WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Customer Research and Trial Update Report
Electric Nation

Report Title	:	Customer Research and Trial Update report
Report Status	:	Final
Project Ref	:	WPD NIA 013 Electric Nation
Date	:	09.11.18

Document Control

	Name	Date
Prepared by:	Karen Platt, Esther Dudek	29.10.2018
Reviewed by:	Nick Storer	30.10.18
Approved (WPD):	Ricky Duke	09.11.18

Revision History

Date	Issue	Status
29.10.2018	0.1	Draft for EA Technology review
31.10.2018	0.2	Draft for external review
09.11.2018	0.3	Final

Contents

Glossary

Abbreviation	Term
BEV	Battery Electric Vehicle
EV	Electric Vehicle
E7	Economy 7
HV	High Voltage
NIA	Network Innovation Allowance
PIV	Plug-In Vehicle
PHEV	Plug-In Hybrid Electric Vehicle
REX	Range Extender Vehicle

1 Introduction

This report provides an update on the customer-facing aspects of Electric Nation ("the Project") – both the customer research questionnaires and trials of smart charging. As detailed below, the project aims to show the technical feasibility and benefits of smart charging and customer acceptance of the concept.

The Project has now completed its recruitment and installation stage. It has installed 673 domestic smart charging units at properties across the Midlands, South West and South Wales. This report will provide an interim analysis of customer research into the acceptability of the second trial to participants in the Greenflux cohort of the trial. Previous milestone reports have contained analysis of the Recruitment survey, Baseline survey and Trial 1 survey. These can be found at:
https://www.westernpower.co.uk/innovation/projects/electric-nation

The report authors would like to thank Impact Utilities, who are providing customer research expertise to the Electric Nation project, for their input and insight into Sections 2 and 3 of this report and for providing graphics included in these sections.

Trial participants were surveyed again after they had experienced at least four weeks of demand management in Trial 2. This report contains preliminary findings of their attitudes, and their charging habits.

This report also provides an update on the progress of the customer trial, focusing on the final movement of customers into routine management, the level of interaction between participants and the smart charging systems in Trial 2, and progress with Trial 3.

1.1 The Electric Nation Project

Electric Nation is a Western Power Distribution and Network Innovation Allowance funded project. WPD's collaboration partners in the project are EA Technology, DriveElectric, Lucy Electric GridKey and TRL.

Electric Nation, the world's largest domestic smart charging electric vehicle (EV) trial, is revolutionising domestic plug-in vehicle charging. By engaging 500-700 plug-in vehicle drivers in trials, the project is answering the challenge that when local electricity networks have 40% - 70% of households with electric vehicles, at least 32% of these networks across Britain will require intervention.

The project is developing and delivering a number of smart charging solutions to support plug-in vehicle uptake on local electricity networks. A key outcome will be a tool that analyses plug-in vehicle related stress issues on networks and identifies the best economic solution. This 'sliding scale' of interventions will range from doing nothing to smart demand control, from taking energy from vehicles and putting it back into the grid, to traditional reinforcement of the local electricity network where there is no viable smart solution.

The development of the project deliverables is being informed by a large-scale trial involving plug-in vehicle drivers that will:

- Expand current understanding of the demand impact of charging at home, on electricity distribution networks, of a diverse range of plug-in electric vehicles - with charge rates of up to 7kW, and a range of battery sizes from 6kWh to 100kWh (All-Electric Ranges from 10 miles to 250+).
- Build a better understanding of how vehicle usage affects charging behaviour.
- Evaluate the reliability and acceptability to EV owners of smart charging systems and the influence these have on charging behaviour. This will help to answer such questions as:
    - Would charging restrictions be acceptable to customers?
    - Can customer preference be incorporated into the system?
    - Is some form of incentive required?
    - Is such a system 'fair'?
    - Can such a system work?

The results of this project will be of interest and will be communicated to the GB energy/utility community, to UK government, to the automotive and plug-in vehicle infrastructure industry and to the general public.

To be eligible to participate in the project Electric Nation participants are required to already have an EV, or to be about to take ownership of an EV. They must live in the WPD licence area (the Midlands, South West and South Wales). In return for taking part in the project the participants receive a smart charger. Trial participants are recruited via a recruitment campaign that has utilised social media, internet presence, traditional PR, attendance at EV events and creating links with EV retailers.

1.2 Purpose and Structure of Report

This report provides an update on the progress of the trial aspects of Electric Nation, both the smart charging roll-out and customer research.

- Section 1: an introduction to the document and its purpose.
- Section 2: the customer research approach, the surveys which customers will complete, and data collected by the trial to date.
- Section 3: final analysis of the Trial 2 survey, including insight into the results from the survey of customers who have received the Greenflux 'High Priority' app.
- Section 4: provides an update on progress with moving all participants into demand management, and the results of demand management at a group level to date for both CrowdCharge and GreenFlux.
- Section 5: describes the second algorithm for both CrowdCharge and GreenFlux, and the level of interaction between participants and the smart charging systems under this part of the trial.
- Section 6: describes the changes being made for algorithm 3, including the testing completed to date and progress with rolling this change out to participants.

- Section 7: sets out the next steps for the trial including both the customer research and smart charging systems (moving CrowdCharge participants from Trial 2 to Trial 3 and decommissioning smart charging at the end of the trial).

2 Customer Research and Data Collection

2.1 Customer Research

Customer research is one of the many data sources being gathered by the Electric Nation trial (others include vehicle telematics data, charge point data, data from apps or demand control preference systems and participant enquiries). This research is being undertaken by Impact Utilities. These sources of information will be used to provide an answer to the overall customer objective of the trial:

> To prove which, if any 'Managed EV Charging to Support Local Electricity Networks' regime applied to trial participants is most likely to be satisfactory to all customers.

A condition of taking part in the Electric Nation trial[1] is that participants complete a number of surveys to enable the Project to understand participants' attitudes toward charging their EVs and their level of acceptance of varying degrees of managed charging. As the trial progresses and the level of managed charging/systems changes, the customer research will map any changes in the participants' attitudes towards charging their vehicles and managed charging.

Participants contact details were collected by DriveElectric, the project partner responsible for participant recruitment and associated data protection[2], as part of the enrolment process. DriveElectric clearly explained to trial participants before they enrolled in the Electric Nation trial that they would have to complete customer research surveys. The graphic overleaf demonstrates the exchange of participant data between DriveElectric and Impact Utilities.

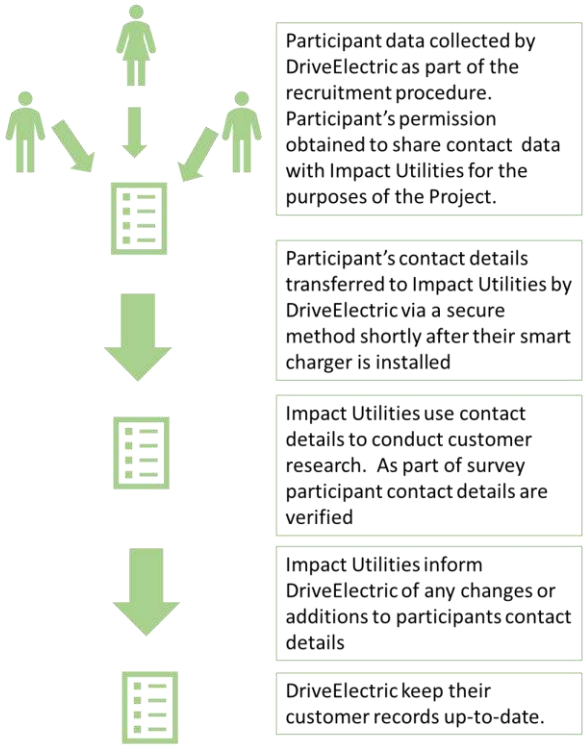
After the installation of a participant's smart charger they were asked to complete the Recruitment survey (see Appendix 1). This survey concentrated on collecting demographic and socio-economic data, information about the participants, their household, their plug-in vehicle (PIV) and their level of satisfaction with their smart charger installation experience. Between 4 and 6 weeks after having their charger installed or after receiving their EV (whichever is later) participants were asked to complete a Baseline survey (Appendix 2) to obtain data on their charging behaviour, their satisfaction with this and their attitude towards having their charging managed. After May 2018 a large enough sample size (i.e. more than 100) of the Baseline survey was collected, to be statistically comparable, so participants were moved into demand management as soon as stable communications had been proven with their charge point.

[1] This condition is highlighted in project publicity literature, such as the Project website and brochure (which can be accessed via the Project website http://www.electricnation.org.uk

[2] The Projects Data Protection Strategy can be found at: http://www.electricnation.org.uk/wp-content/uploads/2016/11/NIA_WPD_013-CarConnect-Data-Protection-Strategy-FINAL.pdf -this is in the process of being updated to be compliant with GDPR.

