ENEVATE WP3
Market Drivers in E-Mobility

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Introduction

There can be little doubt that we live in the age of the automobile. Such vehicles are all around us and impact upon our lives everyday in various ways both direct (we use them) and indirect (we rely on other who use them). There are now over one billion cars on the world's roads – doubling in the past quarter of a century (Sousanis, 2011). The automobile industry represents the single largest manufacturing sector in the world and it is only likely to grow as the inexorable rise of car ownership in developing economies such as Brazil, China, India and Russia exacerbate matters to ever-new extremes. As such, it can be said that a deep-rooted culture of automobility defines our times (Urry, 2007). The significance of the motor vehicle has spread from country-to-country in one of the most all-encompassing, yet little acknowledged, facets of globalisation. The pervasive creep of automobility enabled the tacit acceptance of the ascendancy of the car, leading to the dominance of the 'car system' (Dennis and Urry, 2009). The twentieth century was the century of the car, and it central position became locked-in so that it arouse as the de facto mobility leader for the twenty-first century. This situation is a dangerous one because the car system, as presently exists, is inherently unsustainable.

Transportation currently accounts for one fifth of global oil usage, three quarters of which is from road transportation, resulting in one quarter of all energy-related carbon dioxide emissions, nearly half of which originate from passenger vehicles (International Energy Agency, 2012). Cars are at the forefront of oil usage and carbon dioxide emissions. As oil is a finite resource and carbon dioxide in the atmosphere slowly chokes the planet, it is clear that the current car system does not represent sustainable mobility – one way or another; the needs of future generations are being compromised. In these circumstances, recent years have borne a renewed interest in electric vehicles as a means to reach toward a more sustainable means of personal mobility, while broadly adhering to a comfortingly recognisable automobile model. Rather than an industry-led push, encouragement has come from governmental support and attempts to meet climate change targets. Europe's 2020 vision is for a minimum 20% reduction from 1990 in total greenhouse gas emissions (European Commission, 2010). A significant portion of the measures to be taken to achieve such targets will involve addressing the highly polluting transport sector, including the ubiquitous car.

The first European Union targets for cutting emissions have been introduced in 2012 so that, by the end of the year, 65% of member country's new cars must emit less than 130g/km of carbon dioxide (European Commission, 2012). By 2015, the entire new car fleet must meet that same limit which will be reduced to 95g/km in 2020. Despite producing emissions from both the manufacture of the car and production of the energy source, electric vehicles are classified as zero emissions at point of use. Concomitantly, consumers are being offered an escalating amount of incentives for electric vehicles, such as sizeable purchase subsidies. As a result, the automobile industry are bringing a steady stream of new electric vehicles to market – however, these cars have not proved popular with consumers. While 2011 was supposed to be the year of the electric vehicle

in Western Europe, the technology managed a market share of only 0.09% (11, 563 units) – and sold just over a thousand in the UK (Automotive Industry digest, 2012: 1-3). Electric vehicles sales in the UK market, then, barely registered amongst the near two million new cars that were sold (Ruddick, 2012).

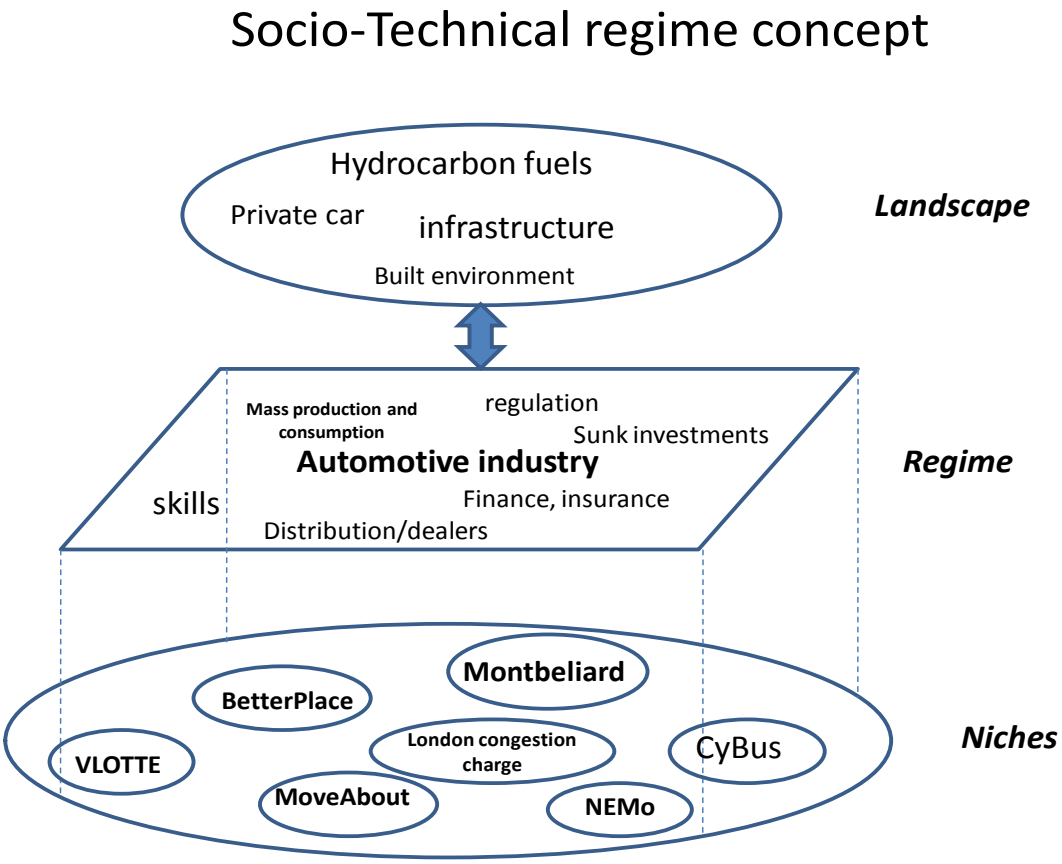
The rate at which electric mobility develops and is taken up as a transport mode depends in part on our ability to engage and learn from initiatives and on the extent of co-operation between various stakeholders. Inefficiencies related to weak co-ordination and dispersed, ad hoc activity means that potential has not been fulfilled. It is in recognition of this situation, coupled with the need to avoid further duplication and resource waste, which led to the formation of the ENEVATE consortium. Consisting of 14 partners from North-West Europe, ENEVATE works to provide tested, evidence-based solutions to help inform and guide policy at regional, state and inter-governmental levels. In this paper, we report on one part of this initiative; the actions undertaken as part of the Electric Vehicle Market Drivers and E-Mobility Concepts study. The objective of this study was to explore market drivers that will influence the acceptance of the different electric vehicle mobility concepts and the conditions needed for realising this acceptance. In this paper, we set out some of the findings from this work.

