't understand why insurance for EVs tends to be more expensive, as Tim C muses -

*The insurance wasn't as cheap as I thought it might be, it turned out to be the same as the diesel Berlingo. I thought it might be cheaper with the lower range, but that wasn't the case*

John S also cannot understand the price discrepancy:

*It really wrankles that, because the [petrol] car can go far and fast and it can catch fire, the [electric] truck can't do any of them things but they want twice as much insurance.....*

### **5.1.3 Technophilia and hobbyism**

Three of the drivers in the study wanted an EV mainly because they like tinkering, building and inventing. Up until the current time, very few EVs have been available to buy off-the-shelf, so some drivers have resorted to building or converting their own. They enjoy this process, and the vehicle is a hobby as well as a mode of transport. For three other drivers the enjoyment of the technology was one of the major motivators alongside others.

John S, a company owner in his 60s, is typical of an EV driver whose main motivation was because he likes the technology. John has a background in the sciences and owns and runs an electric guitar manufacturing company in the north of England. His vehicle, a converted and modified Bedford truck, is made from a truck shell he bought from Auto Trader and parts he bought from various companies throughout the UK. The van started off more as a

project than a hobby, and is now his main daily drive. John also designed and built his own electric generating windmill in his back garden, and fitted his own solar panel which keeps the battery of his petrol-driven classic car from running flat when it is not being used. John says that the electric truck brings a sense of satisfaction of achievement to his life, as well as cost savings, and less smelly driving. Due to John's work, he has a huge workshop and yard, and a large array of tools he can use. He believes that the facilities are important to any conversion project, as he said himself –

*You need a bit more than a Black and Decker and some enthusiasm.*

Jonathan, a GP in his sixties from the south west of England, is a driver whose vehicle is a hobby as well as a method of transport. Jonathan's imported Elcat van is his daily drive and he mainly uses it for commuting as well as for local errands, but it was bought because Jonathan enjoys the technology of the van in the way he doesn't enjoy the technology in his combustion engine car; the other car goes to the garage if there is a problem, whereas Jonathan is more than happy to try and fix the Elcat himself. Most of the time, he enjoys trying to fix the problems with his van. Jonathan refers to his van as a toy –

*I've always enjoyed fiddling with electric things since I was a boy. When I was a boy I had little toys, and now I am a big boy I have big toys!*

Jonathan's van, and the converted electric Metro he had before it, have not worked out as a cost saving over his wife's combustion engine car, but he doesn't mind, and nor does his wife. He sees it as a hobby as well as transport and it keeps him out of mischief.

Surprisingly though, at least to myself, was the relative lack of 'tinkerers' in the study group. As EVs are a developing technology, I expected far more drivers who were interested from an engineering context. What is striking is that the drivers in the study, though may not have a large desire to take on an engineering project, are not put off

owning an EV by the lack of servicing agents and garages. Also evident from the study is that where EVs may have been initially adopted because of the engineering interest, over time the EV becomes normalised within the household as a form of transport and becomes increasingly less of a hobby. Even for those drivers in the study who are the 'tinkerers', they still consider their EV more as a form of transport than a hobby. For Alan, who was initially interested from an engineering context, his EV has become less of a hobby over time –

*Originally, for the first year or two it was a hobby, and then increasingly it became our only means of transport.*

Chris C explains the shift from the EV being an interesting engineering project to just another form of transport. Did Chris adopt his EV because he was interested in it the engineering aspect? –

*I think I would say yes but that very quickly disappears. Your main worry is not thrashing it, not getting done by the speed cameras, that sort of thing. The normal things, the technology only becomes evident when it goes wrong. You know, it's a funny one. Before you do anything it's probably the most interesting thing, but as soon as you've got it, suddenly it's irrelevant, you know what I mean?*

At least four of the drivers have taken on the EV as a project because of the lack of ready-made EVs on the commercial market. One of these drivers, Peter, a maintenance engineer in his fifties, who converted his own van out of a 'chopped-up milk float' explains that –

*When I decided I wanted an electric car in the 1990's there were virtually none commercially available, so my only options were to either build or convert one.*

James, a car enthusiast in his forties from the South East of England, has taken to converting his own car – a Ford Probe – because he wants an EV but is not keen on the small, quirky cars that are currently available like the G-Wiz. He is converting his own EV

because he wants a car that is -

*...modern and clean but still having a nice car, and at the moment, like I say you can buy a Reva G-Wiz and it's not the best looking car in the world but it's nice and green, or you can have a car like a Tesla, but you have to sell your house to get it.*

Russ's interest in EVs started because he saw a Tesla Roadster and decided it was the car for him, but he couldn't justify spending the high amount of cash needed to buy one. As an industrial electrician, Russ was confident enough to convert a Lotus Elise, which looks like a Tesla Roadster, and thanks to his knowledge and skills cost about one-sixth of the price.

For one driver in particular, the car enthusiasm is all about one particular car. Richard, a RAV4 driver from the Midlands in his thirties, has taken the hobby theme to the next level. Cars are Richard's hobby, or more specifically, RAV4's are his hobby. He does not do too much of the repairs and servicing on his electric RAV4, but he does enjoy kitting it up with various technologies, like Bluetooth for his phone and an iPod instead of a standard stereo, as well as features like heated leather seats. He spends a lot of time cleaning and looking after the car, as well as attending car meets and shows. His hobby is more of a RAV4 thing - he also has a conventional one – and he bought the electric RAV4 because it was the most special one he could have. He imported it specially, and is proud to have the only one of its kind in the UK.

For another driver, the hobbyism aspect to his EVs is unwelcome. Tim C originally bought his Citroen Berlingo van because he wanted a solid, reliable EV to fulfil his desire for nicer, environmentally friendly motoring, but after the van broke, Tim says -

*It's become a bit of a project now because it broke and Citroen aren't able to fix it for me so I've had to get more involved than I really wanted to, but that wasn't why I bought it.*

I asked Tim if he enjoyed doing the necessary work on his van. He replied..*not really, no.*

#### **5.1.4 Being different**

While the desire to be different and distinct from other people was only a major motivation for four drivers in the study, and a volunteered contributory factor for two more, seven more admit when asked, that maybe wanting to be different was ‘in there somewhere’. Only five drivers reject the notion completely. What is clear from my research is that while opinion is split on whether being different is a motivating factor or not, none of the drivers worry too much about others’ opinions of them anyway (see Chapter 5.2 below for a fuller explanation of this).

Chris A, an electrical engineer in his forties from the south of England, says that EVs are attractive to him because they are seen as ‘*odd and weird*’, as well as being a cost saving. He does not worry about what others think of him, and enjoys thinking of himself as different, something he says that other people often don’t like to do. Evan a 34 year old electronics software engineer from Scotland says that EVs are attractive to him partly because of the novelty value, though he will not necessarily feel the need to move onto something else if mass adoption takes place.

Martin admits that he’s “....*always had a strong individualistic streak....*” and tells me about a fellow EV enthusiast who refers to other people as ‘*Sheeple*’, something which he finds amusing and pertinent.

#### **5.1.5 Outside Influence**

Only two of the drivers in the study were introduced to EVs by someone else, either directly or indirectly. Most of the drivers heard or read about EVs and started to research

them all by themselves. For some, the EV interest has always been there and they can not remember exactly how their interest began.

One of the drivers was given an EV catalogue by a non-EV driving family member, so was indirectly introduced, although EVs was something he had been thinking about for some time. One was introduced when he visited a commercial stand whilst manning another at an eco-fair. Four of the drivers in the study became interested in EVs because of early EVs like the Sinclair C5 of the 1980s, or the EV1 produced by General Motors in the 1990s. Belinda was the only one who was directly introduced to EVs by another EV driver – her neighbour.

For some, the interest in EVs led to their membership of The Battery Vehicle Society, where they encountered their first vehicle and subsequently purchased (or converted) their own.

As far as I can ascertain, no driver in the study acquired an EV to fulfil a desire to be part of a community. All decided to adopt an EV for their own reasons and then the community involvement followed, either out of necessity in needing information for self-help, or because they recognised that being part of the community would put them in contact with like-minded people. There are some drivers in the study who are not involved in the EV community at all, and others only get involved with the EV community very occasionally.

The influence of social networks discussed by Axsen and Kurani (2009) is not obvious in this study. While EV in this study drivers may have been influenced by information disseminated from innovators in the form of websites or printed media, only a minority of drivers were influenced by direct social contact with other EV drivers. The influence of 'conformity' on EV adoption within the group has been insignificant, as no-one adopted an EV purely because someone else had done so. While 'reflexivity' and 'translation' may play

a part in how EVs develop and are adopted over time, for the drivers in this study who are very early adopters, these processes seem to be irrelevant for now.

## **5.2 DRIVERS' RELATIONSHIPS WITH THEIR VEHICLES**

From getting to know several different EV drivers, it is clear to me that while their attitudes and habits may be similar on various issues, they are still individual people who have diverse relationships with their vehicles.

### **5.2.1 Personalisation and attention**

For most drivers in the study, while they love their EV and enjoy driving it – with many taking it out just to go for a drive rather than for a specific purpose - they see it as nothing more than a machine; a tool to do a job. Very few drivers name their cars. One driver says that “...*people who name cars should be shot*”. Belinda thinks that the naming of something that is essentially a machine is a strange notion –

*I don't name things. If I did that, I'd name the fridge, the freezer, the washing machine, the computer.....*

Four drivers in the study have given their EV a label-type name to differentiate it from their other vehicles, such as ‘*the electric one*’ or ‘*the Wiz*’ (for a G-Wiz). Only two drivers call their EVs by arbitrary, human names, though in one household I suspect this is to help distinguish between the number of EVs, rather than any desire to have a humanistic relationship with them. Two drivers call their Berlingo a ‘*Blingo*’ – which is a commonly used label in the EV community to refer to a Berlingo, as well as being used as a name for an individual vehicle.

Very few of the vehicles I saw had been customised or adapted in any way other than mechanically. Two vehicles had notices in the back windscreen saying ‘*Electric Vehicle*’ to explain to drivers stuck behind just why the vehicle may be slower than them. Nearly all of

the EVs had window stickers, either in reference to the vehicle's electric status, promoting clean energy, or promoting organisations like The Battery Vehicle Society. Belinda has a sticker in the back window of her G-Wiz. It says 'I ♥ dogs'.

Only two of the vehicles had a personalised number plate. One of these was made up of letters from the name of the driver, the other one was letters referring to the vehicle being electric.

Some drivers loathe any form of customisation. While some drivers outwardly advertise that their vehicle is electric, others purposefully choose not to. Berlingo driver David says -

*I would actively dislike that – the whole 'it's an electric car!' thing - apart from anything else I think..... the normalisation of the technology is going to depend on it not being people who paint everything bright yellow and have a big arrow that says 'Look at me, I'm driving an electric car!' or whatever.*



Fig 5.1 A vehicle with a notice informing people behind it is powered by electric

Chris A also does not like advertising his car is electric. He has removable signs he puts on for car shows, but when going about his everyday business, he prefers to be able to creep around with no one noticing. He learnt from experience with a previous EV -

*The Bedford CF I had had a large 'powered by electric' all round it and it was a nightmare, everywhere you went, which was great fun and I'll happily chat about it, I'll happily rabbit away to my heart's content about EVs and anything like that, but sometimes when you just want to pop out to go and get a beer, to go and get some takeaway, or some money out of the hole-in-the-wall, and three-quarters of an hour later you're going 'I've really got to go I'm afraid, I can't stop'. So yes that's one reason why I don't tend to drive with big stickers everywhere.*

The attention that an EV can attract is something that all but one of the drivers has experienced in one form or another. The attention can be from workmates, friends or complete strangers. A few of the drivers have found themselves chatting about the vehicle to strangers in car parks, and most of the interest is positive. Drivers in the study report that non-EV drivers often do not realise that EVs exist and they can be very curious; they ask what they are like to drive, how they run, what they cost. Richard, a RAV4 driver, says that most peoples' first question is how far it goes; a question he does not get about any of his conventional vehicles. Richard's wife has been asked by total strangers if they can take a photograph of the car when she is out and about, even just on a trip to the local shops.

Belinda gets questions from the post office clerks when it comes to renewing her (zero-rated) road tax. They are interested in the cost savings and the act of taxing the car takes longer than it should. Belinda's G-Wiz also attracts strange looks in and around London from people who are "...foreigners and they probably just hadn't seen one and can't work out what it is." Tim N also has a G-Wiz, and says because they are quirky-looking they do seem to attract much more attention than his 'normal looking' Fiesta.

The current novelty value has meant that simply the delivery of an electric car is worthy of a photo and article in the local newspaper. When Jonathan took delivery of his first EV, the

local newspaper came to do an article all about him and his new purchase. Jonathan didn't seem to mind too much.

However, even with the extra attention that EVs can attract, most drivers say that they feel they have the same level of privacy and anonymity as a driver of a conventional car. This is particularly true for those who drive 'normal looking' vans, and also those who are in London, where electric cars are more common. Two say that they do not feel they have the same level of privacy and anonymity because their car is distinctive in their area or because they have chosen to customise it. One driver knows that his van is distinctive because he has chosen to put stickers on it saying it is electric, but does not feel that this affects his privacy in any way.

### **5.2.2 Life enrichment**

The relationships that EV drivers in the study have with their vehicles are diverse and nuanced. Some express the feeling of freedom and of convenience, in the same way that drivers of conventional cars would. However EVs are different to conventional cars in many ways and this can make the relationship between driver and EV different. In some ways, this relationship is enhanced by the fact that the vehicle is powered by electric.

