energy saving trust

Electric Private Hire Vehicles in London

On the road, here and now

UBER

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On the road, here and now

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Executive Summary

Since 2012, Uber has become a significant component of London's transport system, offering private hire journeys across the UK's capital. In consideration of the environmental concerns raised by tailpipe emissions from road vehicles, Uber is interested in understanding how greater adoption of fully electric private hire vehicles can be encouraged.

Between August 2016 and January 2017, Uber carried out an electric vehicle trial with over 50 partner drivers. Throughout this period, participant partner drivers drove fully electric vehicles while using the app. The purpose was to understand the realities of driving a pure electric private hire vehicle in London: what works well, what are the barriers, and how can these barriers be overcome?

Energy Saving Trust, an organisation well-established in the field of electric vehicle research, was appointed by Uber to monitor and analyse the trial. Surveys of the participant partner drivers were carried out at the start, the middle and the end of the trial. Two focus groups were also conducted. On a select group of vehicles, movement data was collected to quantify where vehicles were travelling and stopping around London. Energy Saving Trust brought these sources of data together to analyse the trial.

Partner drivers were drawn to the trial for a variety of reasons and drove one of three different pure electric vehicles – the Nissan Leaf (24kWh & 30kWh models), the BYD e6 and the Tesla Model S.

Both partner drivers and riders were impressed with the electric vehicles' performance and comfort. Partner drivers reported that riders noticed and appreciated the benefits of the electric vehicle and many felt like they had, in effect, "sold" electric vehicles from the journeys they had given.

Despite this, evidence from the trial shows that substantial improvement in private hire electric vehicle charging infrastructure - alongside expected improvements of vehicle range - is required to encourage significant uptake of fully electric vehicles within the industry.

Throughout the study period, the suitability of the vehicles' ranges for private hire driving - coupled with the difficulty in finding a suitable point for rapid recharging - was a continuous concern for partner drivers. This impacted their ability to complete private hire journeys as normal. Around 50% of partners declined journeys at least once a week, often with passengers in the vehicle, with many turning down journeys on a daily basis due to concerns over lack of range.

Movement data also showed that partner drivers operated in a more limited geographic area of London than typical for a vehicle operating on the Uber app. This further indicates concern over range and chargepoint availability.

As the majority of partner drivers did not have access to off street parking, on-street chargepoints were the most popular option for recharging. However, participants overwhelmingly reported the network as being insufficient in terms of both the number and distribution of chargepoints across the city, and time taken to charge their vehicle.

The economic viability of using a fully electric vehicle for private hire in London was ultimately limited by these factors. Most partner drivers reported wanting to drive at least an

additional 10 hours more per week than was possible, impacting their potential to make money through the Uber app.

The financial impact of this additional time off the road was mitigated during the trial by a mix of financial incentives offered to partner drivers taking part - including low vehicle rental prices offered by manufacturers. This helped limit any undue financial cost incurred by participants during the study, but also adversely created vehicle economics that would be very difficult to replicate at scale outside of the trial.

At the conclusion of the study, many partner drivers expressed an enthusiasm to continue using an electric private hire vehicle - assuming it continued to be economically viable. To make this possible outside of the trial conditions, installation of an extensive network of rapid charge points across London, alongside an expected future improvement in pure electric vehicle ranges, is pivotal.

These improvements will help reduce the current challenge of reliably and conveniently charging an electric private hire vehicle in London. If substantial developments in these areas are made, they offer a path to enabling pure electric vehicles to become the future of the private hire industry in the Capital.

Introduction

London's private hire industry provides transport services to millions of people working, living and visiting the capital. Consisting of over 86,000 licensed vehicles, the industry is not an insignificant presence on the capital's roads and, as with all non-Ultra Low Emission Vehicles, tailpipe emissions from these vehicles contribute to environmental issues.

One solution is to transition away from conventional fossil fuel vehicles to pure electric vehicles. A pure electric vehicle has zero tailpipe emissions and can, thus, reduce the impact of road traffic on local air quality. Despite motor vehicles having been in use for over a century, electric vehicle technologies are still relatively new to the market. As such, there are a number of barriers to overcome before they can be widely adopted.

Transport for London (TfL) is the regulator of all public transport in London. In consideration of the concerns surrounding London's air quality, it plans to introduce an Ultra-Low Emission Zone (ULEZ) into Central London as well as ratchet up the emissions limits for most road vehicles. For the licensing of private hire vehicles (PHVs), this will lead to a requirement to become zero emission capable (ZEC) – able to run without any tailpipe emissions. The current timeline for PHVs is outlined in Figure 1. To support this transition, TfL is developing a network of rapid chargepoints across London for the use of Taxis, PHVs and other commercial users. To support this transition, TfL is developing a network of rapid chargepoints across London for the use of Taxis, PHVs and other commercial users. It currently plans to deliver 150 by 2018 and 300 by 2020 (although at least initially, a number of these will be placed on taxi ranks or in taxi rest stops to support adoption of newly licensed ZEC taxis).

Date	Requirement
1 January 2018	Newly licensed PHVs must be: • Euro 4 if a petrol hybrid. • Euro 6 if any other model.
1 January 2020	Newly licensed PHVs must be: • ZEC if younger than 18 months. • Euro 6 if older than 18 months.
1 January 2023	Newly licensed PHVs must be ZEC.

Figure 1 - The current ratcheted requirements for licensing private hire vehicles in London. Source: TfL.

Since its introduction in 2012, Uber has played an increasingly substantial role in London's private hire industry and with urban mobility, more widely, across the capital. At present, around 60% of miles driven on the Uber app are completed in low-emission hybrid vehicles. In order to continue reducing the environmental impact of vehicles available through its app, and with consideration of forthcoming regulations regarding tailpipe emissions in a number of cities, Uber is exploring how best to facilitate adoption of fully electric private hire vehicles.

As part of this work, Uber carried out a trial of over 50 pure electric vehicles in order to better understand the impact that transitioning to electric vehicles will have upon the driver, the customer and the private hire business model. Uber was also interested in exploring what scale and configuration of infrastructure would be necessary in a city like London for large numbers of pure electric private hire vehicles to operate using Uber's model.

Energy Saving Trust (EST) was appointed by Uber to monitor the trial, analyse its findings and produce a report outlining the lessons learned from the trial.

Project Overview

EST has monitored this trial, engaging with partner drivers and analysing data captured throughout. This report details and discusses the results of the trial and outlines considerations for Uber and TfL to better enable a successful transition to electric vehicles across the private hire industry in the future.

Aims and Objectives

The aim of this project was to better understand the impact of using an electric vehicle on the Uber app and the realities of driving a pure electric private hire vehicle in London. The key project objectives to achieve this were:

1. Engage with partner drivers to understand their experience of using an electric vehicle.
2. Analyse journey data to understand the experience of using an electric vehicle.
3. Synthesise all data to provide a robust discussion for what can be learned from this trial for the future use of electric vehicles within the private hire market.

Contributors

EST is an independent, not-for-profit organisation, organised as a social enterprise with charitable status. It has engaged with hundreds of organisations, helping them to reduce fleet-related emissions and costs. It has experience engaging with and providing research for the private hire industry in London. EST has provided data capture, analysis and engagement on this project.

CleanCar has been developed by Fleet Innovations, a vehicle data specialist that helps businesses understand the potential for adopting electric and hybrid vehicles. Using plug-in GPS devices, CleanCar carries out analysis on journey data. Their analysis and raw data has been provided for this project.

Uber has provided insight on data collected via the Uber app.

Methodology

The mixed methods approach applied throughout this project takes into account both quantitative and qualitative sources. Partner driver engagement surveys and focus groups were carried out in coordination with Uber. For journey data, CleanCar provided analysis and raw telematics data and Uber provided insight on data collected on its app. These are outlined in detail in the following sections.

Volunteer drivers either rented an electric vehicle (offered at a low price by manufacturers for a limited number of vehicles during the trial) or in the case of the Tesla Model S, used their existing vehicle. They had the option to complete the trial or hand the vehicle back at short notice so that any problems they had using the vehicle didn't impact on their earnings or inconvenience riders.

The vehicles used in the trial were different in terms of specification, real world price and range:

- Nissan Leaf 24kWh
- Nissan Leaf 30kWh
- BYD E6
- Tesla Model S

Surveys

A series of three surveys was distributed, via Uber, to partner drivers taking part in the trial. Three were carried out in order to appreciate potential variation in the participant's experience throughout the trial.

Number	Reference	Responses
Survey 1	Start	56
Survey 2	Middle	31
Survey 3	End	53

Figure 2 - Details of the survey series carried out for the trial. The reference is how the surveys will be discussed throughout this report.

The nature of the trial resulted in partner drivers joining at different times, leaving at different times and changing vehicles. Consequently, progression through the surveys was not always linear and responses for different surveys overlapped. However, with 140 responses from a total of 108 participants, the response rate has been substantial enough to provide a valid and useful analysis. 19 participants could be identified as completing all three surveys, but it is highly likely that more drivers also did, but could not be uniquely identified as doing so.

The surveys were designed to be wide-ranging with a mix of closed-ended and open-ended questions. Closed-ended response formats included multiple choice, single select and numerical ranking. 14 of the questions were kept as standard throughout all three in order to measure the experience variation, as discussed above.

Analysis

For closed-ended questions, simple statistical methods were used to analyse the responses. Open-ended questions were analysed using a qualitative data analysis approach involving thematic coding before integrating with the remaining data. A full list of the methods employed for the survey analysis is given below:

- Filtered responses for errors
    - Corrected if possible
    - Removed if not possible
- Synthesised the three surveys
- Used a DVLA lookup of VRNs to confirm vehicle make and model
- Identified responses from same partner drivers
- Prepared responses for analysis
    - Simple quantitative analysis
    - Qualitative analysis
- Imported responses into qualitative analysis software
- Coded responses to selected open-ended questions
    - Used an emerging code rather than a pre-defined code
- Returned coded responses into collective database
- Queried each question to understand responses to question.

Focus Groups

Uber arranged for two focus groups to provide EST with an opportunity to investigate the participants' experience on specific subjects through dialogue and discussion between the partner drivers.