Further surveys are conducted towards the end of each managed charging cycle, and then a final survey will be conducted at the end of the trial. The content of these trial surveys is very similar to the Baseline survey in Appendix 2 to allow direct comparison. Surveys enquiring about the participants' experience of using an app ask some questions directly relevant to that app so that feedback can be gathered, for example, about how easy the app was to use.

Figure 1: Exchange of participant data between DriveElectric and Impact Utilities



2.2 Surveys investigating attitudes to managed charging trials

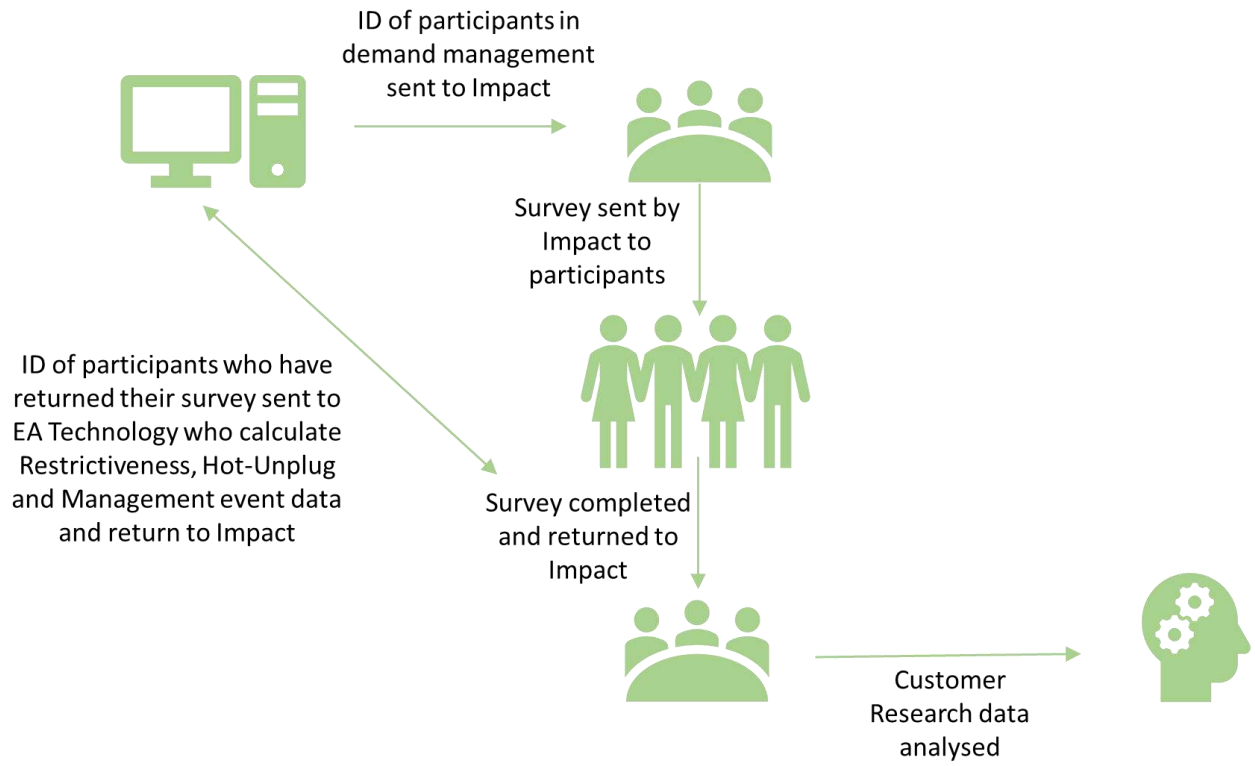
This report will provide interim analysis of the customer survey results from the Greenflux cohort of trial participants who received an app as part of Trial 2. The features of this app are described in Section 5. Not all project participants have been part of this demand management trial to date because of technical issues with their smart charger (mainly communications not working or configuration issues which cannot be resolved remotely – in most cases this does not prevent the customer charging but would prevent demand management)[3]. Further details about this are provided in Section 4.

An important aspect of the Electric Nation trial is to monitor how participants' attitudes to demand management are altered by their experiences of demand management in the

[3] These technical challenges have implications for future potential roll-out of smart charging. The experience gained in this trial is potentially valuable for future research, product development and future roll-out of smart charging. Findings of this type will be summarised and incorporated into the project's final reports.

project. Therefore, it is important that the survey results are analysed in the context of the individual participant's experience of demand management. The flow of information and precise data that Impact Utilities will require to judge the impact of demand management on participants has been considered by the project team. This data and information flow is illustrated in the diagram below:

Figure 2: Data flow for trial 1 survey



Impact Utilities are informed by EA Technology of the ID of participants who have been invited to download the Greenflux app. After the participant had access to the app for at least four weeks they would be issued the Trial 2 survey (for comparison against the first baseline survey it contains many identical questions however at the end it also has questions specific to the app). Impact Utilities issue these survey links to the relevant participants and encourage them to complete the survey, either online or by telephone according to the participant's choice. Impact Utilities will then inform EA Technology when a participant has completed their survey, so data can be generated about the impact of demand management on the participant. Impact Utilities will then use this data to inform their analysis of the survey responses that they receive. A full analysis of this data will be undertaken at the end of the trial.

2.3 Data Collection

Recruitment for the Electric Nation trial and installations of smart chargers into participant's homes started in January 2017. The installations were completed in July 2018.

Trial Survey 2 investigates participant attitudes to the second managed-charging trial. This report only contains analysis of the results from the Greenflux cohort. The second

CrowdCharge algorithm was launched later and requires six weeks to elapse between the date at which the participant was invited to sign-up to the app and the survey being issued. At the time of writing survey responses are still being received from CrowdCharge participants and these will be included in future reports. Some initial detail on the level of engagement with the CrowdCharge app is given in Section 5.1.

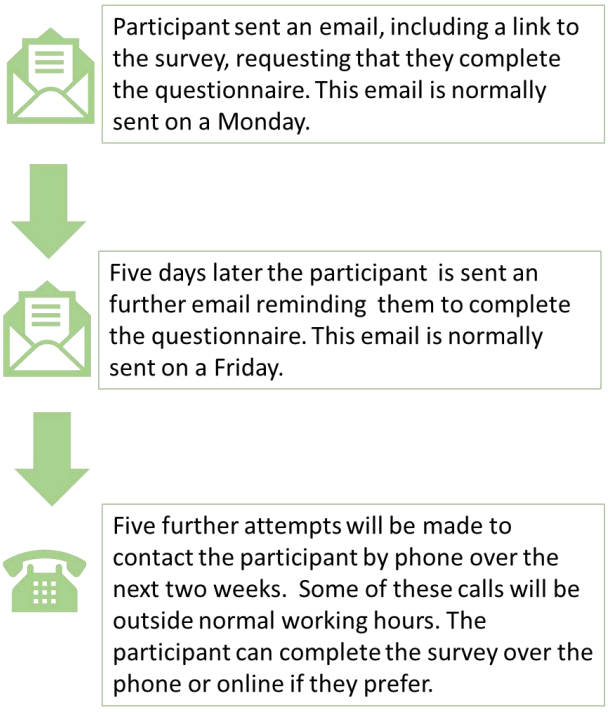
The GreenFlux Trial Survey 2 has involved 250 trial participants who have had access to the Greenflux 'High Priority' app for at least 4 weeks. Response rates are summarised below.

	Surveys Sent	Surveys completed
%	100%	89%
n	250	221

Table 1: Trial 2 surveys completed

It should be noted that surveys do not highlight the charging algorithm, or provide too much information about being managed, which is to avoid biasing the results as we are testing consumer behaviour and acceptance (which includes what changes are noticed/unnoticed by EV owners)

Figure 3: Procedure used to encourage participants to complete questionnaires



For all trial surveys, the participant is sent a link to the questionnaire by email (Appendix 4 and 5). If they fail to complete the survey within an allotted period, then the link will be re-sent with a further email reminding them to complete the questionnaire. If the participant still does not complete the survey, then the survey company will attempt to contact the participant by telephone. The participant will be telephoned several times over the following weeks.

Participants will receive a £10 voucher for an online store (Amazon) for completing each of the optional trial surveys. Completion of the Recruitment survey and the Baseline survey are a condition of trial participation and therefore not rewarded.