The most popular benefit that EVs bring to drivers' lives is cost savings, or more economy, with ten drivers citing this as something that they like about their EV. Chris C, whose main motivation to adopt was to save money, has found that the EV fulfils that desire –

*It's cheap, it saves me a huge amount of money, that's the main thing.  
Literally, it saves I would guess £3000 a year, a conservative estimate.*

Seven drivers in the study express feeling satisfaction about polluting the environment less

than would be the case in a conventional car. David explains –

*I feel a lot better about driving it you know, I do get that feeling that I'm doing my bit for my kids... by driving it. I get kind of the reverse with the petrol vehicle.*

Other cited benefits include the feeling that no fuel is being wasted when the vehicle is in traffic jams or waiting at junctions, not having to make trips to the petrol station, being less dependent on oil, and freedom from the high taxes associated with conventional motoring. These feelings mean that driving an EV is less stressful and creates a sense of wellbeing for a lot of drivers. As Tim C says –

*.....stopped in traffic, stopped at traffic lights, you're not burning fuel, it crawls along quite happily as efficiently as bowling along the road ... it's quiet, it's not smelly, you don't have to think about petrol stations or how much the fuel is costing this week.*

The lack of engine noise of an EV makes the driving experience more enjoyable. John L explains –

*The biggest benefit of driving an EV is the lower level of stress when driving. OK, you get a bit of extra stress from people getting impatient and tooting their horns and what-have-you, but it's smoother, it's quieter, it's more peaceful, you can hear the birds when travelling at low speed, when you stop at the traffic lights, if you get used to driving an EV, even the most posh smooth petrol vehicle you can feel a little vibration running through your body even at lights, and you don't get that with an EV – it is quiet, it's peaceful. It's actually the way the vehicle works, it's smoother and more gentle on the nerves.*

EVs also bring a sense of fun to their owners' lives. Belinda says her G-Wiz is –

*Brilliant! You can't beat it. And I love it when I get to traffic lights and I go straight down the side of the traffic. It's so naughty! Their faces when they realise there's a car next to them. It's even funnier if you pass someone and you recognise them. I enjoy that.*

There are stories on the online forums of EV drivers driving past petrol stations, honking their horns, waving to the customers filling their cars up with petrol and laughing to

themselves all the while.

### 5.2.3 Developing relationships

How drivers in the study currently see their relationship with cars compared to their relationship in the past is again diverse. Seven drivers say they feel their relationship with cars had not changed very much over time. John L says his has only altered a little –

*...I've never been a speed freak, I've always been one for...., because of this early influence of the oil crisis I've always had a general tendency to stretch the economy of whatever vehicle I drive, rather than zoom everywhere at high speed.*

Mike, who believes his relationship with cars is as intense as it has always been, says -

*It's changed in as much as the type of vehicle has changed but I've always been interested in cars, whether it's been the kit cars, the classic cars, interesting cars to drive or electric cars. They are just different cars.*

Nine drivers in the study said that they felt their connection to cars has moved on over time. Some drivers used to have 'boy-racer' and speed-obsessed type relationship in the past, but now it's developed into a more economy-obsessed relationship. Rob is typical of such drivers. He says –

*...the intensity is the same, but what I get out of it is different. Before it would've been boy racer stuff, but now it's more economy and driving experience...*

The drivers who share Rob's attitude put it down to getting older and becoming more sensible. Older drivers remember when car ownership was a rarity and the arrival of a car on the street would be "quite something" while these days cars are seen as a must have convenience and people live round them much more than previous generations.

John S says how he thinks younger generations take cars much more for granted –

*Yes I think so, and I think that would be true enough of all of us. Because going back to when I were a lad, which wasn't that long ago, you know a car was something the ordinary working man had to aspire to, it was a big deal. I think to young people, it's a commodity isn't it?*

The relationships that EV drivers have with their vehicles are diverse and complex. EV drivers adopt EVs for different reasons, and are influenced by outside events in different ways, so it's no surprise that drivers express different and diverse feelings about their EVs.

#### **5.2.4 EVs and gender**

In the group of 23 EV households, three were mixed-sex couples (married or otherwise where both drive the EV), one was a sole female, and 19 were sole males. Of the sole drivers, most have a partner or spouse who are involved in the EV 'thing' to varying degrees.

In the opinions of the male EV drivers, some female partners are more than happy to drive the EV, although it is not considered their vehicle, and some even have their own EV, although the move to electric was, more often than not, a male decision. Some wives are not at all happy about electric motoring, while others are supportive if a little bemused. One wife openly questioned my interest in EVs with amusement. One driver said his wife –

*Accepts it. Same as smoking or something.....Comes with me*

..but that when he decided she should drive one too –

*...I got the [bigger] van first, and then the [smaller van] which was intended for [my wife], and I said to [her] that I was so happy with [the bigger van] that I'm going to buy her one and she went 'Oh God!'.....*

Other partners can be more involved. Alan tells me that the decision to go electric was inspired by his wife, who was a physics teacher. They bought their first EV when they

retired and share the passion and enthusiasm for EVs, being prominent members of The Battery Vehicle Society over the years. Alan's wife is competent in making adaptations to the vehicles and has designed many of the components that were added to make servicing their vehicles easier. When Alan's wife was still able to drive, she drove it as much as Alan.

Mary was the main motivation behind Tim C and Mary's decision to go electric. Mary, having a degree in physics, knew about EVs and, as soon as Tim mentioned that he would like to think about getting one, Mary pushed Tim to go the final step.

Pam and John, company owners and grandparents, have several vehicles between them. One is a Berlingo electric van, and it is taken out in preference to the other, combustion engine vehicles. Pam tends to drive the van more than John, and is happy to do so.

Belinda is the only female driver in the study who made the decision to go electric entirely on her own. She drives a G-Wiz around her home in North London and is happy to do so. She does, however, admit to -

*...a middle-aged woman's fear of being stranded somewhere. It's as simple as that. How the hell I would get it home, I've no idea?*

To avoid this happening, she tends to use the vehicle for trips that are well within the capable range of her G-Wiz, rather than pushing it to its limits in a way that some of more confident male drivers admit they do. In the wider context, electric motoring is currently a male dominated activity. There are few women active in societies like The Battery Vehicle Society, and most of these are part of an EV enthusiast couple, though with a very small number of exceptions; albeit high profile possibly because of the novelty of females in the EV community.

In support of these assertions, a recent study by Cenex (2010:19) showed that while females were more open to the idea of an EV, after a test drive males were more likely to say that they would consider an EV as their regular car than females.

### **5.2.5 Self-image and Symbolism**

Symbolism is a phenomenon where a material object says something to others about its owner, which plays a significant influencing part in the adoption process (see Marsh and Collett, 1986). This is further discussed by Heffner et al (2007a) with regard to hybrid cars in the US where during the purchase process, significant consideration was given to the image that the vehicle would convey to others. Heffner et al (2007b) also discuss how symbolism will be an important consideration in promoting the adoption of fuel-cell vehicles.

Griskevicius et al (2010) hypothesise that one of the reasons for the success of the Toyota Prius – a hybrid-car that is inferior in many ways to less expensive combustion engine models – could be that people are willing to pay extra and make sacrifices in vehicle comfort and performance to show others that they have *prosocial* attitudes. It is noted that demonstrating a prosocial attitude can benefit the individual as it shows that they have socially valuable and desirable personal attributes.

Whether EV drivers, particularly those with 'normal' looking vehicles like the Citroen Berlingo van subscribe to the idea of wanting to project a prosocial image is questionable, even toward the end of positive personal benefit. Most drivers are amused when I ask them how they think they look to others. Sixteen drivers in the study admit that they didn't really consider the image they projected to other people when they decided to go electric, and that they do not really worry very much about others' opinions anyway. Chris A's

explanation of how symbolism wasn't even considered is very typical -

*CA: I would say the majority of people think that I'm a bit of a lunatic I suppose, a nutter, why would anybody want a vehicle that can only do fifty miles?*

*Interviewer: But you don't care?*

*CA: I don't care*

*Interviewer: Did you consider how people would see you when you decided that you would have an EV?*

*CA: God no. Definitely not.*

Tim N explains why he too did not consider his self-image when he adopted an EV –

*How do other people see me as an EV driver? I think probably the answer is I don't really care because I see it more about me doing what I think is the right thing to do and if other people don't like that, that's their problem.*

While some may interpret this 'I don't care' attitude as anti-social or even as a sign of social autism, this is very far from the truth. All of the drivers in the study demonstrated a high social awareness and none were uncomfortable or difficult to talk to. The attitude is more an illustration of the drivers' self-assurance – drivers in the study have a high enough social status and self-confidence for the opinion of 'other' people to have no influence on how the drivers lead their lives.

Regarding how they thought others saw them, drivers in the study used the words 'eccentric', 'peculiar', 'lunatic' or 'nutter'. Other drivers said they think they come across as someone who is concerned about the environment. Mike explains how he was accepted as an 'eco-hippy' at an event purely on the credentials of his car -

*...they did something in Coventry last year and I went along in my G-Wiz on to the stand and that was full of eco-hippies, it was so funny, ..... and halfway through the morning I was talking to this guy wearing a hemp t-shirt and everything else and he wished me 'Happy Solstice' and I thought 'Crikey, he sees me as one of them!'*

Some drivers don't mind appearing different from other people, in fact, some actively enjoy it. Martin says -

*How do I think others see me? Probably I don't care but then that's part of being individualistic isn't it, I think because if you didn't like the fact that people think you are a bit peculiar then you wouldn't [do it].*

### **5.3 DRIVERS' RELATIONSHIPS WITH OTHERS**

As well as having an image of themselves, EV drivers have opinions on other EV drivers and non-EV drivers. Many EV drivers know other EV drivers, some of whom they consider friends. What this section will show is that above all, the relationship with the EV is paramount. Relationships with other EV drivers are side-products of the use of the EV which develop out of a shared enthusiasm and out of necessity, but which reinforce the EV enthusiasm and sustain social learning. While there are drivers in the study who have made lifelong friends because of the EV enthusiasm, there are some who see their involvement as a necessary evil and who would be quite happy to exist outside of the EV community.

#### **5.3.1 Types of people who drive EVs**

I asked my informants whether there was a particular type of person that drove an EV. The responses were varied. Four drivers accepted that there had been a certain 'type' in the past, but that was now changing because more and more mainstream vehicles are coming on to the market.

Alan, one of the more established members of the Battery Vehicle Society explains –

*Yes until recently it's been fanatics, enthusiasts, call them what you want,..... until recently the Battery Vehicle Society members were enthusiasts willing to accept the fact that every now and again they would have to do something to their car to make it go. It's that change that is so crucial, that once you get reliable battery electric cars then the type of person will change from the fanatic to the ordinary driver.*

Seven drivers in the study feel that EV enthusiast groups tend to attract ‘*eccentric lunatics*’ and people who can come across as ‘*odd-bods*’. Five drivers think that EV drivers tend to be people who want to be doing their bit for the environment, or at least be seen to be doing their bit for the environment. Terry, an electric scooter rider, thinks that EV drivers tend to be more intellectual than average and have a different way of looking at life.

Tim C and Mary help run the Battery Vehicle Society, which has been the largest interest group for the enthusiasts that most drivers identify. More recently, Mary has noticed an increase in enquiries from new types of people. She has found that more people are buying EVs because “....*they think it’s a good thing to have rather than because they’re techie or an environmentalist.*” Mary admits that while the numbers are not huge yet, they are on the increase.

Belinda’s comments comparing herself to her G-Wiz driving neighbour show that she is certain that the change is already starting to happen, particularly in London –

*Belinda: I think the accepted norm is somebody with a scruffy beard and sandals, but that’s absolute crap to be honest. People like me drive them, I’ve seen young men in them.*

*Interviewer: So even though that’s the general image, you haven’t found that personally?*

*Belinda: No, not at all. I’ve seen a cross-section of people. [My neighbour] is so different from me.....*

### **5.3.2 Attitudes to others**

As well as attitudes to themselves, and to other EV drivers, drivers in the study also have opinions on non-EV drivers. Four drivers report that other people have misconceptions towards EVs and electric motoring, which is put down to ignorance.

A small number of drivers in the study express that they do not like the attitude that some other drivers have towards motoring, and the lack of concern shown over the amount of miles they drive, particularly for commuting. Belinda thinks that other people can have an arrogant and selfish attitude towards motoring -

*I think if you live in any city with a traffic problem, which London has got, and you're arrogant enough to drive a car that's 12 foot long and takes two parking spaces, you're a bloody dickhead.*

EV drivers in the study know that others have misconceptions about EVs that may be preventing them from making a more positive choice. Belinda often gets asked if her G-Wiz requires a driving license, or if it is a car for disabled people. Rob often gives talks to local groups and says lots of people have no idea about things like the acceleration and speed capabilities of EVs.

Drivers in the study say that the biggest misconception is between the range of the EV and the perceived range that non-EV drivers think they need the vehicle to do. Some think that others are 'short-sighted' and unable to see the benefits of the EV or the dis-benefits of conventional motoring, like dependency on oil or pollution.

Although most drivers know they have a different attitude to motoring, they do not necessarily blame others for not wanting to drive electric. Many EV drivers blame lack of choice of attractive vehicles for others not adopting, as well as the lack of servicing and support. Others think that current production vehicles are likely to be too expensive for EVs to make financial sense, especially among poorer segments of society. This shows that EV drivers appreciate that the current low level of EV adoption shows systematic deficiencies rather than faults on the parts of individual motorists.

Eight drivers appreciate that not everyone is in a position to make the switch to electric motoring, but hope that more will start to think about it. However, four drivers appear unconcerned whether more people switch to electric or not. As one driver explained –

*My attitude to those drivers is if they are stupid enough to ignore the advantages, they're stupid and I don't care basically. If they want to pay, I'm not really bothered from an environmental point of view, if they want to carry on burning money, so be it. They may continue.*

In terms of criticism, few drivers have received anything more than low-level leg-pulling from work colleagues about their electric motoring, and few take it as a personal slander. What little criticism has been received has been focussed on the vehicle itself in terms of its speed, or the safety aspect. Most drivers report positive questions and interest rather than criticism. Any criticism is attributed to ignorance or arrogance on the part of the critic.

### **5.3.3 Relationship with other EV drivers.**

Being an EV driver in 2010 means being part of an elite club. EVs are few and far between and a long way from becoming the norm. Drivers of EVs, however, are extremely likely to know of someone else who drives an EV.

One pair of drivers know each other through work, and one pair already knew each other through their connections to a political party, but overwhelmingly, most drivers know of each other because of their interest in EVs. All drivers know of at least one other EV driver, even if it is just by conversing on online forums.

Societies and interest groups have developed over the years for EV enthusiasts to meet, and to share experiences and know-how. More recently, these societies have embraced the technology of the internet, providing an extra resource for drivers looking to contact other drivers, as well as to disseminate information to others. As discussed above, these societies

are becoming increasingly popular with new EV drivers who are attracted because of the lack of support from more formal sources.

Most of the EV drivers in the study know of other drivers because of their association with these societies. Only two of the drivers in the study are not involved with a society at all. The societies run online forums and also social events, which can be on a national or regional basis. The Battery Vehicle Society also produces a bi-monthly newsletter so members can keep up with developments in the EV world, which is produced both online and as a traditional paper copy. Enthusiast groups are active in local areas in the UK, including in the Bristol area and Manchester area. Members get together with a shared enthusiasm for EVs, but don't necessarily discuss EVs all of the time. Members of societies are more likely to name someone else in the society as a contact rather than non members. Drivers who are not members of a society or are not as active as other members of the society have far fewer contacts than those who are active members.

