TRANSPORT STUDIES UNIT

Go Ultra Low Oxford

Monitoring and Evaluation

Dr Brendan Doody

Dr Tim Schwanen

This report is available to download from www.tsu.ox.ac.uk/pubs/2019-GULO-1.pdf

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Executive Summary

On-street charging technologies can significantly improve access to charging infrastructure for prospective and existing ultra-low electric vehicle[1] (ULEV) owners without private off-street parking space. Go Ultra Low Oxford (GULO), led by Oxford City Council in partnership with Oxfordshire County Council, is trialling five different on-street charging technologies across 30 locations in oxford with approximately 20 private households and a car club. The technologies include one home charger with a cable channel, a lamppost charger and three freestanding bollard chargers.

The trial is monitored and evaluated by the Transport Studies Unit (TSU) at the University Of Oxford, which acts as an independent evaluator. This interim report draws on two rounds of interviews with 18 participating households to provide preliminary insights into the four objectives associated with these activities.

1. Performance of the various on-street charging installations

As part of the evaluation, seven criteria for assessing the performance of the five on-street charging technologies from a user perspective have been identified in an open and bottom-up manner: 1) utilisation; 2) reliability; 3) ease of access; 4) ease of use; 5) risk of damage to vehicle; 6) risk to other street users; and 7) charging installation footprint.

Over the first couple of months of use, the lamppost chargers on average performed marginally better than the home chargers with cable channel. The bollard chargers scored somewhat lower but still more than adequately on most criteria. Their scores were lowest for charging installation footprint and the risk of damage to the vehicle.

Both the identified criteria and the assigned scores should be considered preliminary. They are likely to change over the course of the trial.

2. Adaptations to car-use routines and the formation of charging habits

Changes have occurred not so much in how often, where or when trial participants drive cars but rather in how they negotiate parking and in when, for how long, where and how often they charge. They have developed five types of strategy to access charging spaces (labelled ‘pre-emptive’, ‘opportunistic’, ‘goodwill-based’, ‘observation-based’, and ‘tactical’). When and for how long people charge their cars depends on multiple factors. These include the location and accessibility of a charging space, their daily and weekly activity patterns and routines, the journeys for which they use a car, and the capacity of their battery.

3. Local community responses to the charging installations

Charging installations trigger new conversations among neighbours and generate some interest in ULEVs among neighbours who do not use them. At the same time, trial participants and the visible breakdown of installations can reaffirm negative stereotypes about ULEVs among neighbours and put people off this type of vehicle. The interviews confirmed that tensions may arise among neighbours and in the local community over the aesthetics of charging bollards and associated signage, the use of the pavement by passers-by, and the risk of a vehicle manoeuvring into or out of a parking space and charging bollards on the kerb.

[1] Cars or vans that emit at most 75 g/km Co2 (according to the New European Driving Cycle (NEDC) test), including ‘pure’ or battery electric vehicles (BEVs), extended-range electric vehicles (EREVs), and plug-in hybrid electric vehicles (PHEVs).

4. Scaling up of the pilot within Oxford and transfer to other local authorities

Three lessons can be identified for local authorities elsewhere in the UK that seek to increase EV adoption through the creation of charging infrastructures on public streets in residential areas.

First, the usability or appropriateness of parking spaces for on-street charging depends on a wide range of factors and is therefore an issue that local authorities should consider carefully in decisions about what charging solution to offer and where. An available space for on-street charging is not necessarily also a usable or appropriate place for parking. Whether prospective users consider a place usable or appropriate for charging depends on many contextual factors beyond the installed charging technology. Those factors include characteristics of their vehicle (size, position of the flap), the street (width) and the parking bay (length of bay). They also include the parking practices of neighbours and others, and the perceived risk of damage to one's car or to other users of the road and pavement.

Second, a new etiquette around parking needs to be developed. If parking spaces around charging installations cannot be assigned exclusively to ULEVs, then informal rules need to be encouraged whereby spaces are vacated once cars are not or no longer charging. This will help to maximise the accessibility of charging installations for those vehicles and drivers who need to charge. Stricter enforcement of (formal) parking rules by the police and traffic wardens has a role to play in this, but so have awareness raising and media campaigns. Local policy makers cannot direct the formation of a new etiquette in a top-down manner but they can encourage it and steer the directions in which it evolves.

Finally, Oxford is in some ways a unique and unusual case: the city it is characterised by old, narrow streets, many conservation areas and very high parking pressures. In the subsequent phases of the evaluation the implications of these specificities for the transferability of the insights from the Oxford trial to local authorities elsewhere needs to be investigated further. Most of the above conclusions are nonetheless likely to hold for other UK cities as well.

1. Introduction

On-street charging technologies can significantly improve access to charging infrastructure for owners of ultra-low emission vehicles[2] (ULEV) who live in terraced or communal housing without private off-street parking space. This can reduce one of the key barriers to ULEV uptake within this group. A consortium of parties led by Oxford City Council in partnership with Oxfordshire County Council is undertaking Go Ultra Low Oxford (GULO), a pilot project in Oxford that is funded by the Office of Low Emission Vehicles (OLEV). GULO is trialling five different on-street EV charging technologies across 30 locations on public streets in Oxford over a twelve-month period. Both private individuals and car club users are using the thirty installations.

The Transport Studies Unit (TSU) at the University of Oxford has been commissioned by Oxford City Council to monitor and evaluate the trial. An important aspect of this collaboration is the TSU's role as an independent evaluator. The insights, views and conclusions summarised in this report correspondingly are those of the TSU and may not necessarily reflect those of Oxford City Council. They may be used by Oxford City Council in their decision making about the further roll out of charging installations in public streets across Oxford.

The evaluation by the TSU seeks to address four main objectives:

1. Evaluating the performance of the various on-street charging installations;
2. Examining the adaptations to car-use routines and the formation of charging habits among pilot participants;
3. Identifying local community responses to the charging installations;
4. Developing insights about how the pilot may be scaled up within Oxford and transferred to local authorities elsewhere in the UK.

To understand these issues, we have adopted a longitudinal approach combining quantitative charging data and qualitative interviews with trial participants and other key stakeholders. The report draws on two rounds of interviews with private participants who have started the trial and field-based observations. Due to the various delays in the trial and the unavailability of quantitative charging data, this interim report does not draw on interviews with car club users and stakeholders or report any quantitative information on charging point usage.

The remainder of this document is divided into four main sections. Section 2 provides a brief overview of the research approach and methods that have been adopted to monitor and evaluate the trial. The GULO trial, the technologies considered and the characteristics and motivations of the participants involved in the trial are then elaborated upon in Section 3. Section 4 presents preliminary findings based on the pre-trial and $\pm$1-2 month interviews with private users and field-based observations. The three subsections here address to varying degrees Objectives 1-3. Section 4.1 focuses on accessing the charging installations especially parking dynamics and strategies and the suitability of parking spaces for gaining access and charging (Objectives 1 and 2). Following this, Section 4.2 examines how easy the chargers are to use and some of the habits and routines developing around using the installations (Objectives 1 and 2). Section 4.3 considers how the charging installations integrated into participants' neighbourhoods paying particular attention to the space, signage and markings they require and the extent to which they generate interest in and around electric vehicle ownership and use and become targets for vandalism (Objective 3). Section 5 by providing a summary of the main findings that have emerged out of the initial stages of the research and reflecting on how these insights might be scaled up in Oxford and transferred to local authorities elsewhere in the UK (Objective 4).

[2] Cars or vans that emit at most 75 g/km Co2 (according to the New European Driving Cycle (NEDC) test), including 'pure' or battery electric vehicles (BEVs), extended-range electric vehicles (EREVs), and plug-in hybrid electric vehicles (PHEVs).

2. Monitoring and evaluation research approach and methods

A longitudinal and mixed method approach has been adopted to meet the study objectives. This approach combines the quantitative information on charging point usage and qualitative interviews which will monitor and evaluate technology performance and changes to trial participants' views, routines and habits. It also makes use of observations of the installations over the trial period as well as reporting about GULO in the local media and communications between the City Council and residents as part of consultations, objections, and so forth.

Interviews are being conducted at four different times, one before and three during the trial at ±1-2 months, ±5 months and ±11 months after a given charging installation became available for use. Each interview involves a short questionnaire and open-ended and follow-up questions on a variety of topics. The second (±1-2 months) and third (±5 months) interviews also involve participants giving a video recorded demonstration of how they use the charger.

Recurring topics in the interviews include the performance of participants' charging installation and changes to participants' household and car-related routines. Other topics include:

Interview 1: Personal and household travel; why participants own or use an electric vehicle; their experiences of electric vehicles; the location of their installation; and their expectations of the trial;

Interview 2: Street parking; and community responses to the charging installation;

Interview 3: the costs associated with the charging installation; and the nature and availability of information about participants' charging behaviours;

Interview 4: Participants' reflections and evaluation of the trial.

Field-based observations are also undertaken. Some of these observations have been guided by issues raised during interviews. Others have emerged out of close scrutiny of the installations and the contexts in which they are embedded. Such observations include the size, footprint and visibility of the charger, the width of the street and pavement and size of parking bays, the availability of off-street parking, and the parking behaviour of other drivers.

There were two motivations for using a mixed method approach. One is practical: The scale of the pilot is too limited for meaningful quantitative measurement and analysis of technology performance, changes to participants' routines and habits, and community responses. The other is theoretical: The adoption of a new technology cannot be reduced to a rational decision about whether to use it or not. Instead, it needs to be understood as a complex process of 'domestication' or embedding of a new technology in everyday life whereby perceptions, meanings, identities, routines and habits change over time as people repeatedly interact with, and learn about, the charging installation. Qualitative methods such as in-depth interviews and participant observation are best suited to understanding the complexities of the embedding of new technologies and dynamics in perceptions and meanings.

Objective 1 will be achieved using: quantitative analysis of charging point utilisation (e.g. frequency, distribution over time of day and weekdays), reliability of the equipment and resource input; analysis of brief questionnaires asking pilot participants to rate the convenience, reliability and value for money of the charging installations they are using; and analysis of discussions during the various interviews.