3 Acceptability of the second demand management trial - Greenflux

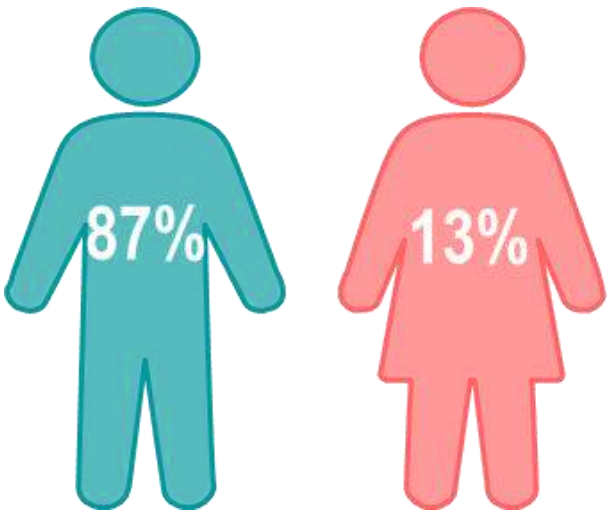
Trial participants in the Greenflux cohort were sent invitations to download the 'High Priority' app in April and May 2018. The trial is fully explained in Section 5. Two hundred and fifty participants were provided with an app developed by Greenflux that gave participants the option to request 'High Priority' for a chosen charging session. After a participant had been able to access the app for around four weeks they were issued a survey by Impact Utilities. This survey is nearly identical to the Baseline survey issued to participants when they had completed 90 days of unconstrained charging although it also contains a number of questions specific to the app. These questions can be found in Appendix 3.

This section provides an insight into the interim survey results at the time of writing. This data does not distinguish between the "charge at will" and "straight into demand management" groups at this time - A full analysis, including distinguishing differences between these two groups and levels of statistical confidence of the survey results, will be provided later.

3.1 Greenflux Cohort characteristics

The Greenflux cohort is similar in participant characteristics to the overall Electric Nation trial.

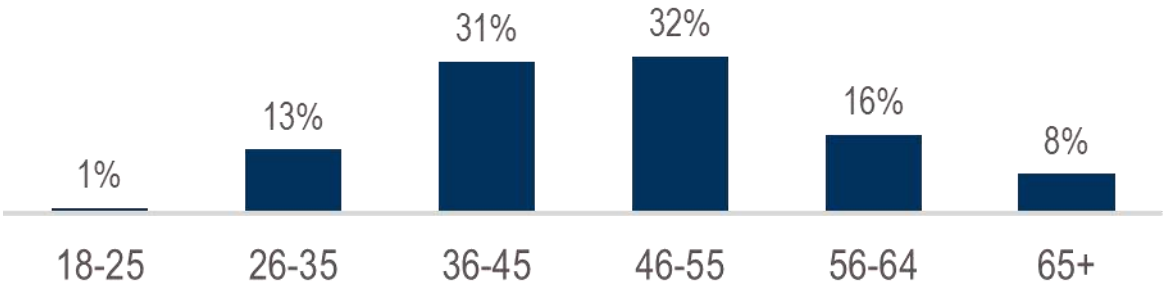
Figure 4: What is your gender? (Base - Greenflux - 322)



The Electric Nation trial group has 12% women and 88% men.

Participants were asked their age.

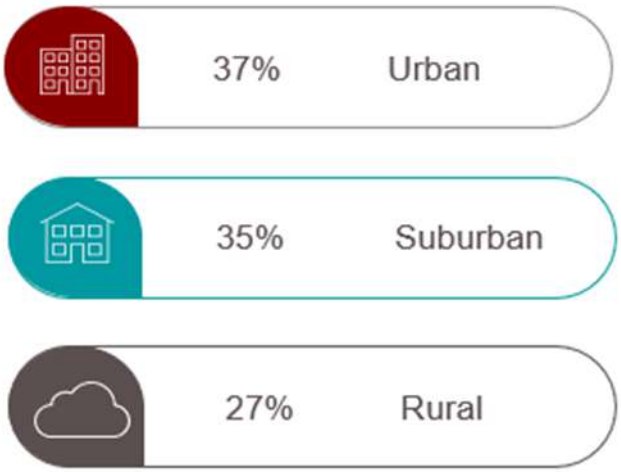
Figure 5: How old are you? (Base - Greenflux - 322)



Again, this is very similar to the characteristics of the project trial group.

The participants are spread across urban, rural and suburban areas

Figure 6: Do you live in an urban, suburban or rural area? (Base - Greenflux - 322)

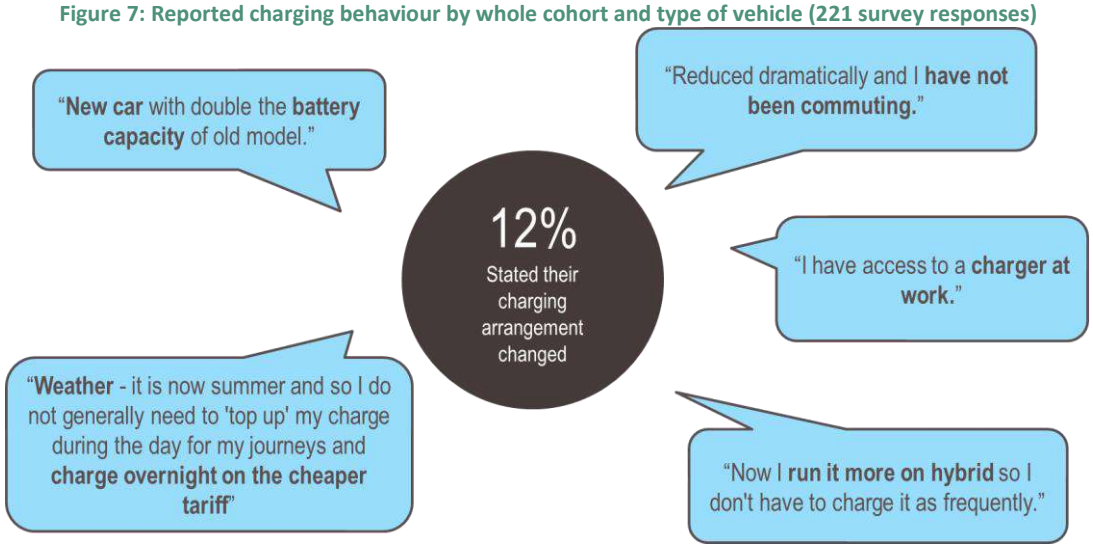


Again, this is similar to the characteristics of the overall trial cohort.

3.2 Reported change in charging behaviour

Participants were asked about their charging behaviour. They reported that their charging behaviour has not changed substantially since trial 1 (only 12% have reported that they have changed their behaviour). Those who have changed their behaviour state that the change in their behaviour is not due to the app or the smart charging.

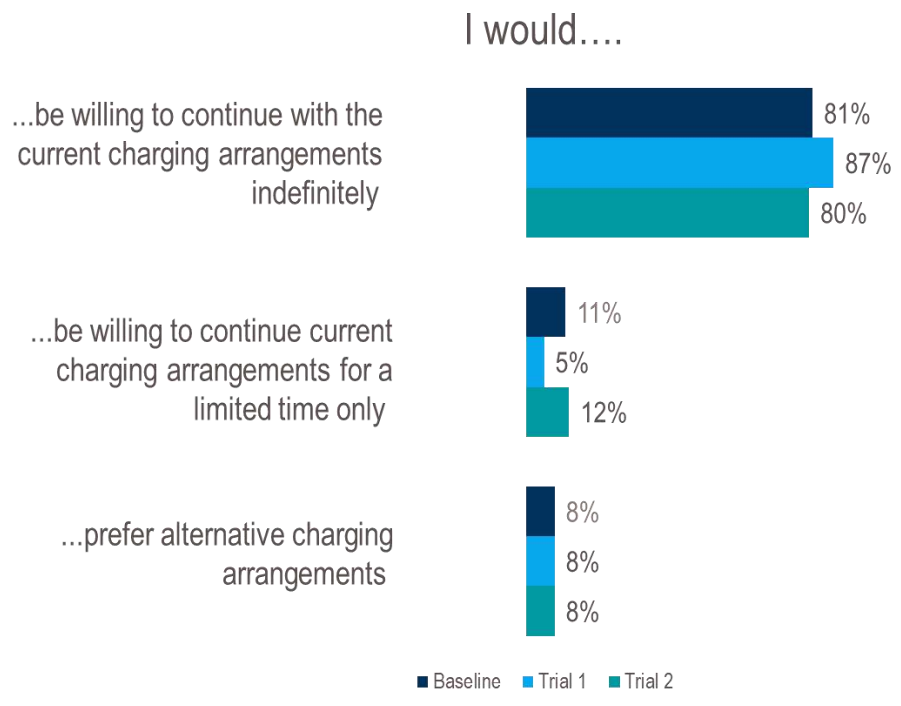
Figure 7: Reported charging behaviour by whole cohort and type of vehicle (221 survey responses)



Most participants (75%) find the current charging arrangements acceptable – compared to 76% acceptability in the baseline survey and 77% in Trial 1. The proportion of participants who find charging arrangements satisfactory is higher - 83% - among those who drive an EV with a 10 – 25 kWh battery.

