

My Electric Avenue (I²EV)

SDRC 9.6: An assessment of the public acceptance of Demand Side Response of EV charging using Esprit

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Project leads



Project partners



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Executive summary

This report describes the research conducted by De Montfort University as part of the My Electric Avenue project to investigate public acceptance of the Esprit system for control of electric vehicle (EV) charging. Esprit provides 'demand side response' (DSR) for local electricity network protection by intervening in the charging of electric vehicles (EVs) when demands on the local electricity network reach a certain threshold. The aim of the research was to provide a response to SDRC 9.6 set out in the Project Direction:

9.6 An assessment of the public acceptance (or otherwise) to Demand Side Response of EVs using this sort of technology.

And to address the additional learnings:

T.1.1.1 - How does a trial encourage the uptake of low carbon technology?

T.1.1.2 - What social factors have an impact on the use of the Technology?

T.1.1.3 - How can a trial be used to educate customers about the electricity network and low carbon technologies?

Acceptability of Esprit

Research findings suggest that the Esprit system for control of EV charging was acceptable to the majority of participants in the My Electric Avenue Technical Trial. The degree of acceptability of Esprit was not related to whether or not participants experienced curtailment of charging by Esprit

Most of the participants in the Domestic Clusters whose charging was curtailed were either not aware of the curtailment, or were not impacted by it. In face-to-face data collection, only one participant reported a significant issue with curtailment where changes to plans were required due to insufficient charge in the vehicle.

Curtailment of charging by Esprit was more of an issue for participants in the Workplace Cluster of the Technical Trial. The majority of participants opted not to charge at the workplace after curtailment began due to the uncertainty of receiving sufficient charge. This uncertainty may result from the interaction of Esprit and the load profile for the Workplace Cluster which caused Esprit to operate in an impractical way.

In face-to-face data collection with Workplace Cluster participants those individuals who needed to charge at the workplace reported being very unhappy with the technology. Acceptability of Esprit by the Workplace Cluster participants as a whole, however, was comparable to the acceptance by Domestic Cluster participants. This may be due to the majority of the Workplace cluster participants choosing to charge at home rather than at work and therefore not being impacted by curtailment.

The control of charging by Esprit was more acceptable to participants in the Technical Trial who viewed EVs more positively (as measured by Experience of and Attitude towards EVs). This greater degree of acceptance was the case whether or not participants had experienced curtailment by Esprit during the course of the trial. The relationship between the acceptability of Esprit and a positive view of EVs suggests that the concept and reality of curtailment are more acceptable to drivers with a more positive view of EVs.

Acceptability of Esprit was also found to be greater among participants who were more comfortable with a lower level of charge in their battery. Additionally, participants with greater confidence in finding alternative charging locations to their home charger had a higher level of acceptance of Esprit.

The types of journeys (e.g. commuting, shopping, transporting others) for which EVs were used over the trial period did not appear to affect participants' view of Esprit. However, with regard to trip length, drivers who had a higher proportion of journeys between 11 and 30 miles at the end of the trial were more likely to find Esprit acceptable; acceptability was also higher amongst those drivers who took more unplanned trips.

Overall there were few changes in either charging patterns or travel patterns following the introduction of curtailment. This lack of change suggests that Esprit control of charging had little impact on the use of EVs or attitudes towards them.

Uptake of Low Carbon Technology

Findings suggest that the My Electric Avenue Trial encouraged the uptake of low carbon technology with some participants installing or intending to install PV, adopting energy efficiency measures, and/or intending to acquire EVs after the trial. By allowing direct experience of a low carbon technology, such as EVs, in a supportive social and economic environment, participants were able to familiarise themselves with the technology, which encouraged them to consider investing in EVs after the trial. A few participants also felt that being involved with the trial had raised their awareness of low carbon technology more generally.

Social Factors

Social factors did not appear to be related to the use of the technology (Esprit). However, the trial participants were not representative of the UK population as a whole in terms of socio-demographics or household composition.

Knowledge of the Electricity Network and Low Carbon Technologies

Pre-trial involvement with the My Electric Avenue trial increased participants' awareness and understanding of both the electricity network and low carbon technologies. Awareness and understanding of low carbon technologies continued to increase during the course of the trial, with actual experience of the technology being the most important factor in increasing both awareness and understanding. The trial also appeared to be successful in educating both participants and the wider community about EVs.

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Definitions

Cluster	A cluster of My Electric Avenue trial participants connected to the same low voltage feeder cable
Esprit	The technology being trialled within the project
EV	Electric Vehicle
ICB	Intelligent Control Box – a component of the Esprit system
MEA	My Electric Avenue – the public facing ‘brand name’ of the I ² EV Project
NVivo	A qualitative data analysis (QDA) software package used to aid in the analysis of the interview and focus group data
Qualtrics	An online survey software which was used to aid the development and distribution of questionnaires to all participants
SPSS	A software package used for statistical analysis

Statistical tests

Cronbach's alpha

Cronbach's alpha measures the internal consistency of a scale, which is, how closely related a set of items are as a group. A set of items with a Cronbach's alpha score over 0.6 can be considered as a single item if there is no evidence of multi-dimensionality.

Factor Analysis

Factor Analysis is a statistical method used to explore the dimensionality of a set of items either for data reduction or structure detection. If there is no evidence of multiple dimensions, the set of items may either be considered separately (i.e. each item is included in analysis) or as a single item (i.e. items are combined to form a single item for use in analysis) dependent on the Cronbach's alpha score.

Kendall's Tau

Kendall's Tau is a non-parametric statistical test used to assess the statistical association of two variables based on the ranks of the data. Non-parametric tests are used when data are not normally distributed. Kendall's Tau is particularly suited to small sets of data. A statistically significant result suggests that there is a relationship between the two variables.

Kruskal-Wallis Test

The Kruskal-Wallis Test is a non-parametric test for comparing three or more unmatched samples. A statistically significant result suggests that there is a difference between at least two sets of data.

Mann-Whitney U Test

The **Mann-Whitney U Test** is a non-parametric test for comparing two unmatched samples. A statistically significant result suggests that there is a difference between two sets of data.

Wilcoxon Signed-Ranks Test

The **Wilcoxon Signed-Ranks Test** is a non-parametric paired-difference test which can be used when comparing repeated measurements on a single sample. It is used to assess whether there is a difference between the measurements at different times. A statistically significant result suggests that there is a difference in the data over time.

1 Introduction

1.1. Purpose

This report provides an assessment of the acceptability of the Esprit technology to participants in the My Electric Avenue trial. In the trial Esprit had the potential to intervene in the charging of electric vehicles (EVs) when demands on the local electricity network reached a certain threshold. This intervention provides ‘demand side response’ (DSR) for local electricity network protection. The focus for research reported here is provided by the Project Direction (the project contract with Ofgem) which asks for:

9.6 An assessment of the public acceptance (or otherwise) to Demand Side Response of EVs using this sort of technology.

Additionally, the report covers the related learnings outlined in the Project Direction:

T.1.1.1 – How does a trial encourage the uptake of low carbon technology?

T.1.1.2 – What social factors have an impact on the use of the Technology?

T.1.1.3 – How can a trial be used to educate customers about the electricity network and low carbon technologies?

1.2. Document Structure

This report presents an overview of **Task 6 Participant Interviews** and contains 4 further sections:

Section 2 provides an overview of the research design, data collection and data analysis procedures used in this research.

Section 3 discusses the results of data collection and analysis in detail, including characteristics of the participants and the findings from questionnaires, interviews, and focus groups.

Section 4 presents a general discussion of the results provided in Section 3 and explores their implication for the deployment of Esprit Technology.

Section 5 presents the conclusions of the research, relates them to SDRC 9.6 and the related learnings, T1.1.1, T1.1.2 and T1.1.3, and provides insight into **SDRC 9.7.1 Question C: Evidence of whether this solution would be feasible or not combining learning from 9.5, 9.6.**

For a detailed discussion of the research design, data collection and data analysis see Sections 2 and 3. For a discussion of the findings and to relate the findings to the SDRC see Sections 4 and 5.

2. Overview of research

2.1. Introduction

The main purpose of this research was to consider the reaction of trial participants to control of electric vehicle (EV) charging by Esprit. This was assessed both through participants' use of, and satisfaction with, their EV and through direct questions about the impact of curtailment of charging.

The research also considered the effect of the trial on participants' knowledge of low carbon technologies and their knowledge of the electricity network, and explored what elements of the trial were most effective in educating participants about low carbon technologies and the electricity network.

The study included two groups of participants: Technical Trial and Social Trial participants. There was a potential for Technical Trial participants to be impacted by Esprit as interruptions to charging by Esprit could affect participants' ability to both charge and use their EV. The Social trial did not incorporate any control of charging by Esprit and therefore Social Trial participants had no direct experience of Esprit. Within the Technical Trial, there were 9 clusters where Esprit controlled home charging (Domestic Clusters) and one cluster where Esprit controlled workplace charging (Workplace Cluster). All participants were provided with a Nissan Leaf EV for 18 months at a discounted cost. The discount was larger for the Technical Trial participants to reflect the greater impact the trial might have on their lives and on the use of their EV. Technical Trial participants were also provided with a home charging point.

Data were collected by questionnaire several times over the course of the project from both Technical and Social Trial participants. In addition, interview and focus group data were collected once for each cluster from Technical Trial participants.

2.2. Research Design

2.2.1. Introduction

The central question that this research addresses is:

In what ways, if any, do users of Electric Vehicles find the control of charging via Esprit impacts their use of the vehicles?

Data were collected on the participants' use of their EVs and on any impact the control of charging via Esprit might have had on that behaviour. Data collection focussed on:

- vehicle use and charging patterns (e.g. EV journey frequency, distance, timing) for both the Social and Technical trials
- concerns over the Esprit technology's intervention (e.g. EV journeys not taken due to curtailed or rescheduled charging)
- perceived satisfaction levels, charging patterns, and travel patterns for participants whose EV charging was controlled by Esprit, including adjustments in behaviour and any problems encountered

Data were also collected on knowledge of low carbon technologies and of the electricity network.

2.2.1.1. Summary of findings from literature review

A review of existing literature on EVs and EV charging suggested several areas of importance for data collection and analysis for this research:

- Motivation for taking part in trials may be important in relation to how people view EVs (Egbue and Long, 2012) and therefore may also be related to how they react to Esprit.
- The availability of other vehicles in the household (the ‘hybrid household’) affects both the use of and attitude towards EVs (Kurani et al., 1996). The availability of other vehicles may also have an effect on the acceptability of Esprit.
- EV users needed to plan journeys more than they anticipated (Graham Rowe et al., 2012). This involves consideration of charge state, which may be more difficult if there is a possibility of charging being curtailed by Esprit.
- Drivers develop habits in relation to when, where and how they charge their EV (Bunce et al., 2014). Patterns include basing recharging of the EV on state of charge, time of day, or availability of a charging opportunity.

The following areas were explored to provide insight into the impact of Esprit on EV users:

- What are the differences in level of satisfaction with EVs between participants with and without experience of Esprit-controlled charging?
- What are the differences in vehicle use and charging patterns between participants with and without experience of Esprit-controlled charging?
- What problems have participants encountered in relation to vehicle charging?
- How comfortable were participants with the concept of Esprit-controlled charging?

2.3. Method

A longitudinal, mixed-methods approach was adopted using online questionnaires and face-to-face interviews and focus groups. Data collection took place over 18 months from December 2013 through June 2015 from three groups of participants: Domestic (n=90), Workplace (n=14) and Social (n=120). Domestic and Workplace clusters were to experience control (in their home or work setting respectively).

It was assumed, pre-commencement of the trials, that Technical Trial participants, including Domestic and Workplace participants, would experience curtailment of charging from the beginning of the trial. Therefore the initial study design proposed comparison between Social Trial participants and Technical Trial participants to explore whether there were differences in satisfaction with EVs between participants experiencing curtailment and those who were not experiencing curtailment.

However, as active curtailment was implemented later than planned, an opportunity arose to compare data from the same participants before and after curtailment was introduced thus providing a more accurate assessment of the impact of Esprit. Furthermore, as a number of Technical Trial participants experienced no curtailment during the trial, there was also an opportunity to compare data from Technical Trial participants who experienced curtailment (Curtailed) and those who did not (Non-curtailed). Data from the Social Trial provided comparative data on EV use and charging habit for a wider cohort.

2.4. Data Collection and Analysis

De Montfort University collected self-report data from both Technical and Social Trial participants through online questionnaires, and also through face-to-face interviews and focus groups from Technical Trial participants. The timing of questionnaires was initially informed by previous literature about EV adoption. Data from face-to-face interviews and focus groups complemented the questionnaire data by allowing the experience of the technology to be explored in depth. Data collection to address SDRC 9.6 (An assessment of the public acceptance (or otherwise) to Demand Side Response of EVs using this sort of technology) focused on:

- Levels of satisfaction with EVs
- EV driving and charging habits
- Concerns from trial participants regarding the potential for the Esprit system to intervene in their EV charging
- Issues encountered due to use of the Esprit technology
- An assessment of the reaction to living with Esprit

Data collection to address T1.1.1 (How does a trial encourage the uptake of low carbon technology?) focussed on:

- Uptake of renewable energy
- Adoption of energy efficiency measures
- Intention to purchase or lease an EV after the trial
- Reaction to the trial process

Data collection to address T1.1.2 (What social factors have an impact on the use of the Technology?) focussed on social factors that might affect satisfaction with the use, and charging of, EVs including:

- Socio-demographics
- Household characteristics
- Attitudes towards EVs
- Motivation for participating in the trial
- Travel and charging/fuelling patterns

Data collection to address T1.1.3 (How can a trial be used to educate customers about the electricity network and low carbon technologies?) focussed on:

- Changes in knowledge about the electricity network
- Changes in knowledge about low carbon technologies
- The importance of different elements of the trial in promoting understanding

2.4.1. Questionnaires

The Qualtrics online survey platform was used to develop and distribute questionnaires. The questionnaires were designed to assist in exploring the effect, if any, of Esprit-controlled charging on the experience of using and charging EVs. (See Appendix I for a complete list of questions, the reason for asking the question and the study objective the question is addressing. Differences between pre-trial and follow-up questionnaire questions are also indicated.)

Questions were also included to address the related learnings on:

- Social factors
- Trial experience
- Knowledge of low carbon technology and the electricity network

The questionnaires were developed specifically for the MEA study. Question development was informed by findings from previous trials of EVs (See Section 2.2.1). The initial questionnaire incorporated a consent statement addressing confidentiality and data protection.

2.4.2. Timing of questionnaire data collection

Table 6-1 in Appendix II presents the final timeline for data collection. The original intention was to collect questionnaire data at five time points in the **Technical Trial**:

1. Pre-trial (one to two weeks before receiving the EV)
2. 6 weeks after receiving the EV
3. 3 months after receiving the EV
4. 10 months after receiving the EV
5. 13 months after receiving the EV

Due to delays in the roll-out of Esprit, questionnaire timing was altered. All Technical Trial participants therefore received a questionnaire at the following times:

1. Pre-trial questionnaire, shortly before the delivery of their EV (Time 1 - T1)
2. Before curtailment began but after participants had been in possession of their EVs for at least 6 weeks and no more than 8 months (depending on delivery date) (Time 2 - T2)
3. Approximately 6 weeks after Esprit became operational in their cluster (Time 3 - T3)
4. Approximately 3 months after Esprit became operational in their cluster (Time 4 - T4)
5. End of trial, June 2015 (Time 5 - T5)

For the **Social Trial**, the original intention was to collect quantitative data at four time points to match the time points in the Technical Trial:

1. Pre-trial (one to two weeks before receiving the EV)
2. 6 weeks after receiving the EV
3. 3 months after receiving the EV
4. 10 months after receiving the EV

This plan was altered in response to delays in the roll-out of Esprit and three questionnaires were sent:

1. Pre-trial (one to two weeks before receiving the EV) (Time 1 - T1)
2. In January 2015 after participants had had their EV for at least 6 weeks and no more than 13 months (depending on delivery date) (Time 3 - T3)
3. End of trial, June 2015 (Time 5 - T5)

2.4.3. Interviews and Focus Groups

Qualitative data were collected once for each cluster in the Technical Trial at staggered times throughout the trial period. Participants in two clusters were interviewed before curtailment began. All other interviews and focus groups took place after curtailment commenced. Written consent was obtained prior to each interview or focus group.

The interviews and focus groups were designed to explore in more depth the experience of using and charging an EV and of taking part in the My Electric Avenue trial in general. Participants from three clusters were invited to attend a focus group; all other participants were invited to participate in an interview. Table 6-2 in Appendix II indicates the dates of the interviews and focus groups and how many participants from each cluster took part. The majority of the face-to-face-data collection occurred towards the end of the project, at which point the Technical Trial had experienced some attrition which left a potential pool of 99 participants. Of these, a total of 72 participants took part in either an interview or a focus group (75% of the Technical Trial participant sample). The remaining 27 participants were unavailable at the times the interviews or focus groups took place. Interviews were conducted in a mutually-agreed location at a convenient time, within a three to four day window that included evenings and weekends to maximise participant availability.

All interviews were conducted by the same researcher to minimise any interviewer effects that might result from using different interviewers and which could bias or confound the data. All interviews were recorded using a digital recorder and note-taking. Interviews lasted from 30 to 45 minutes and used a semi-structured format. Questions were open-ended and focused on key areas of interest: e.g. lack of control, inconvenience, impact on travel patterns, benefits of EVs.

An interview schedule was developed that was based on the needs of the project and findings from previous trials. The semi-structured design allowed findings from earlier questionnaires, interviews and focus groups to be incorporated into later interview schedules.

Participants from two Domestic Clusters took part in two focus groups and participants from the Workplace Cluster took part in one focus group. Focus groups were scheduled at a time that was convenient for as many participants as possible and so the two domestic focus groups were held at the weekend and the Workplace focus group was organised to occur during a workday. The focus groups were facilitated by the same two researchers to reduce any researcher effects that might bias or confound the data. All focus groups were recorded using a digital recorder and note-taking.

Focus groups examined areas of interest similar to those explored in interview. The focus group format allowed exploration of the collective experience that was potentially relevant to the clustered nature of the trial. Also, the discussion between participants allowed the emergence of themes that might not necessarily arise in individual interviews. A discussion guide was developed based on the needs of the project and from a review of the literature. Findings from earlier questionnaires, interviews and focus groups were incorporated into the discussion guides for later focus groups.

2.5. Analysis Procedures

2.5.1. Questionnaires

Data from all time points were downloaded from the Qualtrics online survey platform and combined into three data files: Technical (Domestic), Technical (Workplace), and Social. Prior to analyses, data were screened for accuracy, missing data, and outliers, using a variety of exploratory and descriptive analytical techniques. Accuracy of data was checked to ensure all responses were within the correct range. Negatively-framed items were reverse-scored.

Participants from the Domestic Clusters were divided into two groups: those who had experienced curtailment (“Curtailed”) and those who had not (“Non-curtailed”). Membership of these two groups was determined by comparing the actual number of times charging had been curtailed with interview results to determine the level at which curtailment became noticeable to participants. The number of times charging had been curtailed was determined by analysis of data from Esprit which indicated how often the Intelligent Control Box (ICB) switched off the chargers during EV charging.

Among the participants who were interviewed or took part in a focus group, those who experienced 15 curtailments or more in a single month indicated they had noticed that there were interruptions to their charging. Thus, all participants who experienced at least 15 curtailments in a single month were included in the Curtailed group. All participants who experienced less than 15 curtailments in a single month were included in the Non-curtailed group for the purpose of the analysis.

Multi-item questions exploring Attitude towards EVs and Experience of EVs were reduced to single scales for use in analysis following factor and reliability analysis. Factor analysis was used to explore the data for underlying patterns or clusters (factors) of items. For Experience, exploratory factor analysis suggested that the eight items in the scale did not reflect different aspects of expectation/experience of using an EV. Scale reliability testing returned a Cronbach’s Alpha score of 0.65 for responses to the eight items from all participants in both the Technical and Social Trials at T1. This suggested that it was appropriate to treat the items as a single variable, representing the idea of expectation/experience, for further analysis.

For Attitude toward EVs, exploratory factor analysis suggested that the seven items in the question did not reflect different aspects of attitudes towards EVs. Scale reliability testing, using Cronbach’s Alpha, returned a score of 0.72 for responses to the seven items on the Attitude scale from all participants in both the Technical and Social Trials at T1. This suggested that it was appropriate to combine the items into a single variable, Attitude, for further analysis.

The Experience and Attitude variables were derived by reversing all negatively loaded items and calculating the participant’s average response to the set of items asked within each question. This provided a participant response for the Experience and Attitude variables that was used in subsequent analysis. .

The following areas were explored to determine whether there were significant changes over time:

- Attitude towards EVs
- Experience of EVs
- Attitude towards charging
- Travel pattern data
- Charging pattern data

Wilcoxon Signed-Ranks tests were used in this analysis as the data were not normally distributed.

Relationships between variables were assessed with simple bi-variate correlation using Kendall's Tau, a non-parametric test which is particularly suited to smaller data sets. Correlational analysis was used as there were an insufficient number of cases to allow for more sophisticated statistical techniques.

Between-group differences between participants in the three groups in the Technical Trial (Curtailed, Non-curtailed, and Workplace) and between Technical and Social Trial participants were explored using Mann-Whitney U Tests.

All statistical analyses were conducted in SPSS 22.0. Significance levels were set at $p < 0.05$.

The demographic and household composition data were compared with data from the UK Office of National Statistics to gauge comparability of the participants with the wider UK population.

2.5.2. Interviews and Focus Groups

Recordings from interviews and focus group were transcribed into Word documents and uploaded into NVivo. Thematic analysis was undertaken to identify important themes across the qualitative data.

3. Results

3.1. Characteristics of Participants

Summary of Findings

- There is no indication that acceptance of Esprit is related to the socio-demographic or household characteristics of the Technical Trial participants
- My Electric Avenue participants are not representative of the overall population

Table 3-1 Number of participants responding to questionnaires across time points

Participants	Time 1	Time 2	Time 3	Time 4	Time 5	Attrition
Domestic Curtailed	23	22	22	20	20	3
Domestic Non-curtailed	67	67	66	59	60	7
Workplace	14	13	12	11	11	3
Social	120	N/A	107	N/A	102	18

Table 3-1 details the number of participants at each questionnaire time point during the study. Compared to the UK population, participants in both the Technical and Social Trials were more likely to be male, were much more likely to be educated to degree level or above, and were much more likely to be employed in Professional Occupations or as Managers, Directors or Senior Officials (using Standard Occupation Code (SOC) categories).

Compared to UK driving licence holders, trial participants were more likely to be between 40 and 49 and much less likely to be over 70 or under 29. Compared to overall UK population they lived in larger households, with an average household size of 3.3 and a median household size of 4. The households were more likely to include children, with an average of 1.2 children per household and a median of 2. Finally, the households had a higher number of cars than the average UK household, with an average of 1.8 cars per household at the start of the trial.

Differences between the three groups in the Technical Trial (Curtailed Domestic participants, Non-curtailed Domestic participants, and Workplace Cluster participants) were explored using Mann-Whitney U tests. The only significant difference between the three groups was in the number of over-65s in the household, with a statistically significantly higher number of over 65s in the Non-curtailed group than in the Curtailed group. Between the Technical and Social Trial participants there were statistically significant differences in age, occupation, education qualification and number of drivers in the household. Technical Trial participants were older, were more likely to be in lower SOC categories, had higher educational qualifications and there were more drivers in the household.

There was no statistically significant relationship for Technical Trial participants between responses to *Comfort with Esprit* and gender, age, occupation, educational qualification, size of household, number of children in the household, number of over 65's in the household, number of drivers in the household or number of cars in the household.

3.2. Motivation

Summary of Findings

- Motivation for joining the trial does not appear to make a difference to acceptability of Esprit
- Saving money was the most important motivation for getting involved with My Electric Avenue
- Helping the environment and aiding in the development of new technology were also important motivators, as were an interest in the practicality of electric vehicles and participating in something in the community

Motivation for taking part in trials might be an important factor in how people view EVs and so might also be related to how they react to Esprit (See Section 2.2.1). Therefore participants were asked about motivation for joining the trials in both the initial questionnaire (T1) and the face-to-face data collection. The majority of participants in both trials either ‘agreed’ or ‘strongly agreed’ with the following motivations (Figure 3-1 Motivation for taking part in MEA – Non-curtailed Domestic Participants, Figure 3-2 Motivation for taking part in MEA – Curtailed Domestic participants, Figure 3-3 Motivation for taking part in MEA – Workplace Cluster).

- I am interested in saving money
- I would like to contribute to the development of new driving technology
- I think electric vehicles are the cars of the future
- I am interested in doing something to protect the environment
- I want to judge how practical electric vehicles are

A majority of participants from the Workplace Cluster ‘agreed’ or ‘strongly agreed’ with the following motivation:

- I am a car enthusiast

Fewer participants from the Domestic Clusters and the Social Trial ‘agreed’ or ‘agreed strongly’ with this motivation, suggesting that this was a less important motivation for those participants.

Differences between the three groups in the Technical Trial were explored using Mann-Whitney U tests. **No** statistically significant differences in motivation were found between:

- Non-curtailed and Curtailed participants
- Non-curtailed and Workplace participants
- Curtailed and Workplace Cluster participants

This indicates that there were no significant differences in motivation for joining the trial between the three groups and suggests that motivation is not a confounding factor in considering the differences between these groups. There were statistically significant differences in responses to *I want to judge how practical electric vehicles are* and *I think electric vehicles are the cars of the future* between the Technical and Social Trial participants.

No statistically significant relationship was found between the responses to *Motivation* and *Comfort with Esprit* for Technical Trial participants suggesting that *Motivation* for joining the trial was not related to *Comfort with Esprit*.