Objective 2 will be realised using information from and observations made during the various rounds of interviews. These interviews are semi-structured to ensure a basic level of comparability between individuals and over time but also leave ample room for participants to express their views and discuss what they find important.

Objective 3 will be achieved through an analysis of local newspaper reports on the pilot, online sources, records of consultation processes and events, appeals and objections (if and when submitted to the relevant authorities), and relevant information in interviews with pilot participants.

Objective 4 will be realised by combining information obtained through activities associated with Objectives 1-3 with insights from relevant academic literature and interviews with some of the council staff and other stakeholders involved in the pilot.

3. The Go Ultra Low Oxford (GULO) trial, charging technologies and participants

Go Ultra Low Oxford (GULO) is a twelve-month pilot project funded by OLEV and run by the Oxford City and Oxfordshire County Councils. GULO seeks to test different technologies that might support on-street electric vehicle charging for people who have to park on the street. Both private individuals and car club users are using the thirty installations.

3.1 Charging technologies

There are currently five different charging technologies operating in the trial. A sixth technology may be introduced in future. The five operational chargers have been grouped into three main types: 1) lamppost chargers; 2) bollard chargers; and 3) home chargers. The ease of use of these different types of chargers (see Section 4.2.1) and the footprint and visibility of the installations (Section 4.3.1) are considered later in the report.

1) Lamppost Chargers

a. Ubitricity Lamppost Charger

Features:

- Manufactured by Ubriticity
- Mounted to lamp post
- Slow charger, ±6 hours to full charge
- Power output: 5 kW
- Not compliant with OPCC 1.5
- 1 socket, Type 2 Mennekes
- Accessible with smart cable only
- Billing via Ubriticity

2) Bollard Chargers

b. Smartscape Charging Bollard

Features:

- Manufactured by Zeta Specialist Lighting
- Freestanding pillar
- Fast charger, ±3-4 hours to full charge
- Power output: 7.4 kW
- Compliant with OPCC 1.5
- 1 socket, Type 2 Mennekes
- Accessible with RFID card and app
- Billing via New Motion

2) Bollard Chargers (Continued)

c. e-Post Charging Bollard

Features:

- Manufactured by ePost
- Freestanding pillar
- Fast charger, ±3-4 hours to full charge
- Power output: 7.4 kW
- Compliant with OPCC 1.5
- 2 sockets, Type 2 Mennekes
- Accessible with RFID card and app
- Billing via New Motion

d. Chago Pro Charging Station Bollard

Features:

- Manufactured by Ensto
- Freestanding pillar
- Fast charger, ±3-4 hours to full charge
- Power output: 7.4 kW
- Compliant with OPCC 1.5
- 2 sockets, Type 2 Mennekes
- Accessible with RFID card and app
- Billing via New Motion

3) Home Chargers

e. APT Home Charger and Cable Channel

Features:

- Manufactured by eVolt
- Home charger paired with pavement channel
- Slow charger, ±6-8 hours to full charge
- Power output: 3.7 kW
- Not compliant with OPCC 1.5
- 1 socket, Type 2 Mennekes
- Only accessible from residence where charger is placed
- Billing via home energy provider

3.2 GULO trial participants: Household characteristics, electric vehicle type and motivations

The original plan was to have 30 on-street charging installations across Oxford, ten of which would be allocated to a car club operator and twenty would be located close to the dwelling of twenty private households who had signed up to the trial. Co-wheels were selected as the collaborating car club operator during the procurement process. Out of the ten installations, four of these have been in use since August 2018.

The twenty private households were recruited through a comprehensive media campaign. They have agreed in writing to participate in the GULO monitoring and evaluation. Locations for the installations close to their home have been selected by Oxford City and County Council staff based on consultations with participants and surrounding residents and the characteristics of the electricity supply in those locations. Of the original twenty households, four have dropped out for various reasons and two have been replaced by other households. As a result, there are now eighteen households participating in the trial. At the time of writing of this report (September 2018), all households had been through the first round of interviews but due to delays in starting the trial only twelve of them had been through two rounds of interviews. This report draws on the first- and second-round interviews that were available at the time of writing. For each household there is one main participant who will be interviewed during all four rounds of data collection.

The trial charging installations that are used by eighteen private households are fairly well distributed across Oxford (see Figure 1). While the home chargers are reasonably dispersed across Oxford, the lamppost chargers are primarily situated in the north and the bollard chargers in the east. Despite this, the various installations are located in a range of different neighbourhood and street settings. Some are found in lower socio-economic areas in the east (Cowley, Littlemore, Headington) and others in higher socio-economic areas in the north (Jericho, Summertown). Installations are also present in more central and older neighbourhoods with very narrow streets, conservation areas and newer neighbourhoods with typically wider streets.

The characteristics of the main participants in the trial are presented in Table 1. The vast majority of participants are male (77.7%). There is only one female involved as a main participant (5.6%). Couples in three households have been interviewed together for the first interview. Of these, the only household that has completed the second interview did so again as a couple. In contrast to this gender imbalance, the main participants are fairly well distributed across different age categories. Most participants were living as a couple either with (44.4%) or without children (44.4%).

The type of ULEV and number of cars used by a household is illustrated in Table 2. Over half of the households (55.5%) own or lease plug-in hybrid electric vehicles (PHEVs). The remaining households have either full battery (BEVs; 27.8%) or extended range electric (EREVs; 16.7%) vehicles. This corresponds with broader trends in the UK where, after non-plug in hybrid electric vehicles (HEVs; 60.6%), PHEVs and BEVs make-up 28.1% and 11.4% of new registrations of alternative fuel vehicles (SMMT, 2018). For just over half of the households (55.6%), their ULEV is the only car that they own. The rest of the households had an additional petrol or diesel car. One household had more than two cars.

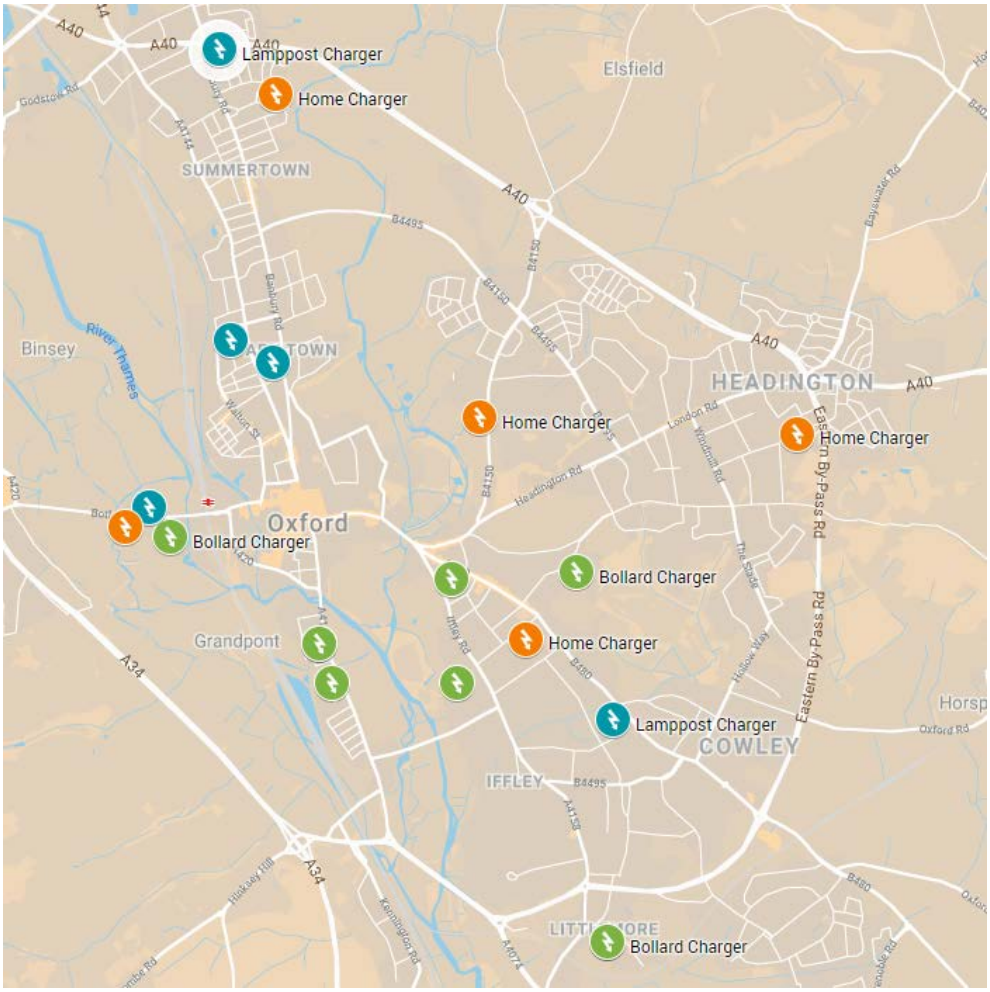

Figure 1. A map of the three different types of charging installations being used by private participants in the GULO trial. At least three lamppost chargers are located in one or neighbouring streets. Charging installations used only by car club members have been omitted. Source: Map created in Google Maps.

Table 1. Characteristics of the main research participant.

Characteristic of main participant	Participants (n=18)	
	Number	Percentage
Gender		
Male	14	77.7
Female	1	5.6
Couple	3	16.7
Age		
20-29	1	5.6
30-39	4	22.2
40-49	4	22.2
50-59	3	16.7
60-69	5	27.8
70-79	1	5.6
Household structure		
Couple household	8	44.4
Couple with children	8	44.4
Living alone	2	11.2

Table 2. The type of ULEV and number of cars in the household.

Cars in the household	Participants (n=18)	
	Number	Percentage
ULEV type		
Battery Electric Vehicle (BEV)	5	27.8
Plug-in Hybrid Electric Vehicle (PHEV)	10	55.5
Extended Range Electric Vehicle (EREV)	3	16.7
Number of cars		
One car	10	55.6
Two or more cars	8	44.4

A primary motivation to partake in the trial for all participants was to have the opportunity to charge their car in a location close to their house. Prior to starting, many existing electric vehicle users had either struggled to find opportunities to charge regularly. A few were using temporary and informal measures such drains and road cones to reduce the chances of someone tripping on the cable while charging (see Figure 2). A number of participants considering adopting an ULEV, found out about the trial researching how and where they could legally charge in Oxford. Alongside access, convenience and legality, other reasons that motivated participants included a desire to reduce the environmental impacts (i.e., air pollution and climate change) of their car use, to support the development of charging infrastructure and to encourage friends, family and neighbours to get ULEVs.