Electric Vehicle Niches

Electric vehicles currently operate in two realms. On the one hand, there are applications in which they are fully competitive with any other driveline technology. For example, in enclosed factory settings, businesses require forklift trucks that do not pollute the surroundings with dangerous and unpleasant toxins, hence electric handling equipment has an advantage over petrol or diesel engines. In the UK, electric milk floats, which have long been used, whereby the inherently early morning usage means that the low noise of an electric engine is preferable to the noise generated from an internal combustion engine. In France, electric quadricycles are popular amongst young people (and those who have lost their driving license), as they do not require a full license so can be ridden by those unable to legally drive a category one car. In each instance, the electric vehicle offers something that traditional internal combustion engine vehicles cannot and, as such, it has been taken up as a viable mobility option. At the same time, other electric vehicle realms largely rely on artificial financial support of various kinds. Crucially, this currently includes the private electric vehicle market, which depends on subsidies such as the UK's Plug-in Car Grant, which reduces the initial purchase cost by up to £5,000. In order for electric vehicles to enjoy enhanced penetration in the market (competing with traditional internal combustion engine cars), it is these areas where electric vehicles have not yet reached full potential that need to be stimulated in various ways. However, the question then arises as to which way of stimulating such markets would be most effective – and could overcome the current inertia that exists. One approach is strategic niche management.

The socio-technical regime transitions literature, and its offshoot of strategic niche management, has gradually gained a foothold in academic thinking about

how technological change might happen (Rip, 1992; Rip and Kemp, 1998; Schot and Geels, 2008). Within this theoretical framework it is argued that a 'regime shift' to a new set of technologies and a new set of accompanying social and economic norms can be initiated through the successful establishment of one or more technological niches. In most cases such niches will arise naturally as a result of changes in the operating environment, such as the invention of new technologies, and Geels (2002) gives the example of the transition from sail to steam in ships. The learning experience from different niches can be combined and new actors can become supportive and gradually clusters of social and technological factors become more and more powerful, such that they can come to replace an established and previously dominant regime. This combination of technological and social factors is essential to bring about such change – technology alone is never sufficient. Changes in the landscape, such as the increasing pressure on the use of fossil fuels, weaken the existing regime, thereby opening up windows through which niche technologies and changed social factors can establish themselves. In the following diagram, derived from Wells et al (2012), an attempt has been made to show these different elements of socio-technical transitions theory within the context of electric vehicle niches.



Although niches often arise spontaneously and become competitive to the extent of pressurising the existing regime, and eventually forcing its transition, it is also possible to provide active support for specific niche technologies that are considered particularly desirable. This is the crux of the concept of strategic

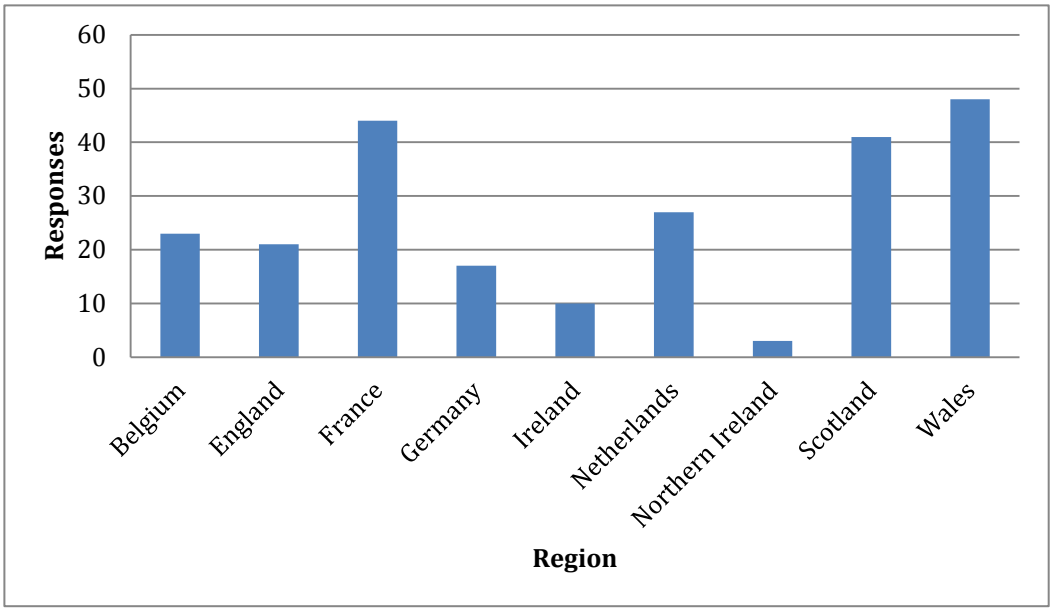
niche management. Where there is a broader socio-political driver for such a shift – as is the case currently through the desire to reduce carbon emissions from transport – a number of key actors can come together to initiate experiments to try and promote such a niche. These experiments attempt to create a protected market space in order to test the viability of an alternative technology and/or set of accompanying norms. If successful, such a concept can then gradually be exposed to ordinary market forces, thereby helping the niche move towards replacing the established but, now less desirable, regime. This is achieved by means of a route that offers gradually removing the protection from prevailing market forces. Niches can then benefit from windows that appear in the dominant regime as a result, very often, of changes in the landscape, such as rapidly rising oil prices. In addition, lessons learned from several such experiments can combine into new niches, thereby gradually adapting and strengthening over time.

According to strategic niche management, a niche such as an electric vehicle pilot needs to be temporarily protected so it can develop and transition into the mainstream. By assessing consumer attitudes, ENEVATE looks to assess what incentives would most likely to encourage them to use electric vehicles. The appropriate incentives can then be put in place in order to create the protection required for the electric vehicle experiment to succeed. In order to achieve these aims, we gained accessed to a number of electric vehicle pilots of numerous varieties – namely, electric vehicles introduced into work fleets, electric vehicle car sharing schemes, short-term electric vehicle leases, electric vehicle test-drives and electric vehicle information events. These were schemes that introduced electric vehicles to prospective new users. They also cover a mixture of urban and rural areas, meaning that a vast array of electric vehicle contexts were explored – a variety quite unlike that in any such previous research studies. Within our pilots, we questioned participants as to their attitudes toward electric vehicles, building upon both their pre-conceived ideas and their informed experiences. This followed the methodological approach outlined in Newman et al (2011). There were two parts to this process, initial questionnaires and follow-up surveys.

We begin with the initial questionnaire, and a description of the demography of the sample.

Initial Questionnaire

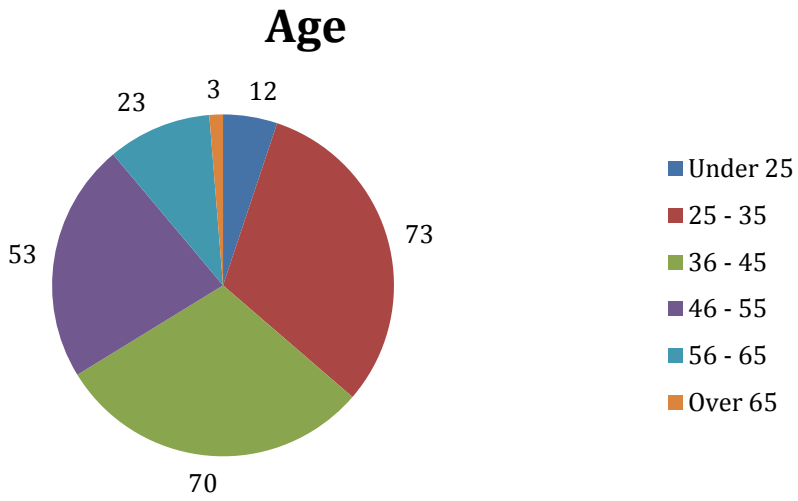
There was a mix of respondents from across North-West Europe. There was no concerted effort to encompass specific social segments, we merely attempted to target anyone who was interested in exploring electric vehicles.