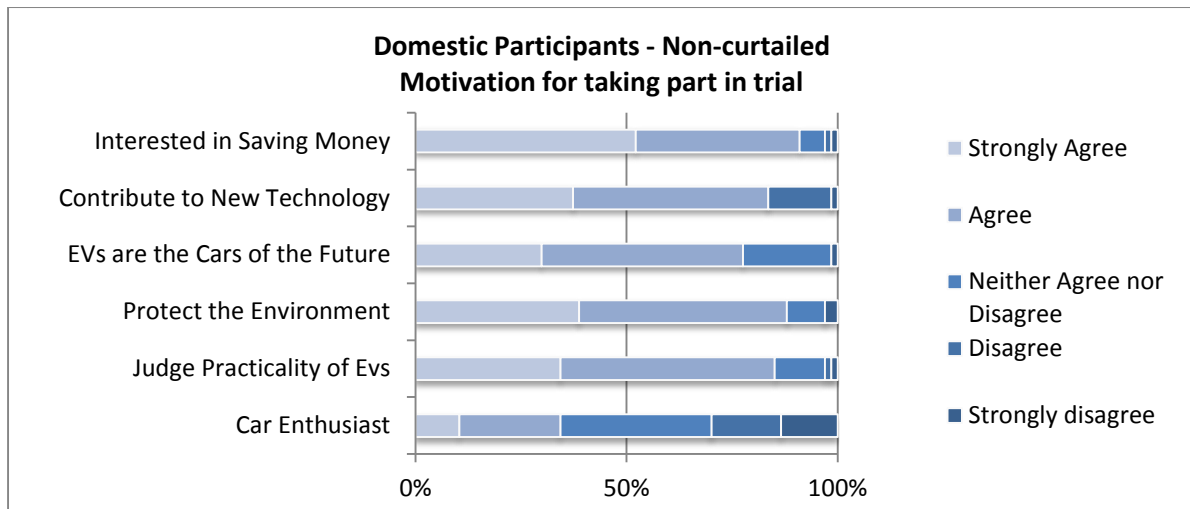


Figure 3-1 Motivation for taking part in MEA – Non-curtailed Domestic Participants

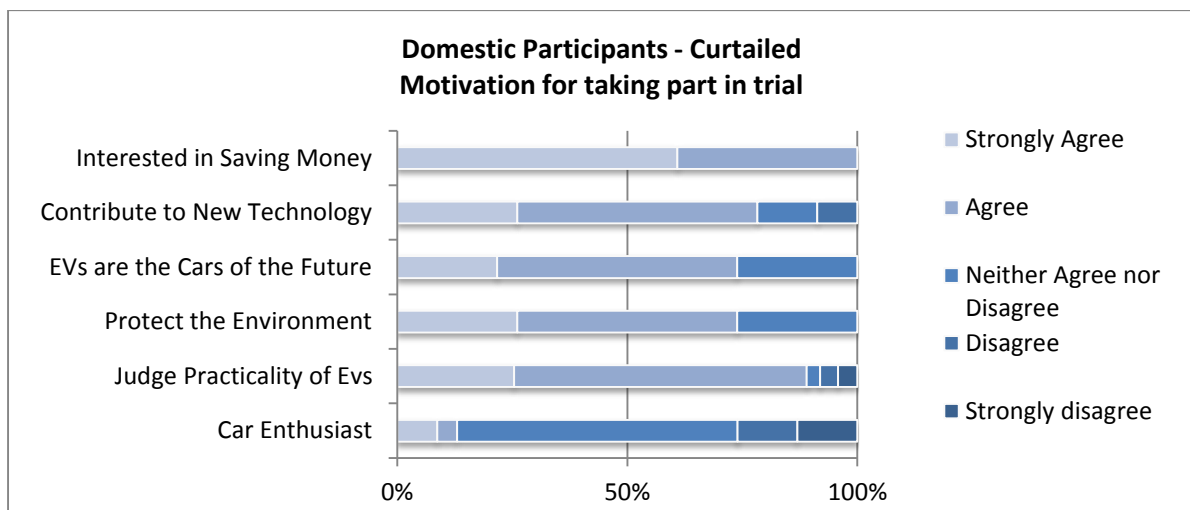


Figure 3-2 Motivation for taking part in MEA – Curtailed Domestic participants

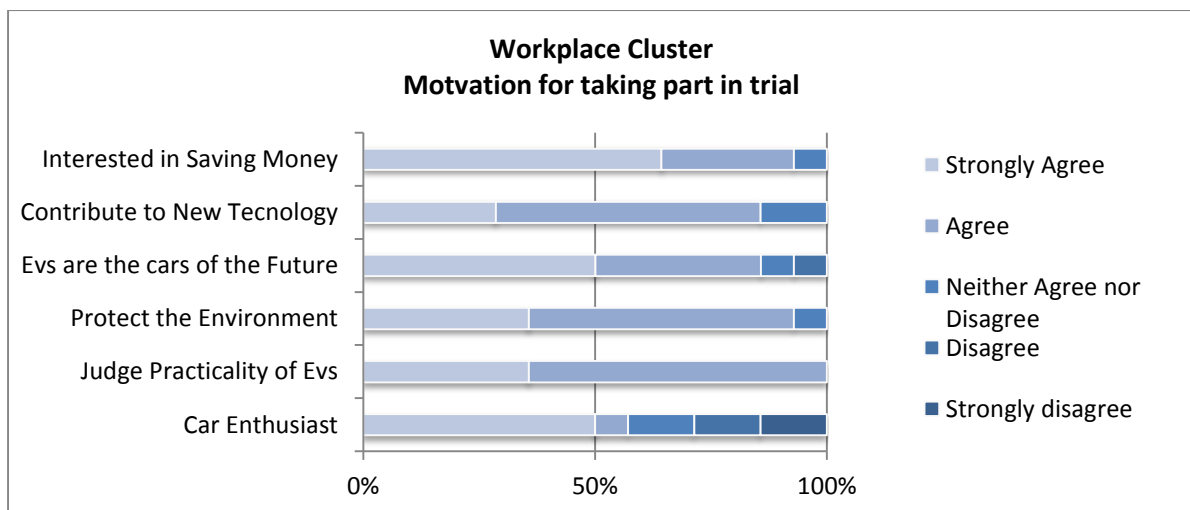
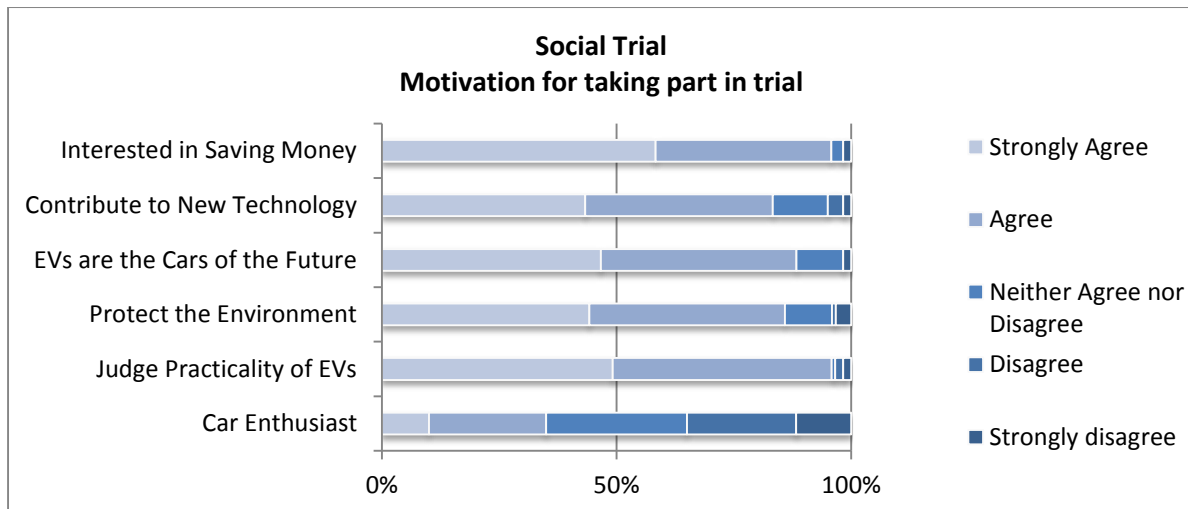


Figure 3-3 Motivation for taking part in MEA – Workplace Cluster



[Figure 3-4 Motivation for taking part in MEA – Social Trial](#)

Results from interviews with Technical Trial participants identified two additional strong motivations for joining the trial:

- Needing to replace a vehicle or acquire an additional vehicle
- Participation in something in their community

Fifteen (15) of the 49 participants interviewed specifically mentioned that one of their reasons for joining the trial was that it coincided with a time when they needed a new vehicle:

I was thinking about getting a car so it was right place right time basically

It just coincided with us realising that due to nursery runs and me about to have another baby that we'd need a second car and this just seemed like a really good way of doing it

This motivation was also identified by several participants in the focus groups.

Six (6) out of 49 participants that were interviewed identified participation, both participation in something in their community and participation in something important, as an important motivator:

I had this opportunity to participate, and I like doing things with the guys on the estate, it is nice to be part of something, and to be part of some sort of trial or experiment because you feel then that you've had an input and I am always a firm believer in you can't really criticise something unless you have experienced [it]

I like the idea of sort of being part of something that could inform the future a bit more in terms of electric vehicles.It is really nice being part of something at the beginning that might inform how they develop.

Participation in something in the community was also mentioned by several focus group participants as an important motivator.

3.3. Satisfaction with Electric Vehicles

Participants' satisfaction with their EVs was explored using two different concepts:

- *Expectation/Experience* of EVs
- *Attitude* to EVs

Questions addressing these concepts were asked in all the questionnaires for both the Technical and Social Trials and differences over time were explored to investigate whether there were any changes in *Expectation/Experience* of EVs or *Attitude* towards EVs. Analysis also investigated whether there were differences between groups in the Technical Trial (i.e. Non-curtailed, Curtailed, and Workplace).

3.3.1. Expectation/Experience of Electric Vehicles

Summary of Findings

- Participants had a positive *Expectation/Experience* of EVs throughout the trial
- Curtailment did not appear to affect participants' *Experience* of using an EV

In the first questionnaire (T1), participants were asked to express their degree of agreement with a set of eight statements about their expectation of using an EV. A similar set of questions about their experience of using an EV was asked in subsequent questionnaires (Technical: T1, T2, T3, T4, T5; Social: T1, T3, T5). These statements were combined to provide an *Expectation/Experience* of EV variable (see Section 2.5.1). The median values for *Expectation/Experience* are shown in Figure 3-5, Figure 3-6, and in Appendix III,

Data Tables for *Expectation/Experience*, *Attitude*, and *Attitude to Charging*

Table 6-3. A value of three represents a neutral response, so the medians for all groups in the Technical Trial and for the Social Trial at all time points indicate a positive view of EVs.

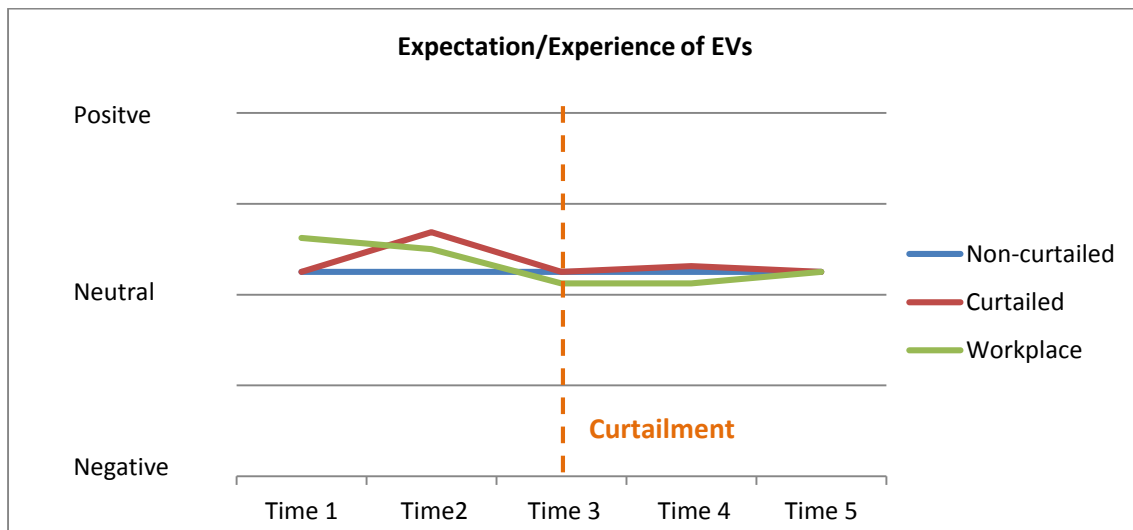


Figure 3-5 Median Expectation/Experience of EVs over time for all three groups in Technical Trial

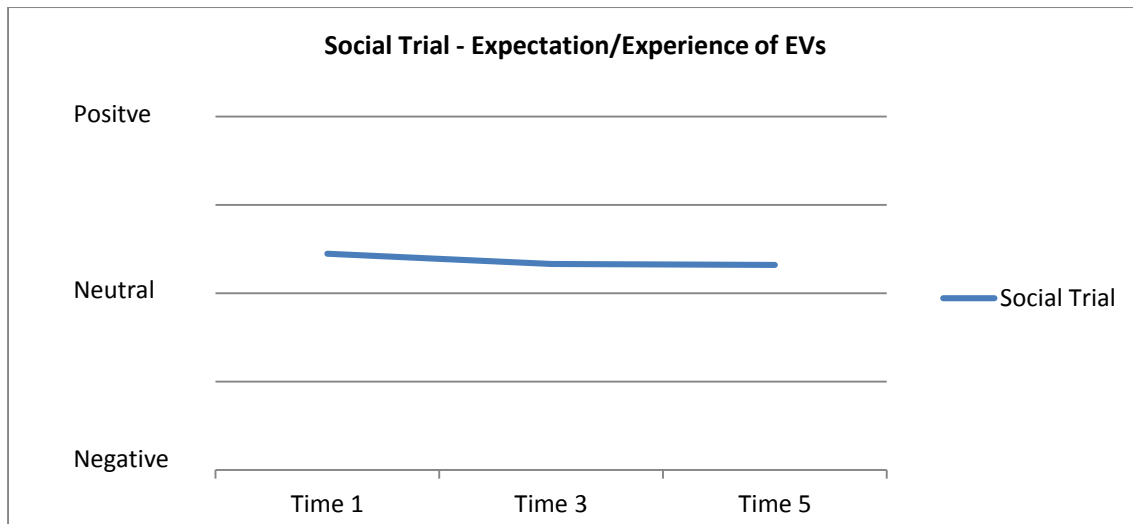


Figure 3-6 Median Expectation/Experience of EVs over time for the Social Trial

Data for all Technical Trial groups from T1 (before delivery of EV) were compared with data from T2 (post-delivery of EV, but before introduction of curtailed charging) and with T5 (the final questionnaire, allowing for the maximum experience of controlled charging). There were no statistically significant differences in responses to *Expectation/Experience* over time within any of the three groups. Analysis therefore suggests that there was no difference in *Expectation/Experience* of EVs related to the introduction of controlled charging. This reflects findings from the Social Trial, where data from T1 were compared with data from T5, and no significant changes were found.

Mann-Whitney U tests, comparing Technical and Social Trial participants at T1 and T5, showed no significant differences in responses to *Expectation/Experience* of EVs.

Change scores for *Expectation/Experience* were also calculated for all groups in the Technical Trial and the changes over time between the three groups were compared to see if there was any difference between the Non-curtailed, the Curtailed, and the Workplace participants in changes in *Expectation/Experience* over time. No significant differences were identified. This again suggests that there was no difference in *Expectation/Experience* of EVs related to the introduction of controlled charging.

3.3.2. Attitude towards Electric Vehicles

Summary of Findings

- Participants had a positive *Attitude* towards EVs throughout the trial
- Curtailment did not appear to affect participants' *Attitudes* towards EVs

In all questionnaires (Technical: T1, T2, T3, T4, T5; Social: T1, T3, T5), participants were asked to express their degree of agreement with a set of seven statements about their *Attitudes* towards EVs. These statements were combined to provide an *Attitude* to EV variable (see Section 2.5.1). The median values for *Attitude* to EVs are shown in Figure 3-7, Figure 3-8, and Appendix III. A value of three represents a neutral response so the medians for all groups in the Technical Trial, and for the Social Trial at all time points indicate a positive view of EVs.

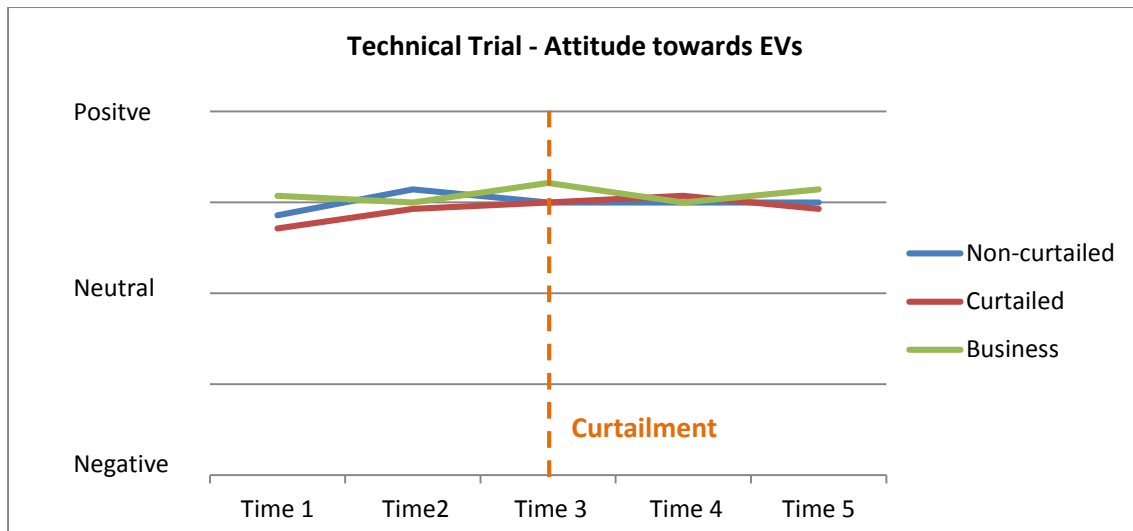


Figure 3-7 Median Attitude towards EV over time for all three groups in Technical Trial

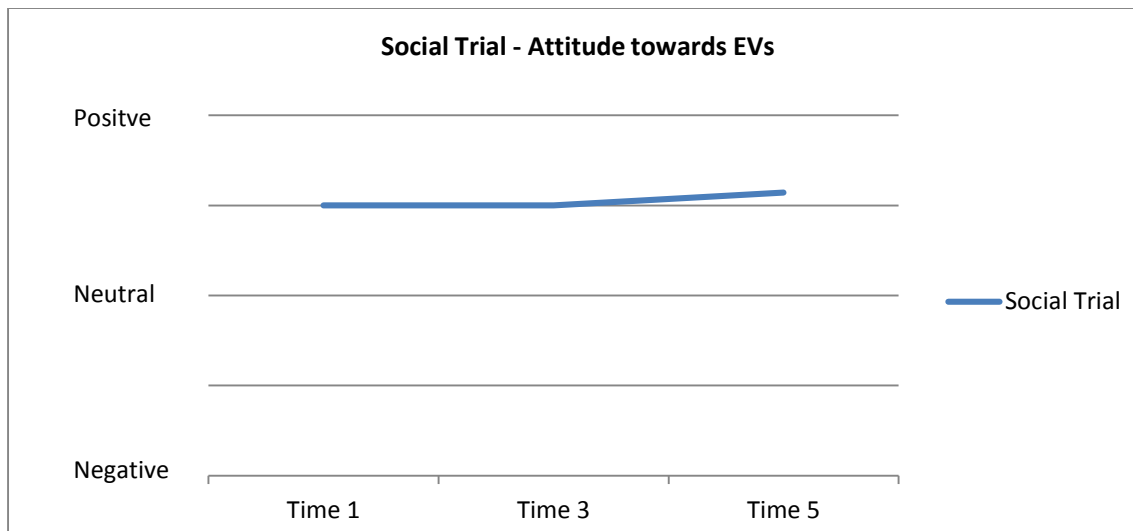


Figure 3-8 Median Attitude towards EV over time for Social Trial

Data from T1 (before delivery of EV) were compared with data from T2 (post-delivery of EV, but before introduction of curtailed charging) and with T5 (the final questionnaire, allowing for the maximum experience of controlled charging). Analysis identified a statistically significant difference over time in the Non-curtailed group from T1 to T2, where responses to *Attitude* to EVs became more positive, and from T2 to T5 where responses to *Attitude* to EVs became more negative.

The change in *Attitude* to EVs from T1 to T5 in the Non-curtailed group was not significant, suggesting that there was a slight initial increase in satisfaction with EVs in the Non-curtailed group, which returned to the original level by the end of the trial. There were no statistically significant differences in *Attitude* to EVs over time for the Curtailed or the Workplace groups. Analysis therefore suggests that there was no change in *Attitude* to EVs related to the introduction of controlled charging.

There was a statistically significant difference between T1 and T5 in the Social Trial with *Attitude* to EVs becoming more positive over time.

Mann-Whitney U tests comparing Technical and Social Trial participants at T1 and T5 showed no statistically significant differences in the responses to *Attitude* towards EVs.

Change scores for *Attitude* were also calculated for all groups in the Technical Trial and the changes over time between the three groups were compared to see if there was any difference between the Non-curtailed, the Curtailed, and the Workplace participants in changes in *Attitude* to EVs over time. Mann-Whitney U tests revealed no statistically significant differences. This again suggests that there was no difference in *Attitude* to EVs related to the introduction of controlled charging.

3.4. Electric Vehicle Charging

3.4.1. Attitude to Charging Electric Vehicles

Summary of Findings

- Participants had positive attitudes to charging at home/workplace throughout the trial
- Curtailment does not appear to have affected attitudes to charging at home/workplace
- Over the trial period, Workplace and Non-curtailed participants became more negative about whether their EV would charge sufficiently in the time available but the Curtailed participants did not
- Non-curtailed participants became more negative towards public charging over time
- Social Trial participants thought it would be easier to charge their EV at home than Technical Trial participants both before the trial began and at the end of the trial

Participants were asked in the first questionnaire (T1) to express their degree of agreement with four statements about how easy they expected to find charging their EV. A similar set of questions about their experience of charging an EV was then asked in subsequent questionnaires (Technical: T2, T3, T4, T5; Social: T3, T5). The mean values for each Attitude to Charging statement are shown in Figure 3-9, Figure 3-10, Figure 3-11, Figure 3-12, and Figure 3-13 Social Trial Attitude to Charging over time (see Table 6-5, Table 6-6, Table 6-7, and Table 6-8 in Appendix III for further details). A value of three represents a neutral response so the means for all groups at most time points indicate:

- a strongly positive view of the *ease of EV charging at home* (or work for the Workplace participants)
- a slightly negative view of the *finding a place to charge away from home* (or work for the Workplace participants)
- a positive attitude towards the *ease of using public charging points*
- a strongly positive view towards *the ability to charge sufficiently available in the time available to charge*.

Responses from T1 (before delivery of EV) were compared with responses from T2 (post-delivery of EV but before introduction of curtailed charging) and with T5 (the final questionnaire allowing for the maximum experience of controlled charging) for Non-Curtailed, Curtailed, and Workplace participants. Analysis identified no significant differences over time in ease of *charging at home* (or work for the Workplace participants) within any of these groups. Significant differences over time were, however, evident in:

- *Ease of finding a charging place away from home (or work for the Workplace participants)*, where there was a statistically significant difference between T1 and T5, and also between T2 and T5 for the Non-curtailed group with ease of finding a charging place away from home decreasing
- *Ease of using public charging points*, where there was a statistically significant difference between T1 and T2 and also between T1 and T5 for the Non-curtailed group with ease of using public charging points decreasing
- *Charge sufficiently in time available to charge*, where there was a statistically significant difference between T1 and T5 for the Non-curtailed group and statistically significant differences between T1 and T5 and T2 and T5 for the Workplace Cluster with charging sufficiently in the time available to charge decreasing

No statistically significant differences were found in responses to any of the charging attitude statements between the start (T1) and the end (T5) of the trial for any of the statements in the Social Trial.

A comparison of the Technical and Social Trial participants at T1 and T5 showed no statistically significant differences in responses to *ease of finding a place to charge away from home*, *ease of using public charging points* or *ability to charge sufficiently available in the time available to charge*. There was a statistically significant difference in responses to *ease of EV charging at home* (or work for Workplace participants) at T1 and T5 with Social Trial participants viewing it as easier to charge their EV at home than Technical Trial participants at both time points.