These were carried out on Wednesday 30 November 2016 and Wednesday 14 December 2016 with attendance of over 10 participants at each event. Both followed the same structure, designating periods of time to cover the following topics:

1. The vehicle
2. The charging
3. The costs
4. The rider experience

A staff member from EST moderated the focus group while another recorded the discussion. The moderator contributed where they thought it would be beneficial to the discourse and sought to strike a balance between allowing the conversation to flow and allowing every participant to have their say.

These focus groups also gave an opportunity for the partner drivers to discuss the Uber app with staff from Uber. Any general discussions that were not specific to the trial were not recorded as part of this research.

Journey Data Analysis

CleanCar devices were installed in four vehicles and journey data was collected and analysed from 11 November 2016 to 17 January 2017. This data included:

- Time/date stamp
- Latitude/longitude coordinates.

The benefit of this data is that it is not dependent on the Uber app being switched on. It can therefore provide a more holistic insight into the operation of an electric vehicle across the entire day.

CleanCar analysis was carried out on the data and the analysis and data was presented to Uber and EST on 1 February 2016. This has been used for consideration later in the report.

Findings

This section brings together the results of the trial from data gathered via the mixed methods approach outlined in the previous section. These findings have been broken down into seven sub-sections. The first is a profile of the partner drivers participating in the trial. Second, an analysis of the journey profile of the trial. Then, each of the four key topics of consideration in the surveys and focus groups: vehicle, charging, economics and rider experience. The final sub-section focuses on the overall experience and opinion of the partner driver.

Partner Drivers

In total, 108 partner drivers were involved in the trial between 29 August 2016 and 16 January 2017. During the trial, a notable number of partner drivers opted to return their vehicles and end their participation. Of these participants, 25% returned their vehicles within three days and, therefore, had limited subsequent participation in the trial in terms of the survey, focus groups or telematics data collection. Upon leaving the trial, partner drivers were replaced swiftly with new participants, ensuring continuity in the number of people taking part in the study.

The results of the Start survey provide a useful insight into the background of the partner drivers. An open-ended question was asked about why they chose to take part in the research. Responses were coded and a number of key themes emerged: financial benefits, personal (non-financial) benefits, environmental benefits and industry benefits. While many responses reflected these themes generally, some sub-themes emerged within each group. Frequency of references to these themes is outlined in Figure 3.

The most common key theme was the associated financial benefits with the trial. Most of these references did not detail specifics but many noted the savings made possible from the lower costs for refuelling or vehicle lease. However, it is important to note that the financial incentives made available to partner drivers taking part in the trial (principally the lower than usual cost of renting an electric vehicle, offered by manufacturers), are likely to be partially responsible for these answers. Thus, it is difficult to extrapolate these views across the wider private hire industry.

Another key theme was the environment. Many partner drivers showed they were passionate about doing something to reduce their environmental impact. Marginally more responses referred to the issue of local air quality than climate change but most referred to the environment non-specifically.

Other key themes included industry and personal benefits. Industry benefits referred to the benefit the private hire industry in London would get from their participation in the trial. Personal benefits referred to any benefits that were beyond financial aspects. Most of these highlight the novelty of the vehicles and that they represent the technology of the future.

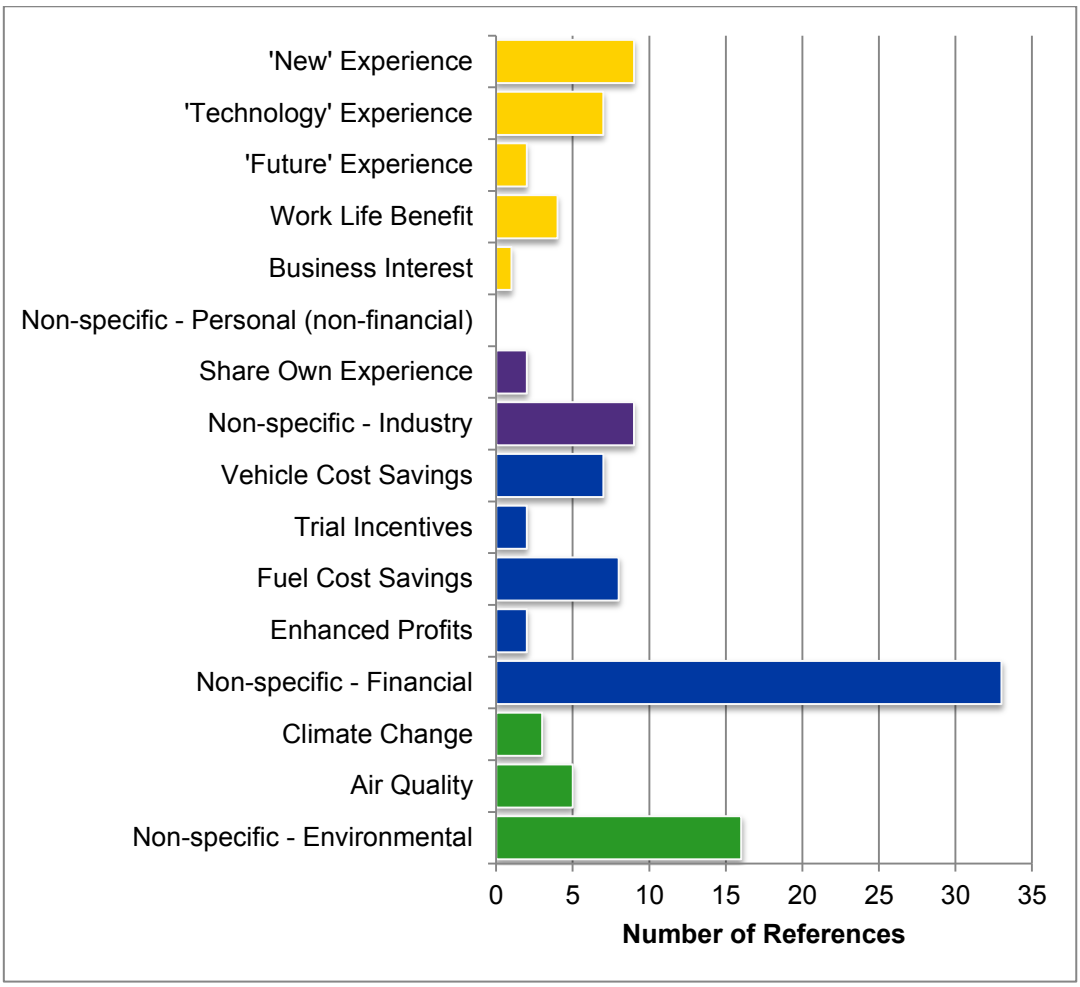

Figure 3 - Emergent themes from the responses to: 'Why have you chosen to take part in the Uber electric vehicle trial?'

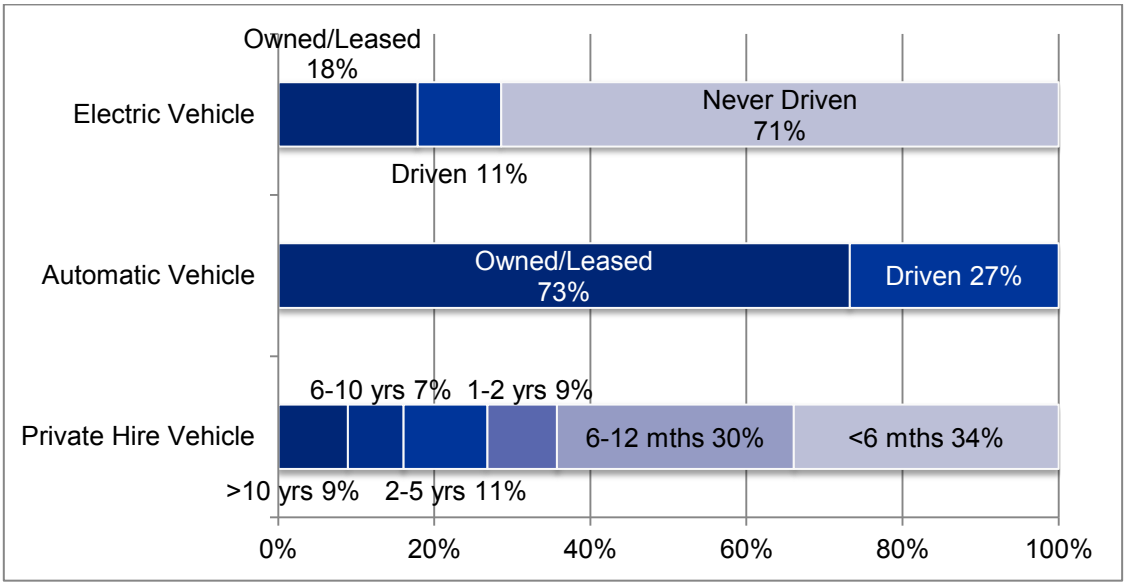

Figure 4 – Experience profile of partner drivers in terms of experience of electric, automatic and private hire vehicles.

Figure 4 highlights the partner drivers' experience. In terms of experience as a driver within the private hire industry, most (64%) responded that they had only been driving for a year or less. However, with 9% reporting experience greater than 10 years, a full spectrum of private hire driving is represented within the data.

Everyone indicated that they had at least some experience of driving an automatic. This is of relevance because all electric vehicles are, in effect, automatic. This can be a barrier to electric vehicle uptake if drivers are accustomed to or have a preference for driving a manual transmission. The result is not surprising considering the presence of automatic vehicles within the private hire fleet. The Toyota Prius is a common model in London and 30% of the responses indicated they drove one prior to the trial. As a conventional hybrid, the Toyota Prius has automatic transmission. Prior experience of driving a Toyota Prius could act as an aid to the transition to a pure electric vehicle.

For 71% of the group, this was their first occasion of driving an electric vehicle. As already mentioned, some partner drivers used their existing vehicle (principally the Tesla Model S) for the trial. While experience of automatics will make the transition easier, other aspects of driving an electric vehicle will require getting used to, notably, charging.