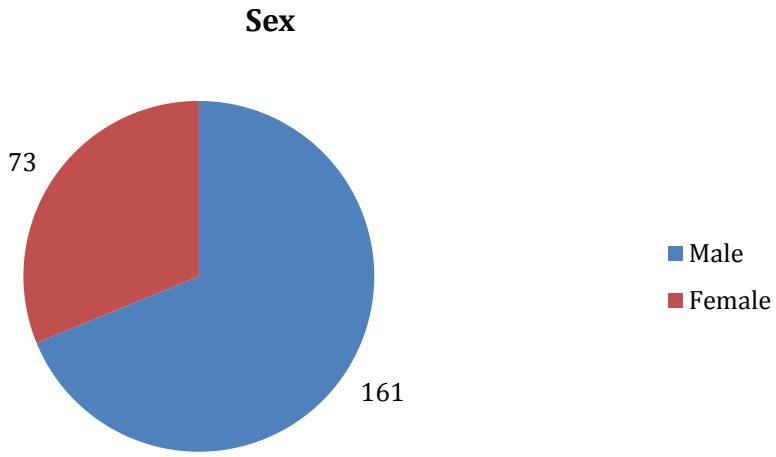
There were 234 questionnaires completed in nine countries. The largest numbers of surveys came from Wales (48), France (44) and Scotland (41).

Pilot	Region	Count	Pilot Type
Angus	Scotland	4	Electric car - work car pool
Armagh	Northern Ireland	3	Electric car test drive
Camarthenshire	Wales	20	Electric car - work car pool
Cornwall	England	6	Electric car - work car pool
Dijon	France	5	Electric car demonstration event
Dublin	Ireland	10	Electric car test drive
Dumfries and Galloway	Scotland	15	Electric car - work car pool
Dundee	Scotland	10	Electric car - work car pool
ENEVATE	North West Europe	4	-
Helmond	Netherlands	13	Electric car lease
Kassel	Germany	14	Electric car test drive
Montbéliard	France	39	Electric car hire scheme
Newcastle	England	15	Electric car lease
Rhondda Cynon Taff	Wales	7	Electric van - works fleet
Scottish Borders	Scotland	6	Electric car - work car pool
Strathclyde	Scotland	6	Electric van in works fleet
Venlo	Belgium	14	Electric car demonstration event
Wallonia	Belgium	22	Electric car demonstration event
Wrexham	Wales	21	Electric car - work car pool

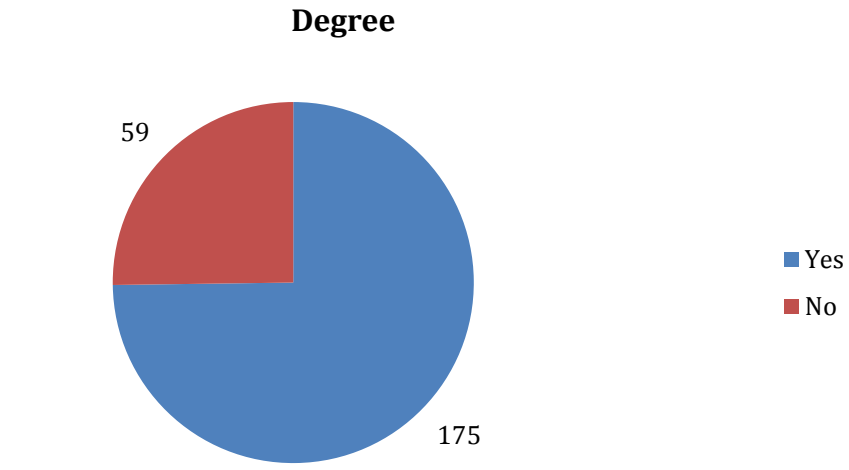
There were 18 pilot regions, alongside a handful of ENEVATE partners completing surveys. The largest samples were taken from Montbéliard in France (39), Wallonia in Belgium (22) and Wrexham in Wales (21).



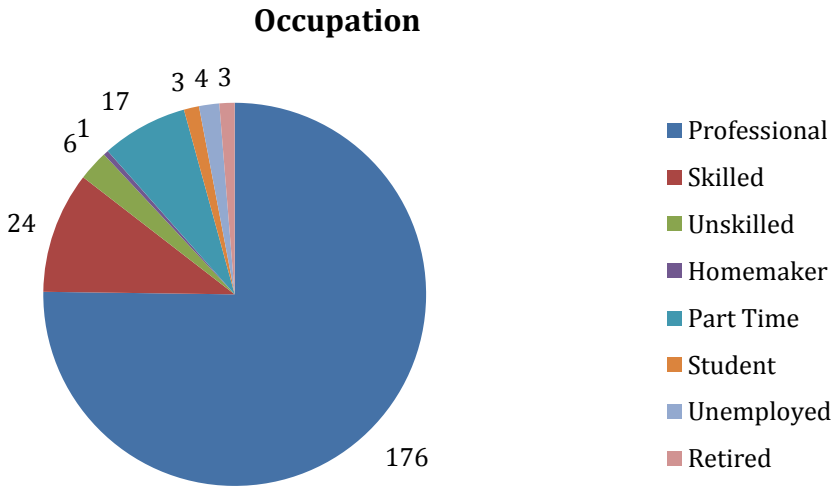
The age profile of respondents was largely spread amongst the ranges of 25-35 (73), 36-45 (70) and 46-55 (53).



More than twice as many respondents were male (161) as were female (73).



A large majority of respondents possessed a degree (175).



Most respondents classified their occupation as professional (176), with smaller numbers skilled (26) and part time (17).

Overall then, though there was a geographical spread, the sample tended towards young to middle-aged, professionals and men. As some of the pilots were work-based schemes, this may account for some of the bias. The sample was also to a large extent self-selecting, which would also further explain the bias in demographics.

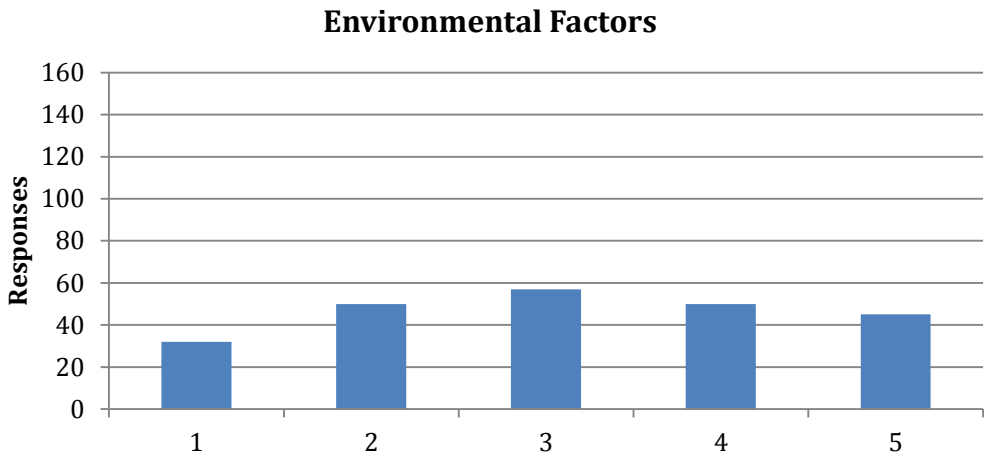
We now move on to consider the substantive part of the initial questionnaire, beginning with questioning on car ownership in general.