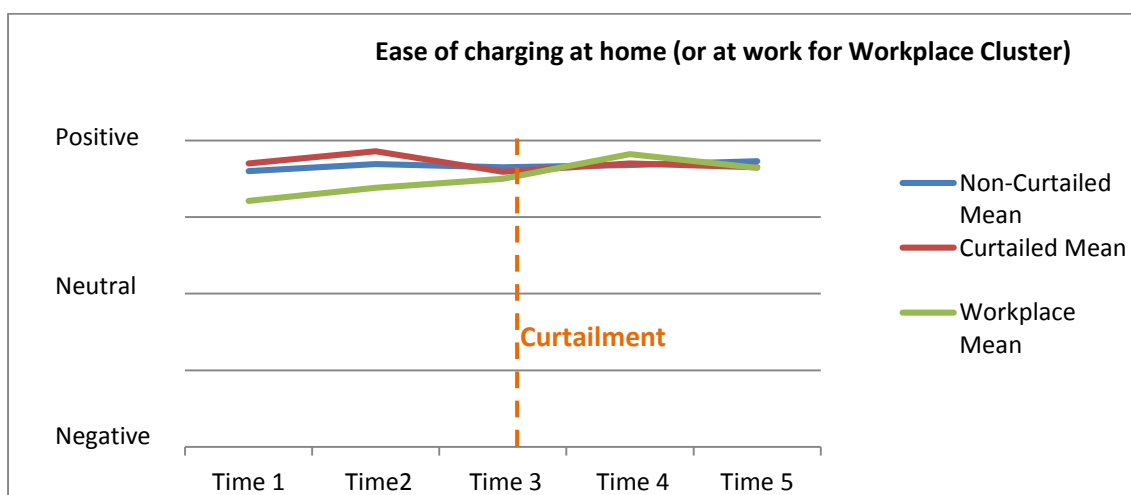


Figure 3-9 Ease of charging at home (or at work for the Workplace Cluster) over time for all groups in the Technical Trial

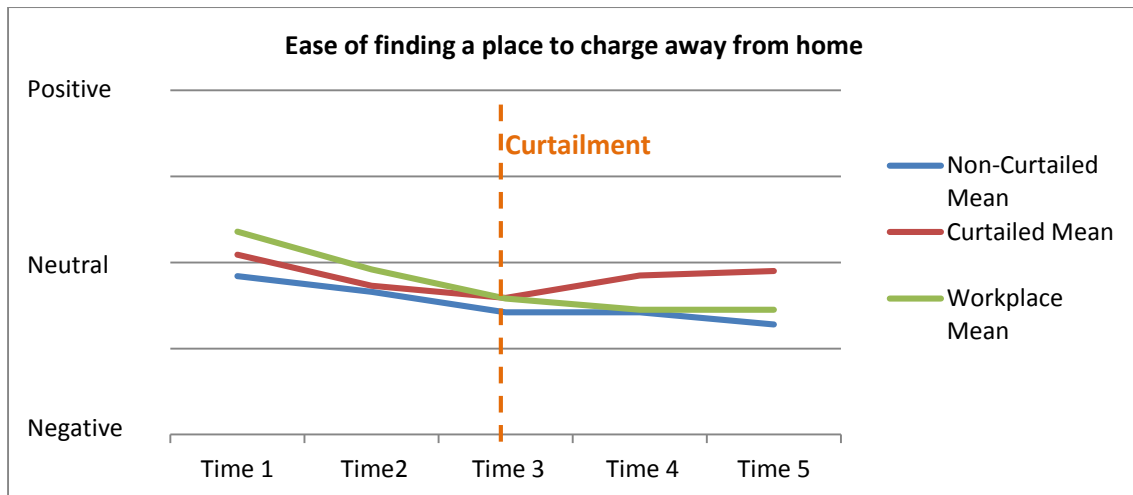


Figure 3-10 Ease of finding a place to charge away from home over time for all groups in the Technical Trial

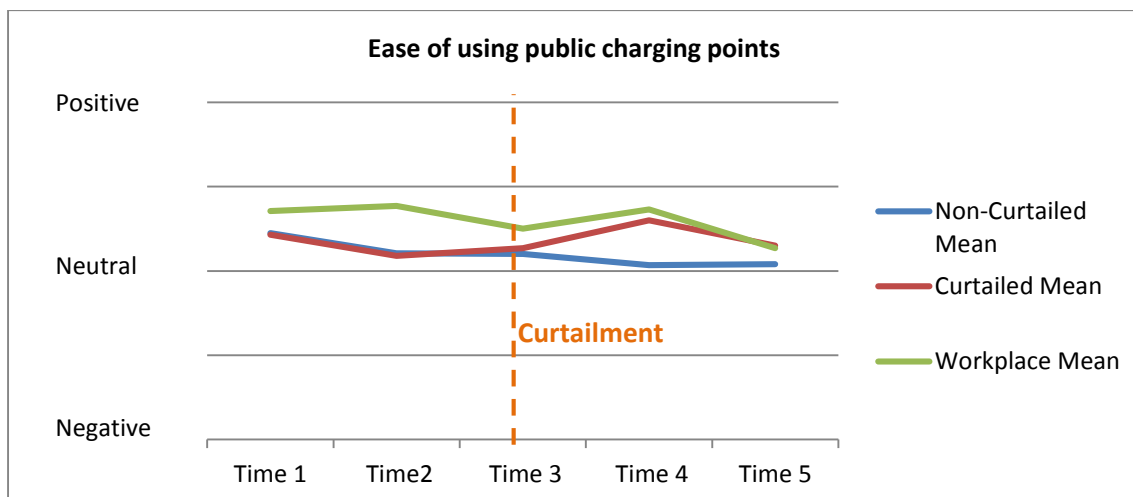


Figure 3-11 Ease of using public charging points over time for all groups in the Technical Trial

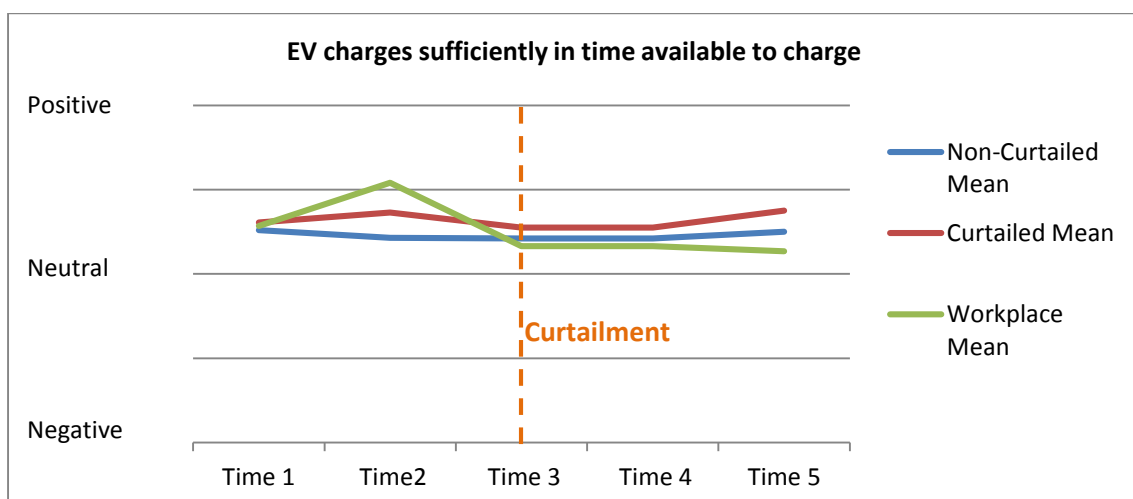


Figure 3-12 Whether the EV charges sufficiently in the time available to charge over time for all groups in the Technical Trial

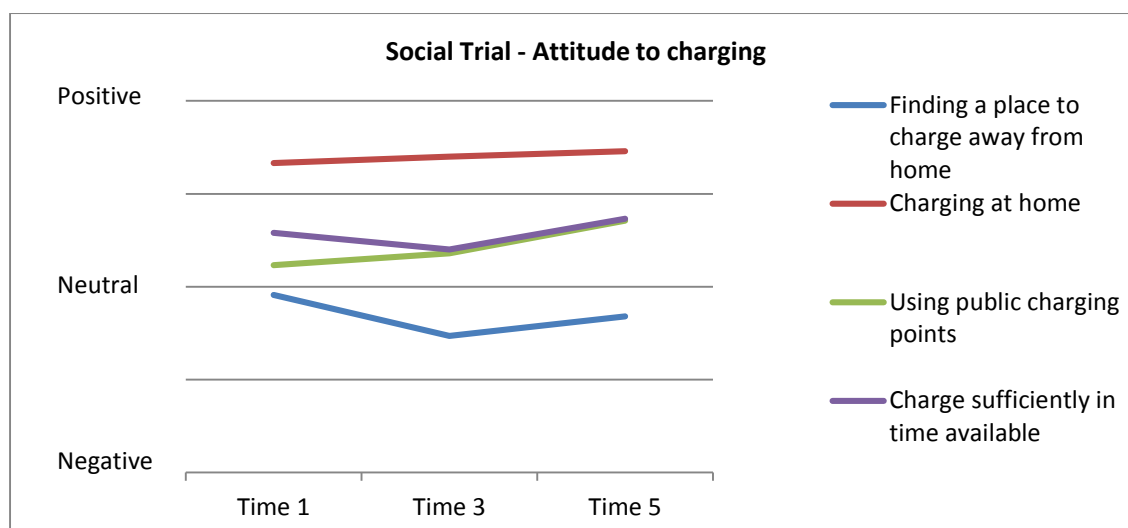


Figure 3-13 Social Trial Attitude to Charging over time

3.4.2. Charging Place

Summary of Findings

- Non-curtailed and Social Trial participants did not substantially change the place they charged most frequently although there was a slight reduction in home as the place Social Trial participants charged most often
- Curtailed participants reduced their charging at home slightly over the course of the trial and increased their workplace charging
- No interview or focus group results from the Domestic Clusters suggest that participants were consciously changing their charging place as a result of curtailment
- Workplace participants substantially reduced their charging at work when curtailment began and increased their charging at home
- Focus group results suggest that Workplace participants consciously changed their charging place as a result of curtailment

Participants were asked to provide information about:

- places they had ever charged
- places they regularly charged
- the place they charged most often

Of the multiple response options (e.g. home, office, public charger), participants could choose all that applied when indicating places they had *ever charged* or *regularly charged*; only one option could be selected for the question about where charging occurred *most often*. The following two sub-sections provide key findings.

3.4.2.1. Places participants have ever charged and places they regularly charge

Table 3-2 and Table 3-3 show the percentage of Technical Trial participants who have ever charged at or regularly charge at certain places at the following time points:

- T2, when they had an EV but curtailment of charging had not yet commenced
- T5, the end of the trial when charging had been curtailed for 6 to 7 months

It is possible that some participants have answered this question in relation to the time since the previous questionnaire resulting in both increases and decreases in responses to whether they ever charged at particular places. Comparing T2 with T5 for places participants *ever charged* there is an increase in workplace charging and public charging points for all groups, but a reduction in the use of rapid charging points.

This reflects interview and focus group comments that it was harder to access rapid charging points because of the numbers of EVs using them. It may also reflect a reduction in longer journeys shown in the travel pattern data. With regards to home charging there is an increase in home charging for the Non-curtailed group and the Workplace group but a reduction in home charging for the Curtailed group.

A similar pattern exists for places at which participants *charge regularly* with the exception of workplace charging which showed a large reduction for the Workplace Cluster. This likely reflects the difficulties which participants in that cluster experienced with curtailment. There was also an increase in the *regularly charged* but a decrease in *ever charged* in the use of rapid charging points among Curtailed and Workplace clusters.

Table 3-2 Places participants ever charge

	Home		Work		Public Charging Points		Rapid Charging Points		Other	
	T2	T5	T2	T5	T2	T5	T2	T5	T2	T5
Non-curtailed	96%	98%	12%	20%	39%	60%	54%	53%	18%	20%
Curtailed	100%	95%	14%	35%	50%	70%	55%	40%	14%	15%
Workplace	92%	100%	92%	100%	46%	82%	85%	45%	0%	9%

Table 3-3 Places participants regularly charge

	Home		Work		Public Charging Points		Rapid Charging Points		Other	
	T2	T5	T2	T5	T2	T5	T2	T5	T2	T5
Non-curtailed	97%	98%	4%	7%	9%	12%	21%	20%	6%	0%
Curtailed	96%	95%	5%	20%	13%	5%	9%	25%	5%	5%
Workplace	77%	100%	77%	64%	23%	27%	46%	55%	7%	0%

3.4.2.2. Places participants charge most often

The percentage of Technical Trial participants charging *most often* at certain places is shown in Table 3-4 Places participants charge most often, for two time points:

- T2, when they had an EV but curtailment of charging had not yet commenced
- T5, the end of the trial when charging had been curtailed for 6 to 7 months

For both the Non-curtailed and the Curtailed participants the percentage of participants *charging most often* at home reduces while there is an increase in charging at work for both groups.

For the Workplace participants the percentage *charging most often* at home increases substantially while the percentage charging most at work nearly halves. This pattern can be seen in greater detail in

Figure 3-14 through Figure 3-17 which illustrate this for the time points at which the three Technical Trial groups (T2, T3, T4, T5) and Social (T3, T5) had EVs.

Table 3-4 Places participants charge most often

	Home		Work		Public Charging Points		Rapid Charging Points		Other	
	T2	T5	T2	T5	T2	T5	T2	T5	T2	T5
Non-curtailed	93%	92%	3%	5%	3%	3%	21%	0%	0%	0%
Curtailed	96%	90%	0%	10%	5%	0%	0%	0%	0%	0%
Workplace	54%	73%	31%	18%	8%	9%	8%	0%	0%	0%

Patterns shown in Figure 3-14, Figure 3-15, Figure 3-16, and Figure 3-17 indicate that the primary charging place did not change substantially over time for the Non-curtailed Domestic participants or the Social Trial although there is a slight reduction in home as the place Social Trial participants charge most often. For the Curtailed Domestic participants, however, there is a reduction in home as the most common charging place at T3, the point at which curtailment commenced. This trend continued to T4 although by trial’s end (T5) home charging as the most frequent place for charging largely returns to previous levels (i.e. T2). This reduction in home charging is accompanied by a 10% increase in charging taking place at public or other charging places at T4 which may reflect the timing of the questionnaire around the Easter holiday period. The major shift at T3 is an increase in workplace charging which may reflect a greater availability of chargers at workplaces as was mentioned in interviews:

Originally it was done at home most of the time but now it is probably split between more at work than at home because I can charge it for free at work....

For the Workplace group Figure 3-16 shows a reduction in Workplace charging at T3 when curtailment began which is maintained to T5 with workplace charging largely being replaced by home charging. This reflects the negative view of workplace charging revealed in the Workplace Cluster focus group.

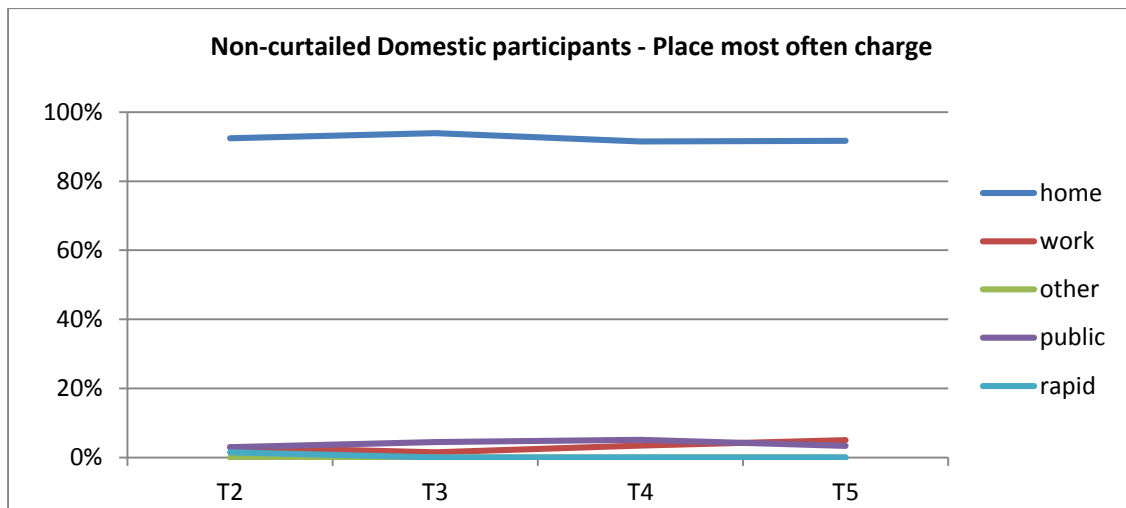


Figure 3-14 Places Non-curtailed Domestic participants charge most often

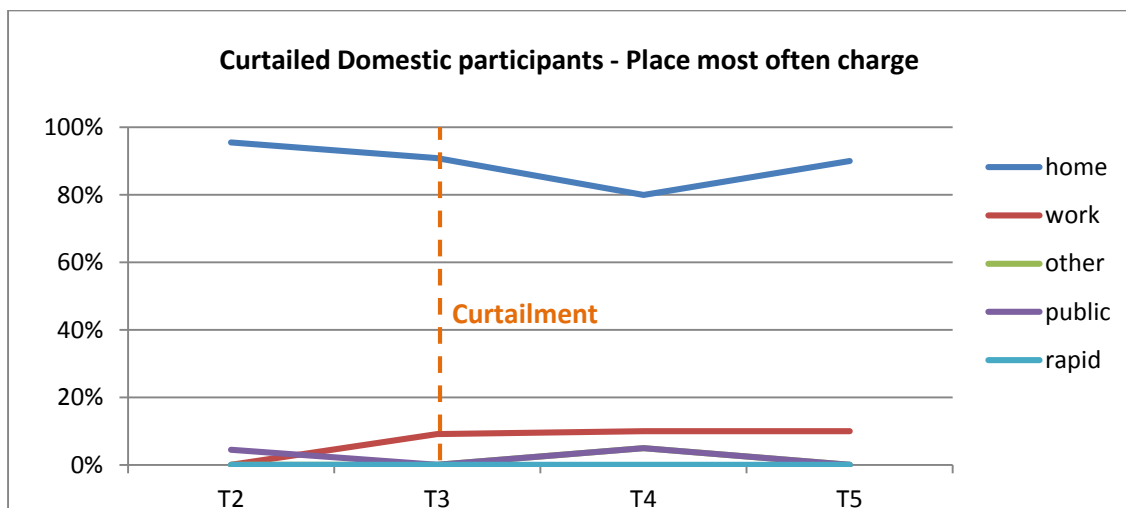


Figure 3-15 Places Curtailed Domestic participants charge most often

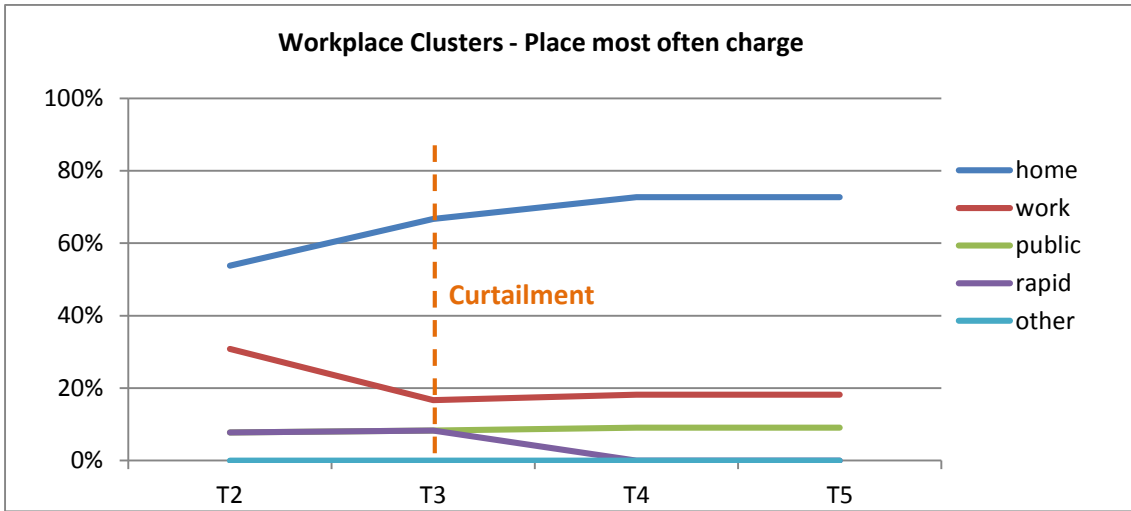


Figure 3-16 Places Workplace Cluster participants charge most often

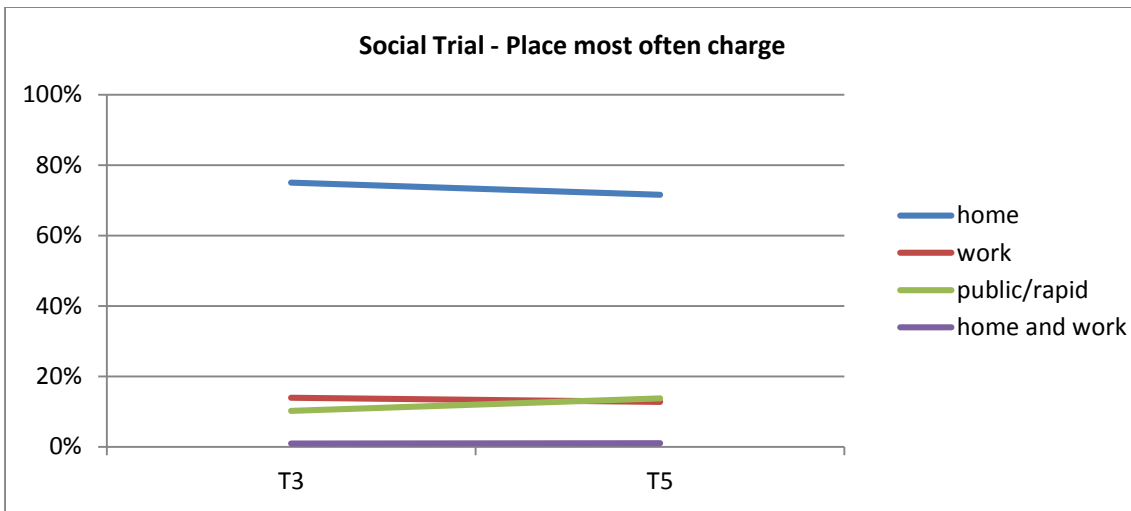


Figure 3-17 Places Social Trial participants charge most often

3.4.3. Comfort with battery charge level

Summary of Findings

- Curtailed participants became more comfortable with a lower level of battery charge over the course of the trial
- Workplace participants became less comfortable with a lower level of battery charge after curtailment began
- Non-curtailed and Social Trial participants became less comfortable with a lower level of battery charge over the course of the trial
- Curtailment did not appear to affect what level of battery charge Domestic participants were comfortable with
- Curtailment may have affected what level of battery charge Workplace participants were comfortable with

Participants were asked what level of battery charge they considered to be low as a percentage of charge remaining either as *percentage of charge* or remaining *bars* on the battery indicator on the dashboard display. Battery levels considered low by participants for all three groups in the Technical Trial and the Social are presented in Figure 3-18, Figure 3-19, Figure 3-20, and Figure 3-21.

Participants' views of what battery charge level they considered low changed minimally over time for the Non-curtailed participants. For the Curtailed participants the level of battery charge considered low reduced over time with a greater proportion of participants becoming more comfortable with lower levels of charge. Workplace and Social Trial participants, however, became less comfortable with a lower level of charge. The concern over battery charge level may be related to reductions in the use of rapid charging points shown in Table 3-2 *Places participants ever charge*.