EV drivers know each other for a variety of reasons. Drivers tend to know each other on a geographical basis, especially where regional group meets take place, and also by make of vehicle. This is particularly true among Citroen Berlingo owners who turn to each other for advice and expertise regarding their particular model of vehicle, regardless of geographic location.

#### **5.3.4 Social relations**

All EV drivers know of at least one other EV driver, some know many more. Often, there are huge geographic distances between the drivers, something that the use of ICT helps to overcome. One driver has more EV friends outside of the UK than inside. Socialising is not frequent, and is usually restricted to online contact, partly because of geographic distance and also due to time-poor nature of many EV drivers' lives.

Although some EV drivers have made lifelong friends with other enthusiasts, for others their contacts are described as acquaintances and colleagues rather than friends.

Face-to-face socialising is usually limited to pre-arranged, EV related events and to informal events for mutual help with repairs. For most, the EV enthusiasm is a small part of their daily lives, and drivers tend to socialise with the same people they always have done – family, friends and workmates.

#### **5.4 SUMMARY**

EV drivers share common practices and views but differ in important ways. Drivers have broadly similar reasons for adopting EVs, but the major reason for adoption is not the same in all cases. Many drivers have environmental concerns, but just as many do not. Other common motivations are cost saving, and enjoyment of electrical technology. Most of the drivers in this study believe that EVs are kinder to the environment than combustion engine cars, even drivers who do not care about the affect they are having on the environment, or those that doubt environmental degradation is happening at all.

Cost-saving is a common motivating factor, although the EV has not worked out to be a cost-saving for all drivers in the study. This difference in cost however is not important to everyone, as other factors also contribute to the decision to adopt. Some drivers adopt EVs because they enjoy the technology, though this motivation was not as common as I initially anticipated. This is due to the relative simplicity of technology in an EV compared to a combustion engine vehicle, and the subsequent lack of need for servicing and maintenance.

Although few drivers in the study volunteer without prompting that they adopted an EV to be different, most drivers are not unhappy to be seen as *'different to the crowd'*. Some describe themselves as *'pioneers'* or *'trail-blazers'*, while most are just happy to be getting

on with motoring in their own way. While drivers feel that others think of them as eccentric or odd, most do not care about what others think of them.

Only a minority of drivers in the study were introduced to EVs by other people. Most drivers researched EVs on their own initiative, and took the decision to adopt alone. EV adoption, so far, seems to be gendered, with few women reaping the benefits of electric motoring. The influence of social networks in the adoption process is insignificant in this study. There is little evidence to suggest that EV drivers have adopted an EV because of direct social contact with others, though this can be significant during the later stages of the diffusion process (Axsen and Kurani, 2009). However, EV drivers have a 'reflexive' image of themselves in relation to other EV drivers, and to others in society, and most are part of an organised group that disseminates information to other sectors of society, as well as assign group values to EVs (Axsen and Kurani, 2009;3-4).

The drivers in the study are split on whether there is a '*type of person*' who drives an EV. The types that were suggested were environmentalists (or token environmentalists), techies, and geeks, though many drivers argue that there is not really a type and EVs can essentially be driven by anybody. The importance of symbolism in purchasing a hybrid vehicle was explored by Heffner et al (2007a), where it was found that what the vehicle symbolised was as important, if not more so, than other features, such as price and economy. It is not clear whether symbolism or the desire to be seen as prosocial played a significant role in the EV drivers' decisions to adopt, however it is obvious that the EV drivers in the study do not mind too much being seen as different and worry very little about the opinion of those outside their respected peer groups.

Few drivers name their vehicles or customise them to any large extent. The vehicles are seen as practical tools to achieve low cost, low emission, quiet, stress-free motoring. For some, their relationship with cars has changed over time, while some feel the same way

they always have about them. The relationship that the individual drivers have with their EVs and other vehicles mean that EV drivers are not a homogenous group, though they share many common ideals and traits (see Chapter Four above).

Drivers in the study think that other people can be mis-informed about EVs and that some drivers have bad attitudes, both on and off the road. However, few EV drivers in the study have received any direct criticism because of their EV motoring, and most attention has been positive.

At the moment EV drivers, on the whole, are a collection of enthusiasts. They communicate with each other, often using ICT to overcome large geographic distances, and they form cliques based on local area, type of EV, or mutual interest. Not all EV drivers get on with all other EV drivers though, and individual personalities are still important for social relations. The forming of cliques supports Rogers' (1995) theory that innovators and early adopters of a technology form cliques to share information.

The changes that drivers in the study have noticed within interest groups such as The Battery Vehicle Society show that although groups were initially set up to provide an outlet for enthusiasm for home-made engineering projects, the groups are beginning to become attractive to more 'ordinary' EV drivers who have no-where else to turn, especially when they need advice or help with a problem. Older members pass on information to newer, less experienced members in a social-learning process, but I have been told that some of the older members are finding the arrival of newer members unsettling, especially of those who buy a ready-made EV rather than get involved in building or converting their own.

The desire to run an EV without the safety net of professional support compels the owner to become part of a collective, sustaining the social processes that are currently part of the EV community. Once EVs become mainstream and better support systems are in place, the

newer members of the community may no longer need to be part of an informal network, and the societies which were designed for the innovator-types will go back to business. Regular EV drivers will be normalised into society, albeit with a few car-enthusiasts groups in a similar guise to the classic car and 'boy-racer' fan clubs that exist today.

EV drivers in the study have made new friends and acquaintances because of their EV enthusiasm, though few have changed their regular socialising habits because of this. For drivers in the study, the EV 'thing' is only one part of their nuanced lives, and social relations will likely move on once EVs are adopted by different segments of society, and EVs become less of a niche, novelty object.

## **Chapter Six – EV use in the Real World**

The electricity industry see mass adoption of the EV as a potential challenge to daily operations due to ignorance about how EVs are used, and about how they may be used in the future. Predictions are based on assumptions, and while no-one can really see into the future, having insight into current practices can at least show which assumptions are accurate and which are not.

This chapter will use on-the-ground findings to provide insight into the everyday use of EVs in the real world, which will support some assumptions and challenge others. Evidence will show how drivers of EVs use their vehicles on a daily basis, how they recharge them, how they maintain them, how typical their travel patterns are, and how the everyday use of EVs can challenge the script that EV designers and manufacturers have written.

### **6.1 DRIVING STYLE**

The main limitation of the current generation of EVs is that they will only travel a certain distance (around 50-60 miles) before they need to be re-fuelled. Although this is the same principle for a combustion engine vehicle, for a combustion engine vehicle the distance between re-fuelling stops is greater, the re-fuelling process is quicker, and the plethora of public re-fuelling facilities enables fuel to be obtained away from home. Conversely, for an EV, the achievable mileage between re-fuelling is much shorter, the re-fuelling process takes a lot longer, and the lack of public re-fuelling facilities means that trips have to be made which are within a more limited distance of home.

Eco-driving can maximise the range of an EV so that an EV can travel further between charges. Due to the differences explained above, eco-driving becomes more significant

when driving an EV. Eco-driving is explained by Barkenbus: –

*“The characteristics of eco-driving are generally well defined and easily characterized. They involve such things as accelerating moderately.....anticipating traffic flow and signals, thereby avoiding sudden starts and stops; maintaining an even driving pace....driving at or safely below the speed limit; and eliminating excessive idling.”* (Barkenbus, 2010:763).

Seventeen of the drivers were able to take me on a demonstration trip so I could familiarise myself with EVs and gain an understanding of the different driving style that EVs both encourage and necessitate. Overall, the vehicles are driven in a way that is economical and respectful of the technology within the vehicle, though the diverse range of technology in the vehicles means that some EVs do not need to be treated quite so respectfully as others. The aim of economical driving is to be kind to the batteries and to get a good range out of the vehicle, without being a nuisance to other road users.

The drivers in the study tend to accelerate gently, leaving more room to emerge into traffic where necessary. They look further ahead to anticipate traffic flows, while the deceleration process starts earlier and is more prolonged. Mechanical braking is executed a lot less regularly than in a combustion engine vehicle. The driving style in an EV is steady rather than slow, though no driver goes above the speed limit regularly. An EV is more likely to be overtaken rather than to overtake another vehicle, although there were one or two notable exceptions.

Actor-Network-Theory (see Latour, 2005 and Michael, 2001) suggests that the vehicle and driver act together to create a whole – Dant (2004) calls this a ‘*driver-car*’ - where neither the vehicle nor driver can act on their own. A-N-T suggests that the driver is actively influenced by the car, as much as the car is by the driver. The notion of the vehicle influencing the driving style used seems to hold true in the real world. Certainly, where the vehicle would suffer from being driven too harshly, care is taken to drive considerately,

both to the vehicle and to other road users. This influence has not gone un-noticed by drivers in the study, as Martin observes –

*..... it's encouraging me to drive more sensibly.*

EVs encourage good driving habits by necessity, and through a desire to optimise energy use. Where the EVs in the study are capable of faster speeds and the batteries are more powerful and tolerant, the vehicles are driven quicker and with less consideration to energy conservation, though still sensibly and not dangerous to the road conditions. The relatively low range and capable speeds of current EVs are encouraging their drivers to adapt their driving styles to suit.

The good driving habits that EVs encourage are also used in the drivers' other combustion engine cars too. Although many drivers admit that their driving style in the EV is different to their combustion engine vehicle, they also say that their driving style in the combustion engine vehicle has changed for the better.

### **6.1.1 Instrumentation**

EVs are fitted with instruments to show how economical the driving is, though the technology differs between EV models. The Citroen Berlingo Electrique is fitted with an eco-meter which is a simple dial with a needle much like a speedometer. There are four zones on the eco-meter: red for very uneconomical driving which could possibly damage the Ni-Cad batteries, a yellow zone for fairly economical driving and some acceleration, green for economical driving and steady acceleration or cruising, and another green zone to the left which shows the batteries are being charged from the regenerative braking system. Berlingo drivers are very good at driving the car in such a way that avoids the needle ever going into the red zone, and stays in the two green zones as much as possible.

Chris A, who drives a Berlingo explains -

*I do try to keep it in the green section, green to yellow. I avoid the red like the plague mainly because when you're discharging into the red, you're going outside the battery parameters. I'm a bit of a battery anorak.*

Other cars, such as the Aixam Mega City, and the G-Wiz have a light that comes on when the driving is un-economical, but does not show how you are doing otherwise. Some cars, particularly conversions, have had an ammeter fitted that shows how many amps of power are being drawn from the batteries in real-time. If the driver is unhappy with the high amount of amps being drawn, they can adjust their driving or, if the vehicle has been fitted with a gearbox, change gear to suit.

### **6.1.2 Regenerative braking**

Drivers are particularly good at getting the most from regenerative braking, which works best when there is a long, slow deceleration. The vehicle is most economical when it is cruising at a reasonable speed rather than frequent and harsh acceleration and braking, which wastes a lot of energy. Due to this, EV drivers are very good at looking ahead and anticipating when they will need to slow down and stop. Andy, a computer engineer in his fifties, who lives in London says -

*If you get to a junction, you try and keep it going, even if it's 2 miles an hour.....the regen braking is quite noticeable, a lot of the time you do not even use the brakes. You get to sort of judge it and slow down in time, like on speed humps.*

Angela, driver of a Mitsubishi iMiev and a G-Wiz, also uses the same style, she says -

*You quite often come up to roundabouts and you don't have to brake before them, you slow down enough so that you can go round safely and you're looking at how far away the cars are on the roundabout and that sort of thing. I find that a better way of driving.*

Chris A, a Berlingo driver agrees -

*It's a completely different drive, you're always looking, I would say at least 500 yards in front, or as far as you can because you are looking to see what is going on so you can adjust your speed accordingly, so you do not have to end up using the brakes.*

The regenerative braking is satisfying to watch. David, who lives in hilly Wales, says -

*I like watching it regenerate, especially when I go down the side of a mountain and it's hard over in the green and I watch the energy meter climb up again. I get a sense of smug satisfaction out of that.*

### **6.1.3 Range awareness and maximisation**

Economical driving becomes important if EVs are used for a trip that is close to their range.

In a recent study by Cenex (2010:2), it was noted that participants in an EV driving trial modified their driving style when battery state of charge drops below 50%. This is a result of 'range anxiety', where the driver starts to worry about whether the EV has enough remaining power to complete the journey, and the need to drive economically becomes more pressing. Tim C, who drives a Berlingo knows that the range is affected by uneconomical driving habits -

*If you're heavy footed and run up to traffic lights and screech to a stop then your range might go down to 35, 40 miles, whereas if you're careful, you can get 50 miles, 60 miles, so the driving style does affect it.*

Drivers in the study are aware of how to drive economically, and tend to employ these practices on longer journeys, but less so on shorter journeys. John L, a farmer and engineer from Wales, goes on lots of long trips in his electric van. He could take his combustion engine vehicle but chooses not to. He tries to maximise the range of his vehicle on long

trips by using eco-driving habits, but not so much on shorter trips -

*....like on my trip to Hereford. I was trying to keep at about 35mph in third gear, and keep it fairly constant....I do not bother so much on short journeys like a quick trip to the shops, I try and keep my foot down. We've got A-roads here and I like to try and keep at 45mph if I can, just to stop holding up the other traffic too much.*

For some drivers, the range of the car makes little difference to the driving style. For Belinda, who drives a G-Wiz around her home in London, the frequent short trips she makes means that getting the maximum economy out of the car is not essential. She drives her G-Wiz like any other small car and admits that she does not know if her driving style makes any difference to the range, because she has never tested it. She keeps the EV in fast mode all the time, instead of eco-mode. She thinks that if she drives slower and in eco-mode, she could get the car to go a whole week between charges, but she just can not be bothered to do that.

Russ, a driver of a converted Lotus Elise, knows that driving his car slower helps maximise the range, but as his main trip is to work and back, and work is only fifteen miles each way, he says it does not matter if he drives very fast, which he does.

Overall, the drivers who need to get the maximum range out of the vehicle know about economical driving habits and deploy them, especially on longer trips. However, no driver in the study uses economical driving to the extreme on shorter trips where the distance is well within the capable range of the vehicle.