Car Ownership Motivation

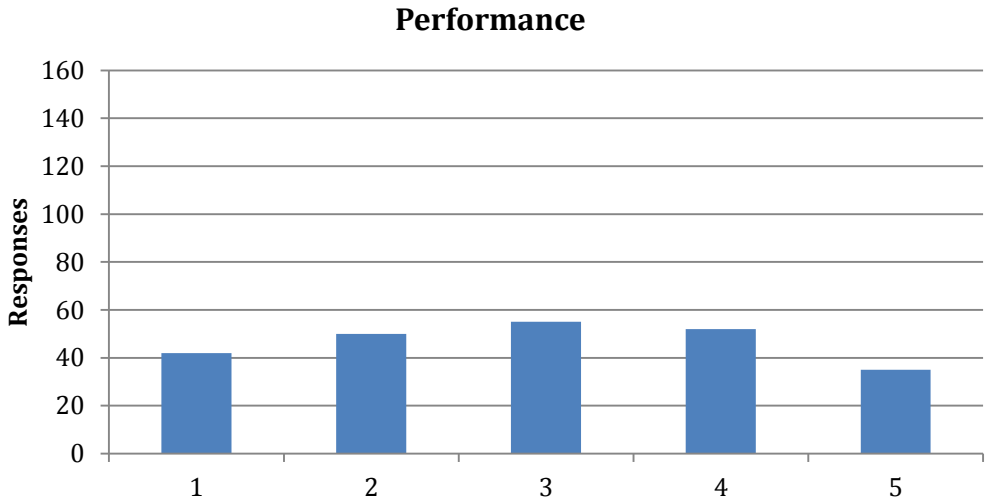
Respondents were posed the question:

When buying your next car, how would you rank the following factors in terms of importance, with 1 being the most important and 5 being the least important?

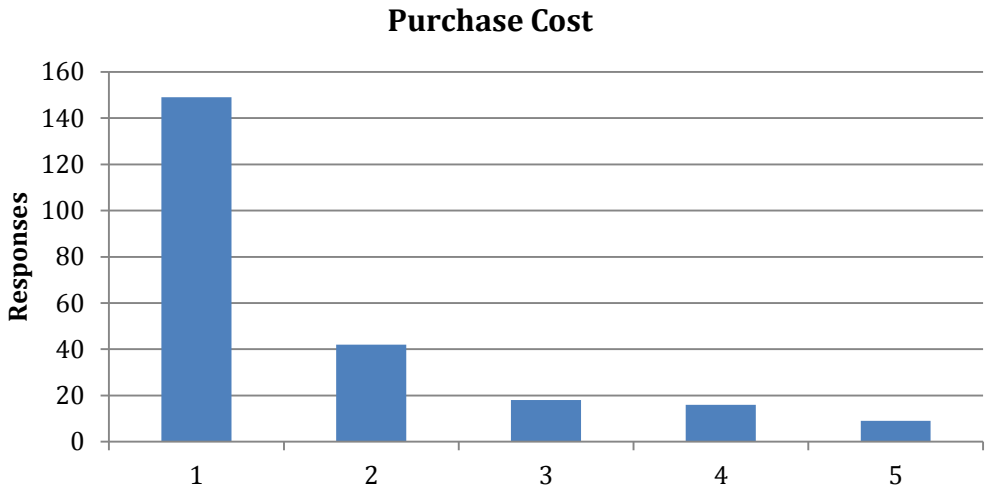
They were asked to rank environmental factors, performance, purchase costs, running costs and size.



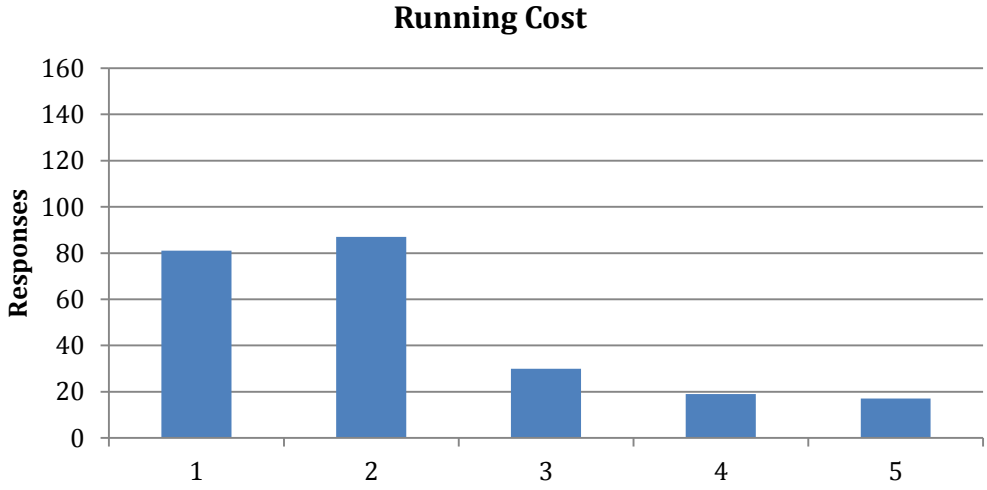
There was a fairly even spread across the options for environmental factors, with the highest number reserved for 3rd place votes (57). There were more 5th placed rankings (45) then there were first place rankings (32).



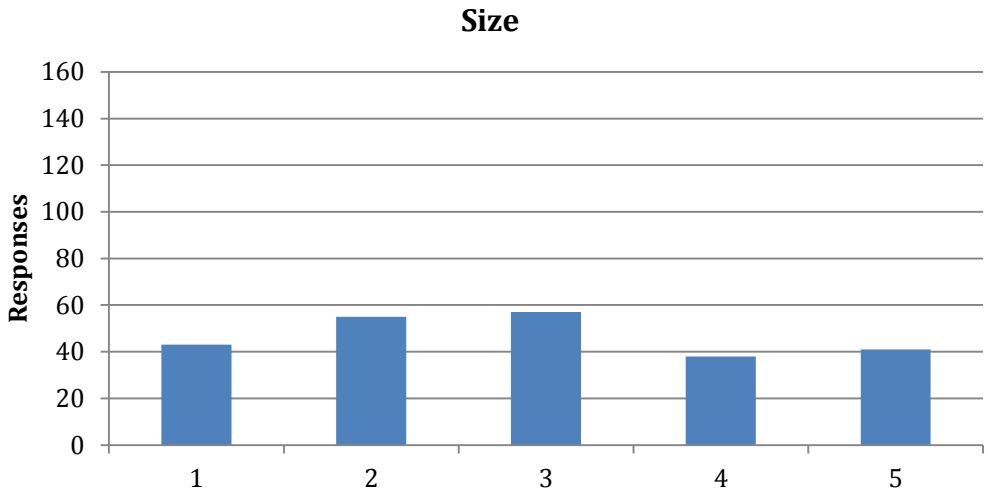
A similar pattern of spread emerged for performance, and it also saw 3rd place votes succeed (55). However, unlike environment, there were more 1st placed rankings (42) then 5th placed rankings (35).