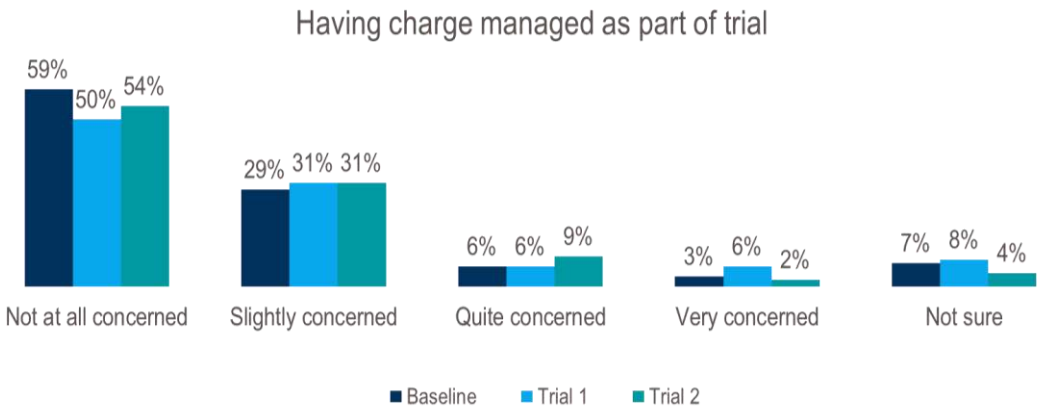
Most participants are still willing to continue with their current charging arrangements indefinitely.

Figure 8: Which statement best describes your attitude to changing your charging behaviour… Base: GreenFlux Baseline (290) Trial 1 (144) Trial 2 (221)



Participants with larger batteries (>35 kWh) where more likely to be less willing to continue with the arrangements. 21% of this group would only be willing to continue with the current charging arrangements for a limited time.

Figure 9:How do you feel about having your charging arrangements managed as part of the trial? Base: GreenFlux Baseline (290) Trial 1 (144) Trial 2 (221)



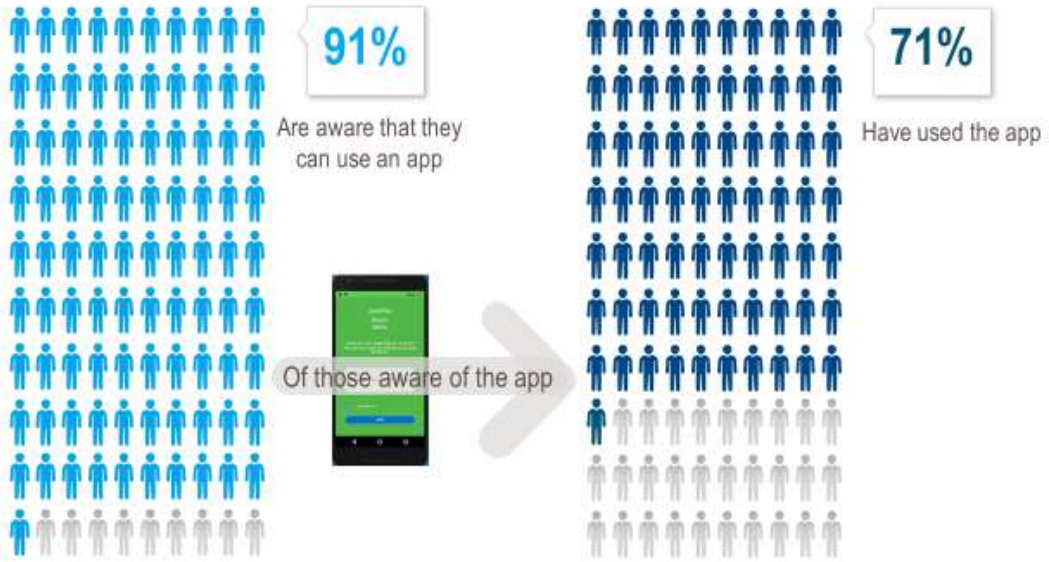
Trial participants still have few concerns about having their charge managed as part of the trial. 85% of participants have no or only slight concerns. Trial participants with a battery greater than 35 kWh are more worried about having their charge managed as 53% expressed concern.

3.3 Participant attitudes to the app

Greenflux trial participants who responded to the survey were asked about the app that they were given access to.

Trial participants were asked if they were aware that they could access an app.

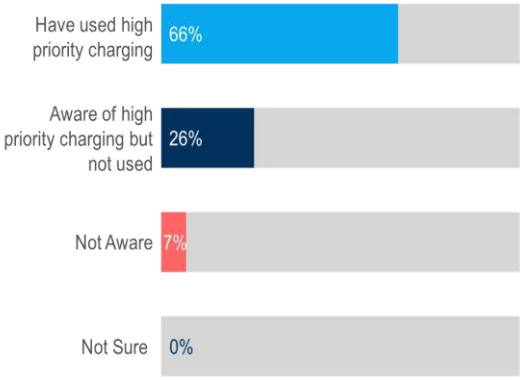
Figure 10: Are you aware that you can access an app to interact with your smart charging system? Base:221, Have you used the app? Base:201



Most Greenflux trial participants who responded to the survey were aware of the app and had used it.

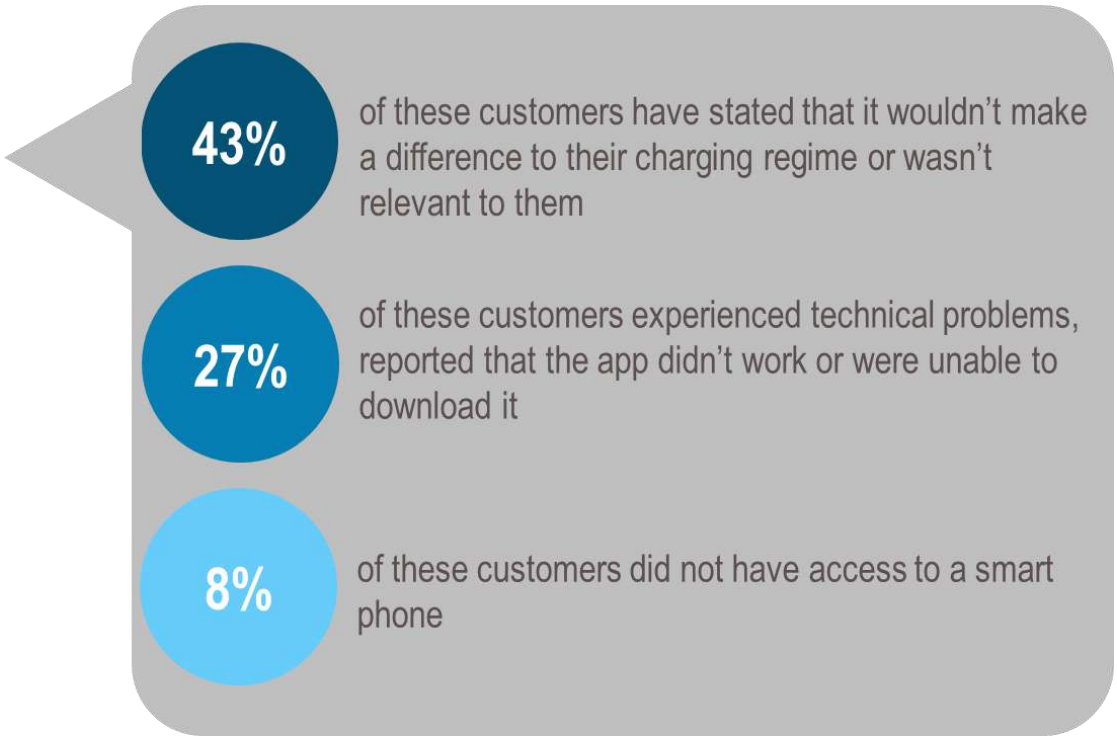
Participants who had stated that they were aware of the app were asked if they knew that they could request high priority charging by using the app.