#### **6.1.4 Driving attitude**

All the EV drivers in the study have sensible attitudes to driving and I did not feel unsafe as a passenger in any of their vehicles. Many have examples of incidents involving other

peoples' misinformed attitude to driving and road use. A lot of drivers think that other drivers have negative attitudes towards EVs. Tim N, who drives a G-Wiz says -

*You do get the odd idiot who absolutely must overtake an EV and perhaps it's not very safe to get past and then you are still next to him at the lights, it's just one ahead in the queue.*

Belinda in London uses the slow speed of the G-Wiz to her advantage. If someone is right up her rear bumper, she slows down to a crawl to teach them a lesson. She thinks other drivers have contempt for EVs and their attitude is one of sheer impatience. She tells me about an incident that happened recently -

*I do not understand this chap yesterday, it was literally, you couldn't fit a fag paper between our two cars, he was literally all the way, and I just got slower and slower and drifted to the middle of the road so he couldn't get past me. I spited him, because I do not see the need for that.*

Alan, a retired physics professor in his 80s, who drives a converted Ford Fiesta, enjoys driving his car around the country lanes near his home. He knows that he drives slowly (at around 20 miles an hour) but knows that at his age, and with the winding roads, going much faster is not sensible. He says ....*occasionally, you do get the odd lunatic who goes too fast.....* but he is quite happy to let them pass and it does not bother him at all. He has put some homemade banners in his back windscreen announcing the fact the car is a 'battery car', explaining to drivers behind him why it is slower than a normal Fiesta, as he thinks it is only fair to let them know.

Martin, who drives a converted Daihatsu van, drives it "*relatively slowly*" and other drivers speed past him but it does not matter to him. He says -

*If you want to overtake then overtake, I just sit back in lane one on the left hand side of the road doing 50mph and all that nonsense passes me by. I do not get involved with it.*

He attributes his attitude to his age. He feels he is ....*older, wiser, more sensible and less testosteroned*....than he was. Many EV drivers attribute their sensible driving attitude to their age, even the younger drivers in the study.

Evan, the youngest driver in the study at 34, believes that his more sedate driving style is partly down to him getting older and wiser, and a realisation that it is a more sensible way of driving. He says he overtakes people less now he is older and drives EVs, even when driving combustion engine cars. Though Evan's driving style couldn't be described as sloth-like, he is very sensible and does drive in a way that anticipates further ahead to make the best use of the regenerative braking. Evan has modified his car by putting in lithium-ion batteries, to be able to do higher speeds, so it's no surprise that he was one of the faster drivers I observed, though still not dangerous and not often over the speed limit on the minor A-roads around his home.

### **6.1.5 Pedestrians**

One of the big concerns about EVs is that they potentially pose a danger to pedestrians and other road users because they are quiet, especially at low speeds. To mitigate this, it has been proposed that the next generation of EVs should be fitted with artificial engine noises to make them more audible (Auto Trader, 2010).

Six of the drivers in the study (around one-quarter) said that they had experienced no problems whatsoever with pedestrians or other road users, although one of these did have problems in his previous EV, and two said they hadn't had problems probably because they didn't tend to drive in pedestrian-heavy areas .

Seven of the drivers in the study said they have experienced problems with pedestrians not hearing their EV, but generally these were restricted to low speed situations, for example in

car parks, or petrol station forecourts. One driver said that while he had not had any problems with people not hearing the car, sometimes animals could be a problem, particularly birds.

A driver in London said that people stepping in to the road was a problem but was not sure whether this was due to them not hearing the EV, or because they are aware of the EV but step out anyway and expect a small car to stop for them.

Tim C has experienced potential problems with cyclists, and as a cyclist himself, he knows they tend to rely on their ears more than other road users. As a consequence, he is more aware and always gives cyclists more room, especially at junctions.

One driver knows that pedestrians not hearing the EV is most definitely an issue, but because he is conscious of this, he is more careful and so far, there has not been any accidents or even 'near-misses'. EV driver awareness is the key to combating the potential problem. A lot of drivers report that they have a high awareness of the potential problem and take steps to mitigate it. Chris A explains -

*I wouldn't say I'd had any near misses, I've just always been, I think possibly because I have driven electric vehicles for so long, that I'm more aware of the whole pedestrian issue, I wouldn't say it's a major issue from what I've found. It's definitely..... you've just got to be a little more aware if you're manoeuvring in a car park, that people do not necessarily hear you....*

Four of the drivers talked about the proposals to fit the engine with artificial sounds. They all thought it was a bad idea. None are convinced it would make EVs safer. Terry, who drives an electric motorcycle says -

*Do I really want to go 'Weeep, weep, weep, weep' while I'm driving about because it would drive me nuts and that wouldn't make me safer?*

Five of the drivers attributed the lack of safety partly to the ignorance of pedestrians. For one driver, he found that it was mainly teenagers who were a problem, while others observed it was people in general not concentrating and relying too much on their ears without taking the time to look. One driver thinks that educating pedestrians to look after themselves is just as important as driver awareness -

*...we have to re-educate the children and the adults as well, to look rather than just listen...*

## **6.2 CARE AND MANAGEMENT**

The biggest maintenance issue for EV drivers today are the care of the batteries. Aside from the batteries, servicing of other parts of the vehicle is a relatively small task. The lack of moving parts in the 'engine' means that servicing is generally restricted to brakes, tyres and small amount of fluids such as screen-wash.

The battery pack in an EV consists of more than one battery. The number and type of batteries varies between models. In some models, particularly in conversions, the batteries will not necessarily be all located in one place. For example, in John S's converted truck, there are eight lead-acid batteries under the load bed, and an extra two strapped to the underside. Russ's Lotus Elise has a number of lithium-ion batteries which are installed wherever there is space, such as under the seats and in the boot. Some vehicles have a mix of batteries but this is unusual and restricted to conversions rather than production models.

The care of the batteries is not a minor undertaking and the type of battery influences the driver's recharging regime. Management of the batteries includes how often they are recharged, at what level they are recharged, if they need to be 'topped up' with distilled water (if they are 'unsealed wet' batteries), and how they should be stored. Care of the

batteries includes respectful driving and is a holistic activity, not just periodic routine maintenance.

Physical maintenance is done on the car in situ, whether this is in a garage, on off-street parking, or on-street. Nearly all of the drivers in the study had some off-road parking facility, such as a driveway or garage. Only two drivers in the study did not have any off-street parking facility – both of these lived in London.

### **6.2.1 Lead Acid batteries**

The most common battery types I encountered are lead-acid batteries. These are relatively low output, but I am told they are cheap and fairly reliable. They are found in older, small cars like the early model G-Wiz, and are often used for conversions.

John S used lead-acid batteries in his Bedford truck conversion. At first he was told not to charge them up too much and let them run down a lot before recharging, which he did. In hindsight, he thinks this was bad advice. He now tops up the charge whenever he gets the opportunity – a regime known as “*opportunity charging*” – and finds the batteries perform better. He has learned from bitter experience that you do not store lead-acid batteries discharged for a long period of time. John tops up the batteries with distilled water regularly, and they take a lot of water, something he attributes to the damage the batteries suffered during storage.

Jonathan has lead-acid batteries in his Elcat van. He knows of Peurket’s Law which states that taking power at half the rate makes the power last more than twice as long. This type of care advice is often disseminated through interest groups such as The Battery Vehicle Society. Jonathan recharges his van every night, no matter how much of the power he has used, so that he can always start the day with a full charge. He understands that this is the best care regime for his type of batteries.



Fig 6.1 - The battery pack in John L's Elcat van showing 12 lead-acid batteries in series. All the batteries are located in the same place, in a standard battery box behind the front seats. A lid goes on to the box so the van can be used for carrying cargo. You have to climb over the box to get to the back seats.

Peter, a maintenance engineer in his 50s, has lead-acid gel batteries in his van conversion. He also uses the opportunity charge regime and tries not to let the batteries run down too much.

Tim N, who drives a G-Wiz containing lead-acid batteries, recharges as soon as the battery level drops below 80% charge, unless he's doing a big journey the next day when he'll recharge to 100% whatever the level. He knows it is not good for the batteries to leave them more than about 80% for too long. Also, as cold weather is known to affect batteries, Tim will set the car to recharge if it is going to be a cold night just to warm the batteries, whatever the battery level.

Belinda has absolutely no idea what type of batteries are in her G-Wiz. She looks after them by topping them up with distilled water whenever the light indicator comes on, as she has been instructed by the dealership. She charges them when the state of charge meter is in the yellow zone, which is usually about twice a week. She never lets them run down completely.

Overall, the understanding of lead-acid batteries among drivers is that they are cheap and reliable. Drivers with lead-acid batteries tend to “*opportunity charge*” and not let the state of charge of the batteries get too low. All drivers in the study who have lead-acid batteries are able to top them up with distilled water using knowledge they have gained from the manual, from other EV drivers, or from experience.

### **6.2.2 Nickel type batteries**

The Citroen Berlingo Electrique contains a discontinued battery called a Nickel-Cadmium, or Ni-Cad for short. Ni-Cad batteries are very reliable, but need to be run down to below 50% at least once a week to keep them in good condition. They are no longer available to buy as replacement batteries, so drivers of Berlingos tend to be more careful. As Rob says-

*I just like to try and look after the batteries because they are like gold dust now.*

Chris A knows all about how best to look after the Ni-Cad batteries in his Berlingo. He tops them up with water whenever it is required, which is usually every 3000 to 4000 miles or before. Being a prominent member of The Battery Vehicle Society, he has heard other drivers’ horror stories about the results of not doing the topping up correctly, so knows what to avoid. Chris uses an EV-Lite (see Chapter 4.3 above) to help him with his routine maintenance. Chris knows how to store the batteries, and also that although the level of the start of a battery recharge does not make a difference to how the batteries perform, starting the charge from flat tends to make the energy meter more accurate. Currently, he

tends to charge his car depending on the mileage he expects to do the following day and the state of charge of the batteries now; he won't necessarily charge every night unless he is planning on doing a lot of miles the next day; then he will recharge to 100%.

David also has a Berlingo and knows that once a week the batteries need to be run down to below 50%. However, his journey patterns means this happens regularly enough to avoid having to do this purposefully. Otherwise, he likes to keep the batteries charged up so his van is always ready for when he wants to use it. David also can top up the batteries with water when needed, which he says is not a small job but it is no hardship to do.

Evan is pragmatic about his battery care. He knows that the recommendation is to let them drop below 50% once a week and, like David, his journeys mean he is doing this anyway, but if this did not happen Evan would not let them run down on purpose as, as he says, the advice could be wrong and he certainly would not change his routine accordingly.

Pam and John, company owners in their fifties, also have a Citroen Berlingo. They use it for short local journeys for domestic purposes and for their business. Ideally, they recharge the van when battery levels drop below 50% but register above 20%. They do not recharge the van every night; only if they know they will have a lot of running around to do the next day.

Richard's RAV4 uses Nickel-metal hydride batteries which are similar to Ni-Cads. He recharges when the battery levels are about 45%, and sets the recharging to take it back up to 83%, as he has calculated through experience that this is the optimal level for his particular car. He tends to wait until the evening to recharge the batteries as the atmosphere is cooler and it is bad practice to charge the batteries up straight after a journey when they are still hot.

Overall, drivers of vehicles using Ni-Cad batteries tend to look after their batteries by recharging them at the optimal levels and by topping them up with water when necessary.

### **6.2.3 Lithium type batteries**

Lithium batteries, including Lithium-Ion, and Lithium-Iron-Phosphate (LiFePo) are becoming more common and are the type of batteries that are going to be used in the next generation of EVs, such as the Nissan Leaf. At the moment, lithium batteries are relatively expensive but give good performance and are the battery of choice for conversionists who are not too restricted by budget.

Martin is one such conversionist. Martin has a full battery management system in his converted van. The computer, with its own monitor and mouse controls, looks after all the batteries in his van, and can report unequal battery levels. Martin has also installed an electric blanket type system on a thermostat to keep the batteries from getting too cold, which means his van is constantly plugged into the mains when idle, even if it is not recharging the batteries. Martin recharges his car at every opportunity, including home, work, and friends houses when visiting.

Mike and Angela's on trial iMiev, a next generation production car, runs on LiFePo batteries. Mike reports treating them the same as the lead-acid ones in his G-Wiz. He understands you have to run them down to flat once a week to keep them in good condition, but otherwise he does not really think about them too much.

Russ's Lotus Elise also has lithium batteries. He makes sure they are kept charged up as much as possible as they wear out if you discharge them too much. He can recharge at work as well as at home.

### **6.2.4 Maintenance and Servicing**

The lack of maintenance and servicing required for EVs is cited as one of the big advantages by seven of the drivers in the study. The low number of moving parts means that there is

little to break on an EV. At least seventeen drivers, particularly those who drive conversions or discontinued production vehicles do most of their own maintenance and servicing with regards to the electrical components, leaving things like the mechanical brakes and tyres to a local garage. One driver is happy to deal with the mechanical side himself, but prefers to send off the electrical components for repair, although he is happy to disconnect them and reconnect them himself. One driver reports difficulty in finding a local garage to look after his EV, but most other drivers have found a garage that can deal with the mechanical side and administer the MOT, where one is required. Most drivers in the study say their local garage mechanics are happy to do the work once they have got over the initial shock of coming across an EV for the first time.

Citroen Berlingo drivers report problems with Citroen themselves, ranging from them trying to help and failing, to specific dealers denying that Citroen ever produced an electric van. Richard has had a much better experience with his local Toyota dealers who are more than happy to work on his electric RAV4, so he lets them do as much as is needed. It is hoped that the next generation of EVs will have a better support system in place, but for now, particularly outside of London, the companies that are willing to support EVs are few and far between. As a result, some EV enthusiasts have started their own independent companies or invented user-friendly devices to bridge the gap (see Chapter 4.3 above).

Those drivers that do their own maintenance and servicing call on other EV enthusiasts for advice or help. Organisations like The Battery Vehicle Society run online forums where owners share experiences, or respond to pleas for help from a struggling owner. Members run informal events and get-togethers so information can be shared and contacts built up. (see Chapter Five above for a full discussion of how EV drivers form a community and share information).

In London, specialists like Going Green can service and repair the EVs that they sell, which is primarily the G-Wiz, however Belinda takes her G-Wiz to the independent garage next door to her house, although she is confident enough to top up the water in her batteries herself, and has yet to experience any major failures that have required extensive repair.

Tim N also has the support of Going Green, but prefers to do any work he is capable of himself, if only to save the trek into London and the time it takes to perform the work. He is able to diagnose his own battery faults using a laptop and a software tool and change faulty batteries, as well as top them up with water when required. Now that his service contract period is up, this will save him a lot of money as well as time. Mike and Angela also carry out all the maintenance work on their G-Wiz, also to save the long trek into London.