Figure 2. Two examples of how trial participants used temporary and informal measures such as road cones and rain drains to reduce the chances of someone tripping on the cable while charging their electric vehicle. Picture taken by: B. J. Doody.

In summary, there are three main types of chargers in the trial: 1) lamppost chargers; 2) home chargers; and 3) bollard chargers. There is some variation in the types of Oxford neighbourhoods and streets in which the chargers have been located. The main representatives from participating households are primarily males, of various ages, living in couples with or without children. Most households have PHEVs rather than BEVs and one car.

The implication of these characteristics for the trial is three-fold. First, given that the vast majority of participants are male, female perspectives on the ease of use, suitability and aesthetics of the charging installations will be significantly underrepresented. Second, because most participants are using PHEVs, they will still able to drive their cars without charging and the consequence of not being able to charge will often be

rather modest. As a result, response and adaptations to the risk of not being able to charge within the trial may differ from those that will be observed when the number of BEVs owned or used by households without access to private off-street parking increases in Oxford in the (near) future. It should be noted, however, that the decision to drive a PHEV rather than a BEV is already a strategy to mitigate the risk of not being able to charge. Third, PHEVs take considerably less time to charge (~3 hours) compared to BEVs (~8 hours). As a consequence, the trial may not generate much insight into how participants fit these charging periods into and around their existing household routines and, where relevant, parking restrictions.

4. Accessing, using and integrating the charging installations

This section presents preliminary findings based on interviews with private users before the trial (Interview 1; see Appendix 1) and after ±1-2 month (Interview 2; see Appendix 2) and field-based observations. At the time of writing, eleven out of the eighteen private users were using the chargers. Due to various delays associated with the introduction of car club cars into the trial and the restricted availability of charging data for different installations, the experiences of car club users and quantitative charging data are not presented in this interim report. These will be covered in the second preliminary report.

The results section is presented in three subsections, which primarily address Objectives 1, 2 and 3. Section 4.1 focuses on accessing the charging installations, paying particular attention to parking dynamics and strategies (Objective 2) and the suitability of parking spaces for gaining access and charging (Objectives 1 and 2). Section 4.2 examines how easy the chargers are to use (Objective 1) and some of the habits and routines developing around using the installations (Objective 2). Section 4.3 reflects on how the charging installations integrated into participants' neighbourhoods, focusing on the space, signage and markings they require and the extent to which they generate interest in electric vehicle ownership and use and become targets for vandalism (Objectives 3). The second interim and final reports will provide further insight on Objectives 1, 2 and 3, and also address 4.

4.1 Accessing the charging installations

4.1.1 Getting access: Parking dynamics and strategies

The ability of different private participants to access the chargers varies considerably across participants and between different times for any particular participant. These factors include:

- the availability of, and demand for, parking in the street – access was easiest in streets with ample availability and little competition;
- how regularly parked vehicles are used – spaces were more easily available in residential streets where cars were used more frequently by their owners or visitors (e.g., workers);
- if residents require a paid parking permit – there tended to be greater competition for available parking spaces in non-permitted areas;
- the availability of ULEV only parking bays – there was a greater likelihood of regular access to these bays than to non-assigned bays; and
- how and when parking restrictions are enforced – gaining access tended to be more challenging during nights and weekends when parking restrictions and rules (residents parking, ULEV only parking bays, yellow lines) were more commonly disregarded and less likely to be enforced.

The extent to which participants have had to adapt their parking-related practices has varied considerably. A general distinction can be drawn here between six participants who routinely face relatively few challenges and five others who to varying degrees struggle to gain access. Participants in the former group tended to live in streets with lower parking pressure. This was due to some properties having off-street parking (driveways and garages), neighbours not always owning car/s and/or parking permits being required. Participants in this group are using all of three types of chargers.

The second group of participants struggle anywhere between once or twice, to most days, a week to gain access. This group were using lamppost and home chargers and generally expressed some concern in the pre-trial interview that access may be the main difficulty they would encounter. These expectations were typically based on their experiences and observations of how their own household car use and activities overlapped with others parking in their street and the fact they would not have a dedicated ULEV parking bay.

Oliver, who lives in an unpermitted area of Oxford, discussed at length how parking availability varies substantially during university term time. During term time there is a significant increase in the number of cars parked in his street. Alongside this, he noted as students typically only use their cars in the evening or weekends this can mean his access to the charging space can be blocked by a parked car for a long time.

Both groups, but especially the second group of users who do not have ULEV only parking bays, have adopted a number of different approaches for gaining access. These can be broadly classified into five categories: a) pre-emptive, b) opportunistic, c) goodwill-based, d) observation-based, and e) tactical.

a. Pre-emptive strategies

Three participants were part of street or neighbourhood groups in their respective areas. Prior to the trial they emailed those groups to explain they were participating in the trial. In this email they noted it was not the intent to give them a private car park and requested that where possible for people to leave the space available for them to charge. Oliver[3] put up a small plaque on the wall outside of his home to make people aware of the trial (see Figure 3).

Figure 3. A sign that one of the participants had made up to raise awareness of their involvement in the GULO trial. To preserve the anonymity of the participant their registration number which appears on the actual sign has been removed. Picture taken by: B. J. Doody.

b. Opportunistic strategies

Some users of lamppost and home chargers in streets with high competition for parking initially gained access on a more ad-hoc or opportunistic bias. This typically involved looking out for an available space when

[3] Pseudonyms have been used to preserve the anonymity of participants.

returning home by car or when passing by on foot. The type of charger had implications for gaining access in two ways. Users of home chargers, especially those with front windows, could more easily detect if and when a space was available. At the same time, the number of spaces available to park was often limited to one, two or three spaces because of the positioning of the channel and the length of available cable. Users of lamppost chargers meanwhile have at least three or more installations available in the immediate area. For some, it was possible to charge (see 4.1.2 for further details) on either side of the lamppost meaning they had access, at a minimum, to twice as many spaces as home charger users. Correspondingly, if a preferred spot closest to home was not available, users would often then drive around searching for another space.

c. Goodwill-based strategies

Of the three charger types, the home chargers seem to be the most amenable to goodwill-based arrangements. This is because the installations are all positioned immediately outside of users' houses. Lamppost and bollard chargers, in contrast, are generally positioned in adjacent streets where users may not know or regularly encounter the owners of other vehicles.

Three home charger users who have good relationships with neighbours have occasionally asked them to move a car to gain access. A couple reported that since making the request neighbours have often left the space available. Lucas and Oliver both felt that asking neighbours to move their cars was not a sustainable strategy though as it demanded too much from them. For this very reason, Oliver has never asked neighbours to move but did initially let people them know via a note or knocking on their door that his charging cable is running around the base of their wheels.

d. Observation-based strategies

Through their experiences over time users of lamppost chargers have learnt which installations are more likely to be available. Edward suggested that he had observed that the charger located in a street with lots of off-street parking was often free when he was looking to charge.

e. Tactical strategies

A number of participants have also developed a range of more tactical approaches to increase their chances of gaining access. One approach adopted by users of lamppost and home chargers has to been to leave their car plugged in even when it is fully charged. This was seen as a way of raising awareness that the space is used for charging, As these two types of chargers can potentially otherwise go unnoticed (see Section 4.3.1), this was seen as a way of raising awareness that the space is used for charging.

Oliver has used this approach in combination with a pre-emptive email and a sign (see Figure 3). To increase the likelihood of securing an available space, he will also move his car closer to a spot he is able to charge in. This then ensures he has a shorter distance over which to manoeuvre his car into the park. Meanwhile, an unintended consequence of informing neighbours and others that his cable is trailing around their tyres is sometimes people will let him know that they are moving their car and the space is available.

Lucas has developed a reasonably sophisticated parking routine to access his home charger. His wife who works as a teacher and arrives home first will park her car in the space where he is able to charge his car. When he gets home later in the evening, he repositions her car elsewhere and then parks his PHEV in the space.

Charlotte, a user of lamppost chargers, finds that when she is looking to charge that most of installations are normally blocked by non-charging cars. Often the only available charger happens to be one located in space with a one hour parking limit. To get around this restriction, she has been leaving a sign in her window explaining that she is part of the trial and to date has escaped any fines.

In summary, the ability to access a charging installation is shaped by the availability of and demand for parking, how regularly vehicles are used, if residents require permit parking, the availability of ULEV only parking bays, and how and when parking restrictions are enforced. Participants have developed a range of strategies to gain access to charging spaces based both on previous knowledge and observations and experiences they have had over the course of the trial. The next subsection now explores how a freely available parking space does not guarantee it will be an appropriate charging space.

4.1.2 Plugging in: Suitability of parking spaces and charging flaps

Sometimes available parking places cannot be used for charging, even if there is no car parked in them. This was due to the size of cars relative to parking spaces, the positioning of the charging flap on the car and where others had parked their car.

Luke and Stefan are both using bollard chargers with dedicated parking bays. Both have long PHEV estate or station wagon-sized cars which have presented challenges for getting into these bays. In Luke's case, he 'couldn't actually get in' because there were vehicles parked on either side of the parking bay, with one in particular parked too far forwards. Meanwhile, Stefan has struggled backing into the space when cars have been parked on both sides of what is an extremely narrow road.

The charging flap dictated for some participants the direction in which they parked and the number of parking spaces available for charging. Steve, for example, uses a home charger and since the start of the trial has parked his car 'the other way round because of where [charging] point is'. He lines it up on the fence posts 'opposite the driver's door' as that helps to ensure 'the best way to get the wire in'. He wants to have the charging flap on the side of the pavement because if 'somebody just drives up and doesn't notice the flap's open it would be a bit of a mess'. In his case, having the charging flap at the front would have been more 'convenient either way round'.