Figure 11: Are you aware that you can use the app to request high priority charging? Base: 201



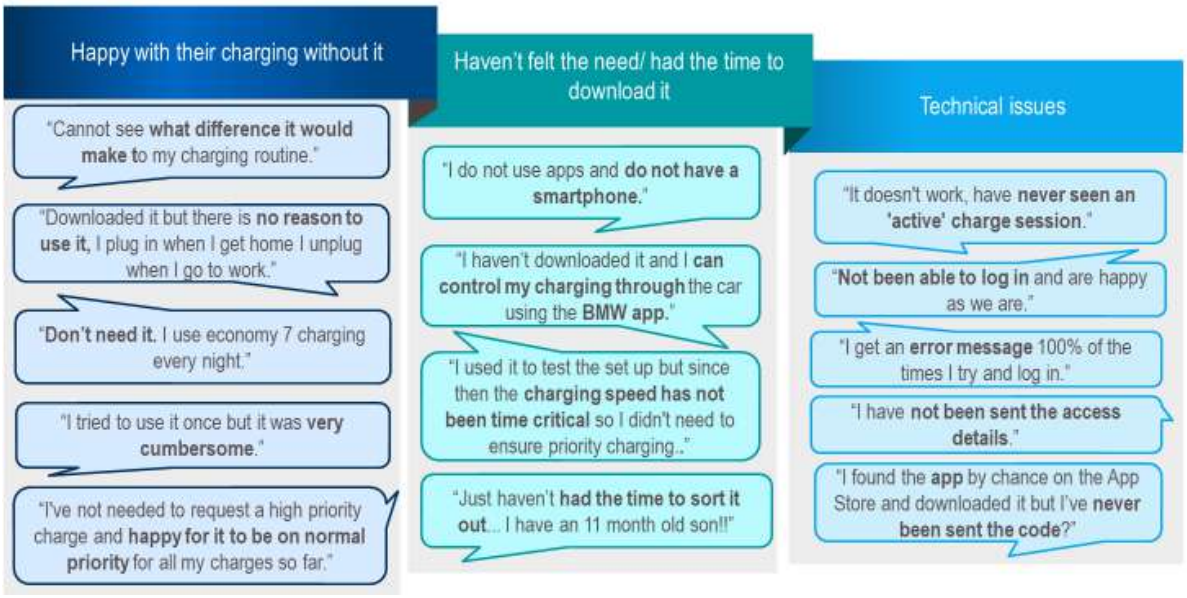
Participants who hadn't used the app were asked why they hadn't. Their responses have been categorised.

Figure 12: Why have you not used the app? (Free text response categorized) (60 responses)



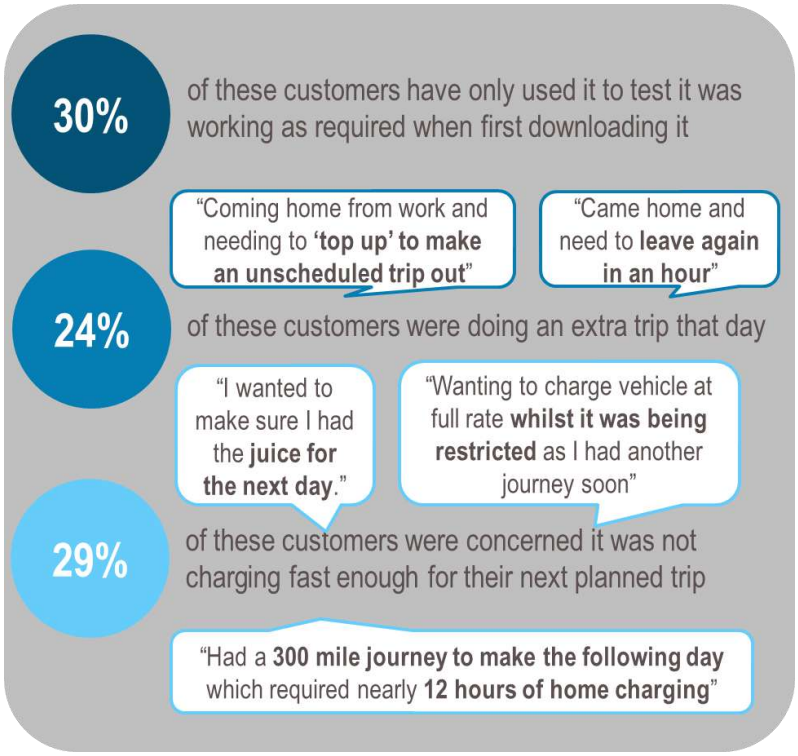
Some of the free text responses provided by respondents who were aware of the app are provide below to add context:

Figure 13: Reasons why Electric Nation participants didn't use the app



Participants who were aware of the app and had used it to request 'High Priority' were asked why they had chosen to use it.

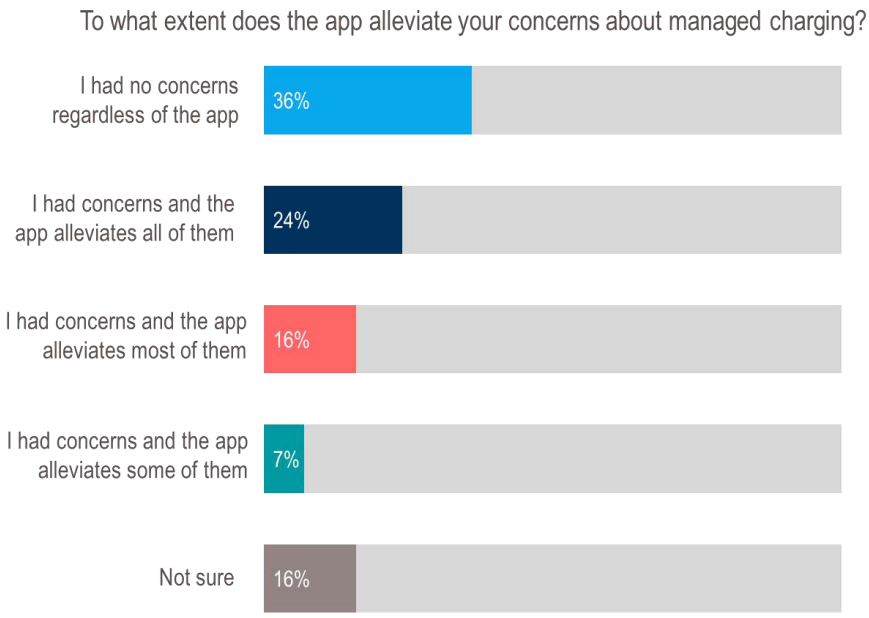
Figure 14: What were your reasons for requesting high priority charging? Base: 132



30% of trial participants only used the app to test that it was working. Other participants used it to ensure they had sufficient charge if they weren't going to have long before they needed to use their EV again that day or if they were planning a long journey the next day and wanted to be sure that the battery was fully charged.

Trial participants who were aware of the app were asked to what extent the app helped to alleviate any concerns that they had about managed charging.

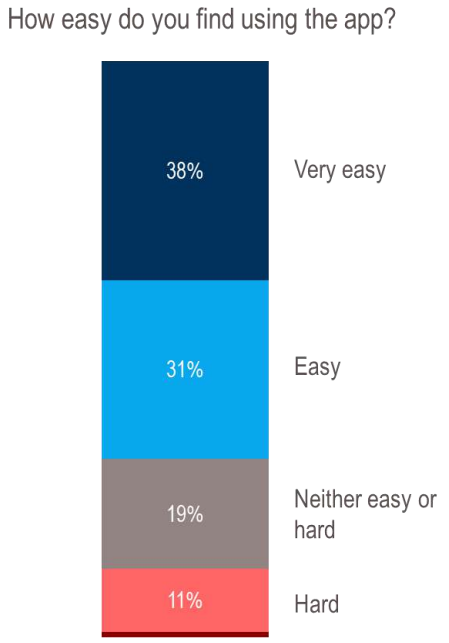
Figure 15:To what extent does the app alleviate your concerns about managed charging? Base: 202



Over a third of participants did not have any concerns about managed charging. 24% stated that the app helped to alleviate all concerns that they may have had about managed charging.

Among trial participants with an EV that has a battery greater than 35 kWh, 36% stated that the app had alleviated all of their concern – a higher proportion than the general trial population.

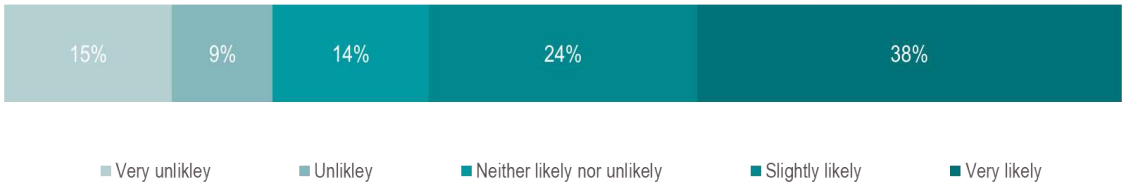
Figure 16: How easy do you find using the app? Base: 143



Overall, most trial participants thought that the app was easy to use.