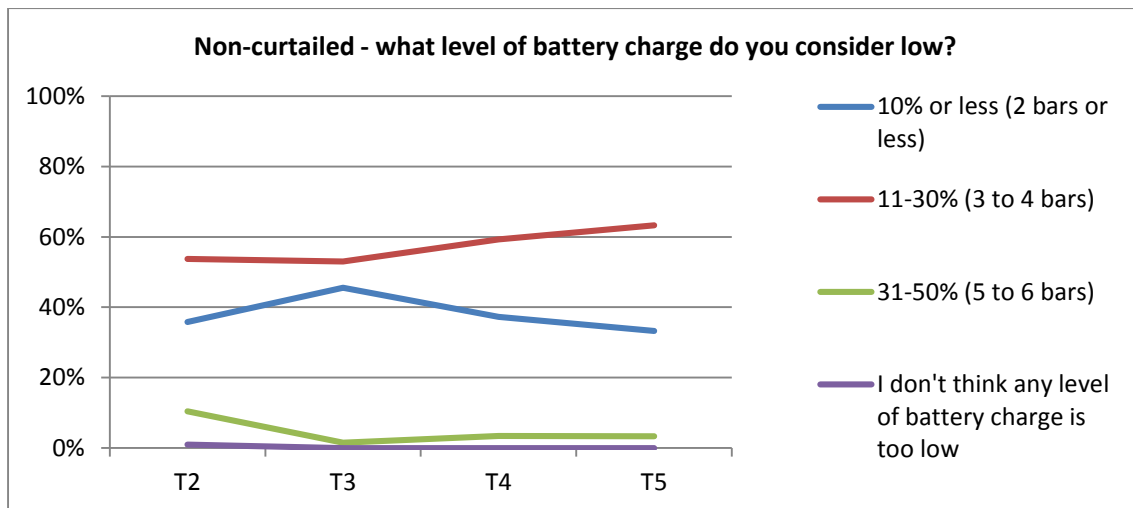


Figure 3-18 Battery charge levels considered low by Non-curtailed participants

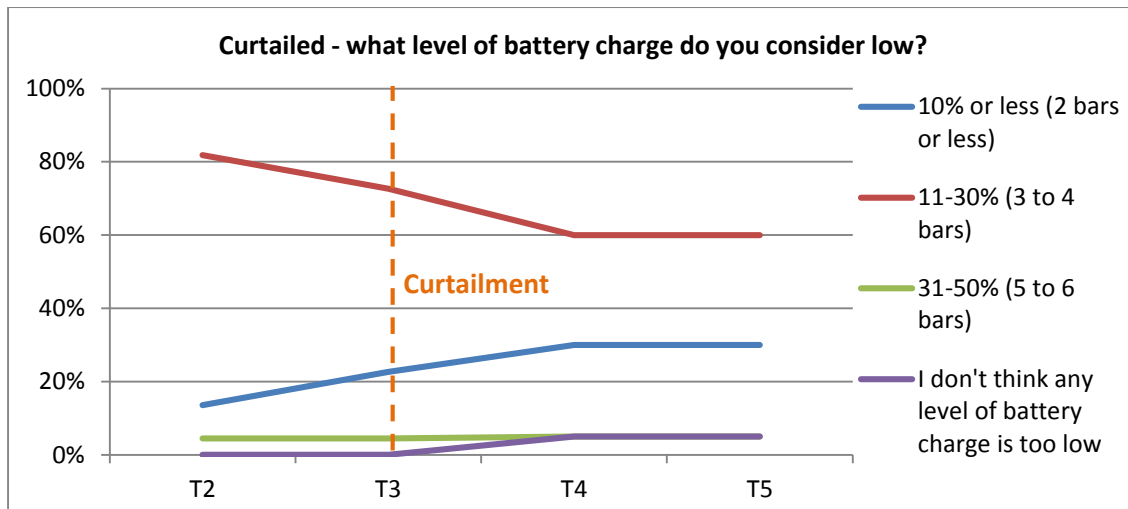


Figure 3-19 Battery charge levels considered low by Curtailed participants

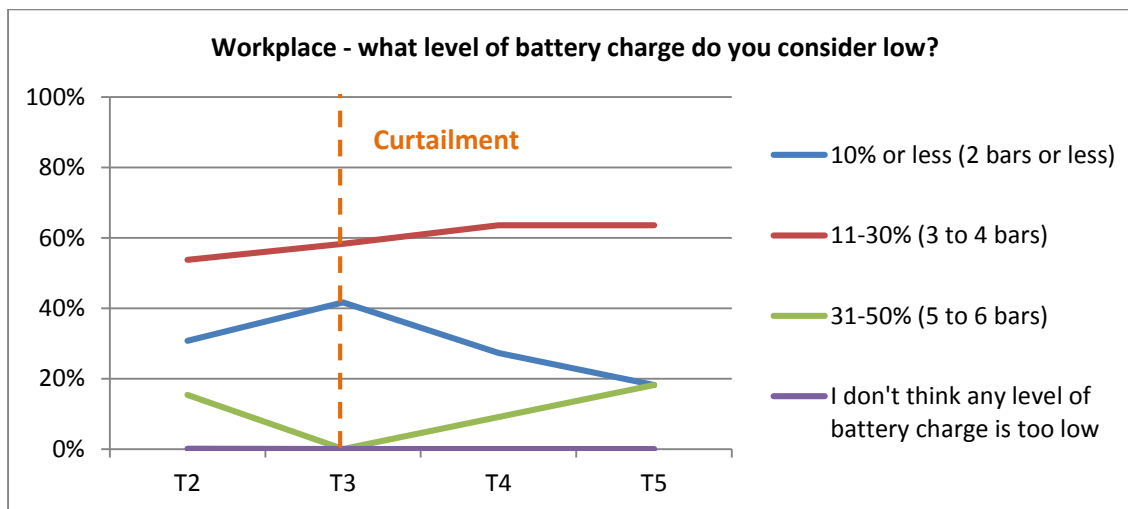


Figure 3-20 Battery charge levels considered low by Workplace Cluster participants

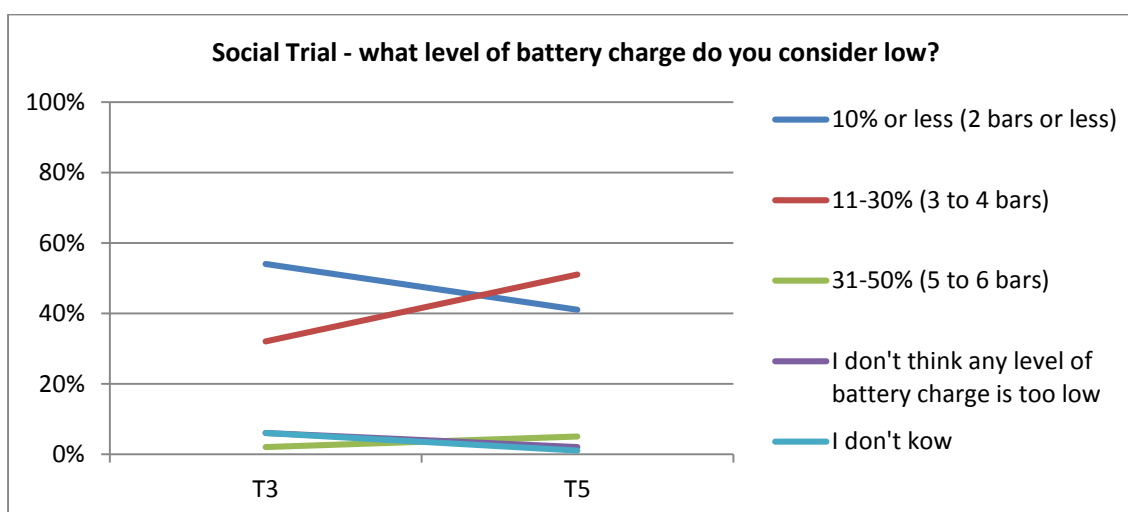


Figure 3-21 Battery charge levels considered low by Social Trial participants

3.4.4. Home charging

Summary of Findings

- Curtailed participants reported that EVs did not charge as much as expected or took longer to charge than expected after curtailment was introduced
- Interview and focus group results suggest that Curtailed Domestic participants were largely unconcerned about curtailment even when they were aware of it
- Curtailment was a major concern for Workplace participants with most participants opting to charge at home due to the unreliability of receiving enough charge and the importance of leaving the charging points to those who had to charge at work due to the length of their commutes.

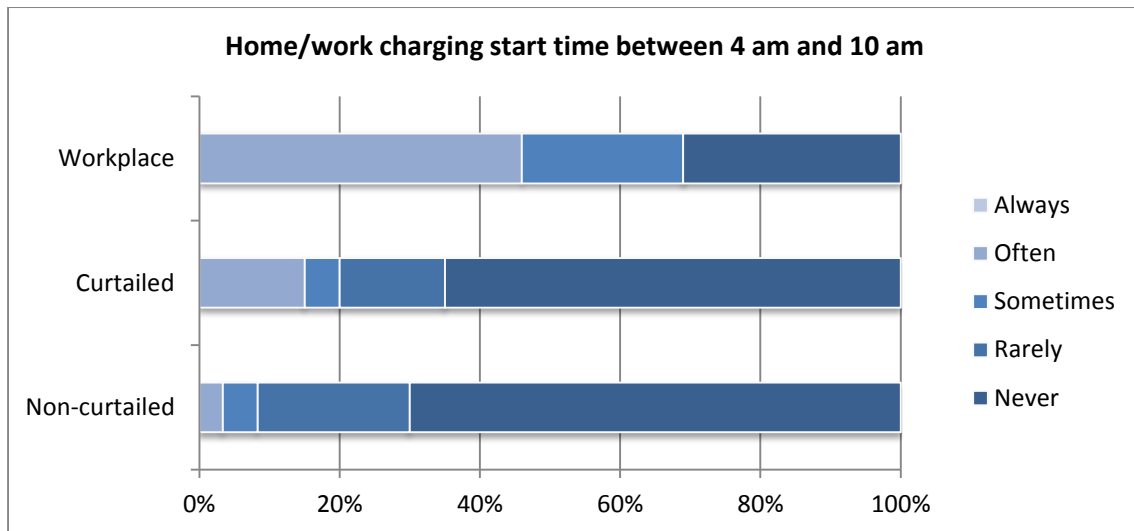
3.4.4.1. Charging Start Time

In the final questionnaire (T5) Technical Trial participants were asked how often they plugged their EV in to start charging at home (or at work for Workplace participants) during four different periods during the day:

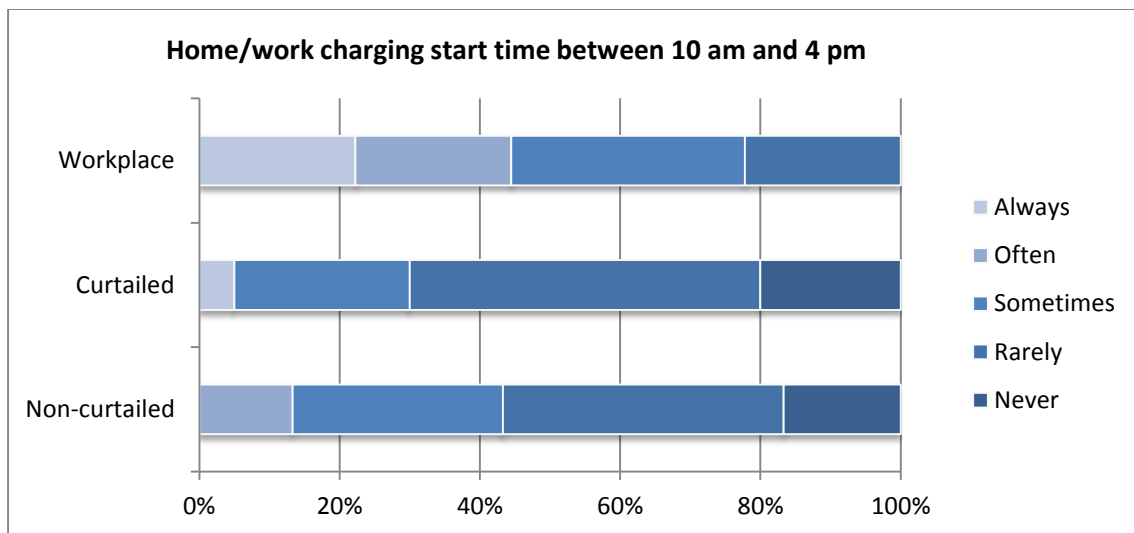
- 4 am to 10 am
- 10 am to 4 pm
- 4 pm to 10 pm
- 10 pm to 4 am

Two of these periods, 4 am to 10 am and 4 pm to 10 pm, covered the periods of maximum load on the network and so represented times when charging was most likely to be curtailed by Esprit. Figure 3-22, Figure 3-23, Figure 3-24 and Figure 3-25 show the frequency of participants starting charging in each of these periods for the three groups in the Technical Trial. Charging patterns for the Workplace participants are quite distinct from the Curtailed and Non-curtailed participants. This is to be expected as the Workplace participants were asked about charging at work and therefore charging would only start during the working day. Workplace participants were most likely to start charging between 10 am and 4 pm and were very likely to start charging between 4 am and 10 am.

Patterns for the Curtailed and Non-curtailed participants were broadly similar to each other with both groups most likely to start charging between 4 pm and 10 pm and likely to start charging between 10 pm and 4 am.



[Figure 3-22 Frequency of starting charging at home \(for Domestic participants\) or at work \(Workplace participants\) between 4 am and 10 am](#)



[Figure 3-23 Frequency of starting charging at home \(for Domestic participants\) or at work \(Workplace participants\) between 10 am and 4 pm](#)

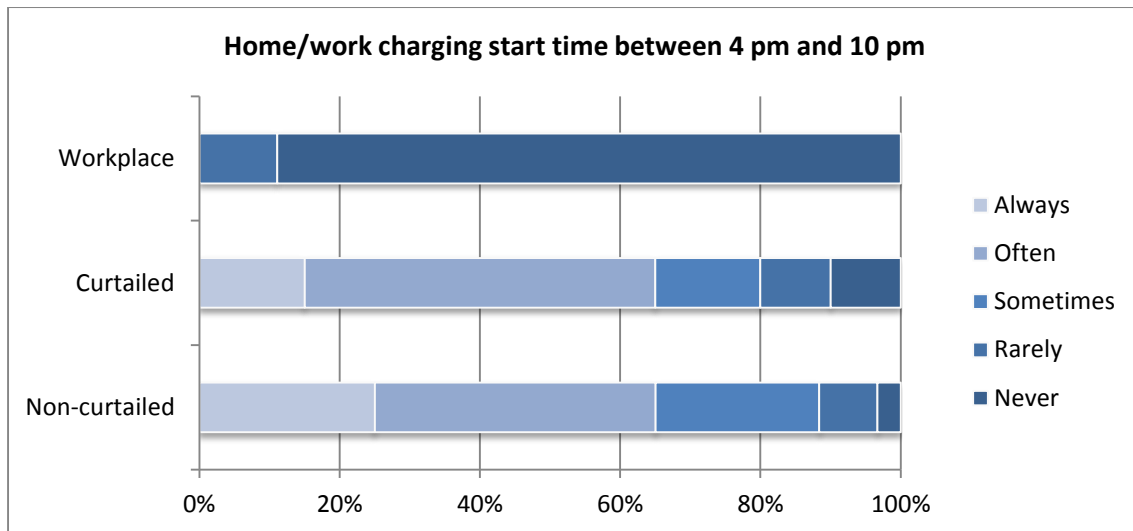


Figure 3-24 Frequency of starting charging at home (for Domestic participants) or at work (Workplace participants) between 4 pm and 10 pm

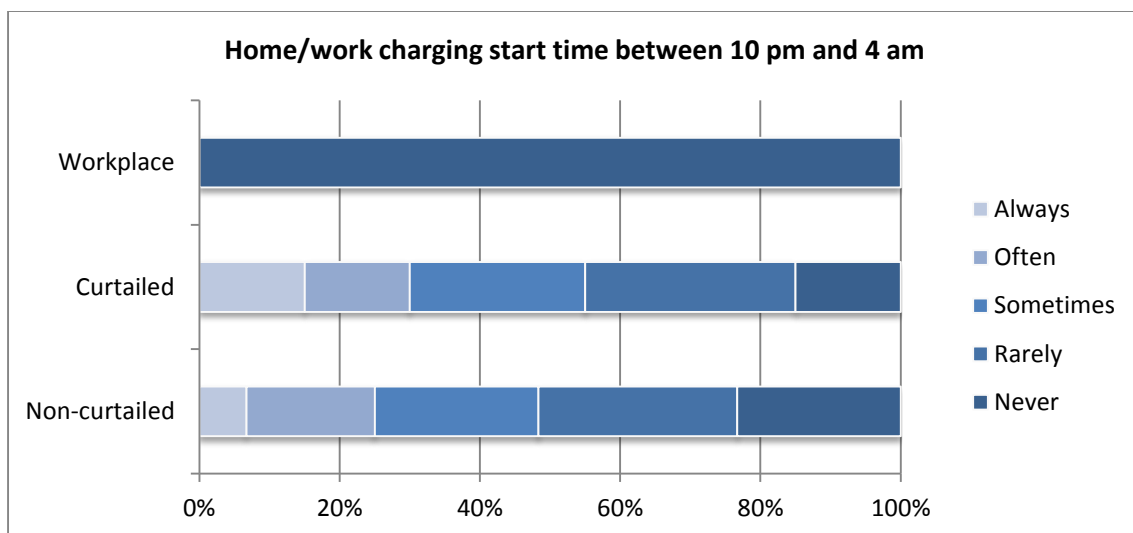


Figure 3-25 Frequency of starting charging at home (for Domestic participants) or at work (Workplace participants) between 10 pm and 4 am

Participants were also asked what level of charge would be acceptable to them when they started charging in the two peak load periods: 4 am to 10 am and 4 pm to 10 pm (

Table 3-5 Percentage of participants willing to accept different levels of charge when starting charging during peak load periods.). Only participants who indicated that they started charging during each period were asked to respond to this question which resulted in low response numbers for the 4 am to 10 am period. For the 4 am to 10 am period approximately the same percentage of the Curtailed and Non-curtailed participants needed 100% of the charge they were expecting, but more Non-curtailed participants would accept only 50% of the expected charge and more of the Curtailed participants would accept 75% of the expected charge. The one Workplace participant who started charging in this time period needed 100% of the expected charge.

For the 4 pm to 10 pm time period approximately the same percentage of the Curtailed and Non-curtailed participants needed 100% of the expected charge and the percentage was higher than for the 4 am to 10 am period. This reflects interview and focus group findings that suggest that most participants in Domestic Clusters charged overnight and expected their EVs to be fully charged in the morning. Approximately the same percentage of Curtailed and Non-curtailed participants would accept 75% or 50% of expected charge for this period. The majority of Workplace participants who started charging between 4 pm and 10 pm would accept 75% of the expected charge.

Table 3-5 Percentage of participants willing to accept different levels of charge when starting charging during peak load periods.

	Start charging 4 am to 10 am			Start charging 4 pm to 10 pm		
	Non-curtailed n=18	Curtailed n = 7	Workplace n = 1	Non-curtailed n= 58	Curtailed n=18	Workplace n=6
Need 100% of expected charge	39%	43%	100%	57%	56%	17%
Accept 75% of expected charge	28%	43%	0%	35%	33%	67%
Accept 50% of expected charge	33%	14%	0%	9%	11%	17%

3.4.4.2. Curtailment

In all questionnaires after delivery of the EV (Technical: T2, T3, T4, T5; Social: T3, T5) participants were asked:

- When charging your electric vehicle at home (or work) has it ever taken longer to charge than you expected or had less charge than you expected?
- Have you ever been prevented from using your electric vehicle due to low state of charge?

Responses from participants within each of the groups in the Technical Trial between T2 (before curtailment began) and T5 (the end of the trial) were compared using the Wilcoxon Signed-Ranks Test. There was a statistically significant difference in the Curtailed group between T2 and T5 with participants reporting that it took longer to charge their EV or that it had less charge than they expected. There was also a statistically significant difference in the Non-curtailed group between T2 and T5 with participants reporting that they had been prevented from using their EV more often due to low state of charge. There were no statistically significant differences between T2 and T5 in either the Workplace participants or the Social Trial participants.

The first finding suggests that participants might have noticed the effect of curtailment on the length of time it took their EV to charge or the charge state. However, there was no statistically significant difference in whether participants in the Curtailed group were prevented from using their EV due to state of charge, suggesting that any effect of curtailment does not seem to have affected EV use.

The second finding is harder to interpret as the Non-curtailed participants should not have experienced any reduction in charging due to curtailment. Nevertheless state of charge does appear to have affected EV use in the Non-curtailed group.

Mann-Whitney U Tests were used to compare the three groups in the Technical Trial at T2 and T5. There were no statistically significant differences between the Non-curtailed and the Curtailed participants for either question. There was a statistically significant difference between the Non-curtailed and Workplace participants at T2 in *Have you ever been prevented from using your electric vehicle due to low state of charge?* with Workplace participants prevented more often.

There was also a statistically significant difference between the Curtailed and the Workplace participants in *Have you ever been prevented from using your electric vehicle due to low state of charge?* at T5 with Workplace participants finding that it took longer to charge or the vehicle had less charge than expected. These findings suggest that Workplace participants experienced more difficulties than either the Non-curtailed or the Curtailed participants.

These questionnaire results are not well supported by the interview and focus group results for the Domestic Cluster participants. The majority of these participants who attended interviews or focus groups voiced minimal concern about the possibility of curtailment. Many of these individuals did not think it would affect them because they only undertook short journeys or charged for 10 to 12 hours overnight. For example:

I haven't noticed it at all, maybe it's just the way I am happy to leave it to charge overnight, it's got the whole night to deal with that.

Others thought they could work around any lack of charge by charging elsewhere:

I can get round it. As long as I can get to work I can plug in at work just with a plug, No it doesn't worry me that much to be honest, there's enough, I've had enough close shaves now to find a way round it whether it is to go to the fast charger at IKEA would be like the nearest one if I need to or whether it is plug in at work, there's plenty of options.

An additional point made by many was that they could always use another vehicle if necessary:

Well it [curtailment] obviously would have if I had had to use the car earlier than I had intended then it would have influenced how far I could go in it, and it might influence which car I took so I think I would feel not uneasy, but it is comforting to have the two cars around so that if it turns out that it hasn't got enough charge to do what I have to do at any point I can always use the other car. Actually that has never happened in the time I've had it but it is always nice to know that that is there if I needed it frankly. I think if it had been the only car I would have worried more about whether it was charged on time.

Several participants did not think short periods of curtailment would be a problem but would be concerned if there were extended periods of curtailment:

if it is just short term it wouldn't be a problem, if they turned it off all night or for a significant period that would be a problem

Only 13 of the 47 Domestic Cluster participants who attended interviews or focus groups after curtailment began noticed curtailment and all but one was unaffected by it:

I just happened to be standing next to the car and noticed that it had stopped charging, the light went out and then it would be charging 10 minutes, 15 minutes after that, otherwise I would never have noticed, never impacted on charge for me

No, no, we've observed charge has been off every now and then which is the software being used but that's not been a problem it's just been an observation. Yes well it's more a case of notice the light not being on, and then it comes on again. So if the light's not on I don't think it is broken I think Oh their software is doing something.

The one participant who was affected by curtailment was attempting to charge his EV between returning from work and going out in the evening, and he did not have access to another vehicle:

It was intermittent so it would sort of charge for 10 minutes and then turn off for 20 minutes and then start charging again.... I had to cancel things or rearrange them, or get the train basically.

Not only were most Domestic cluster participants unconcerned about curtailment on the whole, some were even positive about the fact that Esprit protected the network:

That's good, I like that idea because at least you are not impacting on the network, so it is quite good that is.

The questionnaire results do reflect the focus group results for Workplace participants who were all aware of curtailment and reported substantive effects as a result:

The problems with charging have put me off, I've started to stop at a rapid charger halfway here because that way I know I can get back to that rapid charger if I can't get a charge here

Only 5 of the 11 Workplace participants who took part in the focus group attempted to charge at work, and all five had experienced problems with curtailment. The majority of the Workplace participants chose to charge at home and public charging points due to the unreliability of receiving sufficient charge and the importance of leaving charging points available for those who had to charge at work due to the length of their commutes. Those participants who needed to charge at the workplace reported in the focus group that they were very unhappy with the technology:

[I've] been caught out twice by curtailing charge, and I mean I know what we signed up to was that there would be interruptions but what we've actually experienced have been terminations in charging, so it doesn't go back on again.

3.4.4.3. Measures to make curtailment more acceptable

Summary of Findings

- Technical Trial participants in the Domestic Clusters thought that more information about when curtailment was going to happen would be helpful
- Several participants thought an override button or greater intelligence in the system would be useful
- No participant mentioned financial incentive as a way of making curtailment more acceptable

Participants were asked in interviews and focus groups whether there was anything that would make curtailment more acceptable to them. Several participants suggested that more information would be helpful:

a text message or something I don't know if that is possible but some sort of automated messaging, that would be useful because at least then you would know, it would be less of a surprise

The thing is you don't know what's going on and therefore it sort of, if you saw a little flashing light saying charge too high or loading too much or something and you knew you would be OK that's fine but of course you don't know what's going on

Well the only thing might be if you got a text message saying it is happening that might be useful, if you are planning to do something and you got a text message saying grid under strain, car charging suspended and then car charging resumed

Although CARWINGS can be set up to provide notifications when charging stops, many participants reported during interviews and focus groups that they found CARWINGS difficult to use. Furthermore, CARWINGS provides no information about why the charging has stopped; participants were keen to know why their car had stopped charging.

In addition to more information some participants suggested that some way of overriding or prioritising charging interruptions would be helpful

You should have an override button to say, that you can just press in your garage to say "Do not turn mine off. Mine needs to be high priority" and also, there should be an indicator to say when it is being throttled back, but whatever you, I don't know what the phrase is that you use. So, there should be an indicator on there saying your charge is currently being curtailed and you should have an override to say "stop curtailing me, because I want – for the next two hours, I need the car charging".

No, I mean you could give some prioritisation, if you could override it, there could be some but that would be very difficult to implement I imagine so I hadn't really thought about that but it hasn't really bothered me so I haven't considered it.

Other participants did not think that there was anything that could be done:

I don't think so, I mean they can give you all kinds of sweeteners but if in the end you are not able to use the vehicle then that's a commitment you've made to owning something and you are now not able to use it and that would be a problem.

No participants mentioned electricity pricing or any other financial incentive as a way of making curtailment more acceptable.

3.5. Travel Patterns

3.5.1. Journey Type

Summary of Findings

- There were changes in journey types over time for Technical Trial participants but these were not related to curtailment
- There were no changes over time in journey types for Social Trial participants
- There was no indication that curtailment affected journey types for any participants

Participants were asked about the importance of their primary vehicle for different journey types at T1 and about the importance of their EV for different journey types in all subsequent questionnaires (Technical: T2, T3, T4, T5; Social: T3, T5) and the results are shown in Figure 3-26.

Differences between Curtailed, Non-curtailed, and Workplace participants in the use of the primary vehicle/EV for different journey types were explored using the Kruskal-Wallis Test. There were no statistically significant differences between the three Technical Trial groups in journey type at T1 (original primary vehicle), T2 (EV before curtailment begins), or T5 (EV at end of trial).

Changes in journey types between T1 (pre-trial), T2 (before curtailment began) and T5 (the end of the trial) were compared within the Technical Trial using the Wilcoxon Signed-Ranks Test. There were statistically significant differences between T1 and T5 for *Commuting*, *Business Use*, *Lifts to Others*, and *Other use*. Between T1 and T2 there were statistically significant differences only for *Lifts to Others*. This suggests that there was little difference in use between the original primary vehicle and the EV early in the trial but that 10 months later there were significant differences. There were no statistically significant differences in use over time in the Social Trial.