For some participants the suitability of the parking space for charging was also dependent on where others parked. Two home charger users reported instances of where the cable channel has been blocked by a parked car. Due to the narrow nature of his street, Oliver and others park with one of the tyres on the kerb (see Figure 4). He was 'very frustrate[ed]' when he 'couldn't charge' using his home charger as 'someone had actually placed their wheel on [top of] the cable channel'. This meant he 'couldn't safely tuck it away without creating a trip risk'. The two video stills presented in Figure 5 are taken from Rob's charging demonstration after about 2 months of using his installation. He described the recorded demonstration as a 'failed attempt because whoever's parked that car there's got the tyres right against' the exit to the cable channel and as a result he suggested he 'wouldn't be comfortable leaving [the cable] there' for safety reasons. Rob explained this situation was further compounded by the fact 'the plastic blocks that usually' hold down the cable in the channel have also been 'removed' by someone unknown to him. Out of all the participants, it has been noticeable that home charger users like Rob and Oliver are most conscious of the possible trip risk that the cable might pose for other street users. This is possibly because of the amount of excess cable they have available and the awareness that has been created in part through the process of placing and securing the cable into the channel.

Figure 4. As the street Oliver lives on is so narrow those who park on tend to park with one of their wheels up on the kerb. He reported that there has been at least one instance when someone parked with their wheel over the top of the cable channel. Picture taken by: B. J. Doody.

Oliver's frustration at not being able to charge also stemmed from his difficulties trying to get a park outside of his house during University term time as lots of students park in his street which has no parking restrictions. He requested a sixteen metre cable which allows him 'four bites of the cherry'. The space he obtains dictates what he needs to do with the excess cable. Initially, he use to either knock on a neighbours door or leave a note explaining that he had 'tuck[ed] [the cable] round the[ir] wheels and under their car so it is not a trip risk' and to 'knock [on his door] if [they] need to leave'. 'The problem', he continued, was that on a couple of occasions people have 'just decided to drive off [leaving the cable] exposed' which could have resulted in someone 'parking on top of the cable' and him not being able to 'get it back'. As a result, he has 'rethought' this 'slightly' in that he is no longer 'doing it' with cars he does not 'recognise' which can reduce the number of spaces he can park in to charge.

Figure 5. Video stills taken of a participant demonstrating how he charges his grey BMW 5 Series plug-in hybrid electric vehicle (PHEV). The top video still captures how during the process of feeding the cable into the channel he realises that the end of the channel is blocked by the Mini 3-Door Hatch that has parked too close to the curbing. In the bottom still he can be seen pointing at the cable sticking out of this part of the channel. Gesturing towards the cable he explained how he is not able to run the cable all the way to the end of the channel and then off to the left to plug it into his car and as a result would not be comfortable leaving his car to charge. He packed away the cable immediately after the demonstration. Video recorded by: B. J. Doody.

The cases described here suggest that a freely available parking space does not guarantee it will be an appropriate charging space. Rather, the appropriateness of a space for charging depends on the combination of: a) the charging technology used; b) the make and size of one's vehicle and the positioning of the charging flap on it; c) the width of the street and size of the parking bays; d) the parking behaviour of other drivers; e) a

participant's perceptions of what are appropriate risks for other road and/or footpath users; and f) the ease with which equipment can be retrieved successfully after a charge.

4.2 Using the charging installations

This subsection initially explores how easy to use participants consider the chargers (Section 4.2.1). It then discusses some of the habits and routines they are developing around using the installations (Section 4.2.2).

4.2.1 Ease of use: chargers, cables and cars

Participants were generally positive about how easy and practical their charging installation was to use. The use of the home charger was certainly the most involved and lengthiest, especially in comparison to the lamppost and bollard chargers. Not all participants seemed to have read and followed the instruction manual for the home charger but Steve had. He explained that it suggests you 'plug in [to the wall charging box] [and then] plug into the car before you switch the electric on'. Before giving a demonstration he notes that the whole process is 'quite straightforward':

> I keep the lead in the [opening the latch on the door with his right hand] cupboard under the stairs [pulling out the cable in a plastic bag with his right hand and transfers it into his left before closing the cupboard with his right]. The meter … and the RCD [are also there]. [Takes the cable out of the bag using both hands and places this next to the front door. He opens the front door and walks out towards the car]. It's a very straightforward process better unlock the car [taking the key out of his left-hand pocket he unlocks it with the fob] else the alarm goes off. [He undoes the Velcro strap that is used to wind up the cable. He places most of the cable onto the ground and then lines up the end that goes into the car to ensure he has a sufficient amount of cable to reach. Bending forwards he feeds the cable into the channel. Almost kneeling on the pavement he pushes the little black clip in at the end closest to the fence]. So the little black clip is just helpful in making sure the lead is not loose over the fence. [He feeds the far end over the top of the fence and struggles to push it through a bush before gently dropping it onto the ground. Having done this he stands up and then approaches the car and pushes on the charging flap which pops open. He struggles to take the cap on the end of the charger off] I always forgot to do that the other one [i.e., charging cable] doesn't have a cap on it. [Having plugged the cable into the car] So it tells you when it is ready to charge. [He then walks back around to the other side of the fence and bends down to pick up the cable with his right hand and then uses his left hand to help pull enough of the cable along so that it can plug it into the wall charging box]. And it is a really simple process of plugging in [he lifts the flap to the wall charging box with his left hand and then pushes the cable in with his right. He then unclips the bottom of the RCD (residual current device) with his right hand], unclipping the RCD [he holds the lid to the RCD with his left hand and then turns it on pulling it up with two fingers on his right hand] flicking it on [he pushes the lid back down with his left and then makes it is fully closed by pressing two fingers from his right hand against the lid] and then it is already to go. [Points at the wall charging box] Blue light is on which means it is finished because it is fully charged at the moment.

Steve's account differs from those of lamppost charger users such as Daniel. Like other participants, he emphasised its ease of use: 'It is just totally uncomplicated. I push it in the car, I push it into the lamppost and I walk away. It is as easy as that':

> [Stands up and walks out into the foyer. He picks up his keys from a side table and opens the front door. As he approaches the car he uses his key fob to open the boot of the car which opens unassisted. He pushes open the charging flap which pops out. He then pushes on the cable cover underneath which also pops out. He picks up the cable with his right hand and goes to plug the wrong end of the charger into the car. He transfers the lamppost end with the meter on it into his left hand and then picks up the correct end with his right hand and plugs it into the car] Look I got it

> wrong you are flustering me. [He transfers the lamppost end of the cable from his left into his right hand and taps on the top of the raised boot which then closes by itself. He walks a couple of steps to the lamppost and lifts the flap with his left hand and plugs in with his right. He locks the car with the key fob]. That's it.

Bollard user Evan also stressed how easy the process of charging is when the charger is working: 'it seems to be just plug it in one end and plug it in the other end and swipe the card. I think … the swipe card thing is just normal now [because of] Oyster Cards and [contactless] payment. So it's easy … really':

> [Having finished backing the car into the packing space Evan gets out of the driver's side door and makes his way around to the back of the car and opens the boot with his key fob. He lifts up the floor of the boot with his left hand and pulls out the cable which is stored in a black bag using his right hand. He pulls the cable out of the bag and places the bag on to the floor of the boot and closes the boot. He lifts up the flap on the Smartscape charging bollard with his left hand and plugs the cable in using his right hand. He uncoils the cable using both hands as he walks towards the front his car and then takes the top off with his left hand. Transferring the cable to his left hand he then pushes on the front panel of his car open with his right] then push that open, [he takes the cap off] take that off [transfers the cable back from his left to his right hand] and it's in there. And like I was saying to you, you get that light that comes on and if it is working properly it would be solid green but because at the moment it is not, just says no voltage supply [he points at a colour coded key on the inside of the flap. He walks back to the charger and holds a key fob against it]. When it is working the lights on the charger switch to blue [he points at the right of three lights on the top of the charger] and it keeps flashing as it is now. [Walking back to the front of the car, he points at the orange light] And [that] sort of pulsates to green.

There are several similarities and differences in these three charging processes worth highlighting. To begin, all three accounts draw attention to the way charging practices are dependent on much more than the installation and the availability of a physical parking space. They rely on a range of physical movements including the unwinding of the cable, the transfer of the cable between hands as cable caps are removed, charging flaps and covers are pushed and/or pulled open and cable ends are inserted into the car and installation. A key difference between the chargers here is that only home charger users need to either kneel or bend over in order to feed the cable into the gully. Although slightly more time consuming and physically demanding, completing this task does appear to make users more conscious of excess cable (see also Section 4.1.2).

The extent and nature of these physical movements are shaped by the design, features and functionality of different car models (i.e., key fobs, boot (i.e., automatic or manual) and charging flap opening mechanisms, the location of charging flaps) and charger installations (i.e., covers, port connections, activation processes (physical switches or RFID chips)). For example, the home charger by requiring users to open and flick a switch on RCD box adds another additional step to the process. In contrast, the bollard-style chargers rely on tapping an RFID chip on a card reader and the lamppost charger comes with inbuilt metering in the cable which negates any further steps. Each of the charging technologies initially depends on users learning about how to ensure and detect if the car and installation are charging or have charged properly. This can involve plugging in and starting the charging process in a particular order and learning to understand what is meant by different combinations of light sequences (flashing; solid) and colours (orange; blue; green).

Cables were a recurring topic of conversation, irrespective of which charging technology participants used. Conversations centred on the cost of additional cables, the inconveniences associated with storing cables and using them, especially during wet weather or the winter. Matthew and Emily, for example, discussed how when they purchased their car they were given the choice between two cables and opted for the home supply. The need to 'purchase a special cable' for '£150' or more coupled with their 'ability to charge most of the time

from outside their door' using an existing drain has deterred them from starting to use their bollard charging installation. For a number of other participants such as Edward the cables create new weather or seasonal-related difficulties as they can become 'wet', 'cold' and 'muddy' as they are left outside. Lucas echoed Edward's sentiments whilst noting the challenges of having an '18 metre cable' to charge his car:

> [I]t is a bit of a hassle unwinding the cable and winding it back up [especially as] the cable is getting twisted … because [it seems to have a bit] of a memory. […] There were some gloves that came with the car anyway [laughs] which I've been using [as the cable] gets a bit muddy because it goes across the garden, it gets a bit wet in the rain. [B]ut it hasn't really … made the house dirty or anything because I bring it in and put it in the porch. So yes it's not been a massive issue. [T]he bit of the cable that goes on the road by the car gets a bit muddy but again it's been OK.