In contrast, purchase cost produced a definitively positive result. There was a clear margin of victory for 1st placed ranking (149), with vastly more votes that the next most popular ranking, 2nd place (42).



Also very popular were running costs, though with a more even spread across the first two ranking spots. There were slightly higher numbers of 2nd place votes (87) than there were 1st place votes (81).



As with the first two options, size returns to a more even spread and, again, the most popular choice was to ascribe it a 3rd place ranking (57). In common with size rather than environment, there were more 1st place votes (43) then 5th place votes (41).

When considered together, it becomes clear that financial matters were of primary concern in respondents' car purchasing habits. Purchase cost and, then, running cost were by some margin the most popular options in this ranking exercise – garnering figures of 149 and 81 respectively in 1st place rankings. In contrast, environmental factors were considered the least important consideration, with only 32 ranking it in 1st place– the smallest amount of any group – and the most 5th place rankings, at 45. The expense of purchasing and running a car, then, trumped any concern for the environment amongst these respondents.

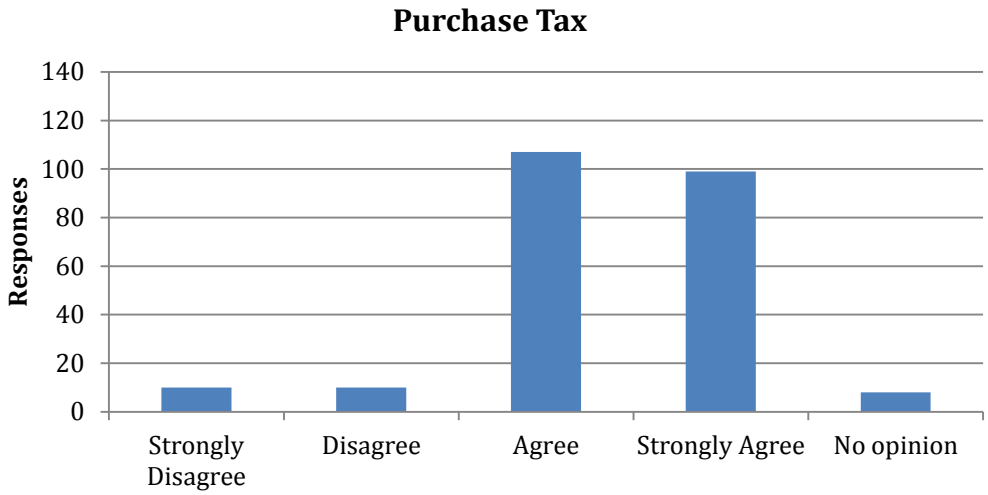
Moving beyond general ownership, the initial questionnaire then went on to address electric vehicle usage in general.

Electric Vehicle Incentivisation

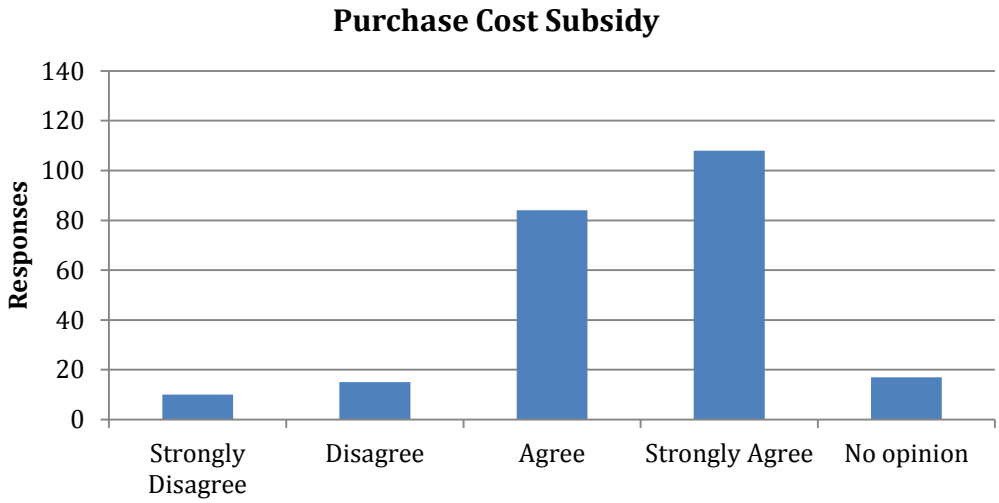
The respondents were asked to respond to a series of incentivisation statements starting with the prefix:

I would be more likely to consider buying an electric vehicle in the future if…

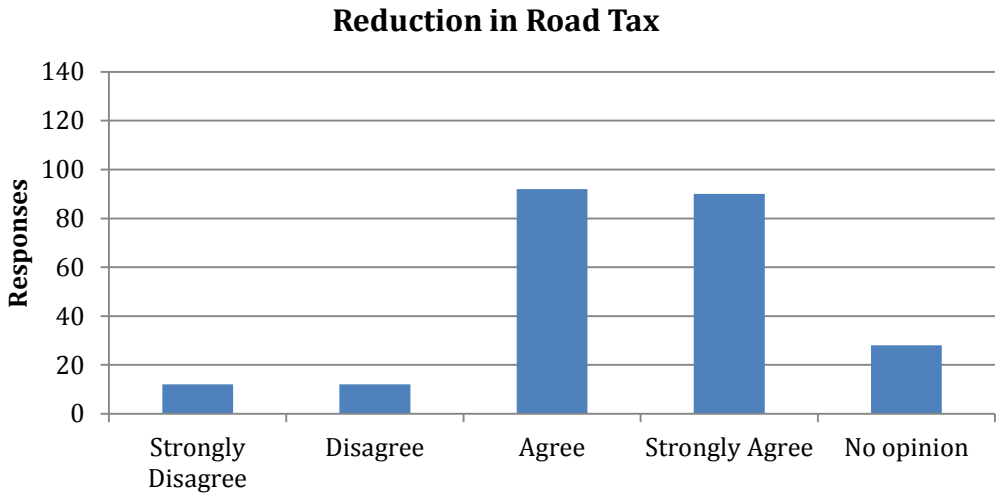
Respondents were then provided with a series of options and asked to place these on Likert scales. The five-point rating system passes from strongly agree and agree to disagree and strongly disagree with an option for no opinion. The first three questions looked at financial incentives, followed by infrastructure incentives and, finally, organisational factors.