Evan appreciates that the lack of repairs his EVs have required may be down to luck, but also to being clued-up enough to spot faults before they turn into problems. He says that his technical ability has been a big factor in making his EVs very cost-effective, as he can save a lot of money on garage repair bills by being able to do the work himself.

Drivers who do their own maintenance and servicing experience obstacles. Often the vehicles are foreign built, so components like circuit boards are printed in foreign languages. The only available manual for the Elcat van is printed in Finnish. Manuals for discontinued vehicles are difficult to get hold of so some drivers' manuals, if they are lucky enough to have one, is a photocopy that another EV owner has made for them.

### **6.3 RECHARGING**

Recharging habits are a large area of interest. EVs use power from the National Grid and while the number of EVs is currently very small, this is expected to increase over the coming years as more car companies release all-electric vehicles and also plug-in hybrid vehicles , for example the Toyota Prius PHEV.

### 6.3.1 Recharging location

All of the drivers in the study do the majority of their recharging at home. At least nine of the drivers in the study are able to charge at their workplace, particularly those who own their business premises. None regularly use, indeed few have any experience of, a public charging point. All but two of the drivers have off-street parking, and some have space for several vehicles. This demographic information corroborates the assumptions of Element Energy (2009:19) who used data from trials and surveys to find that “..EVs are overwhelmingly purchased by multi-car households.....[with] off-street parking....”. Some drivers in the study have installed an outside electrical socket, commonly on the side of the house next to the driveway, while others make use of an existing socket in an outbuilding such as a garage or barn. A few drivers use the sockets which are in their houses and trail leads to the vehicles.

Andy, who lives in a terraced house in London does not have off-street parking. The street he lives on has parking restrictions, so he is only able to recharge at certain times such as the weekend or in an evening. He tries to get parked within close distance of his home as he has to run a lead from his house to the car. Belinda, who lives in London, also does not have off-street parking. She has a residents pass for the street she lives on and usually gets parked outside her home. She too runs a lead from her house to her car. While this recharging practice is not ideal and could potentially lead to accidents and lawsuits, neither Belinda nor Andy know of any incident yet that has caused concern.

Some drivers are able to recharge their EVs at work. Jonathan, a GP, often charges at his surgery, in which he is a partner. He made sure an outside socket was installed when the surgery was built so that he could recharge his van.

Evan's workplace installed a socket and meter for him. He explains -

*Initially at work, I was plugging it in at the back of the building without anybody knowing and I got into a small amount of trouble for that, but in the end they changed their minds and put in a socket and a meter for me.*

For most drivers in the study, public charging points are a rare provision; very few drivers have ever charged anywhere apart from their own home, workplace, and houses of family and friends.

### **6.3.2 Recharging technology**

While the in-car charging technology differs between the different models, no vehicle I encountered uses anything other than either a 13-amp three point plug, or a 16-amp round blue plug. All vehicles are able to charge from a 13-amp socket, and most drivers carry a 16-amp to 13-amp adapter with them in case they encounter a 16-amp socket. One car in the study uses two 13-amp sockets simultaneously. Drivers may prefer to use a 16-amp socket because, although the voltage is still restricted to 13-amps by the in-car technology, the extra 3-amps capacity means the socket does not overheat so fast.

Ten of the drivers in the study, generally those who are on an off-peak electricity tariff, use timers to automatically start the charging at off-peak hours. All said they are able to override the timers, or use an alternative socket if the vehicle needs to be recharged outside of these hours.

Technologies used for recharging are low-cost installations. No drivers in the study have done anything more than installed a 16-amp socket to the outer wall of their house. None use dedicated posts. Some drivers have upgraded the electrical system in their house, such as installing a separate circuit for the EV so that the potential for 'tripping out' the domestic



Fig 6.2 - A driver displays a 16-amp to 13-amp adapter. Most drivers in the study carry this simple piece of kit at all times.

supply is minimised. Some have installed a separate meter on the line serving the EV, so they can observe, mainly out of interest, how much electricity the vehicle uses.

### 6.3.3 Recharging times

At least half of the drivers routinely charge their car overnight. This is especially common where the driver has an off-peak electricity tariff, such as Economy 7. Some drivers do not have an off-peak tariff because it is unavailable for their area, all of whom would use it if it was available. As might be expected, those who drive their vehicles everyday and do the most mileage are more likely to charge their cars every night, and because of the subsequent higher electricity use, endeavour to use an off-peak tariff. Those who do the least mileage tend not to recharge every night as a routine; tending to recharge when the batteries have dropped to a sufficient level.

Even where differential rates do not exist, some drivers choose to charge overnight. Mike and Angela recharge their car overnight, not because they get a cheaper rate, but because they know the carbon intensity of the national grid is lower overnight, and they like to “*do their bit for the environment*”. Michael, a Berlingo driver, likes to wait until the late evening to recharge his van as, as a retired electrical engineer, he appreciates that recharging in the early evening when electricity demand is high within his household has the potential to overload the circuits.

Half of the drivers in the study do not recharge overnight as a routine; charging at different times depending on their own routines. This may be during the day, or in the evening, but is still mainly always at home, with some recharging at workplaces. These drivers tend to do lower mileages and do not recharge as regularly as the higher mileage drivers in the study.

John S recharges his vehicle after he has taken it on a trip and worn the batteries down enough to make it worth recharging. He plugs it back in whenever he gets home and turns it off again when the batteries reach a sufficient level. He does not see the benefit of being on an off-peak tariff as he lives in a two-person household and they do not regard themselves as using enough electricity to be concerned. He says -

*..... we're a two person family so we don't use that a right lot, but if I used the electric daily, I would certainly charge it at one in the morning or whatever on a timer....*

Pam and John, another two person household who use their EV every day but do not necessarily charge it every night also do not consider that moving to an off-peak tariff would be beneficial to them. They do not feel they use enough electricity overnight to justify paying the higher daytime rates associated with off-peak tariffs.

### 6.3.4 Public recharging

Recent coverage in the media on the subject of EVs has covered the installation of public charging points. Companies such as Pod Point and Elektromotive specialise in the manufacture and installation of public charging points across the UK. London already has a small network of public recharging points; some points are free access, and some are by subscription, with or without a per-unit charge.

The most common location for those that do use public recharging points, are in private premises such as shopping centres like Lakeside in Essex, or Cribbs Causeway in Bristol. Tim N and his wife often visit Lakeside shopping centre. The dearth of other EVs visiting the centre mean they practically have their own parking space, and they visit the shopping centre more now that the points are available, and stay longer once they are there.

John L admits that a shopping centre is normally the sort of place he avoids, but he visits Cribbs Causeway in Bristol when passing through, to use the public recharging points, and often spends money while he is there – something that he would not have done before. Jonathan also often uses Cribbs Causeway to recharge his van. He appreciates that the number of ‘brownie points’ that a company receives is large compared to the small cost of electricity they give away for free. Some drivers do not visit a shopping centre any more than they might have done previous to the installation of recharging points, but would welcome recharging points in other places, like leisure centres and supermarkets.

David takes his mother on her weekly shopping trip to her local Tesco store. While he is there, his van is parked for an hour while they go round the store, then he takes his mother back to her house where his van has to be recharged briefly before it has enough charge to

make the trip home. A public recharging point at the Tesco store would mean that David does not have to 'faff' about at his mother's house, but would take no more electricity overall, and would make David a happier customer.

A few drivers in the study reported using public recharging points to show support for them, even when they do not need the charge for their vehicle. They will use the public points as they are free and doing so demonstrates that they are used and required.

While most drivers in the study agree that, so far, they have managed without public recharging points, and none rely on it, four of the drivers express frustration at the lack of public recharging provision. They believe that a public recharging infrastructure is important for EV adoption for a mass market, and because of the ubiquitous nature of electricity, a recharging infrastructure is simple to set up. Chris A explains why he thinks a recharging infrastructure is overdue -

*It's just a 13 amp socket really, yes I've not come across any infrastructure as such yet, and I'd love one it would be nice because then you could go pretty much anywhere*

The fact that electricity is available everywhere means that EV drivers are not as restricted as might be expected. The lack of public recharging points does not put off drivers going to strange places, though these trips need to be planned in advance. Drivers reported needing to go to unfamiliar places, for business or for pleasure. They phone ahead to check with venues, such as hotels, to make sure they will be able to recharge their vehicle and are generally accommodated. Some drivers also make use of the EV-Network. The EV-Network website is an online resource where EV users can list their home or place of work as having an available recharging point, in return for being able to use those of others, and also shows locations of public recharging points. Some drivers use the EV-Network when they

are visiting new places, which also provides a reason to meet up with other EV enthusiasts (see Chapter 4.3 above).

In some cases, drivers reported turning up at pubs, or random houses with gracious residents and asking to charge up. Drivers say that most have been obliging and few accept payment for the service. This is attributed to the good nature of others and the novelty value of EVs. Other places have been less obliging. Chris C, an engineer in his forties, drives a Berlingo and once pulled into a local petrol station to ask to buy some electricity. He was willing to pay £5 even though this is well above the price of the electricity he needed. After the assistant rang the manager to check, Chris was abruptly asked to leave the premises. He says -

*...they were getting quite aggressive and they thought I was some kind of lunatic basically.... so it was not exactly a warm welcome there....*

The introduction of public recharging points would mean EV drivers do not have to rely on the good nature of strangers to help them to travel further afield. The drivers would use public recharging points if they were more readily available, and be willing to travel more often and on longer journeys in the EV if they were able to rely on them. Availability of recharging facilities at destination is very important if the driver is relying on a charge to successfully make the return journey. Rob explains about a recent trip he had planned to London. He found out about a charge point at a tube station on the outskirts where he could park up and get the tube into central London -

*But what was really interesting and what really identified another thing is, I couldn't guarantee that the charge point would be available for me. I would be fully committed to needing eight hours charge at that charge point and that really fed into this range anxiety sort of thing and the importance of having a guaranteed charge, either by booking and also having some notification if the vehicle trips out or is disconnected for some reason.*

The issue that most drivers agree on is the un-necessarily high technical specification of the recharging technology that is being proposed and installed, and the high cost that goes with it. All drivers are happy to find a 13-amp three-pin plug, and some have actually experienced problems with the high-tech charging posts they have used. In one case this was attributed to 'teething problems', but another experienced a direct incompatibility between the in-car charging technology and the 'smart' technology in the charging post. Evan does not think that a cost-intensive infrastructure is a good idea -

*I don't think they should spend huge amounts of money on very fancy roll outs. I think they should ask people, users where they want sockets and put a few in cheaply in city centres, or car parks, or shopping centres and things like that.*

Tim C and his partner Mary were asked to consult a local hotel on the charging technology they should install for their customers' use and how much it would cost. They advised the hotel to install two 16-amp outdoor sockets for a cost of around £300. They recognise that non-EV drivers have misconceptions about the technology required, and the level of use the public recharging points would get.

Almost all drivers in the study agree that a recharging infrastructure is important for EVs to become a mass market product, though many think that the infrastructure will be underused once it is in place. Many drivers believe once an EV is incorporated into someone's life, the perception of need for public charging points would disappear, as Martin explains -

*....well actually there is a difference between what is perceived and what is actually required in areas, because the general public might perceive that this business of range and range anxiety might be a serious impediment to buying or wanting to buy an electric car. If they had one and discovered that most of the time they are recharging when they come home at night then they would then discover that it isn't the case.....*

Indeed, in the CENEX (2010:4) study of fleet EVs in the North-East of England, after having used an EV in their company for a short time, 88% of fleet managers “...*did not see the lack of public recharging infrastructure as a barrier to incorporating [EVs] into their operations.*”

Drivers understand that the investment made in providing a public recharging facility will need to be recouped to enable the recharging infrastructure to be commercially viable. Nearly half of the drivers said they would be happy to pay for public recharging, and most others would pay providing the cost was not significantly more expensive than a standard domestic rate. Four of the drivers said they would not pay for public recharging; either because they do not need to use it, or because they believe that financial incentives should be given to encourage cleaner transport use.

Drivers in the study predict that their use of a public recharging point would be limited to emergencies or to enable them to make a non-routine trip that is outside the range of the vehicle. The bulk of their recharging would continue to be undertaken overnight at home, and use of the public points would form only a small part of their overall electricity consumption.

London-based Belinda is one driver who would not pay extra for public recharging. She currently charges her car overnight using domestic electricity. She says that many people have explained to her that they would love an EV but find it impossible because they live in a flat or too far away from where they park their car. Although Belinda herself does not have her own private off-street parking, she still would not pay to use a public recharging point. This is due to her motivation of having an EV to reduce her motoring costs, and paying a rate higher than a standard domestic electricity price reduces her cost saving.

Evan said that while he was happy to pay a premium for the electricity from a public recharging point, he does not want to be made to pay a subscription. As he lives in a rural area, and his EVs are able to fulfil the majority of his commuting and leisure mileage, he does not need the public recharging facility often enough to justify paying a subscription, and would be happier paying per unit of electricity at the point of use. We compared his preferences to the mobile phone business model, where high-use customers are content to pay a contract rate and lower use customers prefer to 'pay-as-you-go'. As most drivers said that they would probably only use the public recharging facilities in an emergency or on an irregular basis, the pay-as-you-go model seems to make more sense to them. At the moment, no drivers in the study are part of a scheme that charges a subscription to access any recharging facility.

For the moment, drivers do not really see the sense in requiring EV owners to pay to use public recharging facilities. Due to the small number of EVs on the road, demand is currently low and little electricity is taken in this way. The cost of the electricity is low in comparison to the initial investment in the technology, and being able to meter the electric use so that an individual can be charged a fee adds to capital and running costs. Instead, many drivers advocate that businesses should install a low-cost, simple charging facility and let their customers use it for free, enabling the business to benefit from the extra, captive custom and from improved public relations.

#### **6.4 PATTERNS OF USE**

I am interested in whether EV drivers have unusual travel habits that make an EV a suitable transport option, and if these patterns are significantly different to that of the general population. This will establish whether EVs are adopted by people who have very niche travel habits and requirements which are not shared by other groups in society.

#### **6.4.1 Data from a travel diary.**

As well as taking part in a semi-structured interview, households were asked to keep a travel diary for a seven day period of their choosing, of which 17 did. Two diaries covered the use of one vehicle by two people in the same household. The travel diary was a self-completion table for all journeys (either in the EV or another vehicle), which recorded the time and date of the journey, the purpose of the journey, the mileage of the journey, and the number of passengers. Not all drivers in the study completed the diary in the same way. Some recorded journeys as round trips, while others separated these out into two separate journeys (an outgoing journey and a return journey). Interpretation of the diaries meant trying to make sense of the drivers' journeys to get the data into a usable format.