The above discussion highlights how charging practices depend on users making a range of physical movements and learning about how to ensure and detect if the car and installation are working or have worked properly. Three further issues can be identified this context. First, different car models and technologies make explicit or implicit assumptions about the capacities (e.g., to bend, push cables into port) and skills (e.g., identifying and detecting problems) of users. Second, ongoing consideration needs to be given to how charging technologies can be designed to support a more diverse (i.e., able and disable bodied; technical and non-technical) groups of users. Third, some users will likely need to be supported (e.g., information, tutorials, inductions) during the process of learning about charging processes and technologies.

4.2.2 Accommodating charging: Developing habits and routines

There have not so far been significant changes in how often, where or when participants drive their cars. Most adaptations have occurred around how participants negotiate parking and when, for how long, where and how they charge. Participants, as already discussed (see Section 4.1.1), have adopted a number of different approaches for gaining access to charging installations. Much like these approaches, habits and routines around charging developed over time as users became familiar with their car and how long it took to charge using their installation. The timing and length of a charging event is shaped by a participant's proximity to and ability to access a charging space, their personal and/or household routines, how far they have recently driven, the likelihood and nature of upcoming trips and the capacity of their battery.

Steve spoke about how he slowly became accustomed to both the fact he was not inconveniencing anyone charging his PHEV and the duration of a charging event:

> [W]hen I first set it up … like most of these new bits I was popping in and out every [laughs] every quarter of an hour just to see and in a sense [I was] not wanting to inconvenience people. But ... now ... I probably leave it for the best part of an hour before I even pop out again ... depending on how long it's likely to charge for. But the maximum charge time is just over two hours so ... I find now I've got used to the process. It takes more power in the first bit and then it dips off and it's only using for the last half an hour or so and it often finishes earlier than that.

Steve, like most participants, preferred driving in electric mode for comfort, environmental and fuel saving reasons. This was especially the case in Oxford and 'urban areas' as it allowed him to feel 'less guilty' about his contribution to local air pollution.

The nature of recent and upcoming journeys and the capacity of their car battery typically determined how frequently participants charged. Daniel, who mainly used his PHEV to get to and Oxford Parkway, found that 'generally' if the car had been 'used every day then it would be charged every day' as it really only had enough charge for 'one journey and back'. William who drives a BEV tends to charge based on where and what type of driving he anticipates he will be doing and his car battery's state of charge:

> If we're using it in Oxford … then we don't need to charge it up. But when it gets below forty miles then I'll sort of charge it even though we're only going in Oxford. It's easier to charge it just in case we need a longer journey. But we could spend all week in Oxford obviously and only charge it once because … we won't do eighty-seven miles in that time. Where it runs down is if you go motorway driving and you go at seventy [miles per hour] you see you won't get anything like the range it tells you you're getting.

Edward discussed how he typically parks and charges overnight even though his PHEV battery 'only takes two hours to charge' and then disconnects it on his way to the train station in the morning:

> Often … I'll plug it in late at night if there's a space when I get back … or I sometimes will move it charge it if I haven't. Then I'll just leave it overnight and … stop off … on my [cycle] to the station. Unplug the car, throw it in the back and leave it there and then just so as to not occupy the charging point for longer than I need to. I wouldn't necessarily move the car then.

Evan also usually ends up moving and plugging in the car when he gets 'back from work'. This is despite the fact that it is usually his wife driving their PHEV during the day for the nursery and school runs. He explained that it is too much of a challenge for his wife to charge because of the logistics involved:

> Generally [my wife does] not [charge the car] because she's normally turning up with two children in tow. [T]hat is where [the charging space] not being outside your house becomes a bit difficult. Because … [the children] are not at the stage yet where you could leave them next to a road and trust them not to sort of wander out.

The location of the charger also means that before going to bed Evan goes out to 'unplug [and move] it again'. He suggested this works 'quite well' as the car 'takes about two and a half hours to do a full charge' and then he can 'leave the spot for somebody else to use rather than having it in overnight'.

In summary, the cases in this and the previous section (4.2.1) drawn attention to how habits and routines develop over time as people become familiar with their car's electric range and how long it takes to charge using a particular charging installation. The timing and duration of a charging event is determined by a variety of factors. These include the proximity and accessibility of a charging space, their personal and/or household routines, how far they have recently driven and the capacity of their battery.

4.3 Integrating the charging installations into neighbourhoods

This subsection examines neighbourhood responses to the charging installations. Section 4.3.1 begins by considering the footprint and visibility of the charger and how the location and positioning of the installation may make a difference to the responses it elicits. Following this, Section 4.3.2 explores controversies surrounding and the interpretation of and adherence to parking signage and markings. The extent to which the chargers generate interest within local communities is elaborated in Section 4.3.3.

4.3.1 Making space for chargers: installation footprint and visibility

The Ubitricity lamppost chargers integrated quite easily into the physical fabric of the neighbourhood, in part because they are incorporated into existing street furniture and only emit a very small amount of light (Figure 6). These sentiments were shared by a number of participants. Sam explained that when he 'first got in touch with the council' he had envisaged there would have been some sort of 'standalone charger' which would have been 'a complete pain'. Apart from the 'blue lights at night so you can see where the chargers are' (see Figure 6), he stressed how they gave citizens access to 'today's technology' without significantly disrupting the neighbourhood:

> This is the future … for our sort of area which is a fiercely managed conservation area. … [I]t must be the easiest to agree because it relies on the existing infrastructure and doesn't affect the physical appearance of the area. How can we consider anything else [if] your lamppost … [is] in the right position [next to the curve]. … You're not going to find anything better.

Daniel similarly suggested that one of the main benefits of the lamppost chargers are that they are 'discreet' and 'people generally don't want to change'. He felt if people start seeing 'reasonably large boxes with lights on' they 'would feel less comfortable' and noted that because they are 'a fair size' they 'do take up a bit of pavement'. Figure 6 highlights the 'discreet' nature of these chargers but also the potential trip hazard excess cable can create for other street users. Most users of the lamppost and bollard-style chargers showed very little concern for the placement of the excess cable while their car was charging, especially when compared to the users of the home chargers (see Section 4.1.2).

Figure 6. Three images of the Ubitricity lamppost charger which highlight how this installation by being able to be incorporated into existing infrastructure and only emitting a very small amount of light even at night, subtly integrates into the existing physical fabric of neighbourhoods. The right hand image shows how the visibility of the installation, especially for pedestrians, is enhanced when the bright yellow cable with the integrated metering system is plugged into a car. Pictures taken by: B. J. Doody.

Figure 7 illustrates the four main parts of the APT home charger and cable channel system. The first image on the right is of the extended cable which allows participants to run the cable from there house and beyond the end of the cable channel. Participants have cables up to 18 metres in length. The centre image is of the wall box charge point and the RCD (residual current device) box. All participants expressed their general dislike for the box and frustration that the RCD box was not able to be integrated into the wall box charge point. Some participants like Rob (see Figure 7) and Steve were able to have the wall box and RCD installed so that they were largely out of sight from the street. Oliver who was not so fortunate explained in the pre-trial interview how he was 'not happy about having to have a big, fat EV charging box' on the front of his 'nice Victorian house':

> In an ideal world, I would have had it on the side of the house and because I've got the gas box quite low, they can't even put it low apparently. … It's because … [of] where my internal electrics are. [A]lso it means [running the] cable … from the door literally out through the cable channel so it will be one straight line, so it makes perfect sense. I understand all the reasons why it's there. … [B]ut part of me thinks it's going to look a bit ugly.

The cable channel can be seen in the image on the right in Figure 7 and is largely modelled on existing footpath drains. Oliver explained that the cable channel was very effective in storing the cable. His positive assessment of the cable gully seemed to depend, at least in part, on his previous experience of using a yellow cable that came with his car. He explained as there is no cover 'people were almost doing a double take … [and] tripping because the cable was so bright' and they didn't 'realise it was hidden' in the channel.

Figure 7. These images of the APT home charger and cable channel highlight the four main parts of the system, namely an extended cable, the wall box charge point and RCD (residual current device) box and the cable channel. Depending on the location of the wall box on the house, the length of the trailing cable and how close the user is able to park to the end of the cable channel this can also be a largely inconspicuous way of charging. Pictures taken by: B. J. Doody.

The proximity of the installation to a resident's home was a key difference between the lamppost and home chargers. With one exception, all of the lamppost chargers were either a short walk away from a user's house or in a neighbouring street. As a result, it was less likely for these users to regularly encounter or interact with neighbours while charging. This was in direct contrast to the experience of users of the home chargers. Charging more or less directly outside of their property in most instances appears to increase neighbours awareness of the installation and process. This is because they are able to trace the cable from the car and back through the gully to the wall box charger. A number of participants suggested neighbours have tried to avoid parking in the charging space whenever possible. Alongside this, it is relatively easy to overlook that the lamppost is part of an electric vehicle charging system. Sam, a lamppost charger user, observed that 'occasionally' there are people parked in front of all of the charging points, even when other spaces are available. In his view there was a need for some sign that makes people aware that they are charge points. He suggested it could say 'please leave this free for electric cars [to charge] … if other spaces are available'.

Relatedly, Charlotte who has been using the lamppost chargers intermittingly because of person circumstances talked about the difficulty of locating the chargers. When driving around the block to find an installation to demonstrate the charging process she observed that they can be hard to identify especially during the day when blue lights on the lamppost are not particularly visible. As subsection 4.1.1 demonstrates, it is likely that such difficulties would diminish over time as a result of learning but it is perhaps important to consider how new users can be supported during this initial period of adjustment.