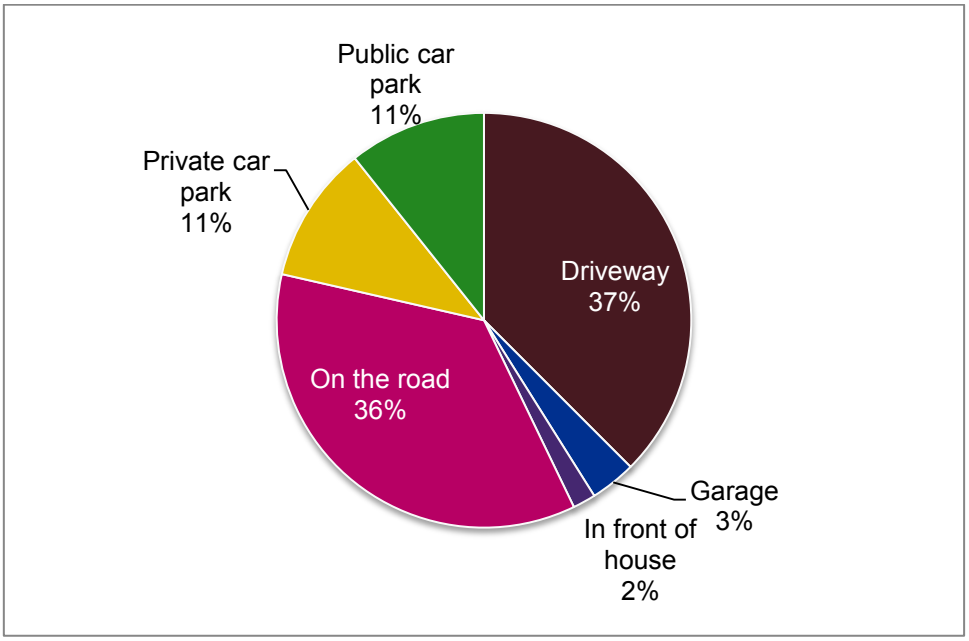

Figure 5 - Responses to 'When at home, where would you park your vehicle?'

Figure 5 provides a breakdown of where partner drivers park their cars at home. Inclusive of driveways and garages, 40% of the participants said they parked on their own property. Understanding this is important because being able to park on your own property provides the potential to install a private chargepoint and charge at domestic electricity rates, allowing drivers to maximise the cost-effectiveness of their electric vehicle. This opportunity is widely considered pivotal for the early adoption of electric vehicles within the private hire industry as it reduces the requirement to charge during driving hours and enables the driver to ensure their vehicle starts the day fully charged.

During the trial, the number of partner drivers who indicated that they had access to off-street parking on their own property was flagged by Uber as being something of an anomalous number. From internal surveys and data not collected as part of the trial, Uber understands that no more than 5% of people driving on its app in London have access to off

street parking on their own property. It is therefore possible that either this trial over-indexed on partner drivers with off street parking – or that the survey question was misunderstood by some.

While the driveway was reported as the most popular location for parking the vehicle, parking on the road was almost equally common at 36%.

Journeys

Throughout the entire trial, close to 200,000 miles were driven by the electric vehicles. CleanCar collected data on a small sample of this. Figure 6 shows a distribution map of this data.

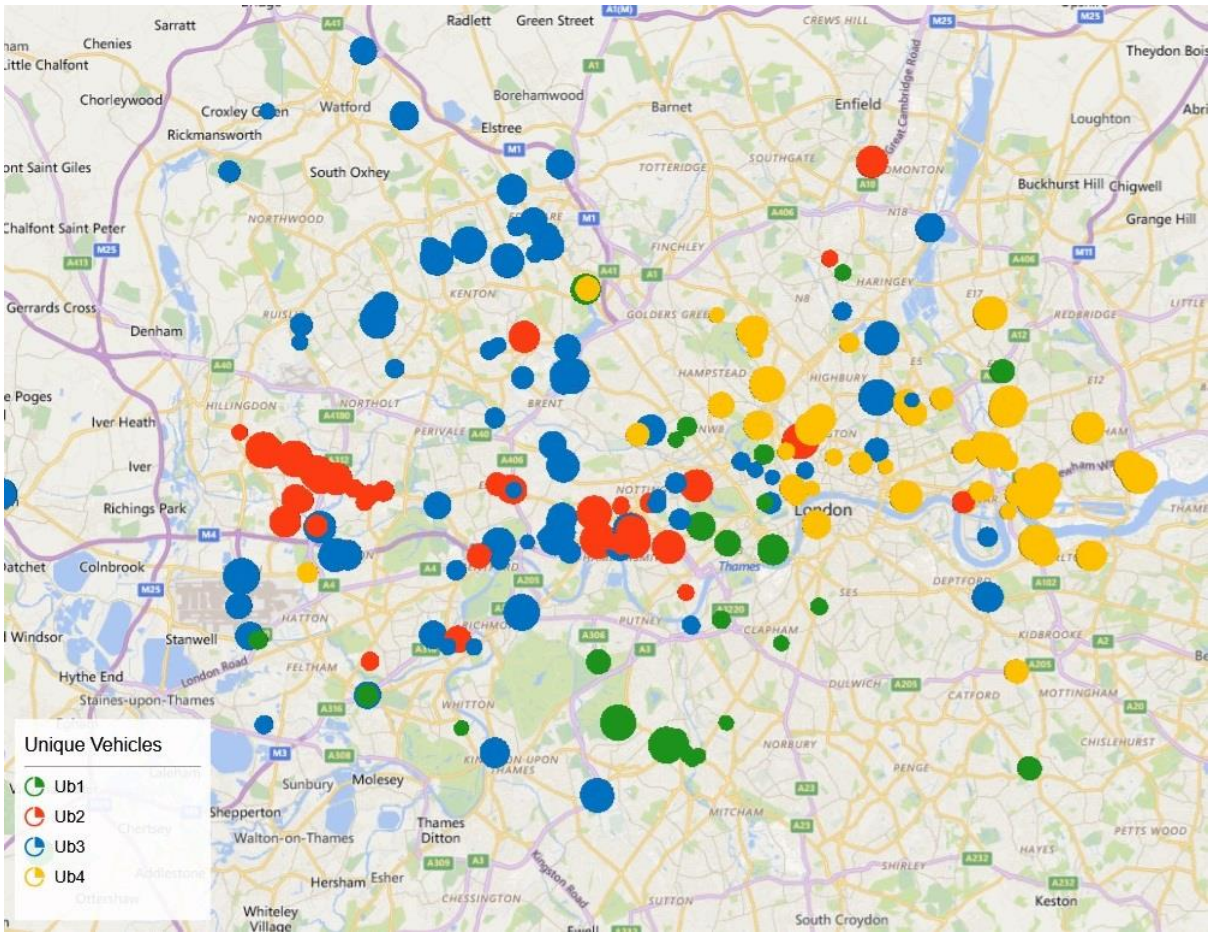

Figure 6 - Heat map of vehicle stops measuring duration and location per unique vehicle.

On Figure 6, each vehicle is identified by a unique colour and each circle represents one stop. The larger the circle, the longer the duration of the stop. Therefore, the largest circles are likely to indicate places where a vehicle parked and may have charged.

From this it is clear that the partner drivers studied tended to drive within a relatively limited geographical area. According to Uber, although many journeys made using the app are local, the distances driven by these four vehicles do appear to be less than would be typically expected. The exception is Vehicle 'Ub3' which drives far greater distances than the others. These variations could be due to differing vehicle ranges or driving patterns (driving a higher or lower number of hours) but equally, could suggest that vehicles in this trial may have their working mileage limited by range.

Vehicles

Three models of electric vehicle were used in the trial: Nissan Leaf, BYD e6 and Tesla Model S. Figure 7 shows the number of each of these vehicles, calculated from the number plate data given in the survey. All three have been used as private hire vehicles in London prior to the trial. The main focus of the trial was on the Nissan Leaf and the BYD e6. Two versions of the Nissan Leaf were used: one with 24kWh battery capacity and one with 30 kWh battery capacity. The Tesla Model S was included as a number of partner drivers already own these vehicles. However, as this vehicle is of a considerably higher specification - particularly range capability - partner driver experience could well be different too.

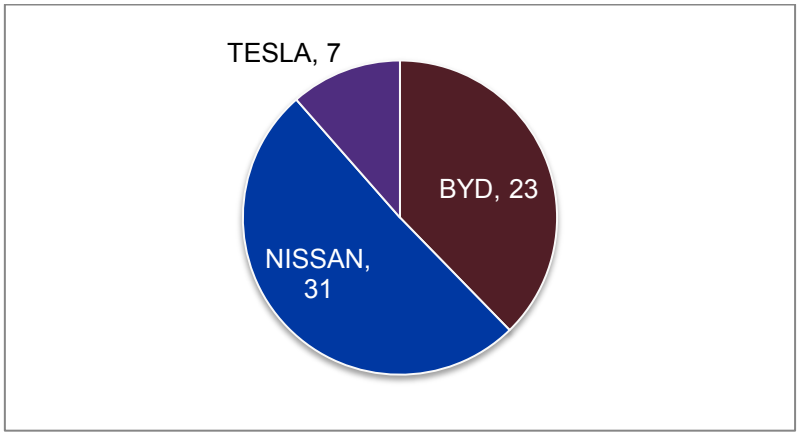

Figure 7 - Responses to 'Which electric vehicle will you be using for the trial?'

72% of all responses indicated use of the electric vehicle every day with only one or two answering that the vehicle is used ‘once a week’ or ‘less than once a week’. This aligns with the assumption of drivers using their vehicle, either commercially or personally, six days a week.

Figure 8 provides an overview of the partner drivers’ opinion of the vehicles. Overall, partner drivers were happy with the specification of the vehicle. These sentiments were echoed in the focus groups. Participants expressed satisfaction with the driving experience provided by the vehicle, stating that it is comfortable and smooth. There were also positive responses regarding the size and shape of the vehicle and references to how rider luggage fitted in without issue. This is evidence that these aspects of the vehicle specifications would not be a barrier to electric vehicle adoption.