Survey respondents were then asked if they would continue to use the app.

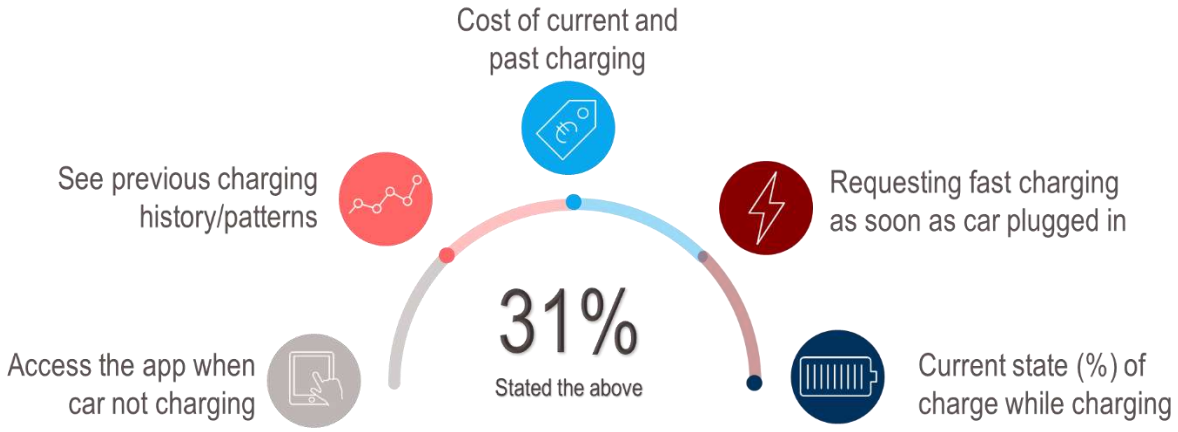
Figure 17: How likely are you to use the app going forward? Base: 221



61% of Greenflux participants stated that they were likely (bases on 'Very likely' and 'Likely' responses) to continue using the app and around two fifths stated that they were very likely to continue to use it.

Participants were asked to identify other functions that they would like from their app. 55% of Greenflux participants who responded to the survey didn't expect to see any other functions on their app. The chart below shows the most common suggested features:

Figure 18: Are there any other features that you expected to see on the app? (Base 221)



3.4 Conclusion

Satisfaction with current charging arrangements among the Greenflux trial participants has remained steady across Trial 2, and the project lifetime. Acceptability of the charging arrangements has also remained high and is consistent with the baseline and Trial 1 results.

The majority of cohort participants were aware of the app and 71% have used it. Of those who did not engage with the app, many were not concerned about having their charging managed and did not feel the need to intervene by using the app.

Two thirds of participants have requested priority charging. However, 30% of these only requested this to test the function. Other participants requested priority charging to ensure that they had sufficient charge for unexpected trips or to plan for long journeys because they had concerns about the potential impact of restrictions on 'normal' charging.

Open comment responses from trial participants suggest that they would like an app to give them more information on their journey history and greater interaction between their EV and their charger in the future.

4 Trial Design and Update on Demand Management Roll-Out

4.1 Introduction

A core part of the Electric Nation project is a large trial of smart charging (demand management). This part of the trial began in July 2017 and has been gradually expanded until early October 2018, with the aim of encompassing all trial participants where reliable communications could be established. The aim of this trial is to evaluate the reliability and acceptability to EV owners of a smart charging system and the influence this has on charging behaviour.

This section describes the trial design in more detail, including the final details of participants who have been moved into demand management.

4.2 Electric Nation Cohorts – GreenFlux and CrowdCharge

Two demand management providers are being used within Electric Nation, GreenFlux[4] and CrowdCharge[5]. Trial participants were allocated to each group during the recruitment process. Each company uses different algorithms to allocate current to individual chargers. Sections 5 and 6 of this report contain details of the next algorithms, and the testing completed on these. The amount of data they have available (e.g. car state of charge) and the way the participant interacts with their system differs between the two providers in later stages of the trial, and in some cases between participant groups for the same provider (e.g. telematics data for CrowdCharge).

The two cohorts were managed during the recruitment phase to ensure a consistent mix of vehicle type and battery sizes. The current balance of the two cohorts is shown in Figure 19 and Figure 20, based on information provided by DriveElectric on installed chargers on 8th October 2018.

[4] https://www.greenflux.nl/en/
[5] http://crowd-charge.com/

Figure 19: Composition of Cohorts (Plug-in Vehicle Type)

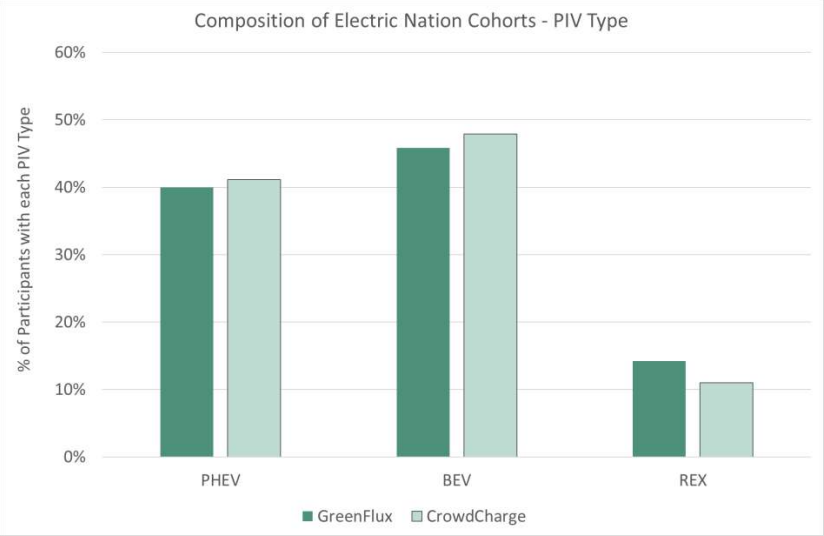
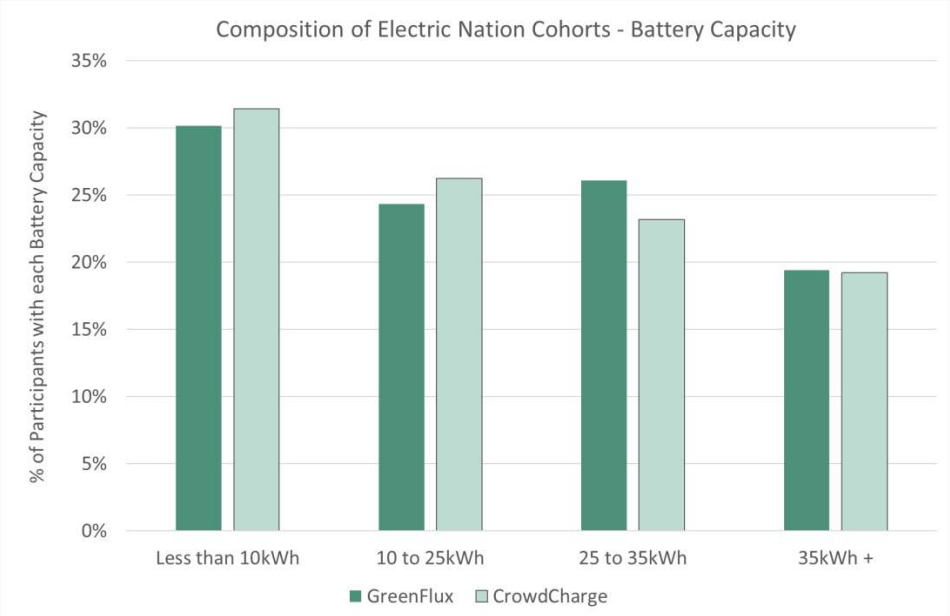


Figure 20: Composition of Cohorts (Battery Capacity)



These indicate that the two groups are well balanced. The Electric Nation cohort can be compared to recent UK sales, and this is shown below for plug-in vehicle types:

Year	PHEV Registrations		BEV Registrations		Total
2016	74%	*(28,798)*	26%	*(10,246)*	39,044
2017	72%	*(34,660)*	28%	*(13,678)*	48,338
2018 (to end August)	76%	*(29,088)*	24%	*(9,038)*	38,126
Total	74%	*(92,546)*	26%	*(32,962)*	125,508

Table 2: PIV Type - UK Sales in 2016 - 2018[6]

[6] Data from: http://www.eafo.eu/content/united-kingdom Accessed 09/10/2018

This does not contain a separate category for range extended vehicles, but as these have an alternative (non-battery) means of propulsion they can be included as plug-in hybrid electric vehicles for the purposes of comparison with UK data. The Electric Nation group is made up of 53% plug-in hybrid vehicles and range extenders, and 47% full battery vehicles (compared to 73%/27% for 2016 to 18 UK sales).