There are three bollard-style chargers in the trial. Figure 8 illustrates the footprint and visibility of the Smartscape, Figure 9 the e-Post and Figure 10 the Chago Pro station chargers. Each of these bollard installations requires a charger and a transformer and all but one has an ULEV only parking bay. This increases the footprint and visibility of these chargers especially when compared with the lamppost and home chargers. Three varieties of tensions, corresponding with these characteristics, have emerged around the bollard-style chargers:

1. Aesthetics: the bollards and the signage associated with the ULEV only parking bay can be considered large and intrusive, particularly when placed in front of windows and/or when there are no front gardens in a street;
2. Potential obstructions: the size and positioning of chargers and transformer boxes coupled with other existing street furniture (e.g., lampposts; bollards; signs) and obstructions (e.g., cars parked on the kerb) can make it more challenging for different users (e.g., pedestrians, parents with prams, wheelchair users) to utilise the pavement, especially on narrow streets;
3. Collison risk: there is an increased chance of risks of collisions for drivers moving in and out of parking spaces when charging bollards are placed too close to the kerb.

Daniel observed that the aesthetics of the bollard-style chargers might potentially give rise to opposition from local residents:

> I've seen the box [chargers] in a few streets [and] can't say they're pleasant to look at and … I think it is like solar panels some people will see the benefit and some won't, some people will look … and go I really don't like that, that's an eyesore.

In elaborating further he suggested he would prefer to see lamppost chargers rather than lots of charging bollards installed on streets:

> I wouldn't want one of those big boxes outside my house. So again it's one of those things … it all sounds a good idea but not in front of my house thank you very much. ,,, [I]f you don't own the space outside your house [and] it becomes a charging point for the local community … nobody wants that. So … you [of course] need multiple charging points [but] you don't want hundreds of boxes. Lampposts probably represent, therefore, one of the biggest opportunities … because they are a reasonable distance to each other and any given street will probably only have a certain number, so [that is] probably one of the most sensible ways of looking at it.

Matthew and Emily discussed at length the consultations and conversations they went through with their immediate neighbour, the wider neighbourhood and the Oxford City and County Councils. Emily noted how they were first shown an e-Post charging bollard: 'this enormous white and green thing and we could see … [our neighbour Peter's] face sort of stiffening'. The benefit of the Smartscape charging bollard, in this context, is that it is approximately half the height of the e-Post and Chago Pro station bollard chargers. Peter, their neighbour, explained that he was not 'troubled' by the charger because it 'doesn't intrude too much' due to its 'size' and the fact 'it is a bit further away'. The downside of this though is the height of the charger coupled with the fact it is 'not quite where [one might] expect it' a number of people have 'come close to tripping over it as they come walking along the pavement'.

Figure 8. Three images of the Smartscape charging bollard show the footprint and height of the charger itself. The left image captures the full footprint and two main parts of the system, the charger and the silver transformer box located under the window sill. The right image illustrates how the blue glow of the charger makes it more visible at night. Pictures taken by: B. J. Doody.

Figure 9. Three images of the e-Post charging bollard show the footprint and height of the charger itself. The central and right images capture the full footprint and two main parts of the system, the charger and the silver transformer box located in front of the brick fence. Pictures taken by: B. J. Doody.

Figure 10. Three images of the Chago Pro charging station bollard show the footprint and height of the charger itself. The central image captures the full footprint and two main parts of the system, the charger and the green transformer box located in front of the brick fence. Pictures taken by: Trial participant Thomas.

He went on to suggest that the main issue was the accompanying 'silver transformer box' which he felt was 'bigger than it need be'. As the left image in Figure 8 illustrates this 'very, very visible' box is positioned almost directly under his windowsill and in very close proximity to this front door which means 'it hits everybody who comes to visit [who ask] 'what's that there for?'. Peter, along with Matthew and Emily, suggested that a 'tight street' like theirs with 'narrow' pavements and roads and 'houses right up on the pavement' are likely to be very 'difficult [neighbourhoods] for the council'. This is especially the case when compared to streets with 'a front garden' where chargers and transformers are 'just less intrusive' as there is more space for to 'ignore [such] street furniture'. Evan to some extent echoed these sentiments in reflecting on the positioning of the Smartscape charging bollard he has been using. He suggested it 'was a good spot' because:

> it's not right outside somebody's house [and] so it's not getting in the way of other people that use the pavement. So that sort of … makes you feel less guilty about having … [and charging a] plug-in hybrid.

Evan also observed though that because the charger is 'quite close to the edge of the kerb' he would have just about 'hit it' a 'couple times' if it were not for the 'parking sensors on the car bleeping'. As highlighted in Figures 8, 9 and 10, all of the charging bollards are positioned very close to the kerb. Although the intention is to reduce the likelihood of people walking in between a charging car and the bollard, this has meant that at least a few of the bollard installations have been hit or knocked by cars most likely reversing into parking spaces.

Overall, there are a number of differences associated with the footprint and visibility of the three main types of chargers in the trial. The inconspicuous nature of the lamppost and home chargers can be construed as a strength and weakness. On the one hand, they do not disrupt the appearance and feel of a neighbourhood. On the other, as they are less noticeable this can decrease people's awareness that parking spaces are used for charging. Although it does appear that by the home chargers have the potential to increase neighbours awareness of the installation and process. Located directly outside and having the cable running back into the participant's property, means it is possible for people to identify the owner of car if they encounter it while charging using this system. Various tensions have emerged around the aesthetics and potential obstruction and collision risk posed by the bollard-style chargers.

4.3.2 Marking out installations: Parking signage and markings

A number of issues and tensions have arisen in relation to the aesthetics and meaning of parking signage and road markings and 'charging etiquette' or the appropriate use of the available charging spaces. These in part need to be understood in the somewhat unique and unusual context of Oxford. Some areas of the city are characterised by old, narrow streets, conservation areas and very high parking pressures. Issues around the aesthetics of signage have tended to come up in older neighbourhoods with very narrow streets (see Figure 11) and conservation areas.

Figure 11. Emily suggested that in 'a tight urban environment' like the street they live on it is easy for neighbourhoods to 'get cluttered up with signs'. Picture taken by: B. J. Doody.

Matthew and Emily, for example, live in a very narrow street where properties do not have any front gardens (see Figure 11). The bollard-style charger that they have been assigned to use is the only one in the trial that is not associated with a dedicated ULEV parking bay and signage. As they explain this is because it would have required a large sign to be installed:

> Matthew: It was a legal requirement [for] the sign had be a [specific] size and [the highways department] could not move from that position.
>
> Emily: [That was] because it had to get all the wording on it to allow them to put a ticket on somebody's car if they were [parked] in there. … We didn't actually want that. We wanted just a small sign to say this is a charging bay … so that people would know and think twice about parking there. … [A]nd there was no compromise between having nothing which is what we've got and having this huge sign that would have to go on somebody's house that couldn't be put on existing poles.

Matthew: [In the end] our neighbour … would not budge [on the sign]. … Generally you know there [are] so many signs … and I [do] question whether they are all necessary but people do object of loads of signs everywhere.

Emily: A tight urban environment like this [street] … gets cluttered up with signs … and people get quite protective about their own frontage understandably. When we [met] with the guy from the [Oxford] County [Council] … I said well you can't possibly have signs that big all down the road … when these things get rolled out and he said no if you had a number down the road we wouldn't have to have any signs because there would be a number to use.

These issues as this interchange highlights are shaped by the distinctive characteristics of their street. Such issues as a result may not come up in the same way in the city's outer and/or more recent neighbourhoods and streets and also not in other places beyond the city.

Other issues and tensions have been associated with the interpretation of road markings and signage and 'charging etiquette' or the appropriate use of the available charging spaces. Evan explained that there has been an 'issue' with Co-Wheels using the wrong charging point and space and at other times using both the car club and the 'electric vehicle space' which is 'annoying' when you turn up 'trying to use it' and 'they are parked there'. He was unclear if they were only supposed to use 'their bay' and 'charger' as technically they are also driving an 'electric vehicle' (see Figure 12). This issue he explained was further exacerbated by the fact that if they have parked in both spaces, Co-Wheels 'haven't got anyone in Oxford so [they] can't do anything about it.

Figure 12. Evan explained how there had been instances where the Co-Wheels car club users have parked the car in the electric vehicle charging space at the front and others when a car club vehicles has been parked in each of the two spaces. Picture taken by: B. J. Doody**.**

James having read the charging signage (see Figure 13), was unsure as to who was able to park their car in the dedicated electric vehicle bay:

> As I currently understand it if I'm a resident with a parking permit I can park there after let's say six o'clock but I wouldn't be able to leave it there or let's say it was an EV, I could park it there overnight then because I've got a permit but then three hours into the next day I'd have to move it. [But] because the street is so busy … with parking if you come home at night and … someone with a permit is there because it's free then they will be parked there [and] unfortunately they will stay. … [So] most likely coming back after six thirty it'll have a person parked there because you're allowed to park there.

After discussing the conditions of parking in the space he went on to suggest that lots of cars park in his street that have not 'got a permit' as 'people take more risk[s] at night [and] park wherever' including the dedicated car club space.

Figure 13. James suggested that it was not clear to him whether or not residents a parking permit were able to park in the electric vehicle charging point after 6.30pm even if they were not driving an electric vehicle. Picture taken by: B. J. Doody.

Charlie discussed how it is not yet clear how the available charging spaces should be most appropriately used. He explained there was 'a bit of an issue' in that the 'charging point … has almost become [his] dedicated parking space' because as no one else has an 'electric' vehicle 'in the street' there is 'no competition'. As a result he does not 'feel too bad about it' and in fact because it is 'an electric car charging bay' if he parks his car 'outside … the charging bay' he now feels as if he is 'taking up a space someone with a normal car could use'. Charlie went on to say that for the most part he ends up 'disregard[ing] … the designations three hour charging' and not moving his car. But even if he was to follow these requirements he felt based on his interpretation of the designation you could legally occupy the space for most of the day:

> It is three hours starting at eight o'clock [0800] so … basically you can easily leave it there until eleven o'clock [1100] or within the confines of the regulation and then again it starts at six o'clock [1800], so if it's three hours you can leave it there [from] three o'clock [1500]. So that [is almost all] of [the] day.

Recognising that the current situation he finds himself may charge, Charlie suggested that it was not 'probably a very accurate reflection of what might be the case in future if there [was] an awful lot of vehicles around that want to use … the charging space'. Here, he observed that at present there is 'no incentive' to vacate the space 'once you are fully charged' and so this is something that would need to be 'thought through' as 'more and more cars want to use these charging points'.