However, scores for the suitability of vehicle range for private hire driving were considerably lower. In focus groups, the range was considered an issue on all vehicle models excluding the Tesla Model S. Driving on motorways and the use of heaters were considered problematic as they reduced the range of the vehicle. Partner drivers mentioned actions taken, such as declining airport journeys or limiting heater use for when riders were on board only. Furthermore, Uber reported that of the vehicles exchanged, the most common was an upgrade from the 24kWh to a 30kWh Nissan Leaf. As indicated on Figure 9, over 50% of the survey participants believed a daily range of over 120 miles was required to make the vehicle worthwhile on the Uber app. This collectively indicates that with the current available charging infrastructure in London, vehicle range is a key barrier to adoption.

Looking at Figure 8 it is worth noting that scores all dropped during the End survey. This is likely to be affected by the season at the time of completion of the trial. Most responses came in winter and just after the holiday period. This period is more commonly associated with greater passenger demand for journeys to and from airports, as well as colder

temperatures. This could be a link connecting the two limiting factors identified above – more airport journeys and more frequent heater use, the combination of which means vehicle range is decreased at a time where fare mileages increase. Furthermore, numerous other studies have identified the range-depleting effect of cold temperatures on electric vehicle batteries.

It should also be noted that winter is traditionally a high-earning period for private hire drivers. The scores from the driver survey could also therefore reflect that inconveniences which led to time off the road, during this busy period, were more acutely noticed by partner drivers.

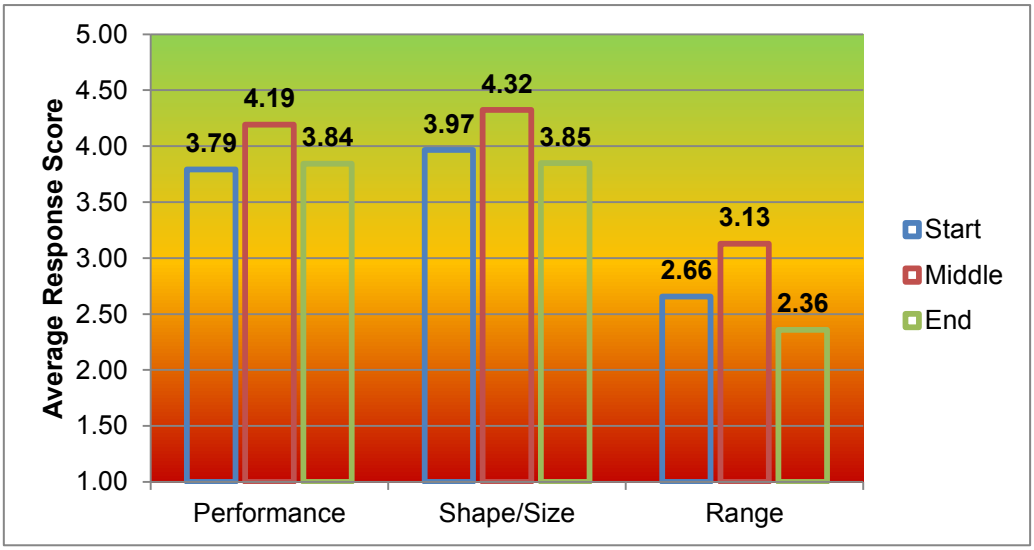

Figure 8 - Mean average scores of responses to 'How positive or negative has your experience been regarding the following aspects about the electric vehicles?' 1 = most negative; 5 = most positive.

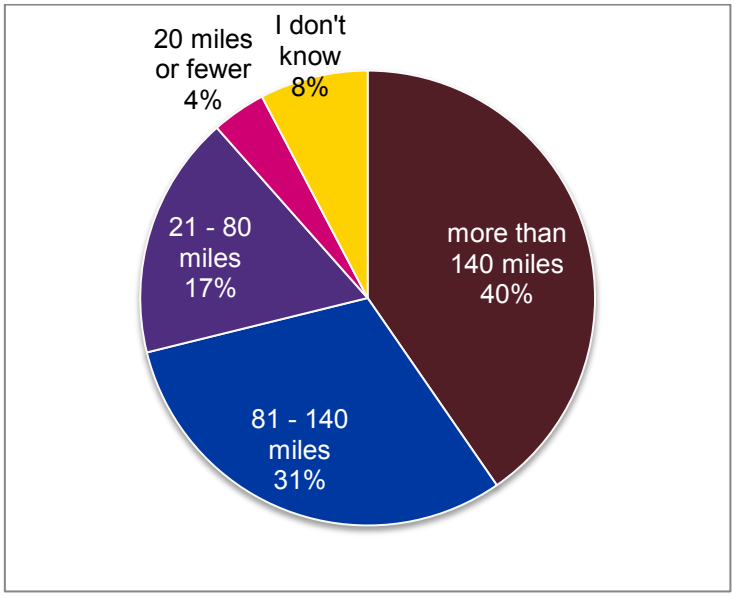

Figure 9 - Responses to 'What is the minimum daily range to make using an electric vehicle on the Uber app worth it?'

Charging

A factor critical to the success of the trial is the ability to sufficiently recharge the vehicle. This topic provided considerable discussion within the focus groups and has many aspects to analyse.

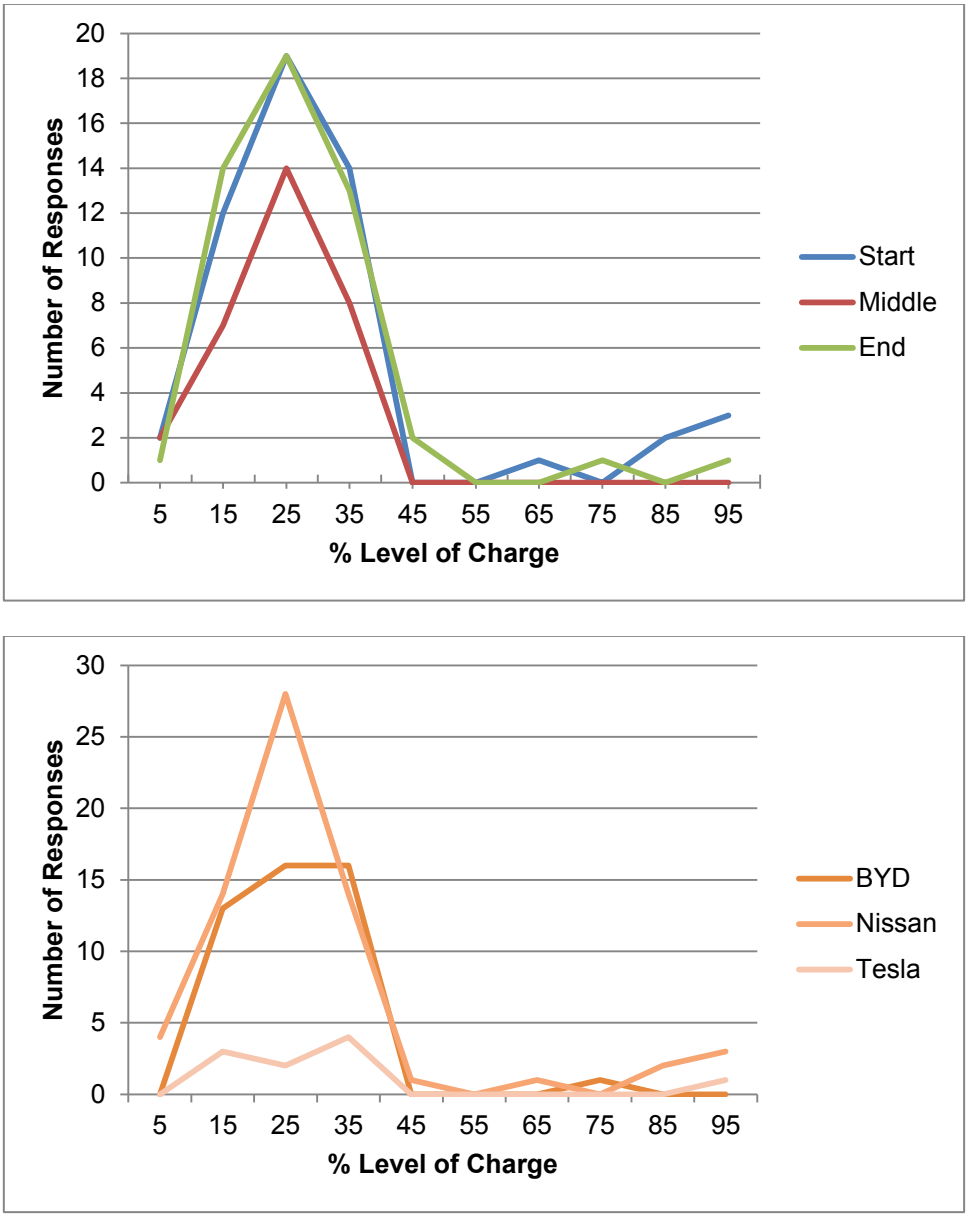

Figure 10 - Responses to 'What level of battery charge would you consider to be insufficient to continue working and require you to recharge?' Top: the difference between surveys. Bottom: the difference between vehicles.

Firstly, it is interesting to consider the behaviour of partner drivers with regard to the remaining level of battery charge when they considered it necessary to recharge. Except Tesla, for all categories displayed in Figure 10, the most common response was '21-30%', hence, the peak at 25%. Most partner drivers would consider recharging with a range of 10-40% charge remaining. This shows partner drivers had confidence with over 50% range remaining but would begin looking for an opportunity to recharge a good distance short of

the real world range of their vehicle. It should also be noted that this finding remained constant over the course of the trial.

It is clear therefore that what matters for private hire drivers is not the absolute real world range of a vehicle, but rather the real world range minus approximately 25%, as this is the point most will begin looking for a chargepoint. It is possible to infer that this is in part due to partner drivers making conservative estimates of a vehicle's range due to fear of running out of charge, but it is also likely that this is reflective of their lack of confidence in the current charging network available to private hire drivers. For vehicle models with very limited range this finding could be significant in assessing their suitability for current private hire use in London.