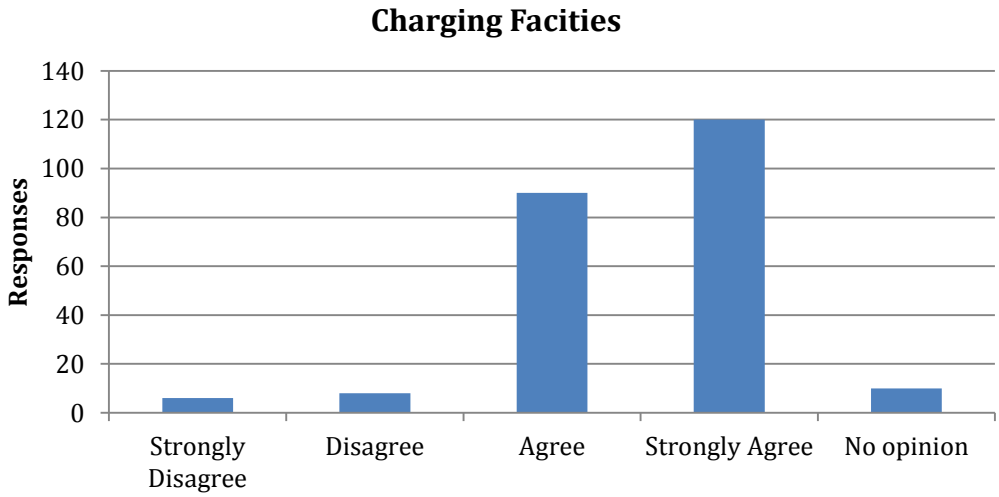
There was clear support for purchase tax initiatives, with a high overall level of agreement. There were 99 strongly agrees and 107 agrees, with very little opposition.



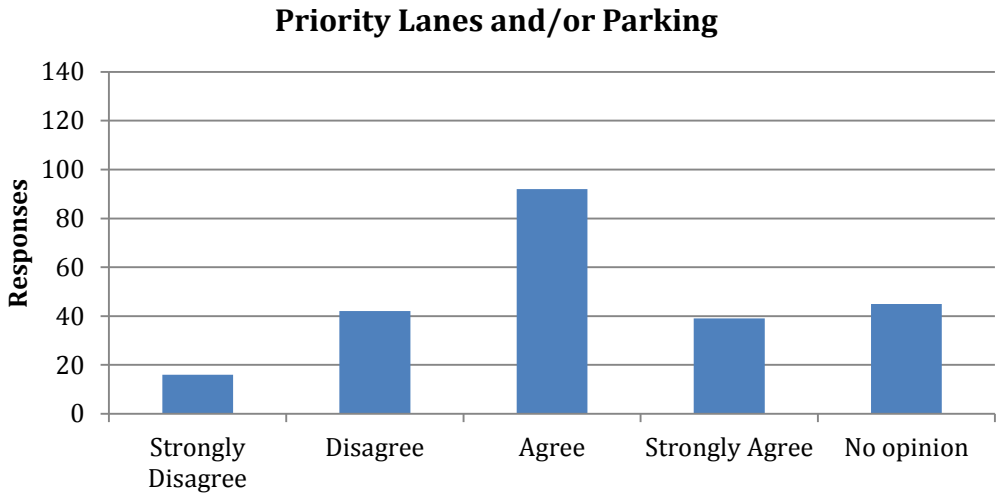
As with purchase tax, purchase cost subsidies were a very popular proposition, with much support. There were 108 strongly agrees and 84 agrees and a low level of negative opinion.



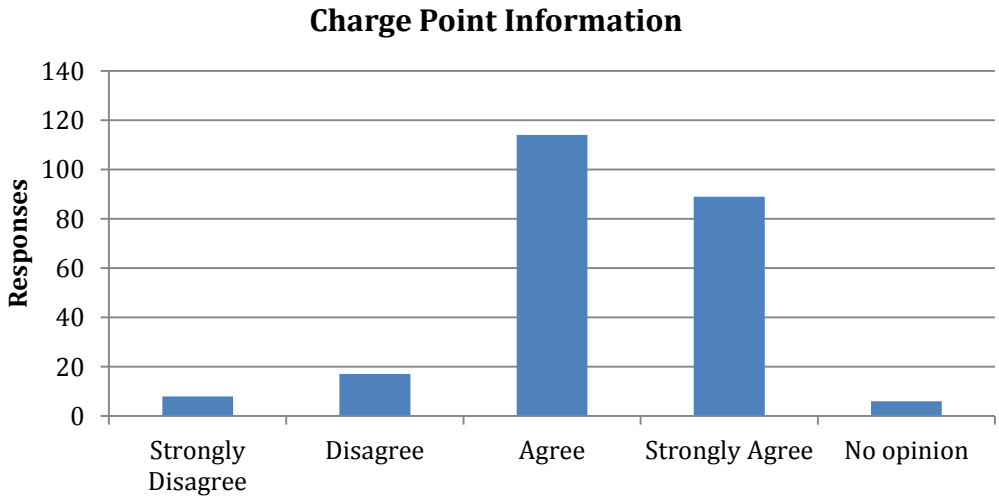
As with the previous two financial measures, the third – road tax reduction – was also very popular. There were 90 strongly agrees and 92 agrees, with little against the idea.



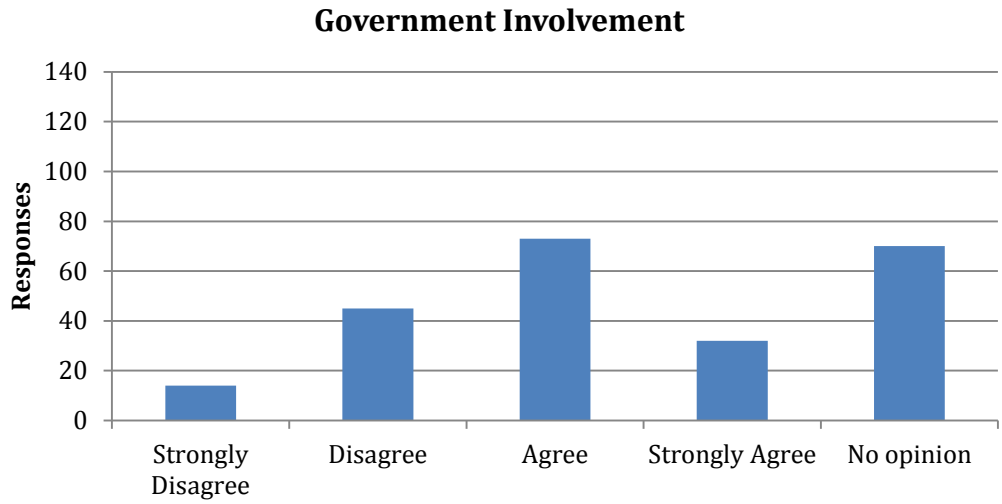
In common with financial incentives, the first infrastructure suggestion of more charging facilities was well received. There were 120 strongly agrees and 90 agrees and little by way of disagreement.