Journeys and mileage were counted from when the vehicle left the house, to when it returned. In all, 155 individual journeys in an EV were recorded. The vast majority of all recorded journeys were made in the (or one of the) household's EVs. Out of the seventeen travel diaries received, only six reported a journey in a vehicle other than the EV over the seven day period. Eleven of the drivers used an EV as their sole vehicle for the entire seven day period, although other people within the household may have used a non-EV during the period.

The average trip mileage in an EV was just over 17 miles, which included the outgoing journey, any detours, and the return journey. The average mileage per EV per day of use was 25.5 miles. This is similar to the findings of the Cabled project, where the average daily mileage during the first part of the trial was 23 miles (CABLED, 2010b).

The highest mileage on any one day in a single vehicle was 85 miles, which was achieved by the EV receiving a one-hour charge at the driver's friend's house at one of the destinations combined with eco-driving techniques. Non-EVs tend to be used where the trip is outside

the range of the EV and also where a larger carrying or passenger capacity is required. In households where both people drive the EV regularly, non-EVs are taken out only if the EV is not available.

The most popular journey reason recorded in the diaries was commuting to and from work, followed by shopping, socialising and travelling to leisure activities, ferrying children about (including the school run), and running errands. Work trips were more common during the week, and shopping and leisure trips were more likely to be made on a weekend. Retired drivers were unlikely to use the vehicle for commuting, and more likely to use it for errands and social and leisure trips. Around one-fifth of journeys were combined journeys; where more than one destination was involved before the return home. For example, some journeys were returning home from work via the school to collect children, or popping into the shops on the way to work.

Two-fifths of journeys involved carrying passengers at some stage. Passengers were most likely to be young children or friends of children (accounting for nearly half of all journeys involving passengers) and spouses. Rather obvious, but not insignificant, is that those drivers in the study with children (or grandchildren) made a lot more passenger trips than those that did not have children. While this is not surprising, it does show that the EV is used as a family car within households with children, and that use of the EV is not restricted to lone, adult trips. There was some evidence of 'double-tripping' by those who had older children; that is taking the child to an activity, then returning home passenger-less, only to go out again later to collect the child before returning again – where the parent does four trips, but the child only does two.

Element Energy, using data from the DfT travel database (Element Energy, 2009) found that half the people in a travel study did not exceed 25 miles on any one day of a seven-day

travel diary period. In this study of EV use, 10 diaries out of the 17 (more than half) showed at least one journey in excess of 25 miles.

Element Energy also found that around two-thirds of commuting trips are less than 10 miles (20 miles round trip). In this study of EV use, six diaries showed a commute in excess of this distance, out of eleven travel diaries which showed at least one commuting trip, meaning that less than half of the sample did not exceed the same distance for commuting.

Data is shown in the table below -

Trip characteristic	DfT travel study/National Travel Survey	This study of EV use
Did <b>not</b> exceed 25 miles on any one day in a seven day period	Half of the sample	Two-fifths of the sample (7/17)
Did <b>not</b> exceed 40 miles on any one day in a seven day period	Two-thirds of the sample	Half of the sample (8/17)
Commuting trip of <b>less</b> than 10 miles (20 miles round trip)	Two-thirds of all commuting trips	Less than half of all commuting trips (5/11)
Commuting trips (of as a proportion of all trips)	Over one-fifth of all trips	Over one-quarter of all trips

Fig 6.3 – Table comparing basic data from the National Travel Survey (Element Energy, 2009) and data from this study

The table above shows that EVs in this study are actually used for longer trips than was found by the National Travel Survey, which would suggest that the perception that EVs tend to be used by people who make infrequent, shorter trips is inaccurate. On the contrary, data from travel diaries of EV drivers shows that EVs are used as well as average, if not more.

For example, within the study group, commuting trips are more likely to be in excess of a 20 mile round trip, and more commuting trips are undertaken than those of the UK population as a whole. Half of the sample in this study of EV drivers exceeded 40 miles on at least one day in a seven day period, compared with only one-third in the population as a whole.

While the numbers involved in this study are low compared to the National Travel Survey, the findings would suggest that there is no reason to believe, at this stage, that EVs tend to be adopted by people with low range, infrequent travel requirements to any significant level.

#### **6.4.2 Use of public transport**

Drivers were asked how often they were likely to use public transport, and for what purpose. Only one driver is averse to public transport completely, and only four of the drivers in the study say they use public transport rarely or not at all.

Buses were the least popular public transport option, mainly because they are expensive and do not go on a suitable route. A couple of the drivers said that they find buses challenging because of physical conditions, so would not use the bus, whether they were able to drive or not. Angela explains why she never uses buses as a transport option -

*I never use local transport. Problem is from here, there's a bus every hour from the middle of the village, so you can only go in one direction, and there's nothing suitable for the school run or for shopping or anything else.*

Use of trains was more common, with six drivers saying they used the train to travel longer distances between cities in the UK. One driver admitted he flew if he had to go a long way in the UK, generally because it is cheaper, though not necessarily quicker, than driving or

going by train. One driver uses the train every day for his commute to work in a major city, after driving his EV to the train station for the first part of his journey.

One of the most common reasons among the drivers in the study for using the train was because the trip was into a large city where parking would be difficult and expensive. This was the case for seven drivers in the study who live in and around big cities like London, Birmingham, Edinburgh and Newcastle-upon-Tyne. Where the train (or underground, or Metro) was more convenient and not much more expensive, it was taken in preference to a car. Evan explains why he tends to take the train when visiting the city -

*We take the train because it's cheaper. Well it's not cheaper but if you had to park somewhere central at the other side, then it would be.*

Drivers seem to have a fairly common-sense attitude to public transport, and all use it where it is more convenient than taking a car. When asked whether they felt they would use public transport more if they did not have an electric vehicle, only one said they might. Almost all said they would take a combustion engine car instead, due to poor public service provision in their area, or the expense. In all cases, the electric vehicle replaced a combustion engine car, or was bought as an extra to substitute petrol mileage for electric mileage. In no cases in the study has the electric car significantly displaced use of public transport.

## **6.5 USER SCRIPTS**

Technology is interpreted by its users and sometimes used in ways not intended by the designers and engineers of the technology. Studying the real-world use of a technology can provide feedback to help develop the technology in a way that is more user-friendly and attractive to consumers. In this study of EV use, many examples were found of how EV drivers were using EVs in a way not originally intended.

### 6 .5.1 Change of use

The most prominent example of users writing their own scripts is shown in the case of the Citroen Berlingo Electric van. The Berlingo Electric was originally produced in the 1990s and into the 2000s and was designed to be leased to utility companies and local authorities to use as a fleet vehicle for their workmen. The Electric model is the same as the combustion engine Berlingo and as such, is a 'workman's van' with two seats to the front, and a cargo bay at the back with doors to the rear for loading, which have windows. It is very typical of its kind. After the leases ran out, production stopped and the companies who had leased them sold the vehicles on. Many of these vehicles, working or not, found their way into the hands of EV enthusiasts.

In the study, eight households own at least one Berlingo Electric. All use them as personal vehicles for domestic use, and those that are self-employed also use them for business errands, though only one is actually a tradesman (part-time electrician). None use



Fig 6.4 – A Citroen Berlingo Electric. Looks like any other small workman's van.

them solely for business, and the EV is seen as a household vehicle rather than a work vehicle. Out of the eight households, two consist of more than two people. The Berlingo Electrique was adopted, not because of its utility as a workman's van, but because, at the time the drivers wanted to purchase an EV, the Berlingo Electrique was the best '*proper*' vehicle available on the second hand market.

Chris C has started to convert his Berlingo Electrique from a two-seater workman's van into a family car. He has purchased some seats and a side door with a window, which were made for a Berlingo Multispace, and is using his engineering expertise to make an EV which will carry him, his wife, and his two children. He is taking his time doing it as he wants it to be robust and safe and not a '*crude*' conversion.

Tim C and Mary's Berlingo Electrique is currently off the road. They have purchased a second one which they are in the process of converting into a long-range vehicle which they hope will travel 300 miles between charges. They are using the cargo bay behind the two seats to store the large amount of batteries that they will need to achieve this range. I am not sure this is what Citroen intended when they re-designed the Berlingo model as an EV, but Tim and Mary's desire for an EV that is not restricted by range is motivating them to do the project.

Another model which is being used for something other than its original intention is the Elcat van. Two drivers in the study drive an Elcat. The Elcat was originally made in Finland for the Finnish postal service to use as a delivery vehicle. They were made with the driver's seat on the right hand side (rather than the left) so that postmen could drop off mail to houses without leaving the vehicle. Again, when the Finnish postal service had finished with them, they sold them off to the public, and because they are right-hand-drive, were attractive to drivers in the UK. Some Elcat vans found their way in to the UK, via John L's EV importing business. These Elcat vans are also mainly used as domestic vehicles and none

are used for delivering mail. John L occasionally uses his van as a camper van as he can use the flat rear storage area for sleeping.

The change of use of electric vans from work vans to domestic vehicles shows that there has been demand for personal EVs from some sectors of society. Converting vans intended for work purposes into cars for personal use has satisfied some of this demand.

## **6.6 SUMMARY**

EV drivers have sensible attitudes to driving. Many are slower drivers out of necessity or out of a desire to conserve power, but not dangerously so. Drivers are good at anticipating the road ahead and are aware of eco-driving techniques, although they do not use them to the extreme all of the time. Such is the desire to use eco-driving to look after the batteries that most drivers, but notably not all, take notice of the various instruments available to them. In this regard, EV drivers are fairly compliant and generally on their best driving behaviour, though with the newer models which contain more powerful lithium-type batteries, the requirement to be slow and steady decreases. In the case of the iMiev, and conversions with lithium-type batteries, driving style can be fast at times though the drivers are still very sensible and have a high awareness of how their driving style can affect the batteries and range.

Batteries are the single biggest care and maintenance issue in any EV. All drivers have an idea how to look after them, whether this is through knowledge gained from the manual, knowledge shared with other drivers, or from experience. Most drivers service and maintain their own vehicles; some through choice, others through necessity. Support for EVs from dealers is poor, and finding a willing local garage is possible but more difficult than finding one to look after a combustion engine vehicle.

A lot of drivers charge their vehicles at home, overnight on off-peak electricity, using no or low-cost technology. Some charge at work. Use of public charging points is rare. All drivers use their vehicles for routine journeys that are known to be within the vehicle's practical range.

The notion of public recharging infrastructure creates mixed feelings. Most appreciate that the infrastructure is required for mass adoption of EVs, though they also feel it will be under-used and has the potential for wasting money. Many drivers would rather see the money spent on low-cost installations at points of interest, like shopping centres and supermarkets. A one-size-fits-all charging system would not work for everybody. Most of the drivers in the study would be willing to pay something to use public recharging points but it would likely be for emergencies and irregular journeys only and there would be a limit to how much they would be willing to pay.

Some drivers of EVs use them differently to how they were originally designed to be used. For the majority, this is by using a vehicle intended to be a works van as a personal vehicle, though not necessarily driving it or treating any differently to how they are supposed to be driven. The way in which EVs are used in the real world show that there is demand for 'proper' family EVs, though current drivers are happy to make the compromise in the short term to enable them to fulfil their desire to drive electric. This compromise has not been too difficult because only a small number of the households in the study consist of more than two people, though this compromise may be a step too far for many mass-market households. Car manufacturers are soon to release EVs that are more practical for a family-market. This would seem sensible considering that some drivers in the study express a need for something with more passenger capacity.

## **Chapter Seven – Future of EVs**

The previous chapters discussed the findings from studying EVs in everyday use, from the perspectives of their drivers. This chapter will discuss the attitudes of EV drivers in the study towards future developments and assess whether the drivers who have present day experience of EVs believe that proposed alternative vehicle technologies have any merit.

There is an expectation among car manufacturers and the media that EV use will grow in the UK. Using discussions with current EV drivers, I will find out whether this belief is shared among the current EV community.

As EVs make the move to a mass-market product, consideration will need to be given to any problems and deficiencies that have arisen, especially to those which will not be tolerated by later adopters. Evidence will be used from this study to inform policy makers of the potential challenges that EVs face in becoming a mass-market product, and some recommendations for action will be made.

### **7.1 ATTITUDES TO FUTURE TECHNOLOGY**

Drivers in the study showed themselves well aware of developments in EV technology. Some talk enthusiastically about new vehicles, like the Nissan Leaf or the Tesla S-Class. Others are excited about charging technology, increased range, and developments in alternative energy production, such as that generated by wind farms.

#### **7.1.1 Fast Charging**

When drivers talk about '*fast charging*', they refer to the facility to charge the car from empty to pretty-much full within twenty minutes to one hour. Fast-charging stations are rare but do exist, for example those for the current Mitsubishi iMiev trial, others are being developed for soon to be released vehicles like the Nissan Leaf.

Five drivers regard fast-charging as being the most significant development in charging practices in the short to medium-term, though a few others were unconvinced and thought that fast-charging would not be practical or make economic sense. Most EVs currently in use are unable to use fast-charging technology. Some are, but with a bigger cable, though this is academic at the moment as few fast charging facilities exist. There is some recognition that fast charging is not as efficient as slow-charging, and may create problems for electricity generating companies. Drivers also acknowledge that fast-charging may not work because of lack of standardisation among EV technologies.

On the whole, fast-charging is seen as a more viable option than other technologies which are being considered, for example battery swap stations. Indeed, Element Energy (2009:19) found that studies have shown that the availability of fast-charging facilities gives EV drivers confidence to travel further between charges and use up more of the available power in the vehicle.

### **7.1.2 Battery Swap Stations**

In the early days of motoring, battery swap stations were used primarily by local commercial trucks. A battery swap station works by removing a pack of empty batteries and replacing them with a full pack. The procedure takes a few minutes, rather than a few hours, and is comparable to a petrol re-fuelling regime. Contemporary battery swap stations are being proposed by companies such as Better Place, where a vehicle drives in, robotic technology removes the batteries from underneath the vehicle and replaces them with a charged pack.