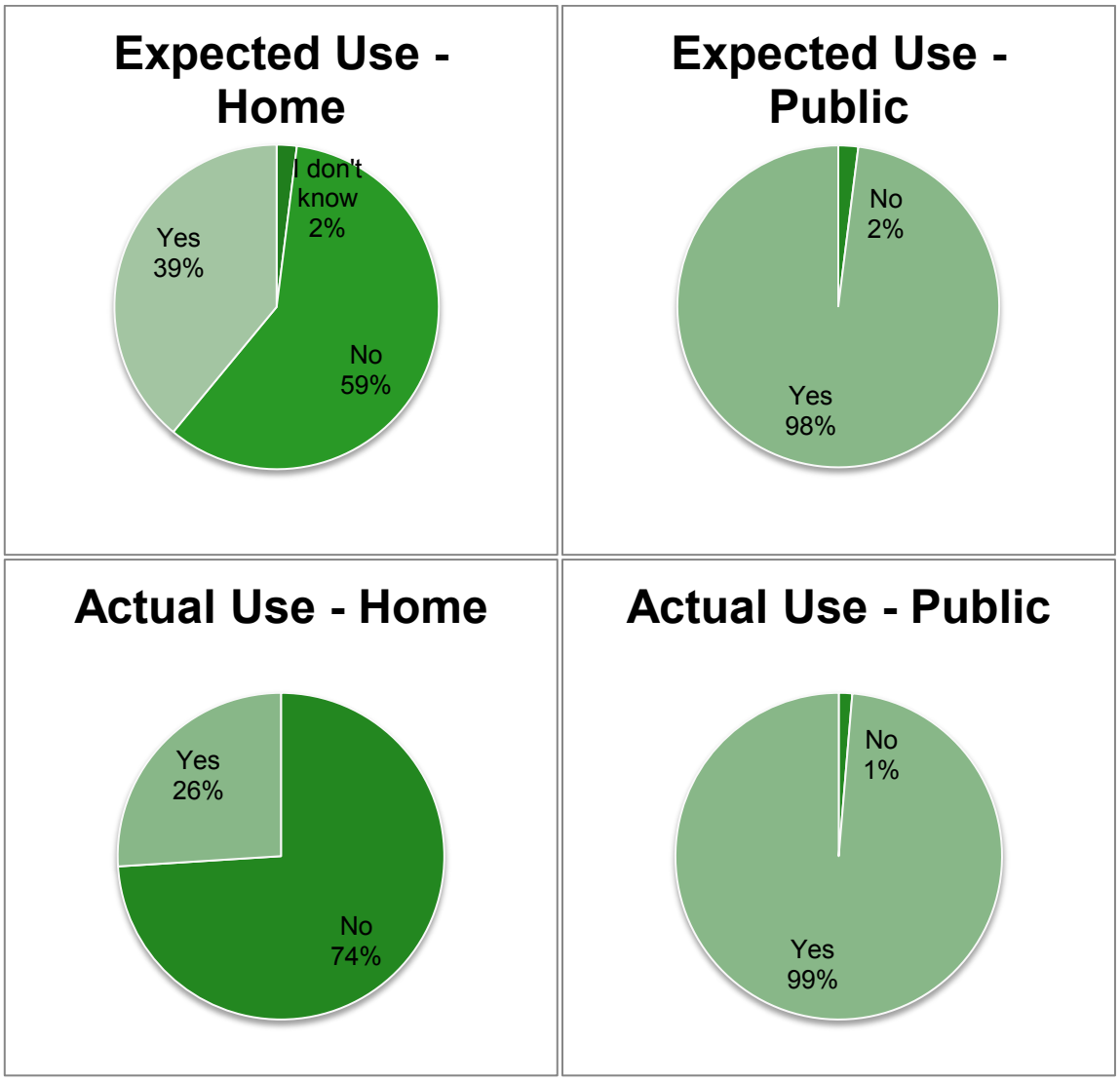

Figure 11 – Responses to: 'Will you charge your electric vehicle at home during the trial?'(top left); 'Will you charge your electric vehicle using public chargepoints during the trial?'(top right); 'Where have you charged over the past 4 weeks (select all that apply)? (bottom both).

Figure 11 outlines a comparison of usage of home and public charging infrastructure. The only notable deviation came in the response to home charging: fewer people charged at home than thought they would. A possible reason for this is three-pin plug charging capacity emerging as inadequate. When asked in the Start survey, 'How will you charge your vehicle at home?' the most popular option (41% of the responses) was 'I will use a three-pin plug to plug into my property's mains'. However, none of the participants in either focus groups mentioned this method was used.

One possible explanation for this is that many participants may have filled in the survey when they had just received their vehicle without fully understanding the complications (such as the cost of a specialist cable) of charging a vehicle from a three-pin plug socket. They may also have misunderstood the type of off-street parking required to charge their vehicle at home.

As only a very small number of participants in the trial installed at home chargers, it is likely that these partner drivers, and a number who used on-street chargers near their home, make up the 26% of respondents who said they charged at 'Home'.

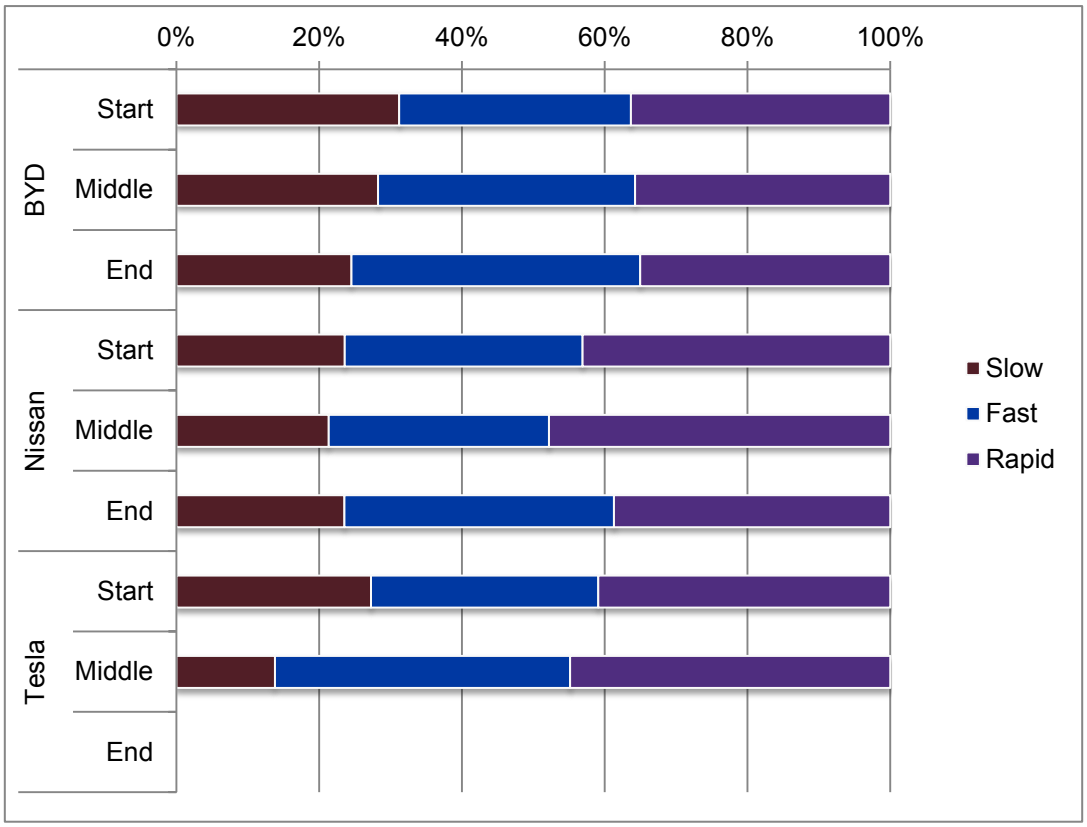

Figure 12 - Responses to 'Using a scale of 1 to 5 (1= never use, 5 = use very regularly) what type of public chargepoint do you use most frequently?' Scores have been compared by converting them into a percentage of the total.

All three surveys showed partner drivers were using a range of chargepoints in terms of speed. However, rapid and fast chargepoints are consistently scored as being used more than slow chargepoints, across all vehicles. BYD drivers have responded with lower usage scores for rapid chargepoints. This may be reflected in the differing specifications of the vehicles and availability of suitable infrastructure.

Figure 13 shows the popularity of chargepoint location type. With no averages reaching a score of 4 or 5, it can be concluded that partner drivers used a variety of locations and did not use a single network or location. On-street charging was attributed with the highest average scores and this was reflected in the coding of free text responses to a similar question (Figure 14).