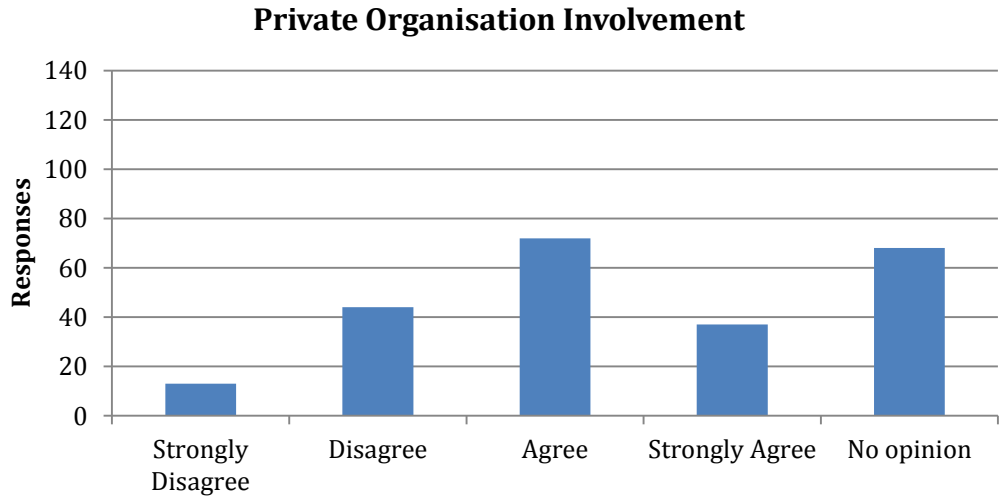
In contrast with that which preceded it, the notion of priority lanes and/or parking produced a more mixed response. There was still overall support with 92 agrees but, also, larger amounts of disagrees (42) and no opinions (45).



In common with the other charge-related infrastructure option, charge point information was very popular. There were 89 strongly agrees and 114 agrees.



The first organisational option – government involvement – produced a mixed result. There was a marginal victory for the agrees (73) but close behind there also 70 no opinions as well as a high proportion of disagrees (45).



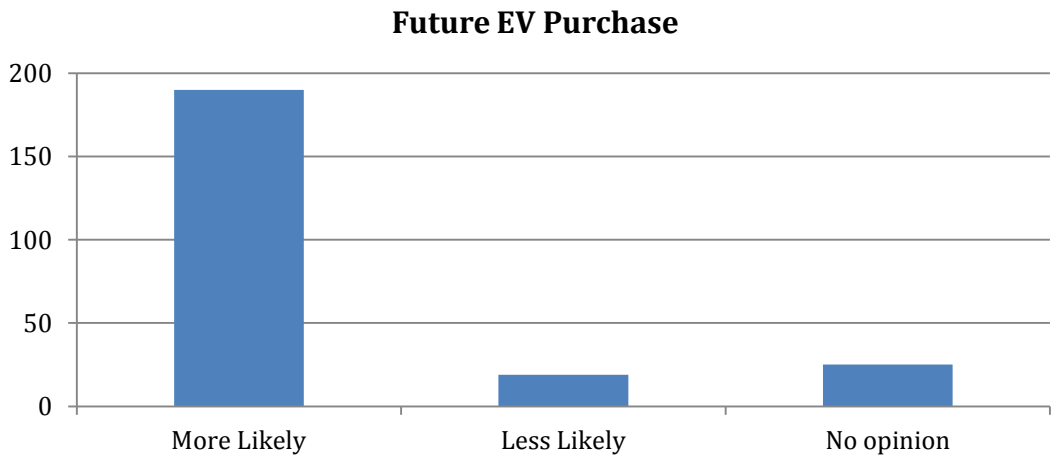
As with the other organisational option, private organisation involvement produced a mixed result. Similarly, there was a marginal victory for the 72 agrees ahead of 68 no opinions, with another large proportion of disagrees (44).

Taken as a whole, there is an apparent value in considering financial and infrastructure incentives as a means to attract respondents toward electric vehicles. Most popular of all was the provision of more charge facilities, receiving 120 strongly agrees and 90 agrees (210). Also receiving a great deal of support, were cost subsidies and purchase tax – cost subsidies garnering 108 strongly agrees and 84 agrees (192) and purchase tax earning 99 strongly agrees and 107 agrees (206). In addition, increased charging information rated highly with 89 strongly agrees and 114 agrees (203). Of considerably less interest was the potential involvement of private or governmental organisations, gathering relatively mild support but also the highest levels of no opinion responses at 70

and 68 respectively. Respondents, then, could find electric vehicles appealing if they were cheaper and the charging situation was improved.

Finally, we asked respondents about their future intentions as regards electric vehicles.

Future Electric Vehicle Intentions



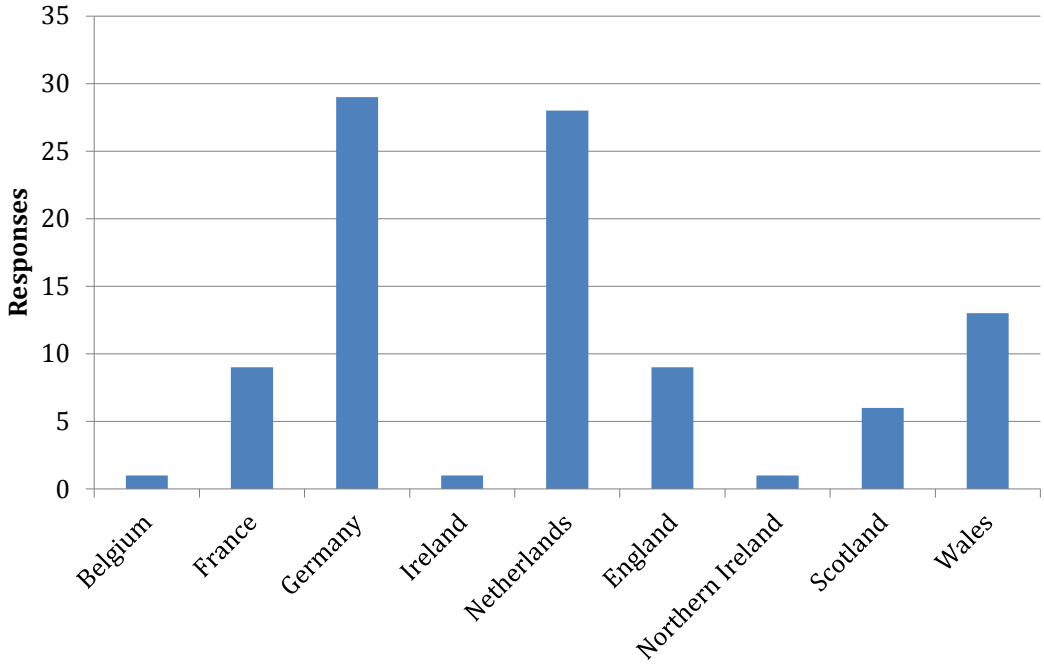
Following their participation an electric vehicle pilot and initial questionnaire, we asked respondents if they were now more or less likely to purchase an electric vehicle in the future. Respondents were overwhelmingly positive, with 190 more likely compared to 19 less likely. There seems to be some significant potential for the electric vehicle market in these responses.

To judge from the initial questionnaire then, the situation for electric vehicles appears promising. Respondents would be willing to consider electric vehicles but only if two vital obstacles were overcome: cost and range. As such, even though generous financial incentives currently operate, these are not considered good enough by consumers. Electric vehicles are still more expensive than their internal combustion engine counterparts, a discrepancy that seems especially galling when they do not offer comparative levels of performance with regards to the restricted range and inadequate charging options currently provided by present battery technology. Progress for the electric vehicle might require waiting for the inevitable improvements in batteries that should appear over time and/or from relative price comparisons altering as, for example, would be hastened by a decline in oil reserves increasing petrol prices. However, in order to seek ways to overcome these barriers sooner, we next conducted a follow-up survey to probe at alternatives to conventional models of vehicle ownership, which might reduce financial outlay and mitigate concerns over battery capabilities.