In summary, Oxford is an unusual and unique case characterised by old, narrow streets, conservation areas and very high parking pressures. Some of the issues and tensions around the aesthetics of parking signage and road markings should be understood in this context. Others such as charging etiquette or how to most appropriately use available charging spaces need to be seen in relation to the novelty and experimental character of the trial. At present, what is 'appropriate' charging etiquette (i.e., freeing up a space once cars are not or no longer charging) is not yet clear or agreed upon.

4.3.3 Generating interest: Chargers as conversation starters and vandalism drawcards

The charging installations generate what might both be considered desirable and undesirable interest within local communities. Most of the trial participants recounted conversations with neighbours and passers-by while plugging in or unplugging their vehicle, as well as more general discussions with friends, family and work colleagues. A great deal of this talk centred on the everyday possibilities and challenges associated with driving a plug-in hybrid or full battery electric vehicle. Much of the focus is on range, the types of journeys you can make, the convenience of charging and to a lesser extent the car itself and the running costs. This excerpt from Sam is illustrative:

> I was plugging in one time and three people who were walking a dog stopped to ask me about it. [T]hey said 'oh we've seen this plugged in [and] wondered who it belong to and what a great idea. … Interactions with … other people […] [have been all to do with … range, sort of like how far can it go [and] what if you run out, that sort of stuff. So those are the substantive questions and most people … that ask about the car are more interested in the fact it's a Tesla and it drives itself.

Some participants with a line of sight from within their home also noted how people reacted upon seeing their electric vehicle charging:

> Lucas: [W]e have a room upstairs with a study and we sit and watch and people kind of walk past [the charging car] and then they turn around [laughs] and … kind of double back and look at it for a bit and then carry on.
>
> Oliver: [W]hen it was first installed I deliberately worked in my wife's office a few days because it's literally on the street so you can hear what people say. … It's amazing … the amount of people that stop and go oh God look that car is plugged in and couldn't believe it and then they kind of look down and go wow it has got a channel.

William felt the sight of his and others cars charging were 'really helpful' in making [people] think' about having to 'go electric one day'. Similarly, Steve felt that 'people are beginning to think … electric cars will be coming' because of discussions around 'petrol and diesel cars no [longer] being produced' and the 'low emissions zone in the middle of town' and 'which cars will be able to drive through that'. For the most part, interactions and observations around the chargers were usually seen to be or experienced by participants such as Charlie as 'good and positive' rather than 'negative'.

Despite this, a few participants questioned the extent to such conversations and interactions might encourage the uptake of electric vehicles. Daniel felt that people are only 'usually interested for about a minute' because it was 'unusual' or novel but 'that's it' as at 'the end of the day it is just a charging point [and] you're just plugging something in'. Matthew, who despite the charger having been live for two months, has not been able to charge because they have yet to by the correct cable. He felt that the 'worst thing' aside from not charging was 'anybody else contemplating getting an electric vehicle' would likely be looking 'at what's happening ' and say 'oh well I would be able to charge there'. In Matthew's view, the unused charging installation is 'a disincentive … for people to think about buying electric car'. Meanwhile, William when asked about 'how [he] gets on' with his full battery electric Nissan Leaf by neighbours, friends and family, said he 'usually tells them' that 'the range isn't good enough … for normal motoring but it's great round the town' and as a 'second car'.

Alongside generating conversations and arousing people's interest, the charging installations have also given rise to concerns about vandalism and the possibility of their car being damaged. Bollard-style chargers which include both the charging station and a transformer have been deliberately defaced and vandalised to varying degrees (see Figure 14). Participant concerns stemmed both from previous experiences of having had cars damaged while being parked on the street and the fact that the cable and lights associated with charging the car make it more conspicuous and visible. Sam, for example, noted how his ten-year old BMW 'has been properly screwed up by … people backing into [and] walking keys along it'. Parking his leased Tesla Model S 'on the road' he feels makes it 'more likely somebody will take a dislike' to this 'very expensive car' and walk 'a key along it or … give it a kick'. He and others expressed concerns about people, especially drunk students, trying to pull the cable out of the car:

> Jericho … is as good a place as any to get drunk in Oxford [and] we are on the way to St Hugh's [College]. … [M]y concern was that we get a drunk student trying to pull [the cable] out. That hasn't happened yet [but] it doesn't mean it won't happen. [I]t's a shiny thing that flashes light and I think it will be like the moon to a moth for a drunk student.

Figure 14. These three images illustrate how some of the chargers have been to varying degrees defaced and vandalised. The Chago station charging bollard in the centre has had the charging flap removed. Pictures taken by: B. J. Doody (left and right images) and trial participant Thomas (centre image).

These participants were not necessarily worried about the cable being stolen as it locked into their car while charging. Their main concern was that this locking mechanism might mean that the internal charging point might be damaged if the cable is pushed and pulled in different directions with sufficient force. None of the

participants were certain of the likelihood of this occurring but speculated that if it did happen it would potentially be ‘exceptionally expensive repair’ (Oliver).

In summary, the charging installations generate what may be seen as both desirable and undesirable interest within local communities. Interactions with neighbours and passers-by and general discussions with friends, family and work colleagues can raise awareness and understanding and/or reconfirm existing perceptions about the ease and utility of ULEVs, especially in relation to their range. Some of the bollard-style charging installations have been vandalised. A few participants have also expressed concerns that the cable and lights associated with charging make their cars more conspicuous and visible giving rise to concerns about vandalism and the possibility of their car being damaged.

5. Conclusion

This first interim report for the GULO trial of five different on-street charging technologies for electric vehicles across 30 sites in Oxford has made use of two rounds of interviews with 18 participating households. In this final section we reflect on the preliminary insights that have been gained in relation to the four objectives of the monitoring and evaluation activities of the GULO project:

1. Evaluating the performance of the various on-street charging installations;
2. Examining the adaptations to car-use routines and the formation of charging habits among pilot participants;
3. Identifying local community responses to the charging installations;
4. Developing insights about how the pilot may be scaled up within Oxford and transferred to local authorities elsewhere in the UK.

5.1 Performance of the installations

Instead of specifying in advance which criteria would be used to evaluate the 'performance' of the installations from a user perspective, we have opted for a more open and bottom-up approach. Many of the criteria were derived from participants' narrative accounts of their views, concerns and experiences during the interviews. This approach has been particularly valuable for two reasons. First, it has allowed us to learn extensively from participants. Second, a widespread consensus across different stakeholders about what 'good' performance means in the context of on-street charging of ULEVs does not (yet) exist, as is not uncommon with new technologies. Table 3 lists the criteria that have been identified so far. This list of criteria can, and probably will, change over the course of the trial[4]. It should be emphasised that the assessment of the three groups of charging technologies is qualitative and preliminary. It is based on: a) the researchers' interpretation of trial participants' narrative accounts, whose number is rather small and does not include car club members; and b) their own in-field observations.

Nevertheless, Table 3 suggests that the different charger types perform better in some of the suggested criteria than others: 1) utilisation; 2) reliability; 3) ease of access; 4) ease of use; 5) risk of damage to vehicle; 6) risk to other street users; and 7) installation footprint. The performance of different chargers on some criteria such as access and risk to other street users depends partly on contextual factors such as characteristics of the vehicles (size of the vehicle, position of the flap), characteristics of the street (width) and the parking bay (length of the bay) and other's parking practices. On average, however, it would appear that, over the first couple of months of use, lamppost chargers just outperform the home chargers across these criteria. The bollard-style chargers seem to perform more than adequately on most criteria, except footprint and the risk of damage to the vehicle.

[4] For instance, over the first few months of the trial, there were few instances of installation breakdown and vandalism. This may of course change.

Table 3. Potential criteria for assessing the performance of on-street charging technologies from a user perspective.

	Lamppost charger (Ubitricity)	**Bollard chargers** (Chago Pro; e-Post; Smartscape)	**Home chargers** (APT)
Utilisation	Good • Regularly used when available	Good • Regularly used when available	Good • Regularly used when available
Reliability	Good • Some temporary problems with chargers not working; • Information available about operational chargers in the Ubitricity app • Problems resolved quickly	Poor (Smartscape) - Good (e-Post; Chago) • Ongoing problems with one Smartscape charger not working (~3 months); • No information available on where to report problems on chargers • Unresolved problem (Smartscape charger)	Very Good • No reported problems
Ease of access	Good • Not dependent on a limited number of spaces (six or more spaces available) • Proximity to user's property varies	Good • Associated with dedicated ULEV parking bay • Dependent on the availability of a limited number of spaces (one or two spaces available) • Proximity to user's property varies	Neutral • Dependent on the availability of a limited number of spaces (between one to three spaces available) • Close proximity to user's property
Ease of use	Very good • Very simple and easy to use • Requires an additional metered cable	Neutral (Chago) - Very Good (e-Post; Smartscape) • The design and lack of instructions mean the Chago charger is initially difficult to use • Others are simple and easy to use	Neutral • Involves a lot of bending and manipulation of the cable especially into the channel • Typically requires a long cable (>10m) which can be difficult to handle
Risk of damage to vehicle	Low • User concerns over the possibility of the charging port being damaged by an attempt to pulled the cable out of the car	High • Possibility of hitting the charging bollard when moving in or out of the park • User concerns over the possibility of the charging port being damaged by an attempt to pulled the cable out of the car	Low • User concerns over the possibility of the charging port being damaged by an attempt to pulled the cable out of the car

Risk to other street users	Moderate • Cable is not stored securely • Majority of lampposts are located close to the kerb minimising the likelihood of people walking between the car and charger and cable on the pavement • Sometimes sufficient excess cable to move out of harm's way • Bright coloured cable is visible in most light conditions • Users generally give little consideration to the risks posed by the cable	Moderate • Cable is not stored securely • Located on the pavement, bollards and transformer box can create additional trip hazards • Bollards are located close to the kerb minimising the likelihood of people walking between the car and charger and cable on the pavement • Cables that come with cars tend to be shorter so not necessarily sufficient excess cable to move out of harm's way • Cables are generally black so less visible especially in bad light conditions and night; • Users generally give little consideration to the risks posed by the cable	Very Low • Charging box installed on the house and channel is incorporated into the pavement • Cable is stored securely in the cable channel • Generally sufficient excess cable to move out of harm's way • Using the cable channel appears to increase users awareness of the potential risks posed by the cable; • Black cable is less visible especially in bad light conditions and night
Charging installation footprint	Very insignificant • Charger incorporated into existing street furniture (lamppost)	Intermediate • Both charger and transformer need to be accommodated on the footpath	Insignificant • Charging box and RCD need to be installed somewhere on the front of the house • Cable channel is incorporated into the pavement

5.2 Adaptations to routines and new habits

So far the research indicates that changes have occurred not so much in how often, where or when people drive cars but rather in how they negotiate parking and in when, for how long, where and how often they charge. This is particularly the case for participants for whom access to a place for charging was an issue. These participants have developed a range of strategies, which have been classified in this report as pre-emptive, opportunistic, good-will based, observation-based and tactical.