The same data source can be used to compare the composition of battery sizes in Electric Nation to recent UK sales, based on the composition derived in the July 2018 report (see this report for details of method and assumptions used).

Using these assumptions, the breakdown for total sales in 2016, 2017 and 2018 can be compared to Electric Nation in the table below.

Battery Capacity Category	Approximate % of UK Sales (2016 – May 2018)	% of Electric Nation Trial Participants
Less than 10kWh	34%	31%
10 to 25kWh	35%	25%
25 to 35kWh	18%	25%
35kWh+	13%	19%

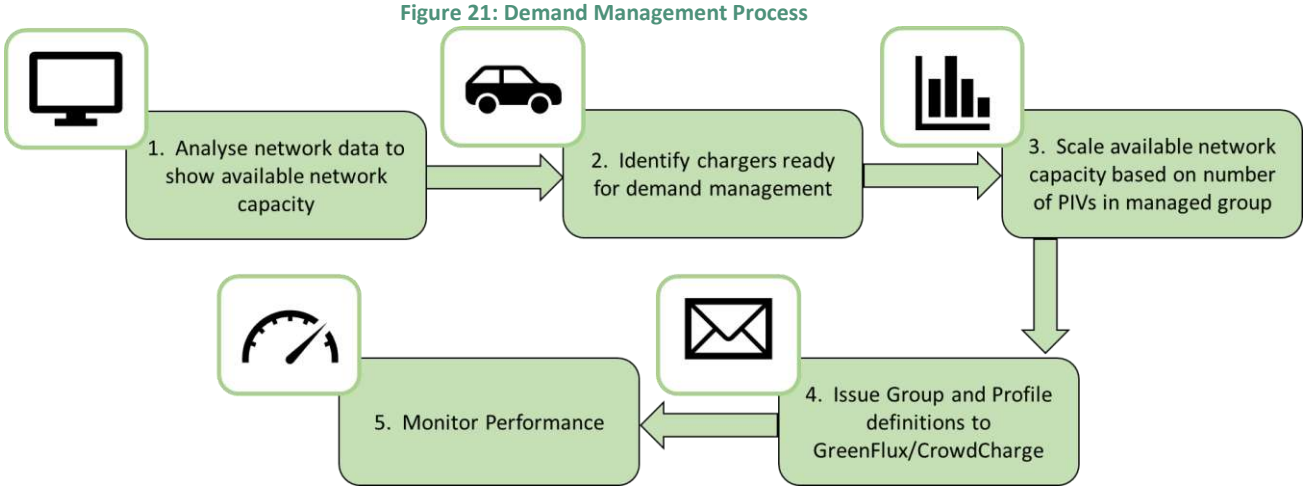
Table 3: Comparison of Battery Capacity Composition - UK Sales and Electric Nation

This shows that the Electric Nation cohort is made up of a greater proportion of vehicles with larger batteries (as well as full battery vehicles as shown above) than recent UK sales. *However, this is likely to be representative of the future scenarios as the cost of larger batteries decrease.*

4.3 Demand Management Process Update

From July 2017 until early October 2018, participants were moved into demand management through a series of group expansions, following the process illustrated below.

Figure 21: Demand Management Process



Further details of each of these stages were given in the October 2017 trial update report[7]. This text is reproduced in Appendix 5 of this report, with the bullets below summarising developments in the period between the end of July 2018 and the time of writing.

- **Analysis of network data to show available network capacity:** Participants have continued to be managed under the combined spring/winter profile through the summer and early autumn. This profile was deployed to ensure some curtailment of charging continued. This would still be realistic for some networks in a scenario where 30% of vehicles are a plug-in variety (i.e. those with less spare capacity than the specific East Midlands example chosen), or on the specific network used but with higher PIV ownership levels. This also ensures that the project can continue to test the acceptability of smart charging solutions. A winter profile will be introduced in early November. The resulting amounts of management are shown in Section 0.
- **Identify chargers ready for demand management:** the process set out in the October 2017 version of the report has continued to be followed. A further 48 participants are now in routine management. Further details of this are provided in Section 4.4 below. No further expansions will take place in the remainder of the project.
- **Scale available network capacity based on number of PIVs in the managed group:** a scaling factor continues to be applied to account for communications reliability in the managed group. This is adjusted each time the group is expanded based on current performance.
- **Issue group and profile definitions to GreenFlux/CrowdCharge:** no change to the process.
- **Monitor Performance:** The level to which demand management has occurred, and the impact of this on participants is under review and this is discussed in more detail in Section 0.

4.4 Progress with the roll-out of Demand Management to Participants

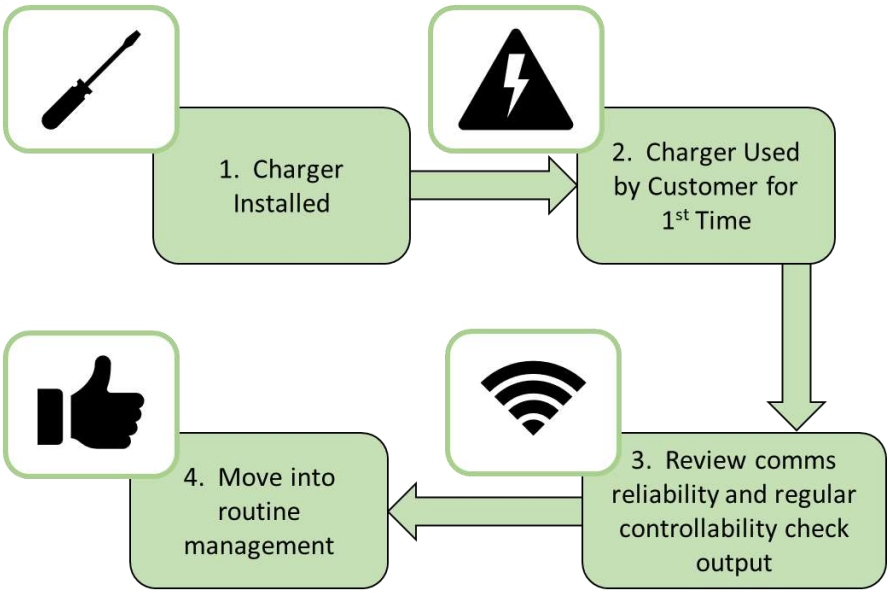
For participants to enter routine management they must pass several tests. At any of these stages it is possible for an issue to occur which could delay a charger entering management. This section outlines the detailed process by which chargers pass through these stages for both GreenFlux and CrowdCharge and the progress made to date with moving participants into routine management.

4.4.1 CrowdCharge

The diagram below shows the stages by which CrowdCharge participants enter demand management:

Figure 22: CrowdCharge Process for Entry into Demand Management

[7] https://www.westernpower.co.uk/docs/Innovation/Current-projects/CarConnect/Electric-Nation-Customer-Research-and-Trial-Update.aspx Accessed 05/01/2018



The number of chargers at each stage is shown in the following table. This represents the final values for the trial, as no further customers will now be moved into demand management.