Follow-up Survey

The follow-up surveys used a self-selected segment of the original sample from the initial questionnaire, as respondents opted whether or not to agree to our

second interview. The geographical make-up of this second sample-within-a-sample was as follows:



There were 97 responses. Again, there was a spread of responses but, due to the nature of self-selection, it was inevitable that some areas would have small numbers. Each was, at least, represented. The most responses came from Germany (29), the Netherlands (28) and Wales (13).

The presumption toward private ownership, and carrying on with existing patterns of car consumption, entail that the full potential that electric vehicles hold for sustainability mobility has not been properly realised. They appear to advocate the replacement of like for like and, as such, encourage the practice of 'problem shift', simply replacing the problems of internal combustion engines with those of electric vehicles and not offering a meaningful solution (Hawkings et al, 2012). Putting aside obvious but less feasible alternatives such as walking, cycling and public transport, there are still an exhilarating range of different ways that cars can be used for personal mobility, which do not simply perpetuate consumer capitalism and the ever increasing numbers of cars being produced and consumed. Some of these options have been set out in a recent report by the RAC Foundation, primed with investigating various ways of challenging current paradigms of automobile usage in the UK (Cairns and Harmer, 2011). The report offers an introductory exploration into the world of possibilities that abounds around access to cars. These offer the chance to break the mould and get away from the notion that households should own the cars they use. In our follow-up survey, we presented four such scenarios to pilot participants in order to gauge their levels of support. Respondents were presented with a series of electric vehicle usage scenarios and asked for their feedback.

The favoured alternative centred on whether respondents had a mobile phone contract and, if so, how they would feel applying a similar model to an electric

vehicle. This option was opposed to traditional ownership, so they would pay for usage of a car rather than owning the car outright. So it was that 63% of responses thought it a good idea in principle, 2.5% considered it suitable for others, 21% did not think it a good idea and 13.5% were unsure. Respondents were positive about this option providing that it offered tangible benefits over private car ownership that it seems to promise, as in the following representative quotes:

> Yes I have, mobile phone contract. I would pay for usage of a car depending on the monthly rate. (Germany)
>
> It sounds like a good idea as long as this service is less expensive than purchasing your own car. (France)
>
> I have never had a personal mobile phone - I would be ok with that form of contract for a car so long as it was not over-bureaucratic. (England)

Another well-liked option focused upon how respondents would feel about using an electric vehicle car-sharing scheme with an online membership and a variety of rental options – akin to the Paris Autolib'. Having paid a subscription, they could pick up a shared car from various points and pay a fee per mile as they use it. In this case, 45.3% of responses considered it a good idea in principle, 7% claimed it suitable for others, 30.2% did not think it a good idea and 17.5% were unsure. There was still some enthusiasm, tempered with a desire for more information and concerns about its applicability outside urban areas, as visible in these exerts:

> Yes, that sounds like a better option: you have the freedom to choose when to drive and you really get what you pay for. (France)
>
> It depends on what the costs per mile in relation to my current mileage rate. Living in a rural area I have a daily commute of 52 + miles. (Scotland)
>
> In the city, it sometimes makes sense. Public transport is fine. For longer journeys, it is no use. I would prefer a different model that recognizes the fact that I would not use it enough to make this economical for me. (Germany)

Less accepted was the notion of leasing electric vehicles on the existing car rental model, as often used by tourists. They would pay a fee to use the car for a set period of time and return it when it is no longer needed. With this option, 44.2% of responses suggested that it was a good idea in principle, 7% considered it suitable for others, 31.4% did not think it a good idea and 17.4% were unsure. Though there was positivity, questions of practicality were raised as shown by the following responses:

> If the price was right this would be an option I would consider but once again it comes down to how accessible this service would be: would cars

> be available when I need them? How flexible would car hire periods be? (Wales)
>
> I like this because it could replace your own car for occasional trips but it would have to be cost effective and practical. (Germany)
>
> Car leasing schemes are too expensive. Anyway, you don't need a car more than one or two hours. (France)

Finally, the least popular proposition looked at the notion a co-operative model of car ownership whereby the local community would purchase an electric vehicle. They would own shares in the car, with one or more vehicles available to book, as required and depending on the type of journey such as an electric car for short trips or a hybrid for longer trips. This time 45.5% of responses found it a good idea in principle, 5.1% considered it suitable for others, 44.3% did not think it a good idea and 5.1% were unsure. More respondents thought that this scheme might not work, especially with concerns over resultant logistical difficulties, as reflected in these statements:

> This idea sounds interesting but I imagine there would be a lot of problems in implementing it. Who would pay for it? Who fixes the problems? Who would be in charge? (Belgium)
>
> It is an interesting idea though it would depend on the availability of vehicles when I require them. In the current financial climate I doubt the community or local government would have the spare finances to purchase what would be a large number of vehicles. (England)
>
> Not sure about this. There would need to be one or more 'managers' of the car to ensure it is being used correctly and the car is cleaned etc. Could cause arguments among the community! (Ireland)

To varying extents, and with a range of caveats, such four options received considerable support – certainly more were in favour than against.

Having considered various alternatives for the future, the participants were asked what they saw the future of car ownership patterns over the next decade. There was a general pessimism as to the continued viability of motoring as it becomes increasingly expensive. If electric vehicles remain expensive, this prediction does not necessarily allow electric vehicles to be considered viable options under conventional ownership patterns. However, such circumstances might create fruitful conditions for electric vehicles under alternative usage models. This can be gleaned from these representative responses:

> Whilst the types of car being demanded may change with lower running costs, emissions, etc. I don't see the ownership patterns changing significantly at all. However with running costs increasing as they are this may, in fact, force some change not through choice but purely and simply

> because of the economics of car ownership and running. (United Kingdom)
>
> There is a great future for car-sharing, I think. It is regrettable that there is insufficient awareness of this concept. I hope the future generations will directly adopt it without thinking, 'I have to buy a car'. Despite the crisis we remain too much stuck in having our own cars. (France)
>
> I think more and more people will use the car-sharing options offered by different companies. The need for having your own car will decrease in urban areas. In the hinterlands, where public transport is not really existent, a personal car will still be needed. If the price for the use of public transport is much less than the price for holding a personal car, more people will use it. (Germany)

Electric vehicles seem worth considering as more than just another car in a crowded showroom.

Conclusion

Overall, the results of the initial questionnaire and follow-up survey combined suggest that there is a future for electric vehicles as a mass mobility node. However, this might not necessarily involve traditional modes of conventional ownership, certainly not while current purchase costs are so high and the resultant battery technology obtained is relatively poor for the sale price. For those interested in promoting electric vehicles for sustainability, then, they have a choice – somewhere along the line more investment will likely need to be made and finances devoted to making the electric vehicle market more attractive; this might require further prices subsidies for private vehicles or it might require research and development of more public alternatives. From our research, there is potential for both – as long as they are ultimately considered cost efficient by the end-user.

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