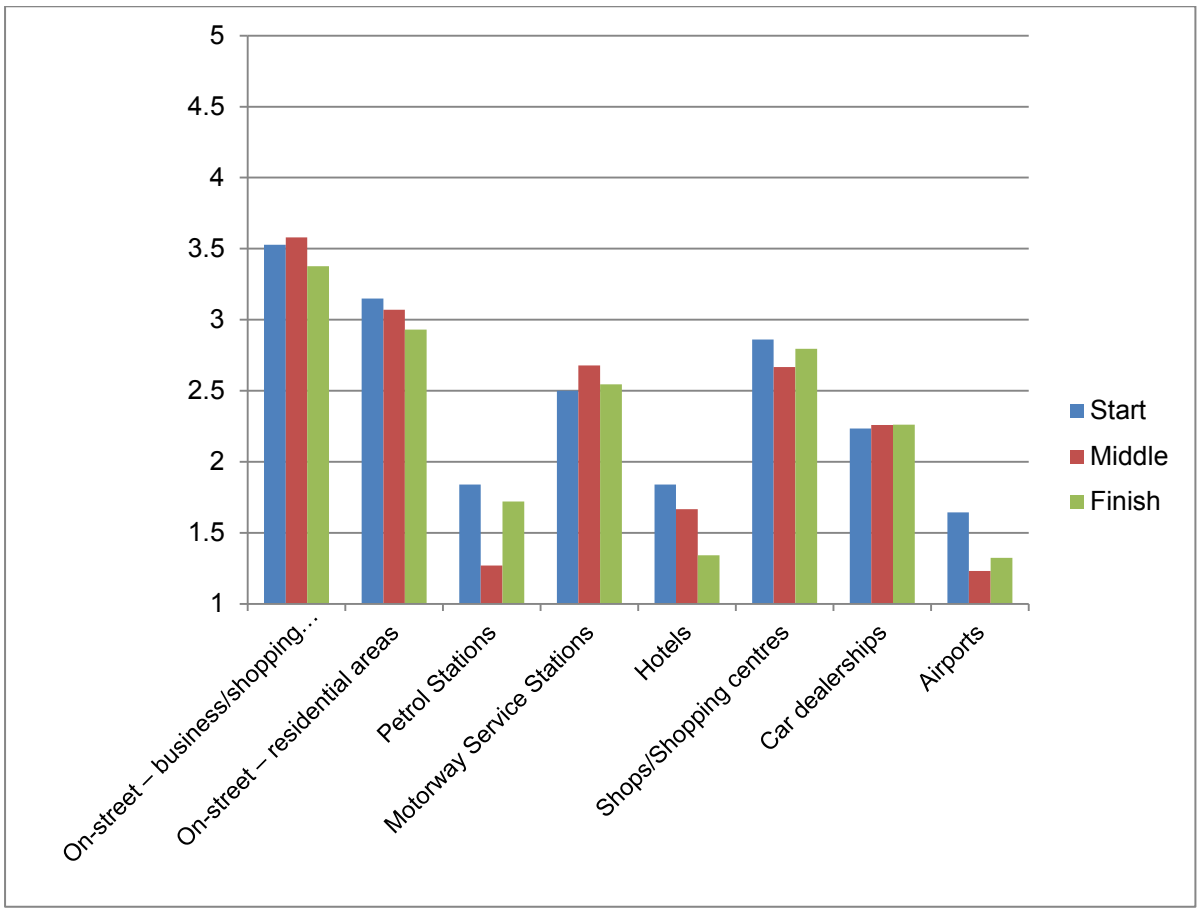

Figure 13 - Average responses to 'Using the scale (1 = never use, 5 = use very regularly), what type of location do you visit most frequently for public charging?'

What emerged was greater granularity of the 'shops/shopping centres' option defined in the previous question, specifically 'Supermarkets' and 'Major Retail Parks'. The 'Major Retail Parks' theme was ranked highly because the most frequently recurring unique response was 'Ikea'. IKEA offers rapid charging at all its UK stores[1], the costs of which are discussed in the economics subsection. With three stores within the M25, partner drivers have identified IKEA chargepoints as convenient. However, in one focus group a limited capacity was identified – queuing is quite often necessary. It is therefore possible that use of rapid chargers at IKEA sites was as indicative of a lack of other rapid charge options as it was of partner driver preference for using these sites.

On-street charging was predominantly the most common location for recharging. Deviation between the two questions' responses in terms of 'residential' or 'business' locations are likely to be attributable to subjective differences in definition – many on-street locations had commercial and residential properties in proximity.

[1] Further details are available on the IKEA website: http://www.ikea.com/gb/en/ikea/electric-vehicle-charging/.

	Start	Middle	End
1	Major Retail Parks	On-street (Residential)	On-street (Residential)
2	On-street (Residential)	Major Retail Parks	Major Retail Parks
3	Supermarkets	Public Car Parks	Public Car Parks
4	Public Car Parks	On-street (Business)	On-street (Business)
5	Car Dealerships	Private Car Parks	Supermarkets

Figure 14 - Emergent themes from responses to 'In which specific location(s) do you charge your vehicle most often?' In order of most commonly occurring theme.

Theme	References
London-wide	16
Petrol Stations	16
Airports	13
Proximity to Home	13
Central London	11
Supermarkets	11
On-street	10
Train Stations	7
Public Car Parks	4
Hotels	3
Shopping Centres	3
Fast food Restaurants	2
Parks and Squares	2
Motorway Service Stations	1

Figure 15 - Emergent themes from responses to 'Are there any locations you would like chargepoints to be installed?' Responses synthesised from all three surveys and ranked in order of most commonly occurring theme.

All three surveys asked an open-ended question on where partner drivers would like chargepoints to be installed. Emerging codes highlighted particular concerns. Firstly, many responses wanted chargepoints ‘everywhere’, suggesting the current density and/or spread of the chargepoint network was insufficient. Secondly, many responses wanted a greater network specifically in Central London. Thirdly, responses wanted chargepoints closer to home.

This topic was explored in detail in the focus groups. Participants relayed situations whereby charging had a considerable impact upon their day-to-day lives. Some partner drivers walked 30 minutes from the nearest chargepoint to their houses, in order to charge in between the hours they drove. Others mentioned getting up in the middle of the night in order to use a charger when it was available.

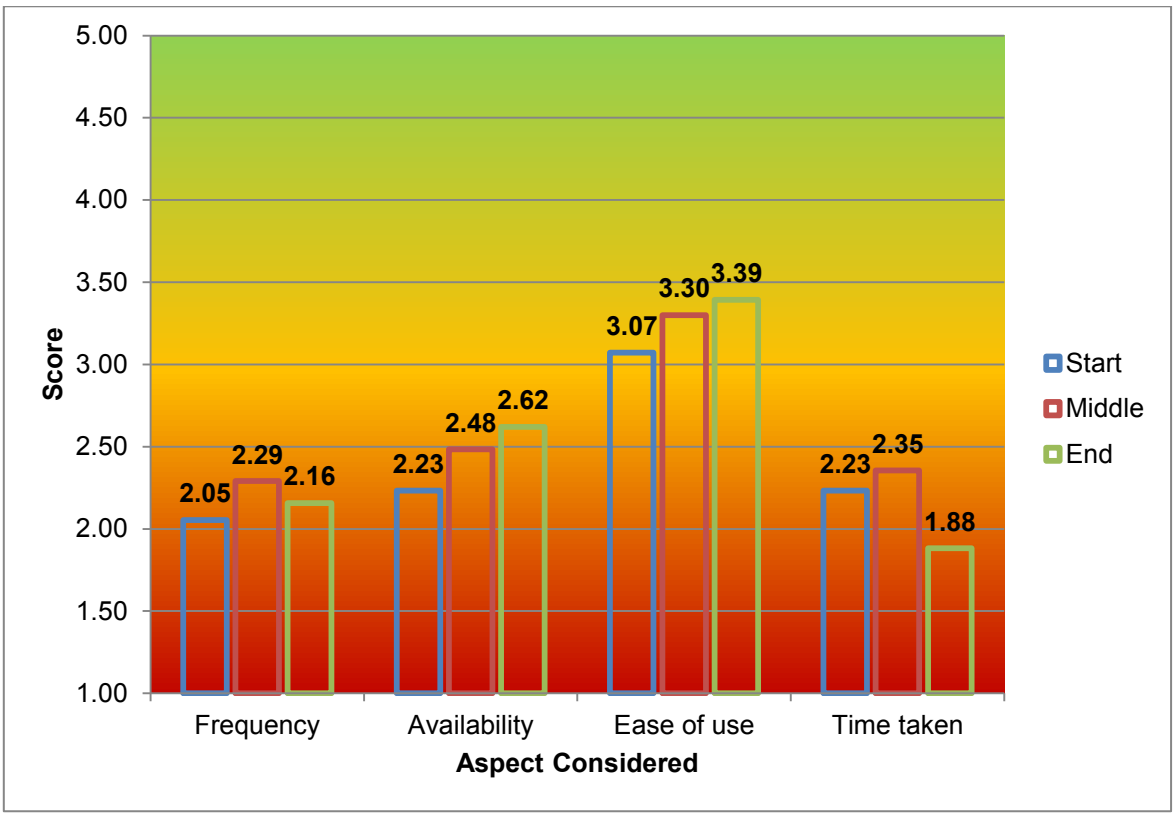

Figure 16 - Mean average scores of responses to 'How positive or negative has your experience been regarding the following aspects about charging infrastructure?'

Finally, the surveys asked for opinion scores on four aspects of charging. The results of these are shown in Figure 16. Compared to opinion scores of other aspects of the trial, these rank among the most negative. However, scores for availability (whether the chargepoint could be used) and ease of use (the ease of the charging event) consistently improved through the trial. This may be a result of experience – the more practiced the partner driver is in charging, the easier and more successful the event is. In focus groups, participants mentioned circumstances of chargepoints being out of service or fully occupied. Advice on how to overcome such issues was shared freely among participants of the focus group. Sufficient provision of information and protocols for chargepoint use should be considered further here.

In contrast, the lowest scores were for frequency (the number of chargepoints in the network) and time taken (the duration of the charge event) showing that, unsurprisingly, even with greater experience the time taken to charge and the ease of finding a charge point did not improve. This was reflected in the focus groups where there was widespread agreement that the number of chargepoints and the speed of these chargepoints needs to increase. These are two key barriers to the adoption of electric vehicles on the Uber app in London.

Economics

As shown in Figure 3, the most common reason for participation in the trial related to financial factors. To allow for a successful migration to electric vehicles, the transition needs to be financially viable for all parties. This subsection discusses aspects affecting expenses and income during the trial.

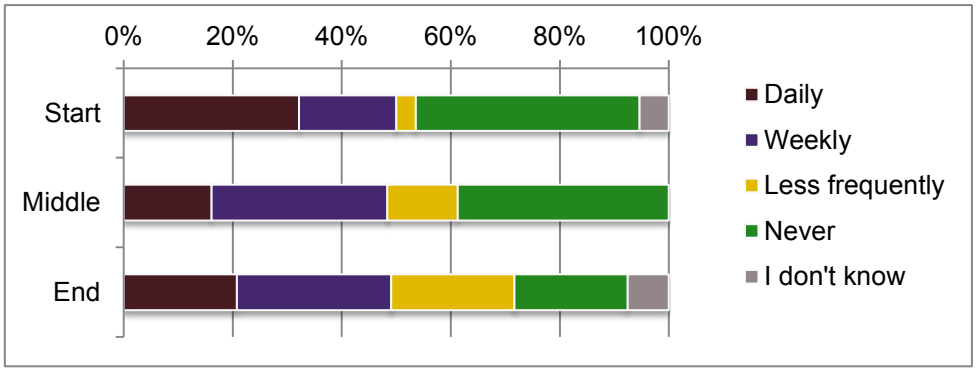

Figure 17 - Responses to 'How often have you declined a journey because your vehicle did not have the range?'