Drivers in the study are not on the whole enthusiastic about the concept of battery swap stations. Jonathan explains the thinking -

*I can't see that working because everybody will have to have the same sort of battery, so you've got to get all the manufacturers on board for that.*

*Secondly, you could abuse the batteries, and you could give them in and the poor charging station would be lumbered with unusable batteries and that would cost them an arm and a leg, because if you've got a petrol station and you buy a can of petrol, it's a can of petrol you know. If you take back an empty can, it's an empty can. But an empty battery might not charge up again if you've wrecked it, you can do all sorts of things, you know like if you've over-discharged it, it won't recharge.*

The concern over battery abuse was the major reason for battery swap stations being considered unfeasible, followed by the lack of will for creating the necessary industry standards, and the commercial problems associated with the high capital investment cost. A few drivers think that battery swap stations are a good idea, but that fast-charging technology will move on at such a level to make the need for battery swapping obsolete.

Concerns over lack of standardisation within the EV industry as a whole is something that crops up as a concern in other issues as well as battery swap stations. Standardisation of EV technology is important in giving consumers the confidence to adopt (Brown et al, 2010).

### **7.1.3 Induction Charging**

Induction charging is where the charging technology is built just beneath the road surface and power is transmitted wirelessly to the vehicle, either while it is parked or when travelling.

Only three drivers talked about induction charging and these were among the more technologically aware drivers in the study. Induction charging is seen as a feasible option, only in the very long term.

### **7.1.4 Vehicle-to-Grid Technology**

Vehicle-to-grid technology, or V2G, is a way of storing electricity in the batteries of idle cars, then using it to supplement the National Grid at times of peak demand, such as early evening. The vehicle would charge the batteries at times when demand and prices are low,

such as overnight, and then sell the electricity back to the grid at times when demand and prices are higher, generating some excess cash for the vehicle's owner.

Over half of the drivers in the study had heard of the concept of V2G, some talking about it before being asked. Opinion on V2G was varied among the group. Just under half of the drivers thought that V2G was a brilliant idea, especially from the view of electric companies, as it would help cope with fluctuations in demand and could save further investment in more power stations. Others thought it was not a very good idea and that it would be more trouble than it was worth to them either personally or to the electric companies.

There were many areas of concern. A major one was that the batteries in their vehicle were not big enough to store enough electricity to make V2G worthwhile for them. This may be true at the present, but next generation EVs will likely have more battery capacity than current cars, so this is something that may alter. Another large area of concern referred to the extra charge and discharge cycles, which might reduce the life of the batteries, though some drivers said that the extra revenue generated by participating in V2G would cover the extra battery costs.

One driver in the study was concerned that the loss of control over the charging of their vehicle would mean that their vehicle might not be ready for use when it was needed. Another driver expressed surprise at the concept because he thought his vehicle would likely be in use at the time of peak demand, and would not be plugged in at home in order for the electric company to take the power from the vehicle batteries.

Russ thinks V2G is a good idea and has no concerns personally over participating. He regards V2G a good way of levelling the peaks and troughs of electricity demand, and that

his batteries would not suffer too much, particularly if enough vehicles took part -

*...if every car that was plugged in and ready to charge at the peak period was drained of 20% of its power, you know that's an enormous amount of power that's being put back into the grid.*

Michael, a Citroen Berlingo driver, queried how much it would cost him to install the technology in his house, and felt he needed to understand more about it before it would interest him. Evan is a big fan of smart grid technology and has no problem with participating in V2G, especially if the technology comes as standard and does not add too much to the purchase cost of the vehicle. He thinks this technology would work better for vehicles where the batteries were leased rather than owned.

The viewpoint of a non-technically minded person demonstrates the resistance that may need to be overcome for the technology to be successful. Belinda, who had not heard of V2G technology until I explained it to her, says -

*I think it sounds far too complex. I think that would go horribly wrong at some point.*

### **7.1.5 Hydrogen Vehicles**

Only two of the drivers in the study talked about hydrogen vehicles, and neither of these spoke of them with any enthusiasm. Hydrogen vehicles are seen as using energy less efficiently than EVs and as posing more difficulties in providing a support network. The lack of drivers who talked about hydrogen vehicles suggests that they do not really think about them in the same vein as EVs.

## **7.2 THE MOVE TO MASS MARKET**

Currently, EVs are a niche technology adopted by people who are better educated, have higher social status and are more 'go-getting' than other groups in society. Drivers in the

study resemble the typical 'early adopter' and 'innovator' profiles that are discussed by Rogers (1995). In the future, as EV technology diffuses through society, the type of person who drives an EV will change and become more diverse.

### **7.2.1 Future Adoption**

Nearly all drivers in the study agreed that electric vehicle use would grow in the UK, with the main obstacles at the moment being lack of choice and a high purchase price. Element Energy (2009:106) carried out a survey of potential EV owners and found that high price, limited range and lack of recharging points are major barriers to EV adoption, with lack of choice being a moderate barrier.

Drivers in this study do not see a limited range as a reason not to adopt, especially if you use it as one car in a multi-car household and are able to make the relatively small adaptations to fit one in to your life. Lack of recharging points are not seen as a barrier, as most recharging is done at home (see chapter 6.3 above), and alternative means of transport are used where the distance needed to be travelled is outside of the range of the vehicle. Indeed, Kurani et al (1994) using specially developed methods with potential adopters of EV technology in the US, found that swapping vehicles with other people in the household, and switching to an alternative vehicle within the household would be two of the most common methods employed by EV owning households to overcome range limitation. They also predicted that early adoption of EVs was likely to be done by *hybrid households* where having one vehicle with limited range as part of a fleet of household vehicles would not be a problem for the majority of multi-car households studied, who would require little or no change to their travel habits.

## 7.2.2 Lessons Learned

Studying EV drivers today can tell us much about how EVs will be used in the future. Below I have outlined the main findings from this study and explained why I think the future of personal transport is a shift from combustion engine vehicles to EVs.

***Finding: EVs are more likely to be the vehicle of choice in multi-car households as EV range increases.*** Many of the EV drivers I spoke to would like to be able to use their EVs more often and for longer journeys. Many would do away with their petrol cars if they had the option. As EV technology improves and EV use increases, mileage in a combustion engine vehicle will be shifted on to an EV, up to the point where the combustion engine vehicle is no longer required, costs permitting. Economic theory tells us that people make the decision between one product and another (in this case, travel modes), based on the relative costs and benefits of each of the products. Substitution will take place where travel in an electric car is not significantly more costly than in a petrol car.

Kurani et al (1994;249/250) argue that the view of an EV as a direct replacement for a combustion engine vehicle is too simplistic, and that a more likely scenario is that an EV would be part of a *hybrid household*, where mileage is shifted onto the EV as much as possible.

Whether electric cars will be used more intensively for long or short trips is not certain, although the drivers in the study would like to be able to use their EVs for longer trips, and more often. That is not to say that they will change their driving patterns just because longer drives are now technologically possible. When advances in technology makes longer trips possible, then an EV can be used in preference to a combustion-engine vehicle more often.

**Finding: High relative cost of EVs will need to be addressed for the mass market.** The drivers I have studied are not necessarily economically rational as conventionally understood. Some drivers find that their electric cars are cheaper than conventional cars, and some do not. However, most drivers have another reason for driving electric other than cost savings. For most of the drivers, concern for the environment (whether this is local or global environment, see Chapter 5.1 above) is high on the list of reasons why electric vehicles are superior to combustion engine vehicles. Another high factor is the driver's enjoyment of the technology. The values that are shared by the drivers I have studied are not necessarily values that are shared by the population as a whole, and other factors such as cost and symbolism will play a much higher part in purchase rationale.

**Finding: EV support systems need to be in place in the future.** There is concern among the group that servicing agents and repair shops need to be available to help future EV drivers to fix their vehicles. Most of the drivers in the study are from engineering or technical backgrounds and are highly educated. The drivers in the group tend to do their own maintenance work, partly out of a passion for do-it-yourself and partly out of necessity. As EV technology diffuses through society, adopters will be increasingly less keen to do their own maintenance work and will need a network of servicing agents and garages to undertake this work. There is a danger that without cost-effective support services within a reasonable distance, EV drivers will attempt to do any repair work themselves. While it may be acceptable for experienced engineers to carry out work on their own vehicle, it is probably not desirable for inexperienced people to interfere with high voltage equipment which could cause serious injury, or worse.

**Finding: EV recharging infrastructure might be 'a dead-duck'.** While drivers in the study, on the whole, are keen on seeing more EV recharging facilities, few were keen on the much-publicised idea of dedicated recharging posts, especially those which involve a fixed –

charge element, such as a registration or subscription fee. Drivers in the study find they do not need public recharging facilities very often, and are happy to find a friendly plug at their destination; whether this is a pub, a hotel, a shopping centre, or a fellow EV driver's house. The assumption that a pay-for public recharging facility will encourage people to adopt EVs may be false. Charging a fee for the privilege of using a public recharging facility adds to the cost of EV ownership and reduces one of the benefits of and motivations for having an EV – the lower running cost. One of the joys of EV motoring is being able to recharge the vehicle using domestic-rate electricity, and anything that is perceived to add more costs to the running of the vehicle will marginally discourage the mass-market from adopting. Public recharging infrastructure will be more useful in places where homes are less likely to have off-street parking facilities. However, if the price of electricity from these points is greater than a standard domestic rate, the running costs of the EVs will be increased and adoption slower.

***Finding: Too much local bureaucracy may cause problems for the wider public.*** In the study I found that the two drivers who did not have off-street parking had to trail leads from the windows of their houses across public pavements to recharge their vehicles. If EV adoption were to increase in areas with little off-street parking, the hazard that this method of recharging would pose to pedestrians would be considerable. To mitigate this, it is very important that a standard is agreed on that would enable people to recharge their EVs using standard domestic electricity rates using a facility that would provide guaranteed, exclusive availability while posing considerably less of a physical hazard to others. This standard would need to be adopted by the various agencies involved which include among others, the local authority and electricity suppliers. One idea would be for all EV recharging infrastructure in a geographic area to be under the jurisdiction of a one-stop-shop, either as a local authority function or a social enterprise. The method agreed on would need to be deployed in a timely manner that minimises cost and bureaucracy, or there is the risk that

EV drivers would find their own solution that may not be in the interest of the general public.

***Finding: The danger to pedestrians does exist but has not yet been realised to a significant extent.*** Drivers in the study recognise that EVs tend to be quieter and understand that this could pose problems to pedestrians, although none have experienced any serious incidents. Awareness of this issue is high among the group and action is taken in higher-risk situations (such as in car parks) to avoid it becoming a problem. Whether later adopters will be aware of this potential issue and be willing and able to take action to mitigate it is questionable. However, one of the benefits of driving an EV is the quietness of operation, which is not only a benefit to the driver but also to wider society in reduced noise pollution. The suggestion that artificial noises should be added to an EV engine to serve as a warning to pedestrians is not an idea that is wholly supported by drivers in the study, who instead see pedestrian and driver education as the answer, rather than taking away one of the more positive benefits of EVs.

***Finding: Driver engagement is important.*** EVs have the potential to reduce the impact of everyday motoring on both the local and the global environment. To realise this potential benefit, it is important that EVs are used to their maximum efficiency and that the materials used to build an EV are made to last as long as possible. Eco-driving needs to be encouraged among EV drivers to extend the range of the vehicle between charges and to extend the lifespan of the batteries. Good design of instrumentation is important in helping drivers to undertake eco-driving successfully. An instrument which provides feedback by showing real-time driving economy is a good way of engaging the driver and encouraging eco-driving. A light which simply tells the driver if their driving is un-economical is not so engaging and for drivers who do not understand how to drive economically, a real-time feedback system would show them where they are going right; not just where they are

going wrong. Driver education is important and should be offered to any new adopter of an EV at point of purchase. This would also benefit the vehicle supplier, especially if the EV or any part of it are leased under warranty, as it will extend the life of the leased equipment and reduce the probability of the vehicle coming back in for repair.

**Finding: The dreaded early evening spike in demand for electricity may not occur.** Half of the drivers in the study charge their EVs at home using overnight electricity for various reasons, the main one being to benefit from a cheaper rate. Drivers who use their EVs the most and do the most mileage tend to be on an off-peak tariff, such as Economy 7. Those who use their EVs less often may not be on an off-peak tariff, but do not necessarily recharge their EV every night. Few drivers charge in the early evening, preferring to wait until later when the batteries and the ambient temperature are cooler. Others tend to spread their recharging through the day so that the vehicle is ready for use as required. Drivers in the study are not special cases in their daily routines; those that work tend to work normal hours, and those that are retired do the normal things that retired people do, like go shopping or visiting friends.

As a group, the drivers in the study have a high awareness of the issues of electricity production and distribution and are sympathetic to the challenges that electric companies face. Later adopters from less technical backgrounds and with lower education levels may not have such high levels of understanding. To avoid an early evening peak in demand for electricity, it is important that financial incentives are offered, especially to higher mileage consumers, and that the reasons for the price differentials are communicated effectively. Consumer education is important and needs to be communicated at point of purchase, as this may be the only contact the consumer has with the EV industry. Later adopters are less likely to be part of an EV enthusiast society where knowledge is shared, so spreading information to later adopters will not be as easy as at present.

However, EV travel patterns are similar to that of combustion engine vehicles. It is not difficult to see that the only reason to recharge the EV in the early evening would be if the EV was low on charge and the owner was planning on going out again that night. Otherwise, it makes more sense to wait and to charge the vehicle overnight, especially if the owner can take advantage of a reduced rate for the electricity.

**Finding: EVs are loved by their drivers and bring a sense of calm, peace and wellbeing to their lives, and have the potential to do the same for wider society.** EVs are inherently easier to drive, quieter and produce zero local emissions. Power stations tend to be sited away from urban cores and because of this, EVs have the potential to reduce pollution in areas of heavy car use. While this may increase demand for electricity and the subsequent pollution that can go with it, in heavily populated areas EVs are able to reduce local noise, smells, and emissions. Urban policy makers need to see EVs as an opportunity and not as a threat. Investment in appropriate public recharging infrastructure and in the facilitation of the deployment of private recharging technology will encourage EV adoption and reduce the number of miles driven in combustion engine vehicles. By not providing suitable facilities for EVs, drivers from outside the urban core will be more limited in their choice of vehicle, and urban areas are in danger of sustaining a dependence on combustion engine vehicles which will maintain environments which no-one wants to frequent.