With regard to charging, the results indicate that habits and routines develop over time as people become familiar with their car's range and how long it takes to charge using a particular charging installation. The timing and duration of a charging event is shaped by a variety of factors. The timing and duration of a charging event is shaped by the proximity and accessibility of a charging space, personal and/or household routines, the nature of recent or upcoming journeys and the capacity of their battery.

5.3 Local community responses

A wide range of responses from neighbours have been identified so far. Many of these are positive, and there is evidence to suggest that the charging installations trigger new conversations among neighbours and

generate some interest in ULEVs among residents who do not use them. At least some of the trial participants seem to fulfil a community leadership role in reference to ULEV diffusion by helping to increase the visibility and awareness of, and familiarity with, ULEVs and ULEV charging in local communities. The flipside is, however, that some participants actively reaffirm existing negative perceptions of ULEVs while others are aware that the failure of the GULO trial or breakdown of the installation may work against ULEV adoption, both of which may put people off this type of vehicle.

The responses also reveal some tensions which can be classified into three main categories. The most obvious of these have revolved around aesthetics. Tensions around signage have been the most pronounced so far, particularly where signs had to be placed on or in front of the dwelling of a neighbour. Comments were also made about the aesthetics of the wall box charge point associated with home chargers and of the bollard-style chargers and associated transformer boxes. On a more positive note, many participants have emphasised how easily the lamppost and home chargers integrate into the `physical fabric of the neighbourhood, in part because they are incorporated into existing street furniture (lampposts) and pavements (cable gully). Participants have also appreciated the size and look of the smaller Smartscape bollard chargers. Anticipated issues such as light pollution from the chargers have not yet arisen.

The other two categories of tension concerned the ease of using the pavement and the risk of collisions between a vehicle moving in and out of a parking space and the location of the installation on the kerb. The size and positioning of bollard-style chargers and associated transformer boxes in addition to other existing street furniture (e.g., lampposts; bollards; signs) and obstructions (e.g., cars parked on the kerb) can make using the pavement more difficult for different users (e.g., pedestrians, parents with prams, wheelchair users), particularly on narrow streets. The placing of bollards too close to the kerb can increase the chance of risks of collisions for drivers moving in and out of parking spaces.

5.4 Lessons for other local authorities

There are three main conclusions about what other local authorities that are seeking to increase ULEV adoption through the creation of charging infrastructures on public streets in residential areas can learn from the insights summarised in this report.

First, the usability or appropriateness of parking spaces for on-street charging depends on a wide range of factors and is therefore an issue that local authorities should consider carefully in decisions about what charging solution to offer and where. An available space for on-street charging is not necessarily also a usable or appropriate place for parking. Whether prospective users consider a place usable or appropriate for charging depends on many contextual factors beyond the installed charging technology. Those factors include characteristics of their vehicle (size of the vehicle, position of the flap), the street (width) and the parking bay (length of bay). They also include the parking practices of neighbours and others, and the perceived risk of damage to one's car or to other users of the road and pavement. The broader implications of these considerations are twofold. One is that only thinking about numbers of charging installations or parking spaces for charging as an indicator of successful policy is inadequate. The other is that parking and charging are profoundly social practices – the social relationships within parking and charging are embedded need to be considered carefully in the development of policy initiatives.

Secondly, a new etiquette around parking needs to be developed. If parking spaces around charging installations cannot be assigned exclusively to ULEVs, then informal rules need to be encouraged whereby spaces are vacated once cars are not or no longer charging. This will help to maximise the accessibility of charging installations for those vehicles and drivers who need to charge. Stricter enforcement of (formal) parking rules by the policy and traffic wardens has a role to play in this, but so have awareness raising and media campaigns. Local policy makers cannot direct the formation of a new etiquette in a top-down manner but they can encourage it and steer the directions in which it evolves.

Finally, Oxford is in some ways a unique and unusual case: the city it is characterised by old, narrow streets, many conservation areas and very high parking pressures. In the subsequent phases of the evaluation the implications of these specificities for the transferability of the insights from the Oxford trial to local authorities elsewhere needs to be investigated further. Most of the above conclusions are nonetheless likely to hold for other UK cities as well.

Appendices

Appendix 1: Interview 1 Schedule: Pre-trial

Introduction

Hi my name is Brendan Doody I'm a researcher from the Transport Studies Unit at the University of Oxford. Part of my job is to monitor and evaluate how the Go Ultra Low Oxford trial influences trial participants' usage and attitudes towards on-street charging technologies.

More specifically, the four areas we will try to understand are how:

1. Different charging installations perform;
2. You adapt to driving and charging electric vehicles over time;
3. Your neighbours and others respond to the installations; and
4. The pilot might be scaled up within Oxford and elsewhere in the UK

In this context, it is important to stress that we are independent from the Council and so you should feel free to openly share any thoughts, feelings or issues that arise during the trial. The information and views will be shared with the Council and other partners only in an anonymised form.

As a trial participant your participation in the project will involve four interviews, this one before, and three at different intervals after, the start of the trial. Alongside this interview the interviews will take place at 1-2 months, 5 months and 11 months after the start of the trial. In doing so, the intention is to identify and explore how participants' views on the charging technology and their associated routines and habits change over time.

As a participant your rights are to:

- decline to answer any particular question;
- ask any questions about the study at any time during participation;
- provide information on the understanding that your name will not be used unless you give permission to the researcher;
- ask for the audio recording to be turned off at any time during the interview;
- be given access to a summary of the project findings when it is concluded.

1. Personal and household mobility

- Describe a normal week in your life. What do you do and where do you go? Is it a fixed or flexible routine? How does it vary on different days/weekends?

2. Exploring electric vehicle use

- How did you come to be involved with or driving an electric vehicle?

- Recent research into everyday travel has found that the way we travel today is often a result of longer term events and processes which sometimes stretch back to our childhoods.

    - To begin on the x or time –axis can you identify the city/town/villages in which you have lived over your life;

    - Can you now note whether or not you had access to a car as either a passenger or a driver;

    - For each of these periods I would like you to now draw a line of your estimated car use during this period;

    - Could you now note down the reasons why you did or did not drive during that period (e.g., for practical reasons; chauffeuring others (children; friends; family) or being chauffeured;

getting to work; getting to different activities; going on holiday; visiting friends; you enjoyed driving; infrastructure);

- How did you feel about driving at the time?
- When did you first become aware of or experience an EV (e.g., 1) as a concept; 2) in person; and 3) as a potential car)?

3. Administer the questionnaire

- The pre-trial questionnaire for both first-time and experienced users of electric vehicles.

4. Experiences driving electric vehicles

- Can you please tell about your experiences driving electric vehicles?

5. Experiences charging electric vehicles

- Can you please tell about your experiences charging electric vehicles?

6. Involvement in and expectations of the trial

- How did you come to be involved in the trial? What motivated you to be involved?
- What are you personally hoping to get out of the trial?
- What do you think the City of Oxford will get out of the trial?
- When will the trial be a success for you?
- At this stage, do you anticipate any issues or problems in the trial?
- What are your thoughts about where your charging installation will be installed?
    - What are your views on the physical attributes (i.e., width of the footpath or street; the size of the guttering; proximity to parking bay) of the site itself?

Conclusion of the interview

- Thank the participant for their time
- Make them aware of the content and timing of the next interview

Appendix 2: Interview 2 Schedule: 1-2 Months into the Trial

Introduction

Hi this is the first of the three interviews which will take place during the trial the remaining two will be at 5 months and 11 months into the trial.

Today we will talk about the we will talk about the performance of your charging installation and your views on it, your charging behaviour and impact it has had on your car use and everyday activities. Alongside this we will cover issues surrounding street parking and community responses to the charging installation. If we have time we may also revisit some of the topics from the first interview around how you have ended up driving an electric vehicle.

As a participant you have the right to:

- decline to answer any particular question;
- ask any questions about the study at any time during participation;
- provide information on the understanding that your name will not be used unless you give permission to the researcher;
- ask for the audio recording to be turned off at any time during the interview;
- be given access to a summary of the project findings when it is concluded.

1. Administer trial questionnaire

- The questionnaire for experienced users of electric vehicles

2. Experiences of charging using the trial technologies

- Can you please tell about your experiences charging your electric vehicle using the trial installation?
    a. What do you like about using the installation?
    b. What frustrates you about using the installation?
    c. Would you recommend this installation to Oxford City and County Councils?

3. Personal and household mobility

- Can you please tell me about how you go about planning your travel?
    a. Has anything in the household changed that has affected this?
    b. How do you manage conflicts in your time schedule and availability?
- Is the charger available when you want to charge?
    a. How do you feel when you are not able to charge?
    b. How do you deal with the uncertainty around charging?

4. Community interactions and responses to the installations

- Does anyone talk to you about being involved in the trial? What sorts of things have they discussed?
    a. How do you think your neighbours or social networks feel about electric vehicles because of your involvement in the trial so far?

- What sorts of interactions have you had with people around the trial installation?

5. Trial technology demonstration [At the charging installation]

- Can you please provide me with a demonstration of how you would go about charging your electric vehicle using the trial installation?

    a. How user-friendly is the installation to use?

    b. What do you have to consider or think about when charging an electric vehicle?

    c. What do you not have to think about? (i.e., what is now second nature or almost automatic for you?)

    d. Is that different from when you started?

Conclusion of the interview

Thank them for their time and if possible, try to reconfirm the best times to meet them. Update them on any outputs that have come out of the research.