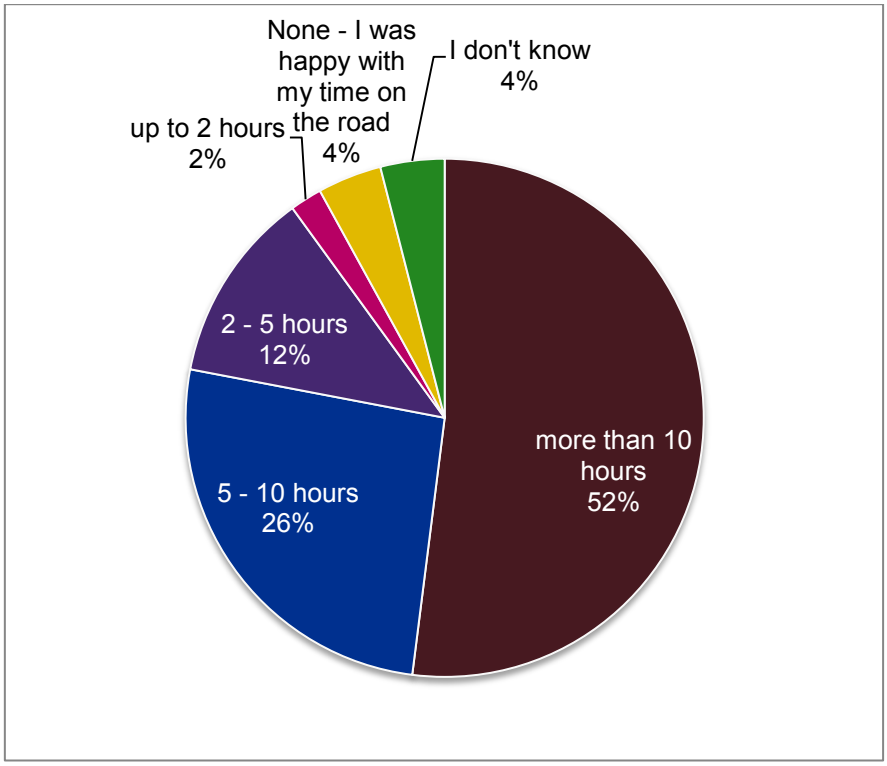

Figure 18 - Responses to 'How many more hours per week would you have wanted to be on the road if charging was easier and faster?'

Income was affected by partner drivers having to decline journeys due to lack of range. Figure 17 shows that the proportion of partner drivers passing up journeys increased through the trial. Despite this increase, the proportion responding that declines were daily or weekly remained stable, at around 50%. This is a level that would be affecting the partner driver's ability to work.

Passing up journeys was discussed in the focus groups. It was suggested by partner drivers that in order to reduce journey rejections, the Uber app could give greater clarity to partner drivers about the direction and length of a trip before they accept. At the time of writing, whilst this feature is not available on all Uber journeys, the Uber app now allows driver to set their preferred destination twice a day (for example a charging station) and then only be dispatched journeys going in that direction. This would now allow partner drivers to head towards a charge point, knowing they'll have the range to complete any journey request they receive through the Uber app.

A second concern identified in focus groups was the working time lost due to charging. This issue is reinforced with the survey responses outlined in Figure 18. With over 50% of responses stating a desire to work in excess of 10 additional hours, time lost as a result of charging is a major barrier to the financial viability of electric vehicles.

In terms of expenses, focus group participants were more positive, indicating fuel costs were cheaper than for a conventional vehicle. However, it was evident that costs were highly variable depending on how the vehicle was charged, with different networks operating different pricing structures. Furthermore, as part of the trial design, specific pricing deals were negotiated with a limited number of charging companies. Beyond the trial is unlikely such deals would be made widely available at scale.

The uptake of any vehicle technology is highly sensitive to fuel cost. Partner drivers noticed price changes occurring during the period of the trial. One specific example raised in both focus groups and surveys was the introduction of payments when using IKEA's chargepoint network (operated by Ecotricity), which became £6 per 30-minute charging session on 14 November 2016. Such events impacted partner drivers' perceptions of electric vehicle costs, and future uncertainty in terms of pricing can limit the long-term adoption of these vehicles. An indicative cost comparison of fuel prices is given in Figure 19, below.

Fuel	Pence per litre	Real world MPG	Pence per kWh	Real world Miles/kWh	Pence per Mile
Diesel	121p	49.61			11p
Petrol Hybrid	119p	60.59			9p
Electric (Home)			12.1p	3.4	3.6p
Electric (Ecotricity)			30p	3.4	8.8p

Figure 19 - Indicative fuel price comparison between typical private hire vehicles.

As shown in Figure 20 (following page), profitability was consistently given a lower score than fuel costs. In focus groups, many participants concluded all financial aspects are lower with an electric vehicle. Expenses were lower during the trial, but, so was income. It is important to note, however, that without the special financial conditions available to most partner drivers taking part in this trial, expenses would have been much higher – and this balance disrupted.

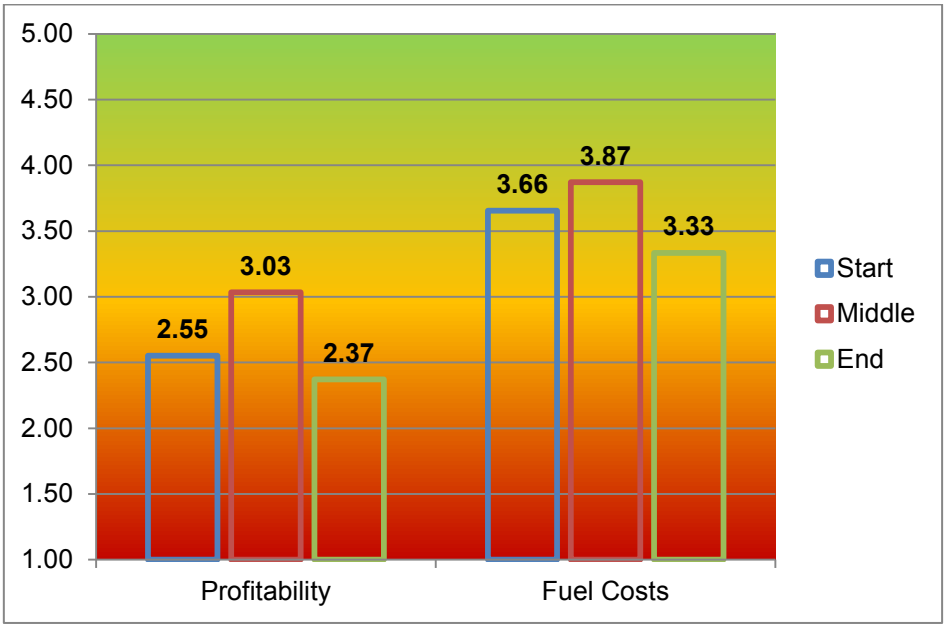

Figure 20 - Mean average scores of economic responses to 'How positive or negative has your experience been regarding the following aspects about how electric vehicles have impacted your work and home life?'

Rider Experience

Over 35,000 unique riders were involved in the trial. It was reported that riders commonly noticed the vehicle technology, either by noting that it was a different vehicle from outside, or from the experience of the drive from the inside. This is evident from Figure 21 – 67% of partner drivers reported riders discussing the electric vehicle technology at least once per work period.

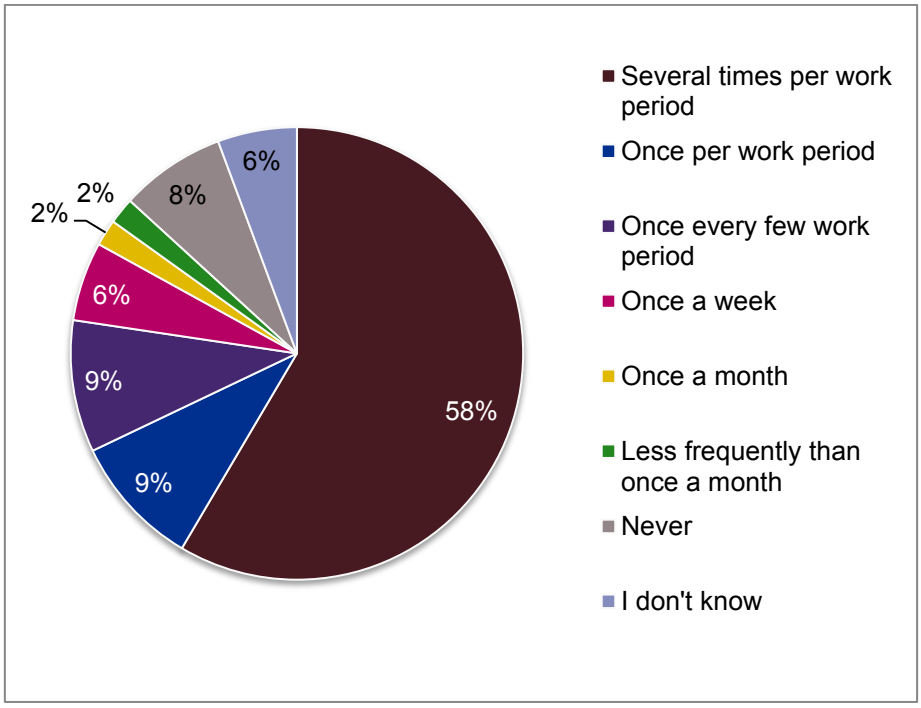

Figure 21 - Responses to 'How often did riders react or comment on the vehicle being electric?'

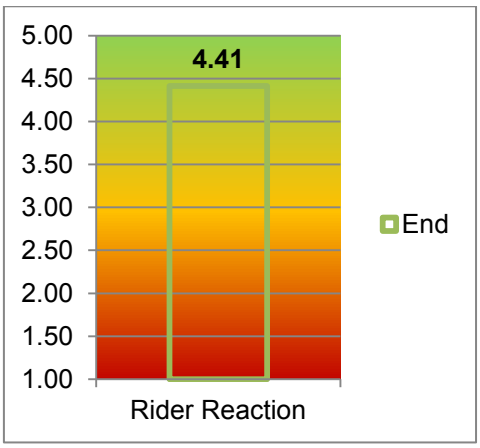

Figure 22 - Mean average scores of partner driver responses to 'Using a scale of 1 to 5 (1 = very negative, 5 = very positive), on average, how positive or negative were riders reactions or comments on the vehicle being electric?'