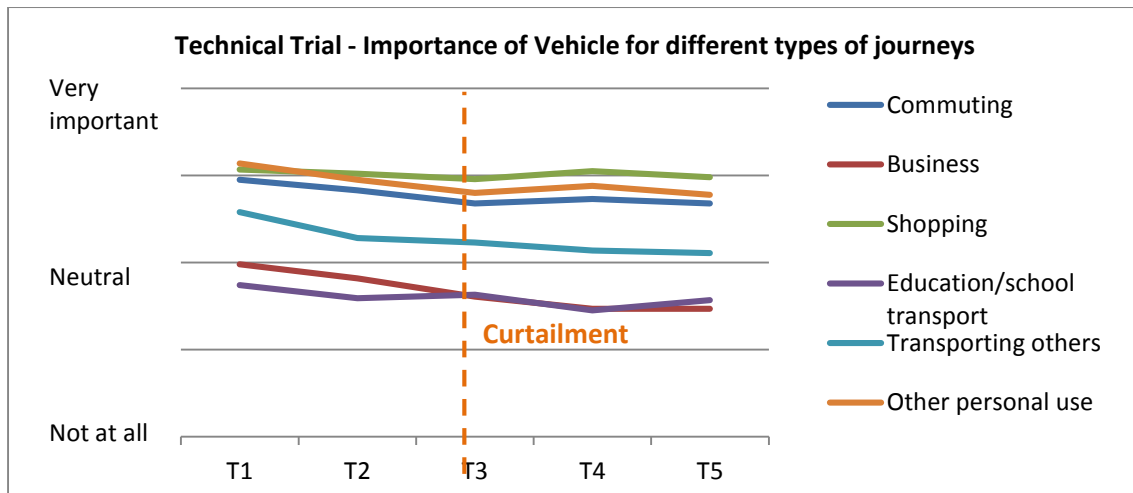


Figure 3-26 Importance of primary vehicle (T1) / EV (T2 to T5) for different journey types for Technical Trial over time

3.5.2. Journey length

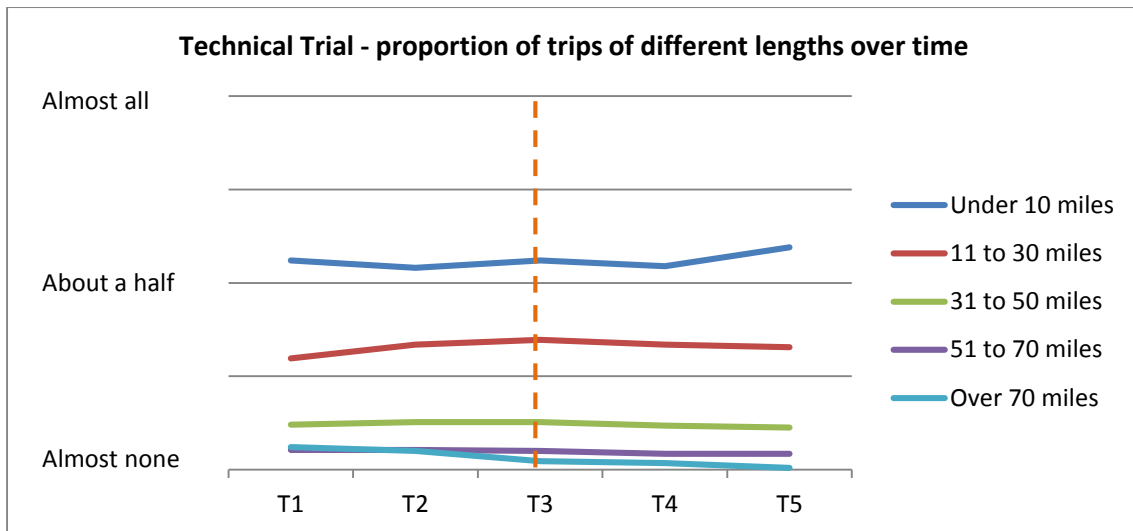
Summary of Findings

- There was a slight decrease in the number of journeys over 70 miles for the Technical Trial participants but this was not related to curtailment
- There was an increase in journeys between 11 and 30 miles for the Social Trial participants
- There was no indication that curtailment affected journey length

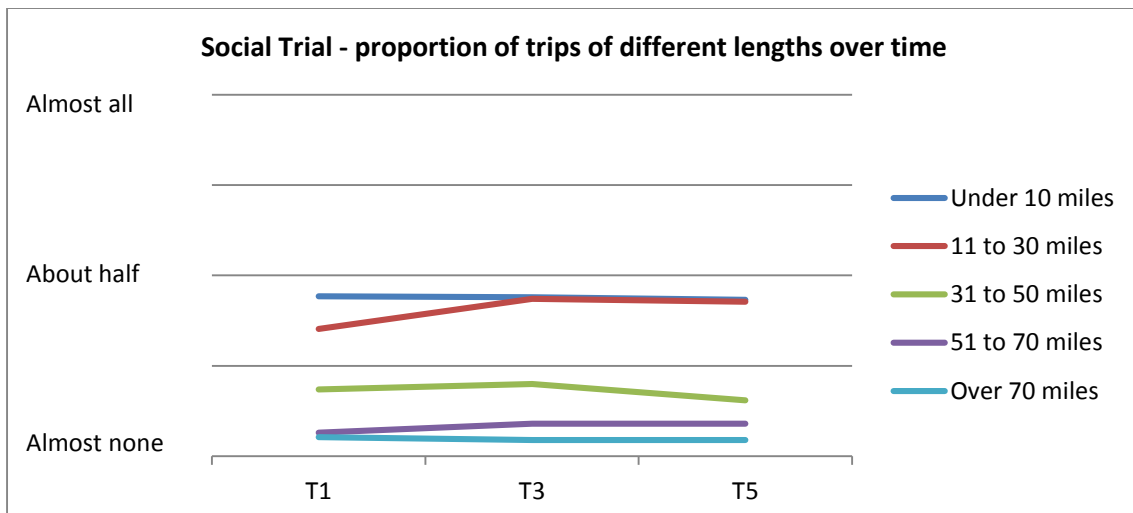
Participants were asked about the frequency of different journey lengths for their primary vehicle at T1 and for their EV in all subsequent questionnaires (Technical: T2, T3, T4, T5; Social: T3, T5) and the results are shown in Figure 3-27 and Figure 3-28.

Analysis revealed no statistically significant difference between the three Technical Trial groups in journey type at T1 (original primary vehicle), T2 (EV before curtailment begins), or T5 (EV at end of trial).

There was a statistically significant difference between T1 and T5 within the Technical trial overall for the proportion of trips over 70 miles long with the proportion of these trips reducing. There were also statistically significant differences between T1 and T3 and T1 and T5 in the Social Trial for the proportion of trips between 11 and 30 miles with the proportion of trips increasing.



[Figure 3-27 Proportion of trips of different lengths for Technical Trial participants](#)



[Figure 3-28 Proportion of trips of different lengths for Social Trial participants](#)

3.5.3. Unplanned trips

Summary of Findings

- By the end of the trial Curtailed and Workplace participants made a greater number of longer unplanned trips than Non-curtailed participants
- There is no indication that curtailment impacted drivers making unplanned trips

Participants were asked to how often they took short unplanned trips (less than 5 miles) and longer unplanned trips (more than 5 miles) in all questionnaires (Technical: T1, T2, T3, T4, T5; Social: T1, T3, T5).

Analysis revealed a statistically significant difference in the number of longer unplanned trips between the Non-curtailed and the Curtailed participants at T5 with the Curtailed participants making more unplanned longer trips. There was also a significant difference at T5 between the Non-curtailed and Workplace participants with the Workplace participants making more unplanned longer trips. There were no significant differences between groups in shorter unplanned trips or between the Curtailed and the Workplace participants in longer unplanned trips.

Changes in frequency of unplanned trips between T2 (before curtailment began) and T5 (the end of the trial) were compared within the three groups in the Technical Trial. There were no statistically significant differences in frequency of either short or longer unplanned journeys for the Curtailed or Workplace participants. There was a statistically significant decrease in longer unplanned journeys for the Non-curtailed participants. These findings suggest that there is no relationship between curtailment and a reduction in unplanned trips.

3.6. Comfort with Esprit

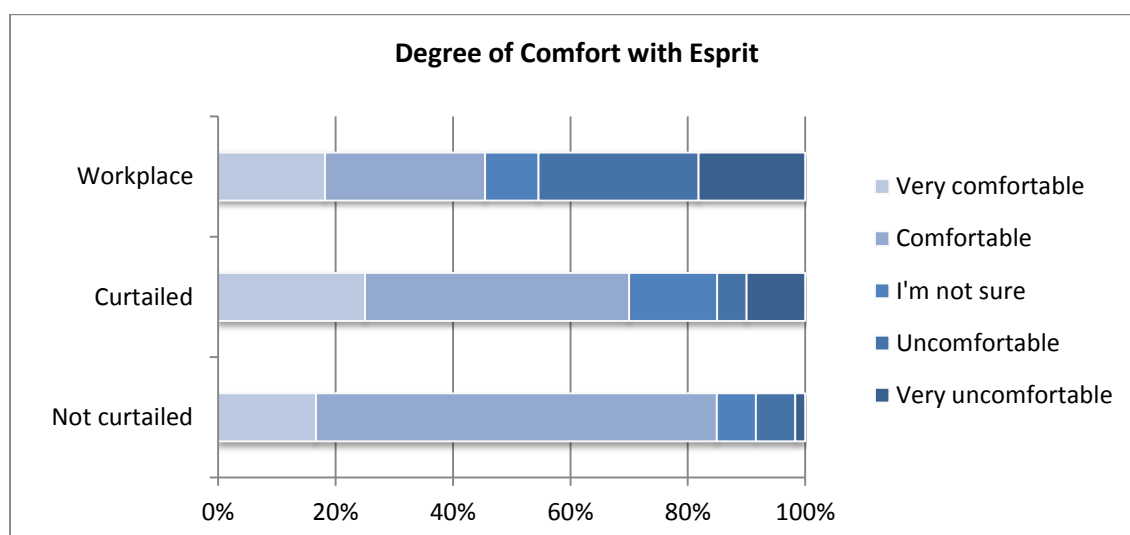
Summary of Findings

- The majority of the participants were *comfortable* or *very comfortable* with the idea of living with Esprit Technology for as long as they had an EV whether or not they had experienced curtailment
- Curtailment of charging by Esprit did not appear to affect participants' satisfaction with EVs
- Greater *Comfort with Esprit* is related to a more positive experience of EVs, a more positive attitude towards EVs, and a more positive attitude towards charging.
- Participants with a higher level of *Comfort with Esprit* took more unplanned trips, thought it was easier to find a place to charge away from home, and a higher proportion of their trips were likely to be between 11 and 30 miles long
- Participants with a higher level of *Comfort with Esprit* also had stronger intentions to buy an EV either at the end of the trial or sometime in the future

In the final questionnaire (T5) participants in the Technical Trial were asked directly about how comfortable they would be living with Esprit control of charging for as long as they had an EV. Analysis revealed no statistically significant differences between the three groups in *Comfort with Esprit* suggesting that experience of curtailment was not related to acceptability of Esprit (Figure 3-29).

This finding is supported by interview and focus group results for the Domestic Clusters with the majority of participants who experienced curtailment either being unaware of it or not being impacted by it (see Section 3.4.3.1). Of the Domestic Cluster participants who took part in interviews or focus groups only one participant reported a substantive impact from curtailment when he was unable to charge in the early evening.

The finding for Comfort with Esprit for the Workplace Cluster is more surprising as the focus group results from the Workplace Cluster indicated that participants were very unhappy about the curtailment of charging at the workplace chargers with the result that the majority of participants did not charge at work. Of the five participants who regularly charged at work all had found that the curtailment of charging was an issue for them, and one had stopped charging at work as a result of curtailment. For two of the participants it was a major issue as they relied on charging at work to drive home in the evening. The results for the *Comfort with Esprit* for the workplace cluster may be related to participants' experience with charging at home rather than their experience with charging at work with the 27% who were uncomfortable or very uncomfortable with the Esprit being those who relied on workplace charging.



[Figure 3-29 Degree of comfort with Esprit for the three groups in the Technical Trial](#)

Comfort with Esprit for the Domestic Clusters was compared with the maximum number of times charging was curtailed by Esprit **per month** from January to June 2015 (Figure 3-30) and with the overall number of times charging was curtailed from January to June 2015 (Figure 3-31) for all Domestic Cluster participants who experienced curtailment. No relationship was found between the number of curtailments and degree of *Comfort with Esprit*.

In addition there was no statistically significant correlation between *Comfort with Esprit* and:

- Place Most Often Charge at any time point
- Importance of vehicle for any journey type at any time
- Charging start time at end of trial (T5)
- EV Takes Longer to Charge or Charges Less at end of trial (T5)
- Prevented from Using EV due to Low Charge State at end of trial (T5)

There were statistically significant correlations indicating a positive relationship between *Comfort with Esprit* and:

- Lower Level of Battery Charge Considered Low at end of trial (T5)
- Experience of EVs at end of trial (T5)
- Attitude towards EVs at end of trial (T5)
- The Charging Attitude variable *ease of finding a place to charge away from home* at end of trial (T5)
- Frequency of Longer Unplanned Trips at end of trial (T5)
- Proportion of Journeys between 11 and 30 miles at end of trial (T5)
- Intention to Buy an EV After the Trial Ends and Intention to Buy an EV in the Future at end of trial (T5)

These correlations may indicate that participants with a more positive experience of EVs and a more positive attitude towards EVs were also more comfortable with Esprit.

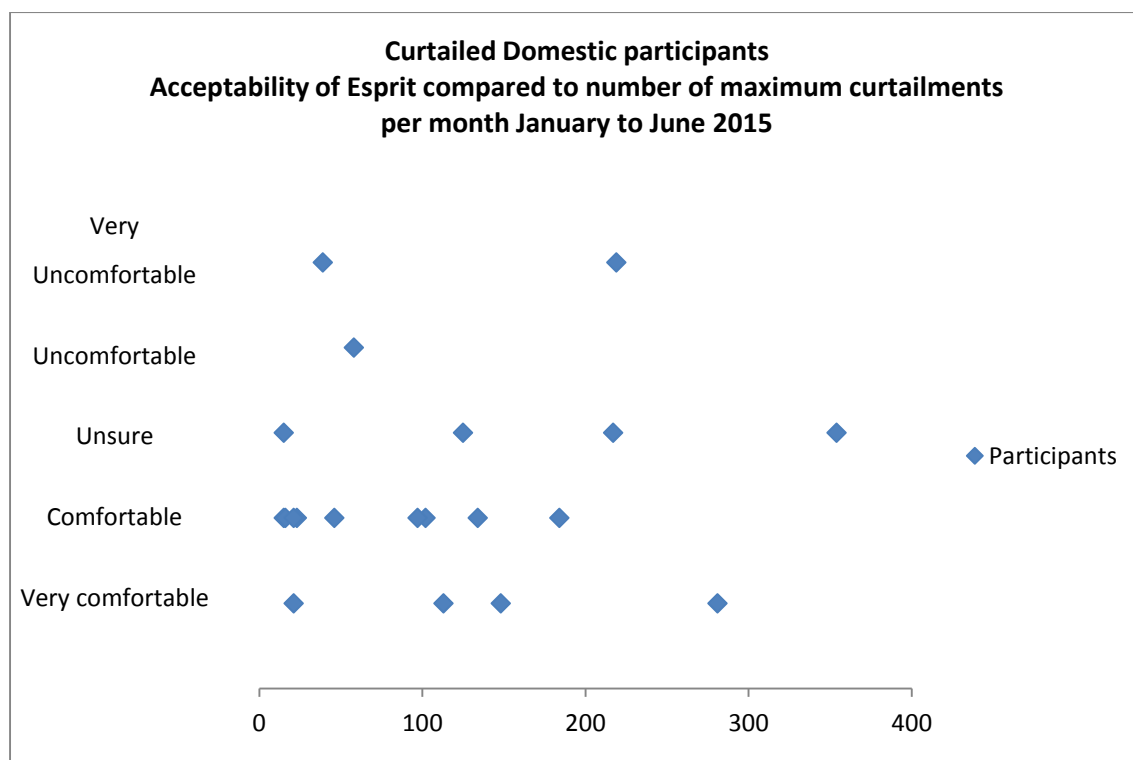


Figure 3-30 Acceptability of Esprit compared to experience of maximum number of curtailments per month for Curtailed Domestic participants, n = 20

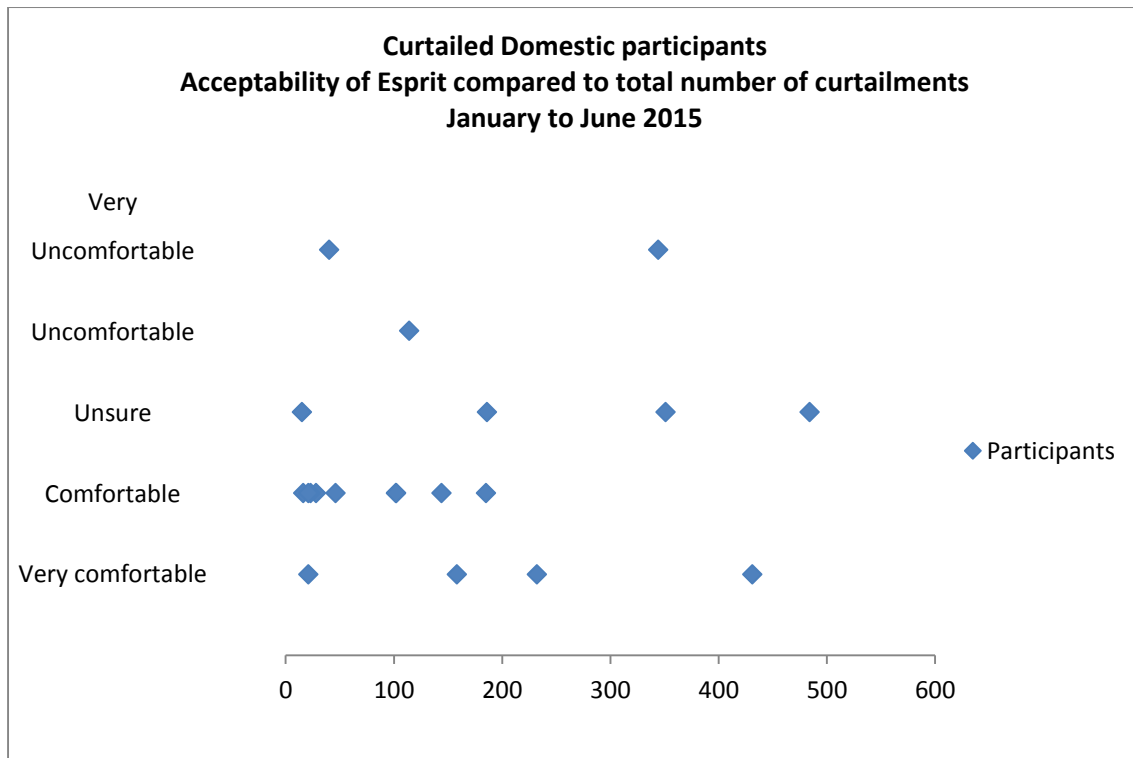


Figure 3-31 Acceptability of Esprit compared to experience of total curtailment for Curtailed Domestic participants, n = 20

3.6.1. Intelligent Control Box units and Chargers

When asked about the home charging units in interviews and focus groups all participants were happy to have the charging unit on their house though there were some concerns about aesthetics:

I think it is so hideous I made a cover to go over it.

I think they're a bit ungainly and look a bit odd but I imagine if this takes off they will become fairly normal

A number of participants did however report concerns with the noise made when the Intelligent Control Box turned the charger off:

You know it is charging so you know it is going to be done by 12, 12.30 and then you hear the thud and you know that it's stopped

It was overnight and it was going clunk clunk and you're thinking what's going on?

3.7. Knowledge of Low Carbon Technologies

Summary of Findings

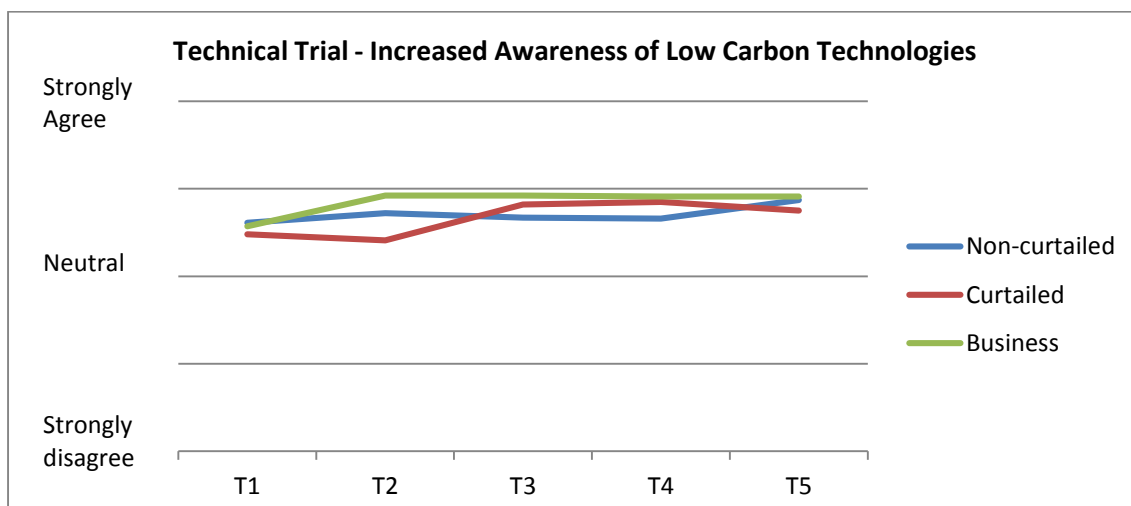
- Participants' awareness and understanding of low carbon technologies increased over the course of the trial
- The actual experience of using an EV and charging point was the most important element of the trial for increasing awareness and understanding
- Project communications were also important in increasing awareness and understanding
- The trial also may have contributed to an increase in awareness and understanding in the wider community

Participants were asked to indicate their degree of agreement with two statements about low carbon technologies in the questionnaires at all time points. The statements were:

- Being involved with My Electric Avenue has increased my **awareness** of low carbon technologies
- Being involved with My Electric Avenue has increased my **understanding** of low carbon technologies

Data from T1 (before delivery of EV) were compared with data from T5 (the final questionnaire allowing for the maximum experience of the trial). A statistically significant difference over time was identified for both questions for both the Technical Trial and the Social Trial (Figure 3-32, Figure 3-33, and Figure 3-34). There was no statistically significant difference in change over time for either question between the three groups in the Technical Trial.

This suggests that being involved with the trial is related to increases in *Awareness* and *Understanding of Low Carbon Technologies*.



[Figure 3-32 Awareness of low carbon technologies over time for the Technical Trial](#)

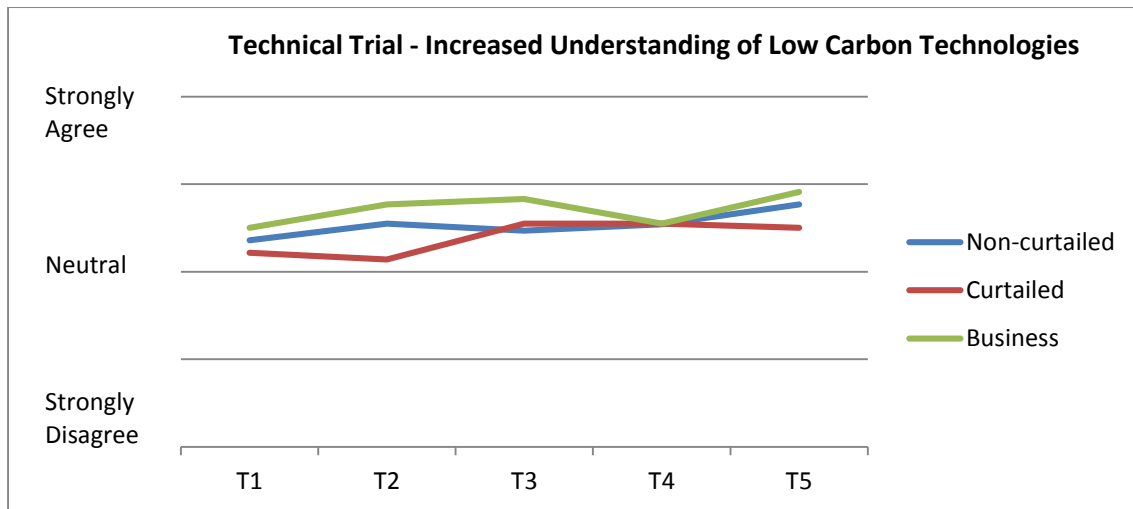


Figure 3-33 Understanding of low carbon technologies over time for the Technical Trial

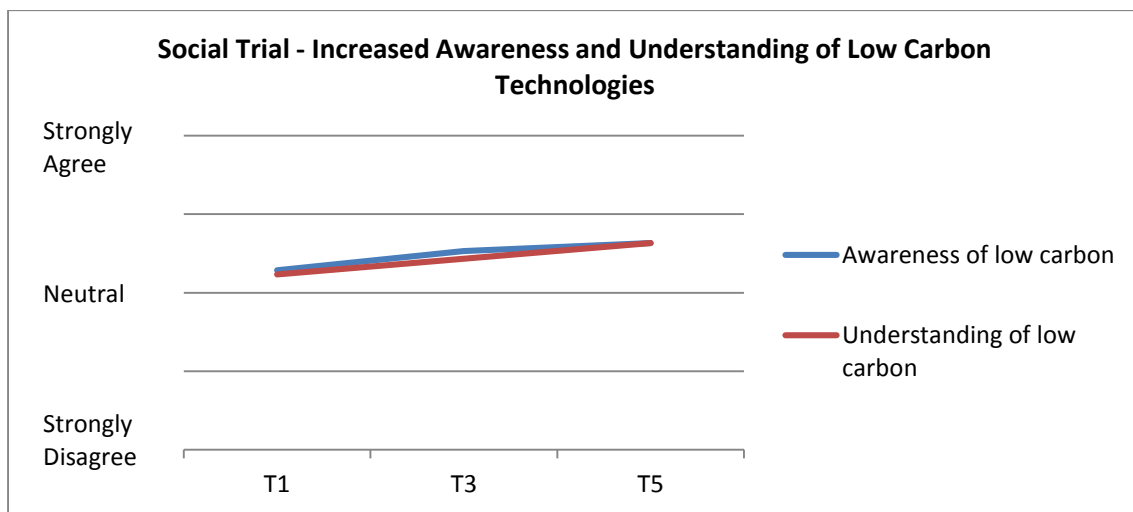


Figure 3-34 Awareness and understanding of low carbon technologies over time for the Social Trial

Questions in the final questionnaire provide an indication of which aspects of the Technical Trial were most important in increasing *Awareness* and *Understanding* of low carbon technologies (Figure 3-35). Responses indicate that the element of the trial which was most important in increasing both *Awareness* and *Understanding* was the actual experience of using the EV and charging points. In addition project communications over the course of the trial were important for increasing *Awareness* and *Understanding*. Amongst Social Trial participants the actual experience of using the EV and charging points was again the most important element in increasing *Awareness* and *Understanding* and project communications were also identified as important (Figure 3-36).