**Finding: EVs are not a threat to public transport patronage.** No driver in the study adopted an EV as an alternative to public transport. All adopted as either an alternative to an outgoing combustion engine vehicle, or to complement their existing vehicles by providing a way to undertake short, frequent trips in a more environmentally friendly and cost-effective manner. Where public transport is a viable option, public transport is used. In many suburban areas of the UK, public transport provision is poor, being infrequent, expensive and not on a route suitable to enable all domestic or professional tasks to be

completed. EVs are currently adopted by suburban, multi-car households with off-street parking, by people with busy lifestyles for whom public transport is not viable. The type of people who rely on and use public transport regularly are either the poor or the elderly who can not afford to buy and run a private car, or live in areas where public transport provision is much better and cars are not a necessity, for example central London. EVs are a direct substitute for and a threat to combustion-engine cars, not to public transport. While policy makers may prefer to focus their efforts on improving public transport, ignoring the potential of EVs to make cities a nicer place could be a mistake.

### **7.3 SUMMARY**

EV drivers in the study feel that fast charging is a viable option, and will enable longer journeys to be made. Induction charging is seen as feasible but the low number of drivers who discussed it shows that it is not an immediate concern. Vehicle-to-grid technology has potential though concerns would need to be addressed, probably through driver education. Battery Swap Stations are considered as fantasy and there are widespread concerns about battery abuse and lack of standardisation, and hydrogen fuel-cell cars are dismissed by those EV drivers that talked about them as an inefficient use of resources.

EV adoption is expected to grow in the UK, once a wider choice of vehicles become available at a lower price. The lack of range is not a concern, and it is not something that has caused too many problems for current EV drivers, nor is the lack of highly visible public recharging facilities.

From the lessons learned during this study, it is clear that EVs can be made ready for mass-market with some modifications and support from the public sector, though care should be taken to address the challenges in a way that meets the needs of the current innovators and early adopters, and also later adopters. Urban policy makers should embrace the

potential of the EV as a way of reducing pollution and making cities nicer places in which to live and work. As a result of mass EV adoption, demand for electricity will rise, though traditional demand-side management (DSM) techniques will go some way to mitigating the threat of the early-evening spike. Citizen engagement is essential in successfully deploying DSM and electricity companies should not underestimate the willingness of citizens to participate.

## Chapter Eight - Conclusion

### **8.1 EV DRIVERS TODAY**

This study has found, as expected, that EV drivers show traits of the innovators and early adopters described by Rogers (1995). As a group, the drivers value economy, and eco-friendly living. Current EV drivers have good jobs, are well educated, and have some altruistic sensibilities, but they are not such a niche group with abnormal lifestyles that makes an EV seem an unviable option for other sectors of society.

EVs are domesticated into everyday life in the same way as any other vehicle, and as part of a multi-vehicle, usually suburban, household. EVs are used in preference to other vehicles within the household. They are used for commuting, running errands, ferrying children around, and shopping. This is far from suggestive of freak or niche lifestyles, and the travel patterns of EV drivers are not significantly dissimilar to those found by the National Travel Survey (Element Energy, 2009).

EV drivers in the study recognise and accept their own car dependency. By embracing a modified version of a car, rather than altogether rejecting the car as a method of transport, they show that they are subscribing to Bordieu's theory of progress in society initiated by individual social actors rather than to the neo-Marxist Touranian theory of trying to re-write society (see Callon, 1987). The drivers in the study take individual action to mitigate their own carbon footprint and optimise their energy use, in the recognition of the difficulties posed in overturning 'locked-in' transport and energy systems within a nuanced, complex society. Few drivers regularly use local public transport in place of a car. Generations of increasing car use has eroded the reliability of the public transport network to the extent where even people with environmental sensibilities find that they still prefer the convenience of private transport.

The perceived disadvantages of EVs, including the limited range and lack of public recharging facilities are not seen as issues by EV drivers. In fact, some drivers were perplexed and amused by my questions about range-anxiety, or about what they do if they run out of power. The main issue is actually the lack of support with regard to the servicing and maintenance of the EV, which drivers have overcome by forming networks and communities of practice which facilitate social learning. Forming of communities for a specific technology is not unusual in the early stages of adoption, but is not necessarily something you would find for other technologies, as the Royal Academy of Engineering explain –

*“In Britain, 6.4 million people do not tune in to TV programmes called Top Domestic Appliances or Top Condensing Boilers in the way they do for Top Gear.” (RAE, 2010;13)*

Cars on the other hand, seem to encourage the forming of sub-cultures, as has been demonstrated by previous studies, such as of hot-rodders (Moorhouse, 1991), or of the Raggare in Sweden (O’Dell, 2001). There is some evidence within the EV community of emerging sub-cultures, such as those which share an enthusiasm for a specific EV model like the Sinclair C5, or the RAV4-E. Once EVs become more popular, EV culture will morph into something similar to current car culture, where people form sub-communities around a particular type of car, such as the VW Beetle, or round a particular activity, for example rallying, rather than just because of the technology used to propel it.

There is a lot of evidence to support the idea that the car can actively influence driving style, which suggests that Actor-Network-Theory (Latour, 2005) has a role to play in studying driving phenomena. The hybrid-car literature (see Michael 2001, Dant 2004) which argues that the car and the driver influence each other, encouraging a two-way relationship would seem to hold true in the case of EVs. However, that is not to say that all

EVs will have a calming influence on all future drivers. Drivers in the study tend to be older and wiser, and have been through their 'boy-racer' phase already, if at all. A desire to drive more sedately is likely to have been a pre-cursor to them adopting an EV and whether all drivers in the study would have chosen an EV in their younger days is questionable.

EVs have huge potential to become a mass-market product. The current market for EVs is multi-vehicle suburban households with typical routines, who do not mind having to carry out repairs and servicing themselves. The availability of off-street parking is important to EV adoption. Almost every driver in the study had their own, private off-street parking, which makes the recharging of the EV undemanding. Those that do not have private off-street parking use innovative methods of recharging which could deter others from adopting EVs. Most of the households in this study have off-street parking, some of which is extensive. In the short to medium term, there is no reason why this demographic will change to any significant level, though with an improved support system in place, the need to carry out DIY repair work will decrease and EVs will become a more viable option for non-engineering types.

## **8.2 THREATS AND OPPORTUNITIES IN ENERGY**

Whether electricity companies should be concerned by the prospect of extra demand is arguable. There is potential for an increase in demand for electricity which will go hand-in-hand with a decrease in demand for petrol and oil, but any spikes in demand that potentially threaten the stability of the National Grid could be mitigated by the deployment of DSM techniques, mainly by price incentives and consumer education.

There is also some potential in vehicle-to-grid (V2G) technology, especially where batteries are leased rather than privately owned. V2G could be an opportunity rather than a threat, and ownership of an EV has the potential to spark an interest in energy issues among the

mass-market which could facilitate the deployment of new energy technologies, such as domestic solar panels, or community wind farms.

### **8.3 CRITIQUE OF RESEARCH**

While I feel that using ethnographic research techniques is an extremely productive way of exploring issues of the everyday use of EVs, and the methods I used to gather this data was carried out to a high standard, in hindsight, there were areas where improvements could be made for any future studies.

The use of Email to study the EV community was an extremely fruitful tool. Early adopters of technology, even in the case of a ubiquitous, mundane item like a car, embrace the use of the internet and email. All drivers were able to successfully get their personality across to me in electronic communications to the end that I was not surprised in the least by any one driver I met in person, and I came away from each visit satisfied that the person I had been conversing with on email and on internet forums was exactly the same as the person I had just been having a face-to-face conversation with. It would seem that Email is not a greatly inferior way of interviewing people, as long as you ask the right questions and use the guidelines to avoid *frustration* and minimise drop-out rates (Meho, 2006:1288). The drivers in the study were more than happy with the use of email as an interviewing tool and I received many excellent comments which demonstrated clearly their agreement on issues with drivers I met in person. In hindsight, I could have asked more questions of the drivers I interviewed by Email, and I could have included more drivers if I had not undertaken the time-consuming visits, however I feel the personal visits were necessary, not only to give me the chance to familiarise myself with different EVs and driving styles, but also to allow me to check that Email is not an greatly inferior method of data collection. In future studies, I would recommend more intensive visits to fewer participants, with the

use of email to increase the sample size. This would mean more drivers could be included while minimising the use of resources.

Carrying out more intensive but fewer visits would mean that visual data collection techniques could be used. For one demonstration journey, I experimented with a video camera alongside my usual voice recorder. The use of video techniques is not a new method, even for the interiors of vehicles (Laurier et al, 2008). I found that the video footage I filmed from the passenger seat of the EV has the potential to demonstrate to others the major differences in driving an EV compared to a combustion engine vehicle. The footage also aided me in remembering the physical and visual context in which the conversation took place. One major advantage of video footage is it can demonstrate to others how the data collection was carried out, helping to dispel the mysteries of academic research.

#### **8.4 FURTHER RESEARCH**

EVs, by their very nature, lend themselves to study by many academic disciplines. There are studies being carried out at the moment into real-world use of vehicles, either by EV model, or by geographic area, which involves questionnaires, black-box data and qualitative interviewing. (see Cabled 2010, and CENEX 2010 for good examples). The main objective of these studies is to feedback travel patterns and other data to industry to help make product improvements and to establish how EVs are used on a daily basis.

As far as sociological studies of EV use goes, it would be interesting to re-visit drivers of EVs once the technology diffusion process has gathered pace. It would be fascinating to see how far the EV driver profile changed, whether the motivation for adoption differs, if future EV drivers feel the same about their vehicles as current drivers, and if the problems and deficiencies that drivers currently face await later adopters.

I would be interested to know what happens to the EV community – Will interest groups like The Battery Vehicle Society still persist and, if so, in what guise? – Is there further evidence of more developed sub-cultures, such as a Nissan Leaf fan-club? – Do drivers still form communities of practice by type of vehicle or has the DIY aspect of car ownership become more normalised and akin to the DIY culture that exists for combustion engine vehicles today?

This study is a snap-shot of EV use and culture in 2010, and further, longitudinal studies of EV use would add much to the debates on car culture and on technology diffusion. How far apart these studies need to be depends on the speed of the diffusion process.

## **8.5 CONCLUDING COMMENTS**

This study has provided an insight into EV use in the UK in 2010. It has found that EVs are a niche technology, adopted by people with classic innovator and early adopter profiles, and because of this, cliques and communities have formed through interest groups, which are facilitated by use of ICT.

All the EVs are loved by their drivers who express a feeling of wellbeing and less guilt when driving them. EV drivers endeavour to speed up the diffusion process by spreading the word and by working with industry to make improvements. Drivers in the study are genuine citizen-consumers who have a high appreciation of energy issues and seek to reduce their energy use in their everyday lives.

Although most EV drivers in the study anticipate and encourage increased EV use, there is a fear within the EV community that increased adoption will lead to a decrease in revenue for the government, and that this decrease will lead to the withdrawal of any financial incentives that currently exist. EVs are currently exempt from paying Vehicle Excise Duty (road tax), and electricity is not subject to the same high level of taxation that is applied to

petrol and diesel, so any decrease in the number of combustion engine vehicles will cause a fall in revenue for the UK government. The Royal Academy of Engineering state that this revenue is £20 billion annually from fuel duty alone and “..it is unlikely that any administration will tolerate a significant loss in that revenue.” (RAE, 2010;12). How a government decides to re-coup this loss will affect the uptake of EVs in the future. While the withdrawal of the zero-rate for road tax will not be too much of a blow and will only affect car owners, any attempt to apply tax to electricity will affect all sectors of society, whether they own an EV or not, and could potentially be *regressive* – that is, poorer sectors of society will be disproportionately affected - and many more people will be subjected to the state of *fuel poverty*. Alternative schemes to generate revenue from motorists that do not impact on non-car drivers will need to be considered, for example pay-per-mile road pricing. However any transport policy has implications for the governing political party and the impetus to not punish the ‘ordinary man’ by penalising the essential practice of motoring will be ever-present.

Car use has had implications over the last century, including environmental degradation and increasing car dependence. There are also positive benefits, such as increased physical mobility which facilitates social relations and sustains social capital (Urry, 2002). Great care must be taken to implement policies which sustain this positive level of mobility and individual freedom, while attempting to mitigate the negative impacts.

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## Glossary

Adoption	The process of starting to use an item or practice, such as a piece of technology, or a cost-saving policy.
Combustion engine vehicles	Vehicles which are powered by a combustion engine, which is fuelled by burning petrol, diesel or alternative fuels such as LPG (Liquid petroleum gas).
Diffusion	The process by which a product or practice is adopted by different sectors in a society.
DSM	Demand Side Management is a set of techniques used by utility companies to manage the demand patterns of consumers in order to alleviate the challenges associated with fluctuating and increasing demand. Good examples would be time-sensitive pricing structures, or promoting the use of energy saving appliances.
EAPC	Electrically assisted pedal cycle. A bicycle with an electric motor which decreases the human effort required thus extending the achievable range of a bicycle journey.
Eco-driving	A method of driving a vehicle which optimises the miles-per-gallon, or miles per unit of energy, within the constraints of road conditions. To be distinguished from hyper-miling.
EV	Electric vehicle. For the purposes of this study, this includes any electrically powered vehicle which can substitute directly for a car, a van, or a motorcycle.
Fast-charging	The process of charging an EV by using a larger current to put a charge into the batteries in a short time period, usually about 20 minutes to one hour.
Fuel poverty	The need to spend 10% or more of a household's income on domestic fuel, leading some to reduce their energy use to uncomfortable or dangerous levels.
Hybrid Electric Vehicle (HEV)	A vehicle which is powered by a conventional combustion engine and an electric motor in tandem. The vehicle is capable of travelling a short distance (around 2 miles) in electric mode only. The batteries are charged from the combustion engine.

Hybrid household	Term coined by Kurani et al (1994) to describe households who have more than one car ' <i>...of different energy systems and must then allocate household travel accordingly.</i> ' (1994:244)
Hyper-miling	The extreme practice of maximising the miles-per gallon, or miles per unit of energy, with less consideration to the road conditions or to other road users.
Lock-in	The point where existing systems are impossible or difficult to overturn because of the high costs and organisation involved in moving to a different system.
National Grid	The electricity supply network in the UK.
PHEV	Plug-in Hybrid Electric Vehicle. A hybrid electric vehicle that has a larger battery pack (so is range-extended) which can be topped up in the same way as an EV, rather than just from the combustion engine.
Range anxiety	The anxiety experienced by a driver who is worried about whether the EV has enough power to complete a journey.
Slow-charging	The process of charging an EV using a small, usually domestic current to put a charge into the batteries over a period of a few hours.
V2G	Vehicle-to-grid technology is a two-way system where vehicles can send excess stored power from the batteries back to the National Grid, as well as take power from it.