The opinion score for rider reaction asked in the End survey returned the most positive score from all surveys. The resulting discussion prompted by the rider's reaction to the electric vehicle appears to have been enjoyable for both parties. Comments mentioned riders 'loved' their vehicle and, in return, liked engaging in this conversation. Some participants of the focus groups felt they had in effect sold electric vehicles from the journeys they have given. The riders enjoying the journey may have been reflected in the high rider ratings (Figure 23).

Vehicle	Average Rider Rating
Nissan Leaf	4.76
BYD e6	4.80
Tesla Model S	4.84

Figure 23 - Average rider ratings for participant partner drivers throughout the trial (maximum score 5).

However, not all riders' experience was positive. Partner drivers reported riders being frustrated if a journey could not be completed, due to lack of range available in the vehicle at the time. In the focus groups, partner drivers recalled instances of accommodating riders by allowing them to wait in their vehicle until an alternative vehicle could pick them up to complete their booking when journeys had to be terminated prematurely due to lack of range.

Overall

A number of questions in the surveys, and notably the End survey, asked the partner driver to reflect on the experience of using the electric vehicle. These included questions on the suitability of using the electric vehicle outside of work life. For organisations operating private hire services in London using a driver-owner model, the suitability of an electric vehicle for personal use is important.

Opinion scores came out positive regarding this aspect (Figure 23). Participants in the focus groups discussed this in detail. Some mentioned considerable impacts, such as having to spend significant extra time in their vehicle when charging away from their local area (often at unsociable hours) or being unable to drive their children to school. Some described how they had adapted their lives around the charging of the vehicle, such as going for a run while the vehicle is charging.

These scores were higher and more stable than the scores for the overall experience of the trial. While the average score was positive in the Middle survey for overall experience, the other two surveys had average scores just negative of neutral. Across the full trial, overall experience did not improve significantly over time.

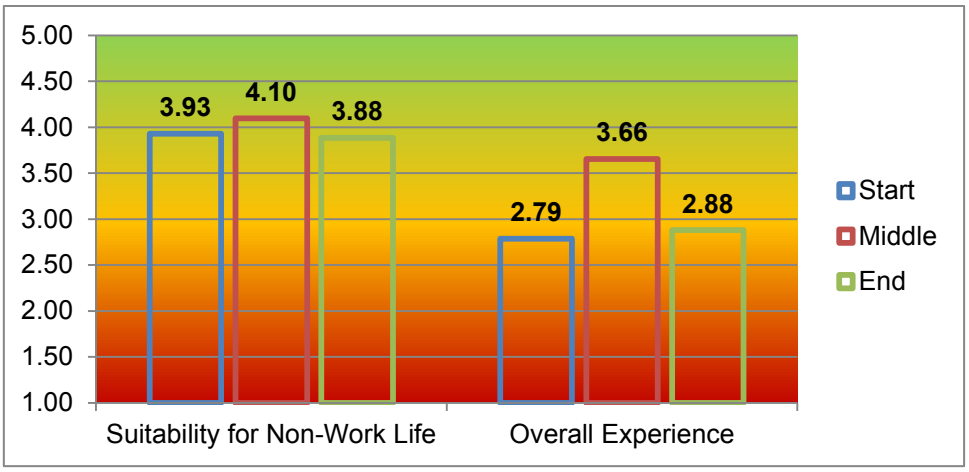

Figure 24 - Mean average scores of overall responses to 'How positive or negative has your experience been regarding the following aspects about how electric vehicles have impacted your work and home life?'

While a large majority was pleased to have taken part in the trial (Figure 25), decisions on whether to continue using an electric vehicle were very mixed. Marginally more partner drivers indicated they would not continue than those who would – even under the financially altered (and improved) conditions of the trial. However, 26% responded with the option 'I don't know', highlighting the greatest level of uncertainty out of all the surveys. This split was reflected when the question was asked in the focus groups – many participants had not decided on how they will continue.

Open-ended questions were given to allow partner drivers explain why they would or would not continue. These responses were coded into emergent themes. For those continuing, responses fell into three obvious themes: financial, environmental and personal benefits. Personal benefits referred to the non-financial aspects of the vehicle that partner drivers enjoyed including the noise reduction and satisfaction of driving. These reasons align similarly with the reasons for why partner drivers chose to take part in the trial.

Reasons for why partner drivers decided not to continue primarily focused on issues with charging or the suitability of the vehicle's range for private hire driving. These centred on:

- frustration of time taken to charge
- lack of a charging network
- lack of rapid chargepoints
- limited range of the vehicles.

Others included the explicit reason that costs would increase in the absence of the trial's financial adjustments.

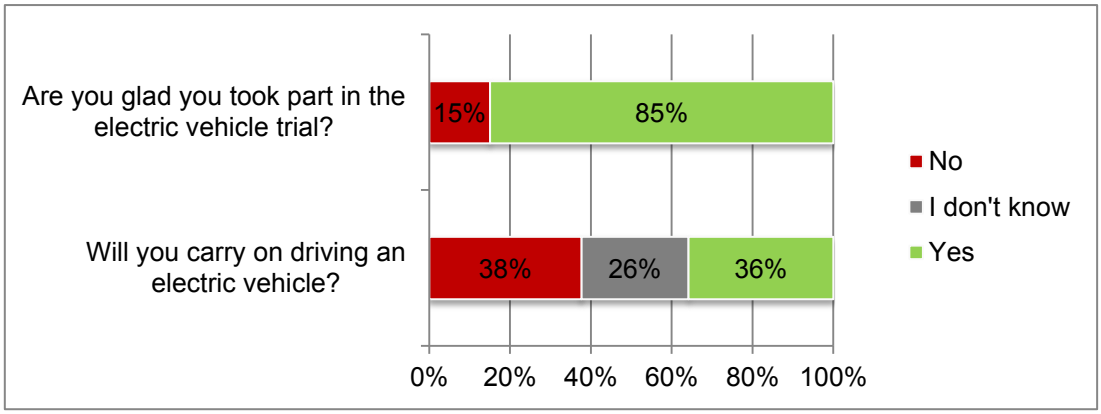

Figure 25 - Responses to 'Are you glad you took part in the electric vehicle trial?'; 'Now that you have finished the trial, will you carry on driving an electric vehicle?'

Why continue? Theme	References	Why not continue? Theme	References
Financial Benefits	9	Charging Issues	9
Environmental Benefits	7	Vehicle Issues	5
Personal Benefits	5	Lease/rental Issues	4
		Enhanced Costs	4
		'Not Suitable'	3
		Ratings Impact	1

Figure 26 - Responses to: 'Why will you continue?'; 'Why will you not continue?'

Figures 27 and 28 display word clouds of two concluding questions on what the best and worst things were about using electric vehicles on the Uber app. All responses to these two questions have been queried for word frequency with the most frequent words centred and enlarged. The difference summarises the key benefits and barriers identified throughout the research. While the 'best thing' includes many different aspects, the 'worst thing' is centred around issues of charging and range.

Figure 27 - Word cloud of responses to 'What is the best thing about using an EV to drive on the Uber app?'

Figure 28 - Word cloud of responses to 'What is the worst thing about using an EV to drive on the Uber app?'

Conclusion

This research has sought to understand the impact of using a pure electric vehicle on the Uber app and the realities of driving an electric private hire vehicle in London. It has summarised and discussed findings from Uber's electric vehicle trial carried out from August 2016 through to January 2017.

The use of electric vehicles on the Uber app has had a number of positive impacts. The partner drivers have enjoyed taking part in the trial and are driven by the combined financial and environmental benefits of using pure electric vehicles. Over the course of the trial, use of fully electric vehicles saved more than half a tonne of NO_x and 22 tonnes of CO_2, compared to a conventional hybrid vehicle. Data has shown that vast majority of fares were completed and, with the temporary financial conditions already discussed, partner drivers have been able to continue operating on the Uber app. Some were electric vehicle owners before but most were not. Many said they would be happy to continue with this new technology.

Very positive aspects of the trial included the vehicle specification, the use of an electric vehicle for non-work life, and the rider experience. This is encouraging as having a vehicle that meets expectations and is enjoyed by both drivers and passengers is important for the successful adoption of new technologies.

However, this trial shows that a number of issues still limit the current viability of using a pure electric private hire vehicle in London.

Principally, evidence from the trial suggests that a far more robust charging infrastructure than currently exists - alongside expected improvements in battery range - is required to encourage significant uptake of pure electric vehicles within the industry.

Throughout the trial, partner drivers were limited in the work they could do because the vehicle's range - and supporting charging infrastructure - was insufficient for numerous journeys. In addition, partner drivers found their potential driving (and therefore earning) hours limited by the amount of time taken to charge their vehicle. In particular, the absence of accessible rapid chargepoints in London significantly limited partner drivers' ability to recharge conveniently or quickly. Together these factors create an economic disincentive to the adoption of electric private hire vehicles.

The key reason partner drivers were involved in the trial was for financial reasons, and financial aspects of the trial were both positive and negative. What is clear, however, is that whilst cost reductions in areas like refuelling bought some benefit to partner drivers (particularly alongside financial incentives offered as part of the trial), the time taken to charge and the reduction in fare-paying journeys available hindered profitability.

If electric private hire vehicles are to be adopted by private hire drivers at scale, the cost (both time and financial) and convenience of charging and running an electric vehicle must reach near parity with non-electric options. This trial has shown that although there is cause for optimism with regard to both riders' and drivers' readiness to embrace electric vehicles, even with financial support through incentives such as below market vehicle rental costs, this parity remains a distance away.

Although longer range models are already making electric vehicles more competitive with non-electric options for private hire driving - with further improvements expected - the road to

overcoming the challenge of ensuring electric private hire vehicles can charge quickly and conveniently is less clear.

The title image for this report is a word cloud of the text entered by partner drivers in all three surveys and at the centre of the visual representation is the word ‘charging’. This word was the most referenced word in all the surveys. In the focus groups, there was consensus among participants that an extensive network of rapid charging was the key issue holding back electric vehicle adoption within the private hire industry. To move toward quick and widespread adoption of pure electric vehicles, this barrier will need to be swiftly addressed.