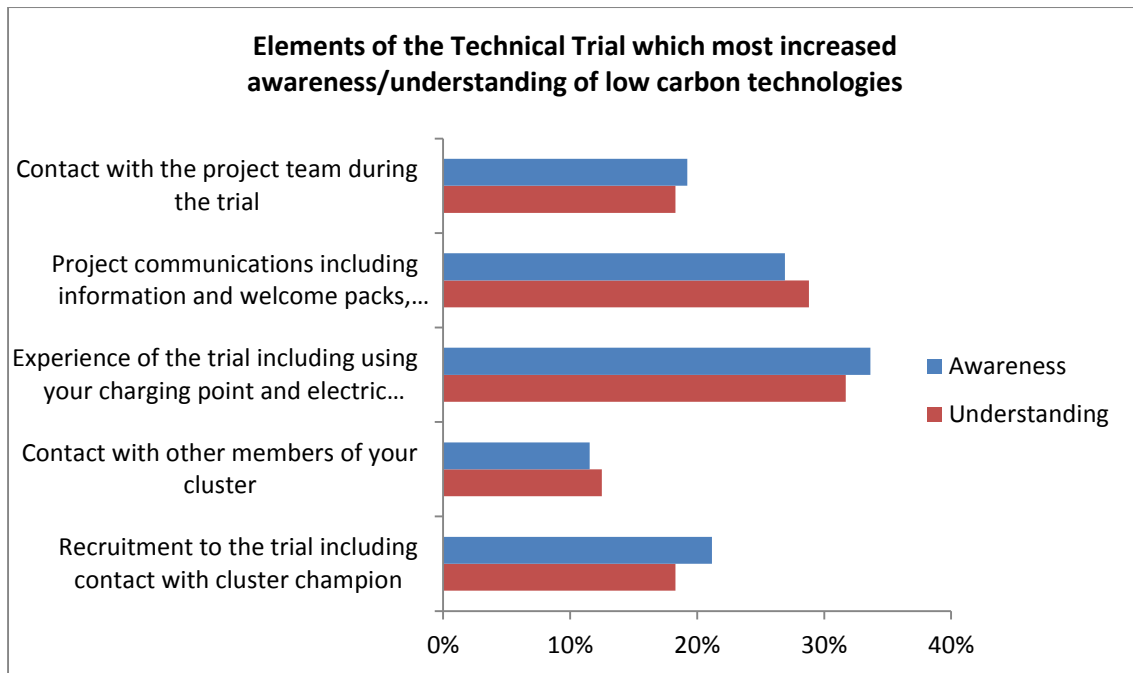


Figure 3-35 Elements of the Technical Trial which most increased awareness/understanding of the low carbon technologies

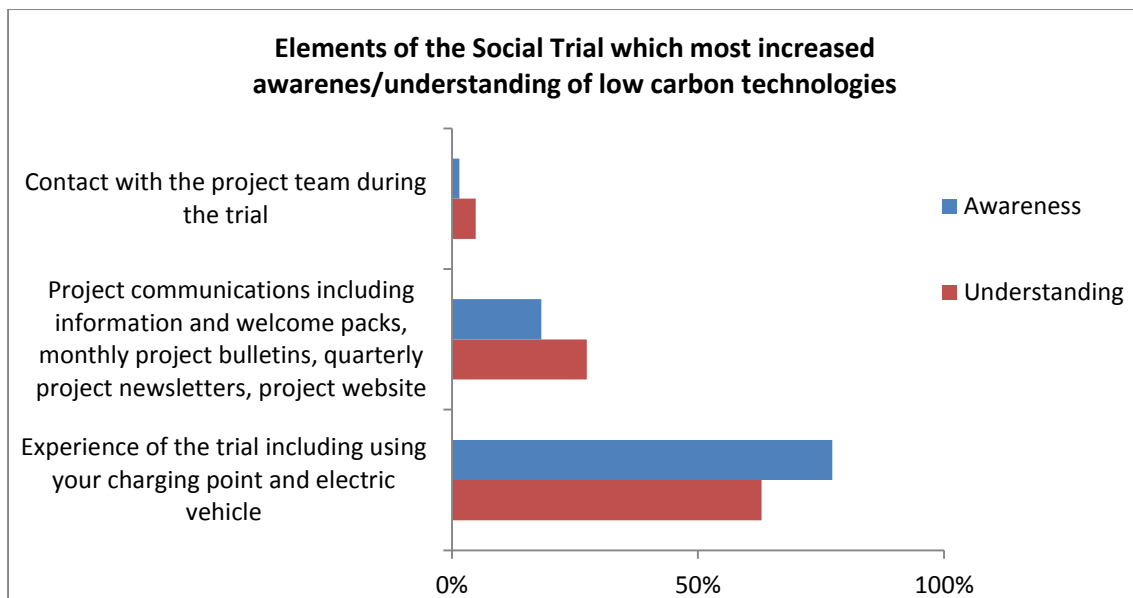


Figure 3-36 Elements of the Social Trial which most increased awareness/understanding of the low carbon technologies

3.7.1. Wider community

Data from interviews and focus groups suggest that the trial may also have increased *Awareness* and *Understanding* of low carbon technologies in the wider community. Many participants reported that there was substantial interest from friends, family, and people in their community in the practicalities of using an EV:

You get a lot of interest so when I took the car to work the first time and people coming to look and wanting to go in it and family when they came up all wanted a ride and to drive it and things so there's sort of a lot of interest because it's a new thing I suppose

Electric cars are still pretty rare but everyone understands the way that the future will probably go so a lot of people at work are always interested in the topic when we bring it up

3.8. Uptake of Low Carbon Technology

Summary of Findings

- Approximately 6% of participants installed PV during the course of the trial
- Several other participants indicated that they were considering PV as a result of being involved in the trial
- The number of participants who definitely intended to buy or lease an EV at the end of the trial increased slightly over the course of the trial

3.8.1. Renewables and energy efficiency

Participants in both trials were asked whether they had PV or any other renewable energy sources. In the Technical Trial nine households had PV at the beginning of the trial and another three households installed PV during the course of the trial. In the Social Trial 26 participants had PV at the start of the trial and another nine installed PV during the course of the trial. One focus group participant stated that installation of PV was the result of taking part in the trial and a number of interviewees stated that they were seriously considering PV as a result of taking part in the trial.

I got the car and then there was a scheme like in the estate and they knocked and said oh we can put it [PV] on and I thought you know what that would be ideal because the electric car has got me focussing on renewable technology and I thought well I definitely want to do it, this is something I want to do where before having the car I might have thought hmm I don't know what would the need for that be

Several interviewees stated that they were doing more to save energy around the home as a result of taking part in the trial. An additional action taken by several households was a switch to an all renewable electricity supplier, for example:

Changed electricity suppliers, I do like the fact that we are using green electricity and gas

3.8.2. Intention to buy or lease an EV after the trial

Participants were asked in all questionnaires to express their degree of agreement with four statements about their intention to buy an EV after taking part in the trial. These were:

- I intend to buy an electric vehicle after participating in this trial
- I intend to lease an electric vehicle after participating in this trial
- I intend to buy an electric vehicle sometime in the future
- I would only buy an electric vehicle if there was some form of financial incentive

Data from T1 (before delivery of EV) were compared with data from T2 (post-delivery of EV but before introduction of curtailed charging) and with T5 (the final questionnaire allowing for the maximum experience of controlled charging) for all three groups in the Technical Trial (Figure 3-37, Figure 3-38, Figure 3-39, and Figure 3-40). No statistically significant differences over time in 'buy an electric vehicle sometime in the future' or in 'only buy an electric vehicle if there was some sort of financial incentive' were revealed.

However there were statistically significant differences over time in:

- *Intend to buy an electric vehicle after participating in this trial* where there was a statistically significant difference between T1 and T5 for all groups, and also between T2 and T5 for the Non-curtailed and Curtailed groups with intent to buy decreasing
- *Intend to lease an electric vehicle after participating in this trial* where there was a statistically significant difference between T1 and T5 and also between T2 and T5 for the Non-curtailed group with intent to lease decreasing

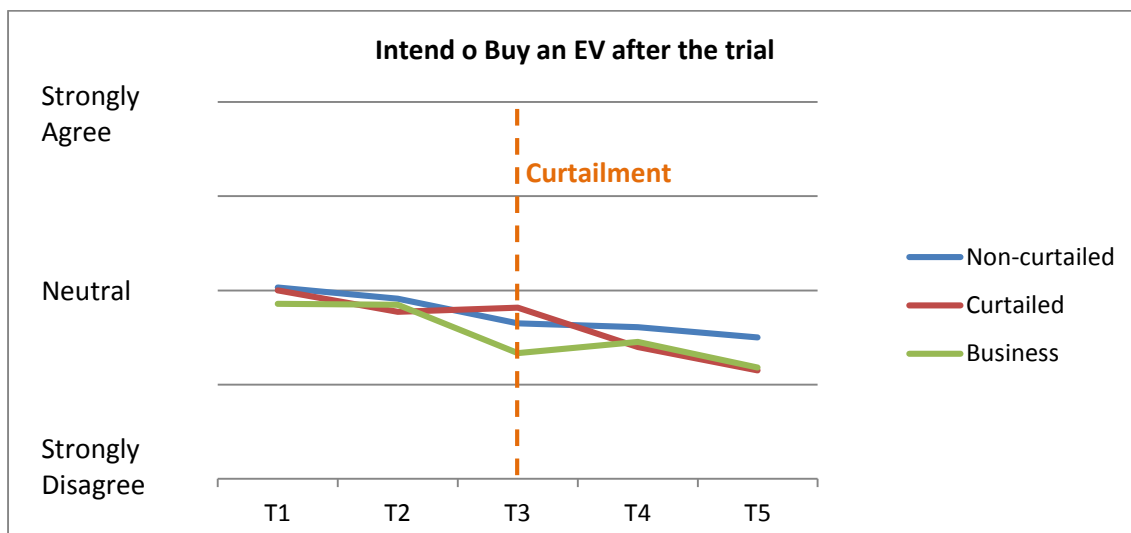


Figure 3-37 Intention to buy an EV after the trial

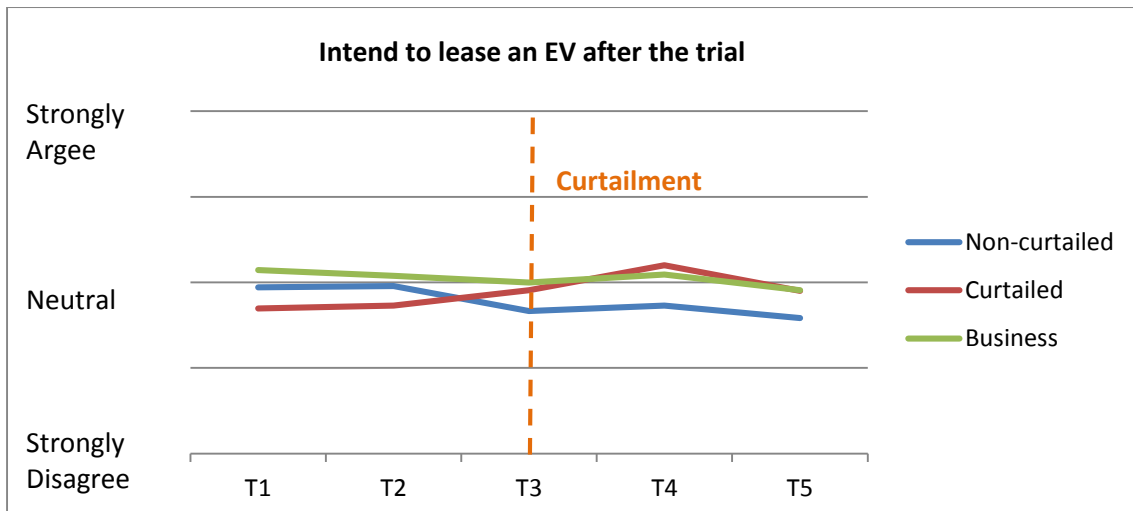


Figure 3-38 Intention to lease an EV after the trial

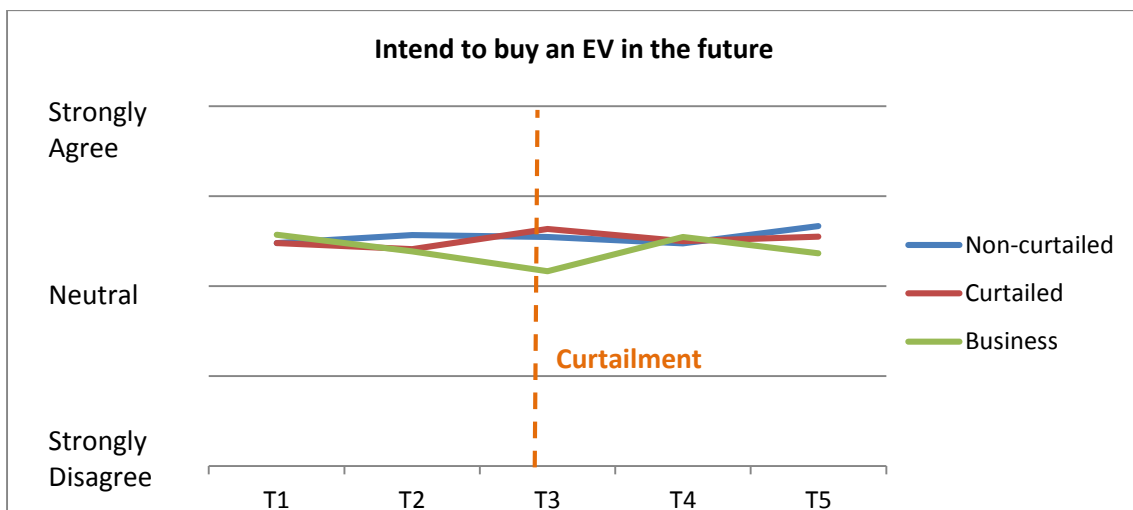


Figure 3-39 Intention to buy an EV in the future

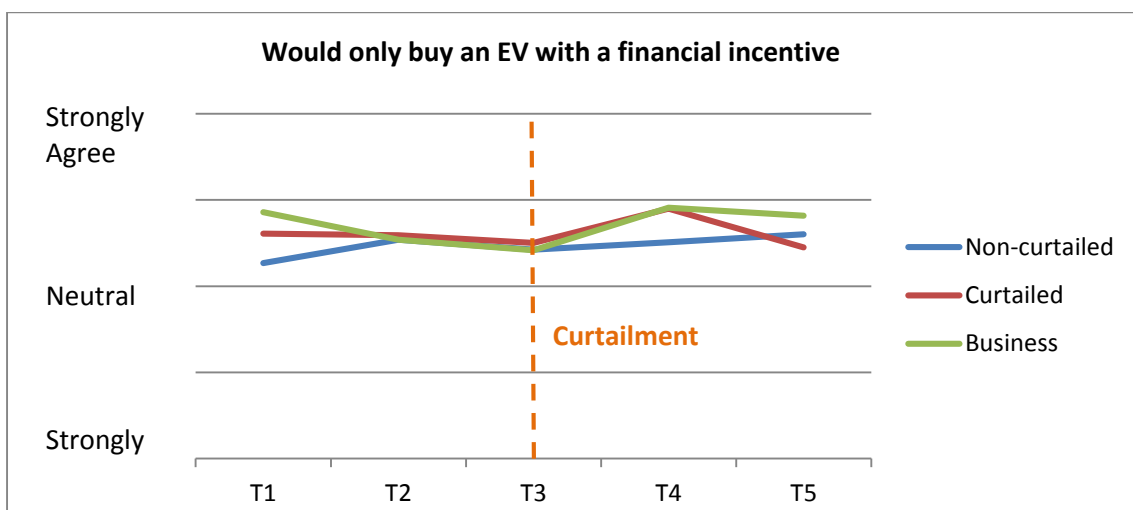


Figure 3-40 Intention to buy an EV if there was a financial incentive

An examination of the distribution of the responses over time for the intention statements shows a number of interesting patterns (Figure 3-41, Figure 3-42, Figure 3-43 and Figure 3-44). From T1 to T5, the number of strongly agree/agree responses increases, with the exception of intent to buy an EV after the trial. The number of neutral (neither agree nor disagree) responses decreased between T1 to T5 for all statements. Across all four statements there is an increase in the number of strongly disagree/disagree from T1 to T5. These patterns suggest that experience with an EV may have helped participants to develop a better idea of whether or not an EV would meet their needs.

Interview findings support this suggestion. Almost all participants really liked their EV but many raised concerns about the thought of buying or leasing one. The main concern was financial; EVs were seen to be very expensive for what most households thought of as their second car.

A good second vehicle but expensive to purchase with limited mileage

Range was also a concern for many participants as illustrated by the following comment:

The car is great, enjoyable to drive and perfect for local transport. But the elephant in the passenger seat is low range. 80 miles is simply not enough

Secondary concerns were over how long the batteries would last and what the replacement cost of the batteries would be. A number of participants also felt that it would not make sense to invest in an EV immediately as the technology was still evolving so quickly:

Once the batteries can do approximately 200 miles on one charge I will be interested in having another electric car

This may explain why a majority of participants *agreed* or *strongly agreed* with the statement *intend to buy an EV in the future*. Almost all participants would have been happy to continue to lease their EV at the trial rate.

Overall the findings suggest that the trial encouraged people to consider purchasing an EV, a sentiment illustrated by the following comment:

A very worthwhile trial and I have enjoyed participating in the trial. Prior to the trial it is unlikely that I would have considered an EV

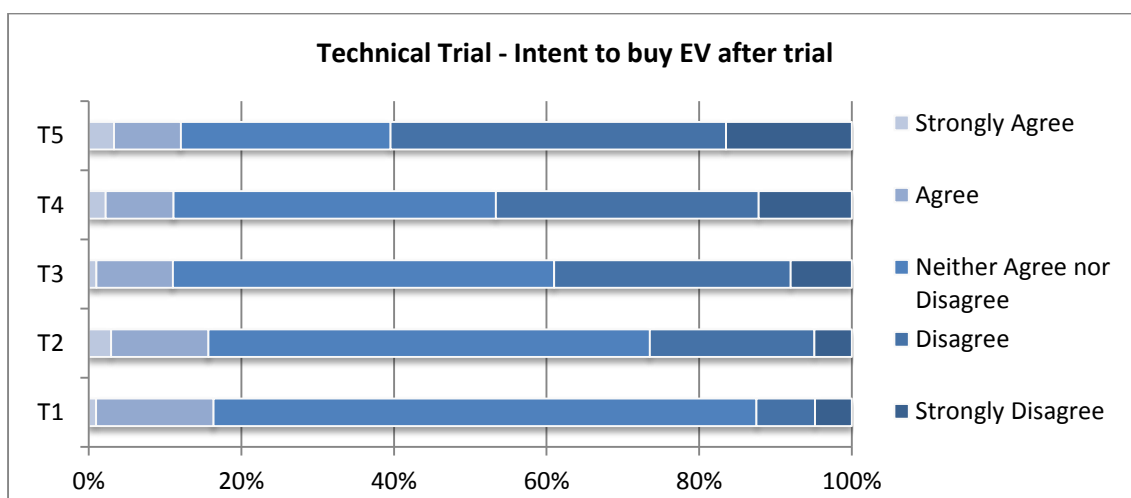


Figure 3-41 Percentage of Technical Trial participants over time intending to buy an EV after the trial finished

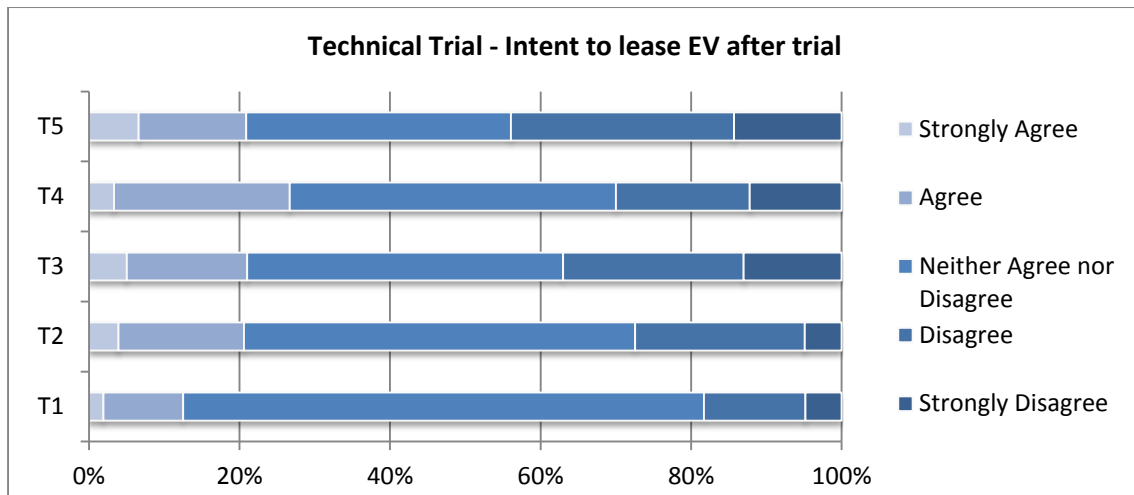


Figure 3-42 Percentage of Technical Trial participants over time intending to lease an EV after the trial finished

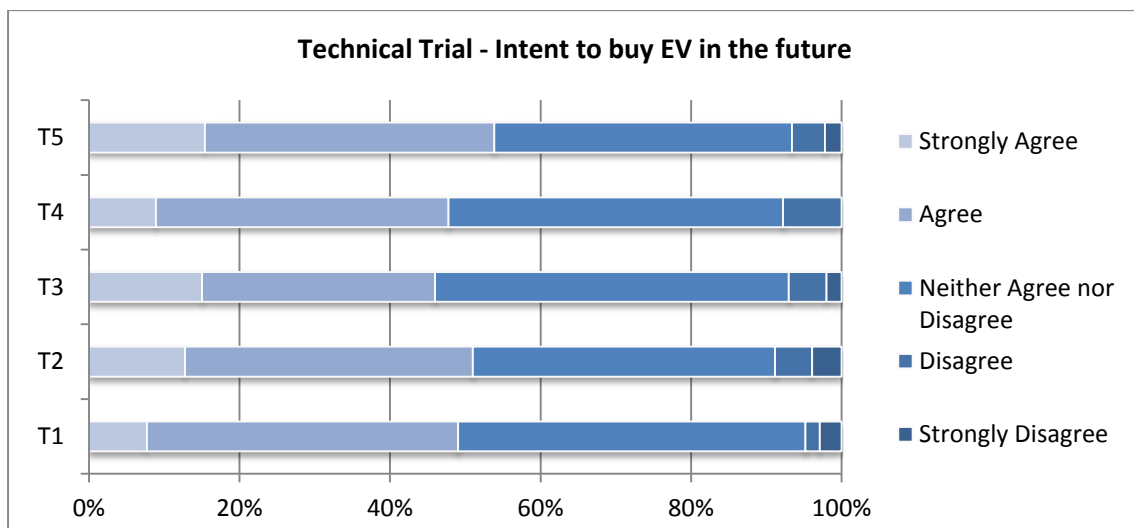


Figure 3-43 Percentage of Technical Trial participants over time intending to buy an EV sometime in the future

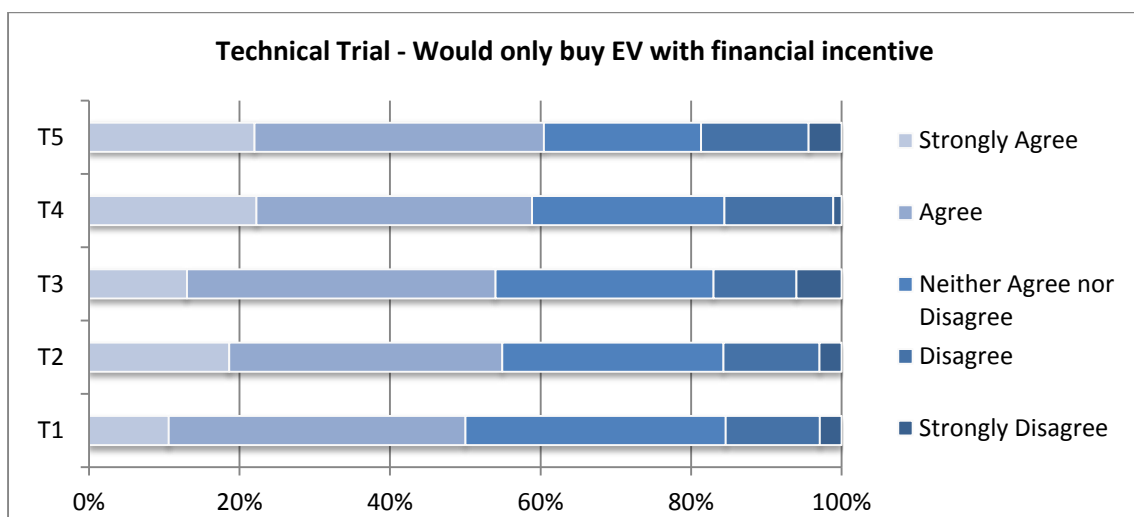


Figure 3-44 Percentage of Technical Trial participants over time who would only buy an EV with financial incentive

3.9. Knowledge of Electricity Network

Summary of Findings

- Participants indicated that pre-trial involvement with the My Electric Avenue Trial increased their awareness and understanding of the electricity network
- Awareness and understanding of the electricity network did not increase further over the course of the trial

Participants were asked at all time points to indicate their degree of agreement with two statements about the electricity network in the questionnaires. The statements were:

- Being involved with My Electric Avenue has increased my *awareness* of the electricity network
- Being involved with My Electric Avenue has increased my *understanding* of the electricity network

Results are shown in Figure 3-45, Figure 3-46, and Figure 3-47. Data from T1 (before delivery of EV) were compared with data from T5 (the final questionnaire allowing for the maximum experience of the trial). No statistically significant differences over time were found for either question in both the Technical Trial and the Social Trial.

This suggests that involvement with the My Electric Avenue Trial did not increase *awareness* or *understanding* of the electricity network over the course of the trial. However, the results from T1 do suggest that pre-trial involvement with the project did increase *awareness* and *understanding* of the electricity network for both Technical and Social Trial participants. The average response at T1 to the questions suggests that participants agreed slightly the involvement with the trial increased their *awareness* and *understanding* of the electricity network.

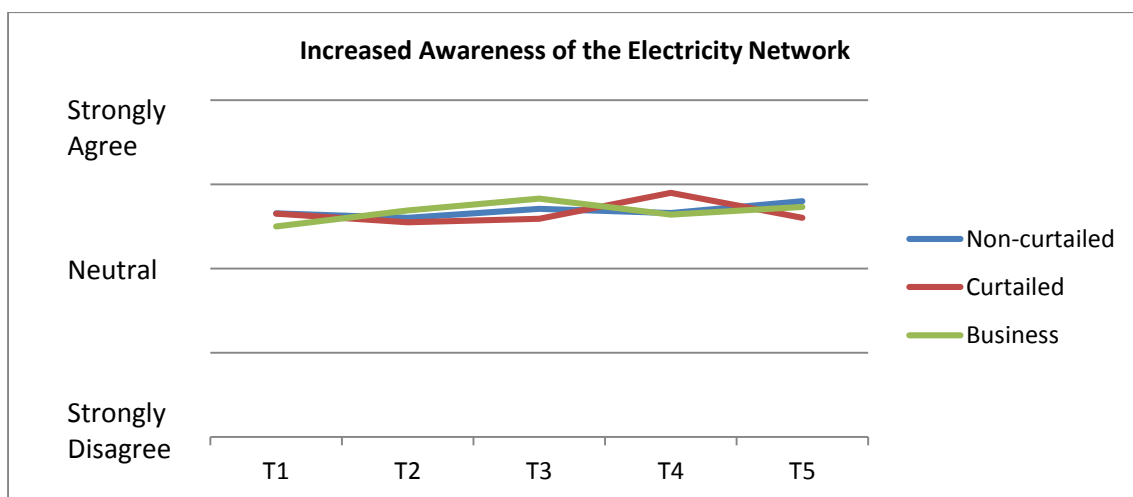


Figure 3-45 Awareness of the Electricity Network over time for the Technical Trial

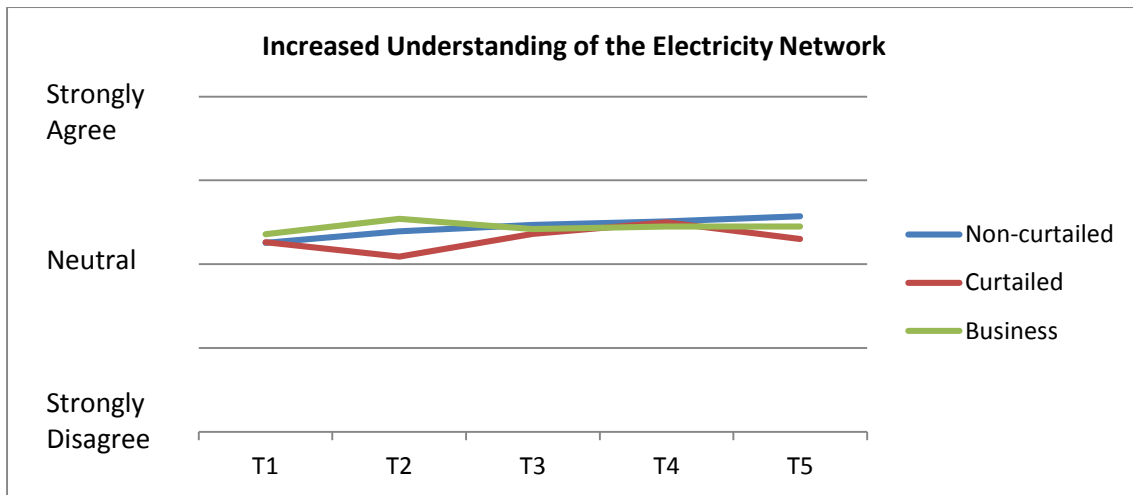


Figure 3-46 Understanding of the Electricity Network over time for the Technical Trial

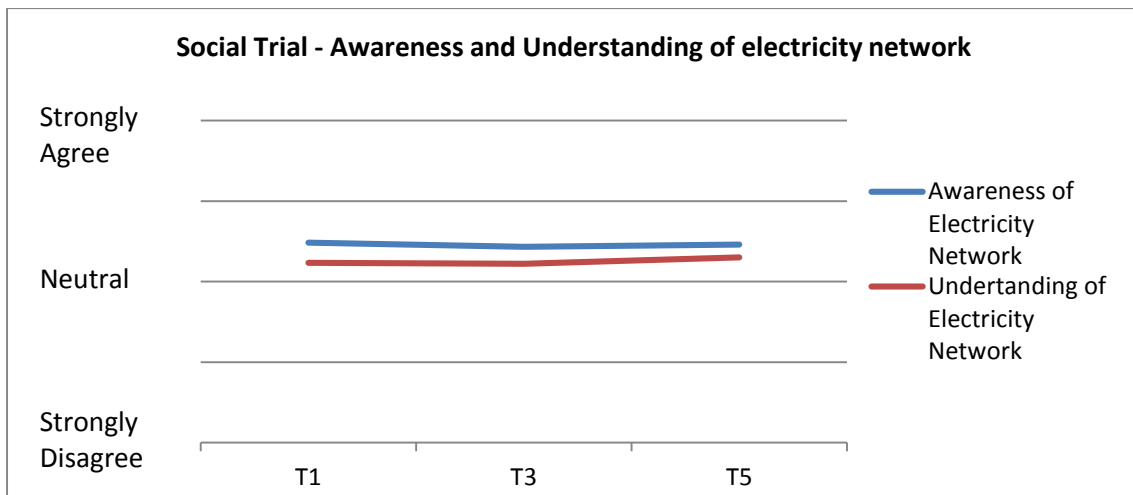


Figure 3-47 Awareness and Understanding of the Electricity Network over time for the Social Trial

3.10. Trial Experience

Summary of Findings

- Participants rated the trial and the project team highly
- The majority of participants were positive about the possibility of being involved in another trial of low carbon technologies

In the final questionnaire (T5) participants were asked to rate the overall trial experience (Figure 3-48) and to rate the MEA project team (Figure 3-49). Participants from the Domestic Clusters and the Social Trial rated the overall trial experience highly on a scale of 1 to 10, with some Workplace Cluster participants being less enthusiastic. There were some complaints about the Nissan dealer support:

Nissan dealerships are not clued up enough about EVs and do not give good enough support. Initial attempts by me to use CARWINGS was made more difficult because the website was confusing

Additionally, some comments suggested mixed experience about communication from the project:

I have enjoyed the trial and communication is good

Got a bit confused who was dealing with what - lots of emails from different people but all were very good. Quick responses to queries

The MEA project team were also rated highly by the majority of participants:

Very helpful and friendly team - only negative comment: some of the documentation was a bit confusing to some of my cluster members

I think they are all fine! A couple of times I have been "stuck", and they have done their best to help and advise me. 10 out of 10

Overall, participants were grateful to have been part of the trial:

Thank you for your support during this trial you have all worked very hard to meet all of our challenges. I have enjoyed the experience and will miss the car when it returns

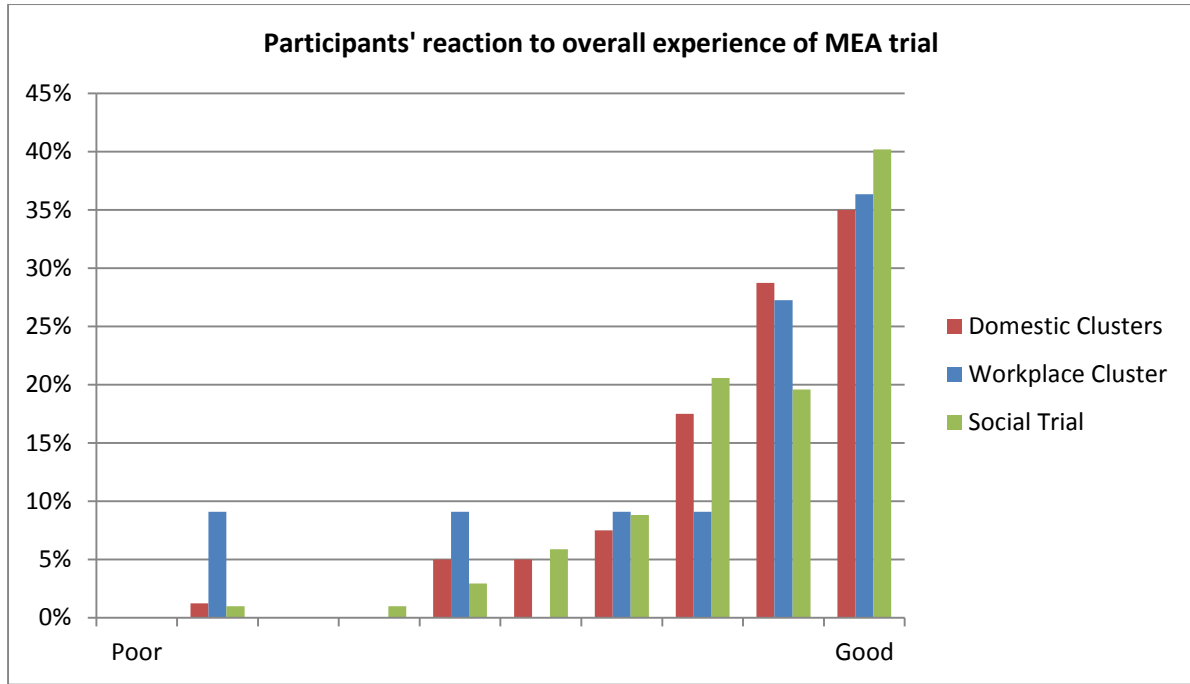


Figure 3-48 Participants' reaction to the overall experience of the MEA trial

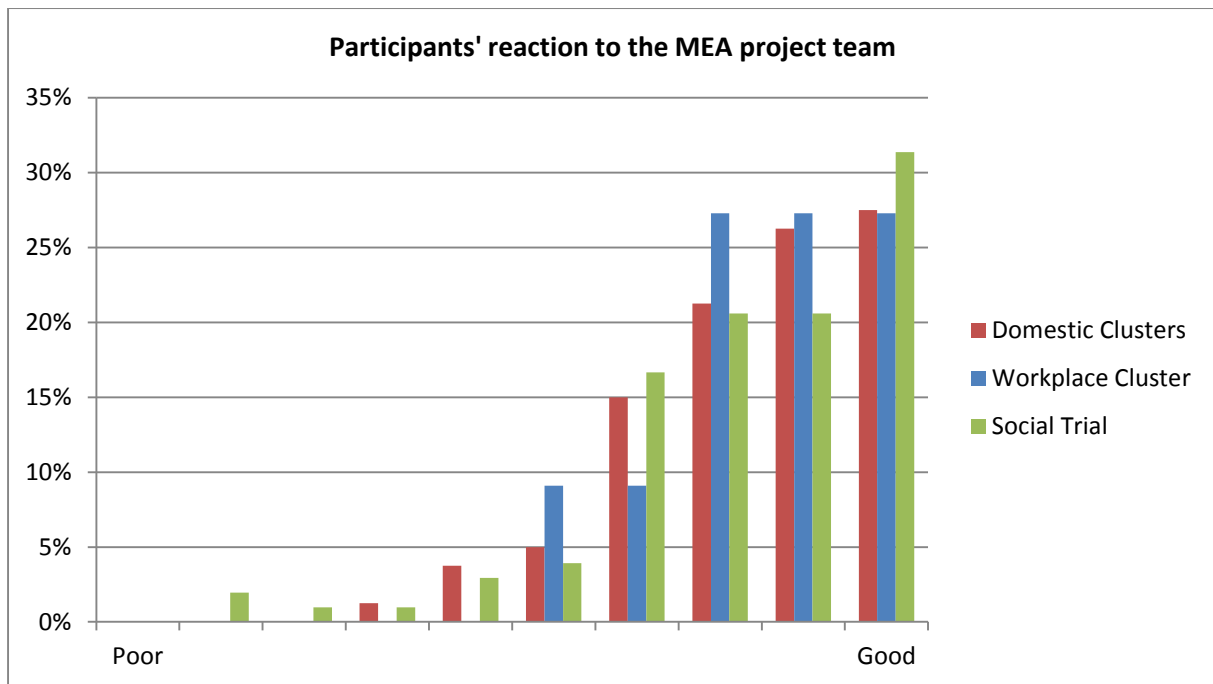


Figure 3-49 Participants' reaction to the overall experience of the MEA project team

In the final questionnaire (T5) participants were also asked whether they would be likely to participate in another trial of low carbon technologies, and if so what it was that attracted them about the idea (Figure 3-50). The majority mentioned benefits to the environment. The opportunity to trial new technology and the opportunity to contribute to current research were also mentioned; only a few noted the financial benefits.

As a family, we're keen to do what we can to save the environment for future generations

Fun being part of a research project and being a pioneer

Efficient way to try new technology without the cost of buying & with lots of support

Participants also mentioned the value of being in a trial as a way to gain understanding about new technology as well as for promoting inclusivity of access to new technologies which might otherwise be too expensive.

Trials like these are very important for understanding the best systems to be used, and benefits to be gained, from the introduction of these new technologies, like EVs. They also give a valuable opportunity to people like myself, who might not otherwise be able to afford such technologies, to do so. So, thanks very much, it's been great, and I LOVE my LEAF!

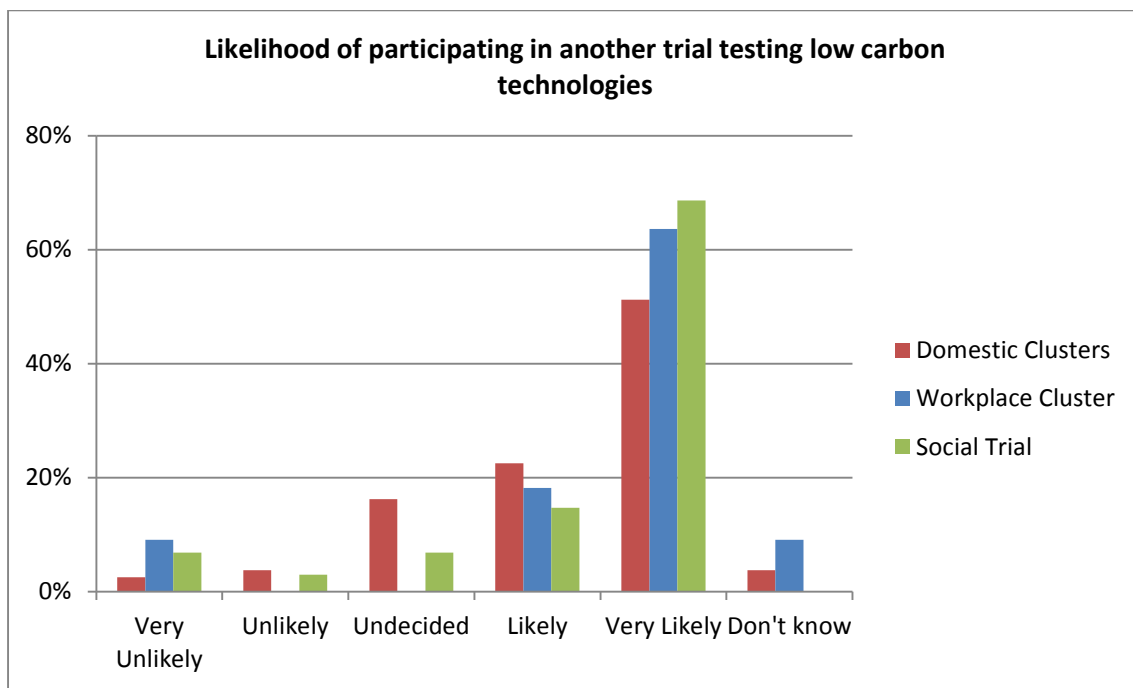


Figure 3-50 Likelihood of participants taking part in another trial of low carbon technologies

4. Discussion

In the My Electric Avenue trial Esprit had the potential to intervene in the charging of EVs when demands on the local electricity network reached a certain threshold. The research presented here explored the reaction of trial participants to the control of EV charging by Esprit in order to assess the acceptance of Esprit technology. The research also considered how the trial encouraged (or otherwise):

- the uptake of low carbon technology
- what social factors impacted the use of the technology
- how participating in a trial educated participants about the electricity network and low carbon technologies

The reaction of participants to Esprit control of charging was investigated through participants' satisfaction with, and use of, their EVs and through direct questions about the impact of curtailment on charging. The uptake of low carbon technology was investigated through exploring participants' intention to acquire EVs and through their adoption of renewable technologies. Socio-demographic characteristics, household characteristics, motivation for joining the trial, attitudes to EVs, and travel patterns were explored to assess the relationship between the acceptance of Esprit and social factors. Awareness and understanding of the electricity network and low carbon technologies were addressed through direct questioning.

A longitudinal study design collected data across an 18 month period from three groups of participants: Domestic (n=90), Workplace (n=14) and Social (n=120). Domestic and Workplace clusters were to experience control of their EV charging (in their home or work setting respectively). Data were collected via online questionnaires and face-to-face interviews or focus groups (see Section 2.4.3). Within the Domestic clusters, a proportion actually experienced curtailment of charging over the course of the trial (Curtailed) and a proportion did not (Non-curtailed).

4.1. Acceptability of Esprit and Social Factors

4.1.1. Socio-demographic and Household Characteristics

It was considered possible that socio-demographic and household characteristics would affect the acceptance of Esprit with different types of participants and households finding it easier or harder to live with Esprit. Although trial participants are not representative of the UK population, and therefore it is difficult to generalise the findings to the UK population, within the trial participants there was no correlation between Comfort with Esprit and any of the socio-demographic or household data. This suggests that the acceptance of Esprit was not related to socio-demographic characteristics such as age and gender, or to household characteristics such as number of children and number of vehicles.

4.1.2. Motivation for joining the trial

Findings from previous studies suggested that there might be a difference in participants' reaction to EVs based on their motivation for taking part in the trial and that this might affect their acceptance of Esprit. There was no statistically significant relationship between *Motivation* for joining the trial and *Comfort with Esprit*. This suggests that *Motivation* was not related to the acceptance of Esprit.

4.1.3. Satisfaction with Electric Vehicles

It was considered possible that their degree of satisfaction with EVs, represented by *Experience of EVs* and *Attitude towards EVs*, might affect participants' acceptance of Esprit. It was also possible that Esprit's control of charging might affect participants' satisfaction with EVs. Results show that participants had a positive *Experience of EVs* and this did not change significantly over the course of the trial, either for participants who had experienced curtailment, or for those who had not. There were no significant differences in change over time in *Experience of EVs* between participants who experienced curtailment and those who did not.

Participants had a positive *Attitude towards EVs* and this did not change significantly over the course of the trial, either for participants who had experienced curtailment, or for those who did not. There were no significance differences in change over time in *Attitude towards EVs* between participants who experienced curtailment and those who did not.

Both *Experience of* and *Attitude towards EVs* were positively related to *Comfort with Esprit*. This suggests that *Experience* and *Attitude* may have a significant impact on the acceptance of Esprit, and that Esprit's control of charging did not significantly affect either the *Experience of* or *Attitude towards EVs*.

4.1.4. Charging Patterns

4.1.4.1. Attitude to Charging

Attitude towards Charging might be related to the acceptance of Esprit with participants who had a more positive attitude towards charging being more accepting of Esprit. *Attitude towards Charging* might also be affected by Esprit's control of charging in which case participants' attitudes towards home charging (or charging at work for the Workplace participants) might become less positive as a result of Esprit's control of charging. To investigate this, *Attitude towards Charging* was explored through four questions on charging. Participants were found to have positive attitudes towards charging at home (or at Work for the Workplace cluster) and these did not change significantly over time. Social Trial participants thought it was easier to charge their EV at home than Technical Trial participants both at the beginning and the end of the trial.

Only one of the *Attitude to Charging* questions was positively related to *Comfort with Esprit*, which was *ease of finding a place to charge away from home* at the end of the trial. This suggests that overall *Attitude to Charging* was not related to the acceptance of Esprit and that Esprit's control of charging did not significantly affect *Attitude to Charging*.

4.1.4.2. Charging Place

Charging Place might be related to *Acceptance of Esprit*, with those who charged more often away from home (or work for the Workplace participants) being less affected by Esprit and therefore more accepting of Esprit. *Charging Place* might also be affected by Esprit's control of charging with participants changing the place they charged most often as a result of Esprit's control of charging. Results showed that the places participants charged most often did not change substantially over time for individuals in the Domestic Clusters. For Workplace Cluster participants, however, there was a substantial reduction in charging at work when curtailment commenced.

Most Frequent Charging Place was not related to *Comfort with Esprit*, suggesting that the acceptance of Esprit was not related to the place where participants charged most and that Esprit's control of charging did not significantly affect *Most Frequent Charging Place* for Domestic Cluster participants. For Workplace participants, however, Esprit's control of charging did significantly affect *Most Frequent Charging Place*.

4.1.4.3. Comfort with Battery Charge Level

Participants who were more comfortable with a lower *Battery Charge Level* might be more likely to accept Esprit because they were less concerned about state of charge. Esprit's control of charging might also be expected to affect *Comfort with Battery Charge Level*, with participants becoming more concerned over time about lower charge levels due to uncertainty in recharging. This was not the case, however; Curtailed participants became more comfortable with a lower *Battery Charge Level* over time, despite the introduction of curtailment. The Workplace participants, however, became less comfortable with lower *Battery Charge Levels* after curtailment began.

A preference for higher levels of battery charge over time was also seen in the Non-curtailed Domestic participants and in the Social Trial participants, none of whom experienced curtailment. There was a positive relationship between comfort with lower *Battery Charge Level* and *Comfort with Esprit*. This suggests that *Battery Charge Level* was related to the acceptability of Esprit, with participants who were more comfortable with a lower *Battery Charge Level* being more comfortable with Esprit. Esprit's control of charging does not seem to have affected *Comfort with Battery Charge Level*.

4.1.4.4. Charging Start Time

It was considered possible that *Charging Start Time* might have an effect on the acceptability of Esprit as participants who regularly started charging at peak load times were more affected by Esprit and therefore might be less accepting of the technology. There was, however, no significant association between *Charging Start Time* and *Comfort with Esprit* suggesting that *Charging Start Time* was not related to the acceptability of Esprit.

4.1.5. Travel Patterns

4.1.5.1. Journey Types

The distribution of *Journey Types* might affect the acceptance of Esprit as participants who used the EV for particular *Journey Types* might be more likely to accept the technology. Furthermore it was considered possible that Esprit's control of charging might affect *Journey Types* with certain types of journeys becoming less frequent due to uncertainty over charge state. Although there were significant changes in the importance of the EV for different *Journey Types* in the Technical Trial, this does not seem to be related to whether or not participants experienced curtailment. There were no significant changes in the importance of vehicle for different *Journey Types* in the Social Trial.

No relationship was found between the importance of the EV for different *Journey Types* at the end of the trial and *Comfort with Esprit*. This suggests that the acceptability of Esprit was not related to the distribution of *Journey Types*.

4.1.5.2. Journey Lengths

The frequency of journeys of different lengths might affect the acceptance of Esprit since participants who used the EV for shorter journeys might be more likely to accept the technology. Additionally, it is feasible that, Esprit's control of charging might affect *Journey Lengths* with certain lengths of journeys becoming less frequent due to uncertainty over charge state. Results from this research suggest that although there were significant changes in the proportion of trips of different lengths in the Technical Trial, these do not seem to be related to whether or not participants experienced curtailment.

There were also significant changes in the in the proportion of trips of different lengths in the Social Trial.

While there was a significant positive relationship between the number of Journeys between 11 and 30 miles and *Comfort with Esprit*, no other relationships between *Journey Length* and *Comfort with Esprit* were found. This suggests that participants who have more journeys between 11 and 30 miles may be more likely to accept Esprit.

4.1.5.3. Unplanned Trips

The frequency of *Unplanned Trips* might affect the acceptability of Esprit as participants who used the EV for fewer unplanned trips might be more likely to accept the technology. It is possible that Esprit's control of charging might also have affected the number of *Unplanned Trips* with such trips becoming less frequent due to uncertainty over charge state. This does not seem to have been the case for participants in this study as Curtailed and Workplace participants made significantly more *Longer Unplanned Trips* than Non-curtailed participants at the end of the trial.

There was a positive relationship between the frequency of *Longer Unplanned Trips* and *Comfort with Esprit* at the end of the trial. This suggests that participants who took a greater number of *Longer Unplanned Trips* might have been more likely to accept Esprit. These findings also suggest that Esprit's control of charging was not related to a reduction in *Unplanned Trips*.

4.1.6. Comfort with Esprit

4.1.6.1. Curtailment

There was a significant increase in occasions when EVs did not charge as much as expected, or took longer to charge than expected, in the Curtailed group. However, interview and focus group results suggest that Technical Trial participants in the Domestic Clusters were largely unconcerned about curtailment, even when they were aware of it.

Curtailment was a major concern for Workplace participants, with most participants opting to charge at home due to the unreliability of receiving enough charge at work and the importance of leaving the charging points to those who had to charge at work.

There was no significant relationship between *Comfort with Esprit* and either *EV Takes Longer to Charge* or *Prevented from Using EV due to Low Charge State* at the end of the trial. This suggests that curtailment may not have had a substantive impact on the acceptability of Esprit.

A majority of participants in the Technical Trial were *comfortable* or *very comfortable* with the prospect of Esprit controlling the charging of their EV. This was true of all three groups in the Technical Trial: participants in the Domestic Clusters who had not experienced curtailment, participants in the Domestic Clusters who had experienced curtailment, and participants in the Workplace Cluster. Although there were no statistically-significant differences in the degree of *Comfort with Esprit* between the three groups, it is interesting to note that the Workplace Cluster had the highest

percentage of participants who were either ‘Uncomfortable’ or ‘Very Uncomfortable’ with Esprit. This may reflect the difficulties experienced by those members of the Workplace Cluster who relied on charging at work to be able to travel home. It is also interesting to note that a similar percentage of the participants in the Domestic Clusters that had not experienced curtailment were *uncomfortable* or *very Uncomfortable* with Esprit as those who had experienced curtailment. This suggests that the experience of curtailment did not affect the degree of comfort that participants felt with Esprit.

4.1.6.2. Satisfaction with Electric Vehicles

Although *Comfort with Esprit* does not appear to be related to the degree to which participants experienced curtailment, *Comfort with Esprit* was related to both *Experience of* and *Attitude towards EVs*, which were used as measures of satisfaction with EVs in this study. Participants with more positive *Experience of* and *Attitude towards EVs* were more likely to be comfortable with Esprit’s control of charging, whether or not they had experienced curtailment during the course of the trial. This suggests that the concept and reality of curtailment are more acceptable to drivers with a more positive view of EVs and that the acceptability of the technology is related more to positive feelings about EVs than to the actual experience of controlled charging.

4.1.6.3. Charging Patterns

Comfort with Esprit was not related to *Attitude towards Charging*, except for a negative association with *Ease of Finding a Place to Charge Away from Home* at the end of the trial. This might suggest that participants who were less confident of finding an alternative to charging at home were less comfortable with the prospect of curtailment.

Comfort with Esprit was also not associated with the place participants charged most often. There was, however, a positive correlation between *Comfort with Esprit* and a lower acceptable battery charge level at the end of the trial. Participants who were more comfortable with Esprit were also more comfortable with a *Lower Level of Charge* on their battery.

4.1.6.4. Travel patterns

Comfort with Esprit was not related to the distribution of *Journey Types*, but it was positively related to the proportion of *Journey Lengths* between 11 and 30 miles at the end of the trial. It was also positively related to the frequency of *Longer Unplanned Trips* at the end of the trial.

4.2. Knowledge of the Electricity Network and of Low Carbon Technologies

In addition to considering the acceptability of Esprit, this research explored whether the My Electric Avenue trial increased participants’ awareness and understanding of the electricity network and of low carbon technology. It also considered whether the trial encouraged the uptake of low carbon technology.

4.2.1. Awareness and Understanding of the Electricity Network

Actual involvement in the trial did not significantly increase participants’ *Awareness* or *Understanding of the Electricity Network*, but pre-trial involvement with My Electric Avenue increased both *Awareness* and *Understanding* for both the Technical and Social Trial participants, as reflected in their responses to questions at the start of the trial. This may be the result of information provided as part of the recruitment process.

4.2.2. Awareness and Understanding of Low Carbon Technologies

Responses to questions at the start of the trial also suggest that pre-trial involvement with My Electric Avenue increased participants' *Awareness* and *Understanding of Low Carbon Technologies*. This increase continued over the course of the trial with significant increases in *Awareness* and in *Understanding of Low Carbon Technologies* for participants in both the Technical and Social Trials.

For participants in both trials, the element of the trial identified as most important in increasing both *Awareness* and *Understanding* was the actual experience of using the EV and charging points. The second most important element was project communications during the course of the trial. For the Technical Trial, the recruitment process was also important in increasing *Awareness* and *Understanding*, as was contact with the project team. These findings suggest that the opportunity to use low carbon technologies was the most effective way to increase understanding of them.

4.2.3. Encouraging the Uptake of Low Carbon Technology

Results from both face to face and questionnaire responses indicated that some participants had installed renewables or taken steps to improve energy efficiency in their homes as a result of being involved in the project. Approximately six percent of participants installed photovoltaics over the course of the trial.

Several participants mentioned in interviews or focus groups that they had purchased, or were intending to purchase, or lease an EV at the end of the project. However, the findings from the questionnaires suggest that, overall, there was a decrease in the intention to buy or lease an EV.

This apparent discrepancy is related to fewer participants being unsure about their intention to buy or lease an EV after the trial. There are increases in those who *strongly agreed* that they intended to buy or lease an EV after the trial and those that *strongly disagreed*. In other words, the trial appears to have helped participants make up their mind about whether they would, or would not, purchase or lease an EV.

5. Conclusions

The aim of the research presented in this report was to provide an assessment of the acceptability of Esprit technology to participants in the My Electric Avenue trial, as required in SDRC 9.6, and to address the related learnings T1.1.1, T1.1.2, and T1.1.3. This section presents the conclusions from the research undertaken by De Montfort University to meet that aim.

5.1. SDRC 9.6 - An assessment of the public acceptance (or otherwise) to Demand Side Response of EVs using this sort of technology

The majority of the participants in the My Electric Avenue trial were *Comfortable* or *Very Comfortable* with the idea of living with Esprit Technology for as long as they had an EV. There were no data that suggested that curtailment of charging by Esprit affected participants' satisfaction with EVs. There was some evidence that acceptance of the technology was related to participants' experience of EVs, their attitude towards EVs, and their attitudes towards charging and battery charge levels. There were no data suggesting that Esprit's control of charging affected satisfaction with EVs or had a significant effect on the use of EVs. However, the sample size of participants who actually experienced curtailment was small and further research, with a larger sample size, over a longer period of curtailment, would be desirable. It is also important to note that the My Electric Avenue participants were not representative of the UK population as a whole.

5.2. T.1.1.1 - How does a trial encourage the uptake of low carbon technology?

During the course of the trial, approximately six percent of the participants decided to install photovoltaics and, where data were available, that decision was at least partly related to participation in the trial. Participants reported a greater awareness of, and interest in, low carbon technology as a result of participating in the trial, and a number of participants had purchased or leased an EV, or were intending to do so, by the end of the trial.

5.3. T.1.1.2 - What social factors have an impact on the use of the Technology?

A variety of social factors were considered that might have had an impact on the use of the Technology, including:

- Socio-demographic and household characteristics
- Motivation for joining the trial
- Satisfaction with EVs
- Charging patterns
- Travel patterns

None of these social factors appeared to be systematically related to use or acceptance of Esprit, except overall attitude towards EVs, as measured by:

- Satisfaction with EVs
- Comfort with lower battery charge levels

5.4. T.1.1.3 - How can a trial be used to educate customers about the electricity network and low carbon technologies?

Participants became more aware of the electricity network and increased their understanding of it through pre-trial involvement with the project. Participants also became more aware of low carbon technologies and increased their understanding of them throughout the trial. This increase was primarily attributed to the actual experience of using an EV and charging points. However, project communications during the course of the trial, contact with the project team and the cluster champion, and the recruitment process all also played an important role. Participants also reported that their use of an EV helped to educate people in the wider community as the EV provoked conversations with family, friends and beyond.

5.5. SDRC 9.7.1 Question C - Evidence of whether this solution would be feasible or not combining learning from 9.5, 9.6.

The learning from SDRC 9.6 suggests that, from the point of view of public acceptance of the technology for participants who charge primarily at home, Esprit would be an acceptable solution for control of charging to protect the local electricity network. However, for participants who charge at the workplace this is less clear due to the difficulties experienced with the Workplace chargers, which led to termination rather than interruption of charging in many cases.

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Appendix I Questionnaire questions with rationale for inclusion and related study objective

Questions which have been modified from the pre-trial questionnaire are in blue.

Questions which are new in the second questionnaire are in red.

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
1	1	1	Cover note for questionnaire	
-	-	2	Consent statement to ensure informed consent prior to data collection <i>Not repeated in second questionnaire as consent has already been obtained</i>	
2	2	3	Determine whether the respondent is the main driver. Allows changes in main driver over time to be identified. Any change in main driver may affect results <i>Repeated from pre-trial questionnaire to explore whether the main driver has changed. A change in main driver is likely to affect travel patterns and it is important to know if there has been such a change when exploring how travel patterns change over time as a measure of satisfaction with EVs.</i>	
3	3	4	Determine whether there will be other drivers using the electric vehicle regularly which would affect the data coming from the vehicle <i>Repeated from pre-trial questionnaire to explore whether there has been a change in other drivers using the EV.</i>	
4	-	-	Determine whether participants are using the CARWINGS system. Participants who use CARWINGS may experience less range anxiety due to a wide range of CARWINGS functions which might impact the acceptability of EVs. <i>New question not in pre-trial questionnaire.</i>	

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
-	4	5	Determine motivation for joining trial <i>Not repeated in second questionnaire as motivation for joining trial can only occur before or at the point of joining the trial</i>	
-	5 and 6	6 and 7	Previous experience with EVs <i>Not repeated in second questionnaire as previous experience of EVs will not have changed.</i>	
-	-	8	Determine whether the participant used a conventional vehicle pre-trial. <i>Not repeated in second questionnaire as pre-trial use of a conventional vehicle will not have changed.</i>	
-	7	9	Details about primary conventional vehicle prior to trial <i>Not repeated in second questionnaire as the details of the primary vehicle used before the trial will not change</i>	
5	8	10	Information about numbers of conventional vehicle owned Changes in number of conventional vehicles owned during the course of the trial may reflect the uptake of low carbon technology if EVs replace conventional vehicles. <i>Repeated from pre-trial questionnaire to assess changes in number of conventional vehicles owned, and with links to other questions, assess whether this could be due to acceptance, or rejection of EV (and therefore Esprit).</i>	9.6 T.1.1.1
6 to 15	9 to 18	11 To 20	Information about electric vehicle use Acceptability of Esprit may be based on how the EV is used. The type of journeys they typically take (unexpected/planned), how far they go (mileage) and the type of roads they usually drive on (speeds) will all shape how they react to the EV, and in particular, Esprit if their charging is limited. Changes in how the participant uses the EV during the trial may reflect uptake of low carbon technology if the participant changes their travel patterns and behaviour as a result of using an EV.	T.1.1.2 9.6 T.1.1.1

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
<i>Modified and repeated from pre-trial questionnaires to monitor driving patterns.</i>				
16 and 17	19	21	<p>Information about charging patterns for electric vehicles</p> <p>In addition to driving behaviour and travel patterns, acceptability of EVs, and by proxy Esprit, may also be influenced by how participants view different levels of charge.</p> <p>It is possible that participants who usually maintain a high level of charge will perceive a greater impact from Esprit should it limit their charging. This may have an impact on acceptability of Esprit.</p> <p><i>Modified and repeated from pre-trial questionnaire to monitor if charging patterns are similar to fuelling patterns and if they change over time.</i></p>	T.1.1.2 9.6
18	20	22	<p>Expectation/experiences of the impact of using an electric vehicle</p> <p>Participants' experiences of using an EV (awareness of its limitations for example) compared to their expectations may influence to what degree they accept EV use. If they are disappointed by EV use they may reject the technology as Esprit may in effect create a further limitation on their use of their EV.</p> <p>Therefore expectation/experiences of using an EV are a factor which may be related to acceptability of EVs and which may have an impact on acceptability of Esprit.</p> <p>These questions have been altered slightly from the pre-trial questionnaire to ask about their experience of each of the statements provided. Therefore pre-trial asks about their expectations of how the 'EV will suit their daily EV travel needs', during the trial it asks, 'how much to they agree, that the EV is matching their daily expectations'.</p> <p>Measuring any difference in answers to this question over the trial may indicate how a trial can educate customers about low carbon technologies. Expectations may become more or less positive, but changes in expectation may reflect experience with, and education about, electric vehicles as well as acceptance of Esprit.</p>	T.1.1.2 9.6 T.1.1.3

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
<i>Modified from pre-trial questionnaire from expectation to experience of using an EV.</i>				
19	21	23	<p>Intention to buy or lease an electric vehicle after the trial</p> <p>Intention to buy may be linked to attitudes and expectations of using EVs. It is possible that those who have had a negative experience of an EV also have negative attitudes/expectations and are unlikely to continue to lease or purchase an EV.</p> <p>Like expectation, and attitude, intention to buy or lease an EV after the trial is a factor which may be related to the acceptability of EVs, and therefore (by proxy) to the acceptability of Esprit.</p> <p>Differences between pre-trial and during trial responses may relate to how a trial can encourage uptake of low carbon technology – there may be greater or lesser willingness to buy/lease after experience with electric vehicle as well as acceptance of Esprit.</p> <p><i>Repeated from pre-trial questionnaire to monitor changes in intention to buy which might be related to the acceptability of EVs.</i></p>	<p>T.1.1.2</p> <p>9.6</p> <p>T.1.1.1</p>
20	22	24	<p>Attitude towards electric vehicles</p> <p>How far Esprit is accepted, via the EV, may also be influenced by the participants' general attitude towards EVs.</p> <p>Monitoring their attitudes over the course of the trial will allow the research team to monitor any changes in attitude, which could then be related to the impact of Esprit. This could then be used to draw conclusions with regards to how a trial such as this can educate customers about low carbon technologies (particularly their impact on daily life).</p> <p>Similarly, the difference between pre-trial and during trial responses may relate to how a trial can encourage the uptake of low carbon technologies. An increase in positive attitude towards electric vehicles may encourage adoption of EV technology as well as acceptance of Esprit.</p> <p><i>Repeated from pre-trial questionnaire, to monitor changes in attitudes towards EVs over the trial</i></p>	<p>T.1.1.2</p> <p>9.6</p> <p>T.1.1.3</p> <p>T.1.1.1</p>

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
21	23	25	<p>Attitude towards charge levels</p> <p>Attitude towards charge levels is a social factor which may be related to acceptability of EVs and which may have an impact on acceptability of Esprit. Previous studies have indicated that attitude towards charging may be related to acceptability of EVs. However attitude towards charging has been subsumed in the concept of range anxiety. In exploring the acceptability of Esprit it is important to explore whether attitude towards charging is distinct from range anxiety.</p> <p>Difference between pre-trial and during trial responses may relate to how a trial can educate customers about low carbon technologies</p> <p>Difference between pre-trial and during trial responses may relate to how a trial can encourage the uptake of low carbon technologies. A change in attitude towards charge level may encourage adoption of EV technology as well as acceptance of Esprit</p> <p><i>Modified from pre-trial questionnaires to use bars as shown on the LEAF display instead of percentages which were used in the initial questionnaire as participants would not be familiar with the bars.</i></p>	<p>T.1.1.2</p> <p>9.6</p> <p>T.1.1.3</p> <p>T.1.1.1</p>
22	24	26	<p>Place of charging</p> <p>Place of charging is a factor which may be related to acceptability of EVs and which may have an impact on acceptability of Esprit. For example, charging may be more difficult in a car park or on a shared drive, and this may impact on responses given.</p> <p><i>Repeated from pre-trial questionnaire to explore if charging place changes</i></p>	<p>T.1.1.2</p> <p>9.6</p>
23 to 25	-		<p>Place and type of charging</p> <p>Place and type of charging may affect acceptability of EVs and therefore have an impact on the acceptability of Esprit. For example people who charge their cars away from home may experience less impact from Esprit.</p>	<p>9.6</p> <p>T.1.1.2</p>

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
			<p>Changes in place and type of charging may relate to changes in acceptability of EVs and have an impact on the acceptability of Esprit.</p> <p><i>New questions not in pre-trial questionnaire</i></p>	
26			<p>Determine whether participants pre-heat or pre-cool their electric vehicle using mains electricity. Pre-heating or pre-cooling an EV with mains electricity extends range and may affect the acceptability of EVs.</p> <p><i>New question not in pre-trial questionnaire.</i></p>	
27	25	27	<p>Attitude towards charging opportunities</p> <p>Attitude towards charging opportunities is a social factor which may be related to acceptability of EVs and may have an impact on acceptability of technology.</p> <p>Difference between pre-trial and during trial responses may relate to how a trial can educate customers about low carbon technologies</p> <p>Difference between pre-trial and during trial responses may relate to how a trial can encourage the uptake of low carbon technologies. A change in attitude towards charging opportunities may encourage adoption of EV technology as well as acceptance of Esprit.</p> <p><i>Modified and repeated from pre-trial questionnaire to reflect experience rather than expectation.</i></p>	<p>T.1.1.2</p> <p>9.6</p> <p>T.1.1.3</p> <p>T.1.1.1</p>
28 and 29	-	-	<p>Information about possible Esprit intervention and effect on charging</p> <p>Assessing whether the EV has ever not charged as expected</p> <p>Determining whether participants ever did not use their EV due to charge state</p> <p>Monitors experience of Esprit through the course of the Technical Trial</p> <p>Differences between responses in the Technical and Social Trials may indicate that participants have noticed the intervention of Esprit in their charging. No difference might suggest that Esprit intervention is not noticeable to participants</p>	9.6

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
<i>New questions not in pre-trial questionnaire</i>				
30 to 32 to 28	26	28 to 30	<p>Information about household electricity use</p> <p>These questions will be used to inform University of Manchester modelling of the network loads</p> <p>These questions will be used to assess whether the household has experience with controlled charging (storage heating) which may affect the acceptability of Esprit.</p> <p><i>Repeated from pre-trial questionnaire, to monitor if there is any change in the household's use of electricity which may affect modelling of the network loads.</i></p>	T.1.1.2 9.6
33 to 36 to 31	29	31 to 34	<p>Information about household electricity generation</p> <p>To inform University of Manchester modelling of the network loads.</p> <p><i>Repeated from pre-trial questionnaire to measure change (if any) which may affect modelling of the network loads?</i></p>	
37 and 38 and 33	32	35 and 36	<p>Electricity Tariffs</p> <p>Similarly to experience in controlled energy usage, experience with regards to time of use tariffs may impact or at least influence participants' views of Esprit. This will be measured during the trial to allow the research team to draw conclusions on attitudes towards energy use, in particular timing of energy use. It would be particularly interesting to note if those who do not use time of use tariffs at the pre-trial, do so later on, as this may indicate some impact of the trial on their attitudes and behaviour in energy management. This may also relate back to their attitudes towards charging and charging behaviour.</p> <p><i>Repeated from pre-trial questionnaire to monitor change (if any) in the use of time of use tariffs.</i></p>	T.1.1.2 9.6
39	34	37	<p>Experience of time-shifting electricity use</p> <p>Experience with time-shifting of electricity use may have an impact on the acceptability of Esprit.</p>	T.1.1.2 9.6

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
			<p>These questions will be used to assess whether the household has experience with time-shifting which may affect the acceptability of Esprit, as Esprit works on the same principles. For example, it may be likely that those with experience of controlled energy usage are perhaps more accepting of this philosophy when charging their EV. It would also be very interesting to see if those who do not currently use time-shifting (pre-trial), perhaps start to do this during the trial. This would allow us to draw conclusions about whether a trial like this could teach customers about low carbon technology, and encourage uptake of new technology (or even smarter energy usage).</p> <p>This would also allow for matching between Social and Technical Trial participants.</p> <p><i>Repeated from pre-trial questionnaire to monitor change (if any) in the household's use of time-shifting of electricity use</i></p>	T.1.1.3 T.1.1.1
40	-	-	<p>Scheduling of EV charging. Participants who schedule their EV charging to take advantage of time of use tariffs or for other reasons may have different experiences of Esprit control.</p> <p><i>New question not in pre-trial questionnaire</i></p>	
41 to 48	35 to 42	38 to 45	<p>Socio-demographic and household information</p> <p>These are social factors which have been related to acceptability of EVs in previous studies and may have an impact on the acceptability of Esprit.</p> <p>A change in these factors may explain an otherwise unexplained change in behaviour recorded by the car, or the survey responses.</p> <p><i>Repeated from pre-trial-questionnaire to monitor change (if any). Changes in socio-demographics may affect travel patterns and acceptability of EVs.</i></p>	T.1.1.2 9.6
49	43	46	<p>Increases in awareness and understanding of the electricity network and low carbon technologies.</p> <p>This question will capture the level of understanding and awareness of low carbon technologies (in a rudimentary form).</p>	T.1.1.3

Second question-naire	Initial Pre-trial question-naire	Final pre-trial question-naire	Rationale for asking question	Study Objective
			<p>Measuring this over time will allow the research team to assess the impact of the trial on participants' awareness and understanding, which may provide insight into how a trial like this can 'teach' customers about low carbon technologies.</p> <p><i>Repeated from pre-trial questionnaire to assess change over time which may be related to learning during the trial.</i></p>	

Appendix II Timelines for data collection for all clusters

Table 6-1 Timeline for data collection for all clusters

		Questionnaires					Face to Face		
2013		T1 Pre-trial	T2 Second	T3 Third	T4 Fourth	T5 – Fifth	Interviews	Focus Groups	
			Before EV delivery	>6 weeks after EV delivery	Approx. 6 weeks after curtailment	Approx. 3 months after curtailment	Final		
2014	Dec	All clusters							
	Jan								
	Feb								
	Mar								
	Apr								
	May							Wylam (no curtailment)	
	Jun								
	Jul			Except Lyndhurst					
	Aug								
	Sep							Chineham (no curtailment)	
	Oct		Lyndhurst						
	Nov								
Dec									

		Questionnaires					Face to Face	
2015	Jan						Chiswick	
	Feb			Chineham Chiswick Marlow Whiteley			Whiteley Marlow	
	Mar			Lyndhurst South Gosforth South Shields 1 South Shields 2 Wylam Your Homes			South Gosforth	Your Homes
	Apr				Chineham Chiswick Marlow Whiteley		South Shields 1 South Shields 2	South Shields 1 South Shields 2
	May				Lyndhurst South Gosforth South Shields 1 South Shields 2 Wylam Your Homes		Lyndhurst	
	Jun					All Clusters		

Table 6-2 Dates of interviews and focus groups by cluster with number of participants involved and total number of participants in the cluster at that date

	Number interviewed	Number in Focus Group	Number in Cluster	Date
Wylam	7 plus additional driver	-	10	May 2014
Chineham	8	-	10	September 2014
Chiswick	5 plus additional driver	-	8	January 2015
Whiteley	8	-	10	February 2015
Marlow	6		9	February 2015
Your Homes	-	11	12	
South Gosforth	6		9	March 2015
South Shields 1	2	7	11	April 2015
South Shields 2	-	5	12	April 2015
Lyndhurst	5	-	7	May 2015

Appendix III Data Tables for Expectation/Experience, Attitude, and Attitude to Charging

Table 6-3 Median scores for Expectation/Experience of EVs for Technical and Social Trial participants

	Time 1	Time2	Time 3	Time 4	Time 5
Non-curtailed Median	3.2500	3.2500	3.2500	3.2500	3.2500
Curtailed Median	3.2500	3.6875	3.2500	3.3125	3.2500
Workplace Median	3.6250	3.5000	3.1250	3.1250	3.2500
Social Trial Median	3.2500	-	3.2500	-	3.2500

Table 6-4 Median scores for Attitude towards EVs for Technical and Social Trial Participants

	Time 1	Time2	Time 3	Time 4	Time 5
Non-curtailed Median	3.8571	4.1429	4.0000	4.0000	4.0000
Curtailed Median	3.7143	3.9286	4.0000	4.0714	3.9286
Workplace Median	4.0714	4.0000	4.2143	4.0000	4.1429
Social Trial Median	3.8571	-	4.0000	-	4.0000

Table 6-5 Means and Standard Deviations for Ease of charging away from home

	Time 1	Time2	Time 3	Time 4	Time 5
Non-curtailed	2.84 (.947)	2.66 (.930)	2.42 (.946)	2.42 (.894)	2.28 (.904)
Curtailed	3.09(1.083)	2.73(1.120)	2.59(1.098)	2.85(1.040)	2.90(1.021)
Workplace	3.36(.745)	2.92(1.256)	2.58(1.165)	2.45(1.368)	2.45(1.440)
Social Trial	2.91(.970)	-	2.47(.935)	-	2.68(1.179)

Table 6-6 Means and Standard Deviations for Ease of charging at home

	Time 1	Time2	Time 3	Time 4	Time 5
Non-curtailed	4.60(.524)	4.69(.499)	4.65(.644)	4.68(.539)	4.73(.482)
Curtailed	4.70(.470)	4.86(.640)	4.59(.796)	4.70(.470)	4.65(.489)
Workplace	4.21(1.051)	4.38(.506)	4.50(.905)	4.82(.405)	4.64(.505)
Social Trial	4.33(.663)	-	4.40(.685)	-	4.46(.792)

Table 6-7 Means and Standard Deviations for Ease of using public charging points

	Time 1	Time2	Time 3	Time 4	Time 5
Non-curtailed	3.45(.764)	3.21(.862)	3.20(.932)	3.07(.962)	3.08(.926)
Curtailed	3.43(.945)	3.18(1.097)	3.27(.935)	3.60(.754)	3.30(.923)
Workplace	3.71(.611)	3.77(.725)	3.50(1.382)	3.73(.905)	3.27(1.191)
Social Trial	3.36(.765)	-	3.23(1.005)	-	3.40(1.055)

Table 6-8 Means and Standard Deviations for EV will charge sufficiently in the time available to charge

	Time 1	Time2	Time 3	Time 4	Time 5
Non-curtailed	3.52(.704)	3.43(1.104)	3.42(.962)	3.47(.858)	3.50(1.050)
Curtailed	3.61(.499)	3.73(1.032)	3.55(1.184)	3.90(.912)	3.75(1.020)
Workplace	3.57(.756)	4.08(.494)	3.33(1.073)	3.33(.809)	3.27(.905)
Social Trial	3.71(.726)	-	3.58(.869)	-	3.73(.798)