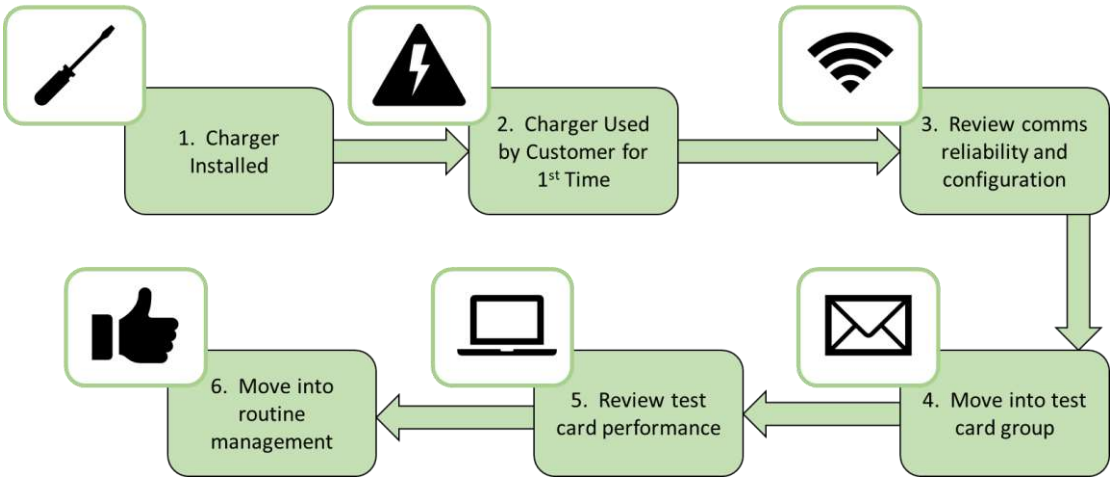
Stage	Number Passed Stage	Notes
1. Charger installed	332 (based on information supplied on 17th September)	
2. Charger used by participant for 1st time	292 of 332 (at final review on 26th Sept.)	A transaction record was not available for the remaining 40 chargers. There are a variety of potential possible causes for this: • Communications reliability – if chargers were not communicating with all parts of the back office then no transaction records would be available. • Charger not yet in use – e.g. car not yet delivered. This is unlikely as the final CrowdCharge installation took place on 30th July 2018.
3. Review communications reliability and controllability	263 of 292 'used' chargers	29 chargers had been used but could not be transferred into routine management: • 10 were only communicating with part of the CrowdCharge system or had configuration problems with one part of the system. This prevented a controllability check taking place. • 16 either had no communication to any part of the CrowdCharge system, or the reliability of this was poor. • 3 were communicating with all parts of the back-office system but hadn't been used for a significant period of time.
4. Move into routine management	263 of 332 installed chargers (= 79%)	263 chargers have moved into routine management between July 2017 and the beginning of October 2018.

Table 4: Roll-Out of Demand Management to CrowdCharge Participants

4.4.2 GreenFlux

The diagram below shows the stages by which GreenFlux participants enter demand management.

Figure 23: GreenFlux Process for Entry into Demand Management



The number of chargers at each stage is shown in the following table.

Stage	Number Passed Stage	Notes
1. Charger installed	344 (based on information provided 10th September)	
2. Charger used by participant for 1st time	337 of 344	Of the 7 chargers without a transaction record, only two were online, suggesting that the main cause of the lack of transaction records is communications.
3. Review communications reliability and configuration	315 passed (of 337 which have been used)	315 chargers passed a review of their communications performance and configuration. Of the remaining 22 chargers (i.e. those that have been used but did not reach the test card phase): • 14 did not pass a check of their communications performance. • 7 had a variety of configuration problems which were not resolved by early October 2018 (in some cases because of poor communications) • 1 participant has left the project
4. Move into test card	315 into test card	315 chargers entered the test card phase since early July 2017.

Stage	Number Passed Stage	Notes
5. Review test card performance	296 passed of 315 reviewed	The causes for failure at the test card phase were: • Charger offline (7 of 19): this prevented meter values being sent to the online portal, therefore the test card performance could not be evaluated. • Delayed meter values from charger (3 of 19): delayed meter values indicate a communication problem whereby chargers can send information out but may not receive charging profiles from the back office. This leads to problems with smart charging and so these participants were not transferred into routine management. • Lack of transactions in test card phase (3 of 19): successful transactions were required to pass this phase. These transactions must occur when communications are working. • Failure at test card phase due to BMW issue (2 of 19) • Unusual behaviour in test card phase (2 of 19): these issues could not be resolved before early October 2018 and these participants will therefore not move into routine management. • Prior use of a timer (1 of 19): earlier in the trial the GreenFlux algorithm required an adaptation to allow maximum current to be allocated to vehicles which have used a timer. Whilst this algorithm was in development some participants were removed from smart charging. The majority of these consented to return to the test card phase and have passed through to routine management. One customer remained and will not move to routine management. • Dropped out of the trial (1 of 19): this participant no longer owns an EV.
6. Move into routine management	296 of 344 installed chargers (= 86%)	296 chargers were moved into routine management between July 2017 and October 2018. To date, 22 participants have either left the project or been removed from the smart charging group for various reasons: • 11 due to an issue with vehicles which enter a hibernation state when paused, but do not restart when current is made available again. This group is dominated by participants with BMW 330es. This was investigated on the Electric Nation test rig. A combination of settings was found which resolved all the issue in all the tests carried out. However, when deployed on vehicles in the field it was not successful in all transactions, so these participants have been removed from the trial. • 7 where unreliable communications have resulted in chargers being repeatedly 'stuck' at 13A and this is insufficient for the customer. • 4 participants have left the project for various reasons.

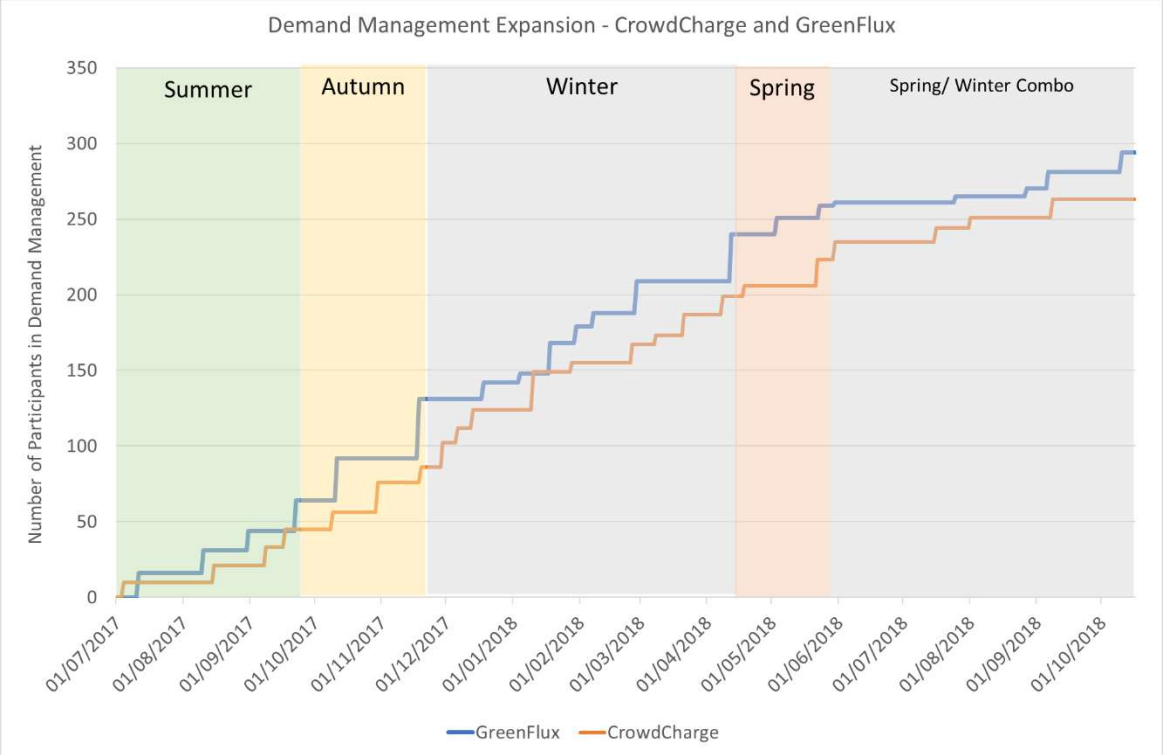
Table 5: Roll-Out of Demand Management to GreenFlux Participants

As summarised in the table above the main reason which prevented customers from entering routine demand management was a lack of reliable communications. A total of 29 of the 48 (60%) installed chargers which did not enter management were due to communications issues.

4.5 Results of Demand Management to Date

The first 'routinely managed' groups were established in July, and these have been expanded multiple times over the course of the project. These group expansions are shown by the steps on the graph below.

Figure 24: Demand Management Expansion over Time - with Seasons



Progress with moving participants into routine management has slowed in recent months, as can be seen from the extended periods at each level, and much smaller step changes. This is due to the rate of installations decreasing in early summer 2018. Chargers which were installed earlier in the project but are not in smart charging have long standing problems (typically relating to either communications or configuration as detailed above), and so could not be moved into demand management.

As described above (see Section 4.3) a combined spring/winter profile was applied from mid-May onwards which ensures some management is still required, as shown in the sections below. Participants will be moved back onto a winter profile in early November, until smart charging is disabled before the end of the year.

4.5.1 Occurrence of Demand Management at a Group Level

The level of demand management which occurs is a function of the demand limit profile and the charging diversity of the managed group. As increasing numbers of participants in the group plug-in at the same time then it becomes more likely that demand management will occur. Management (curtailment of available current from chargers) also becomes increasingly likely as the seasons change through the year, as the 'spare' network capacity

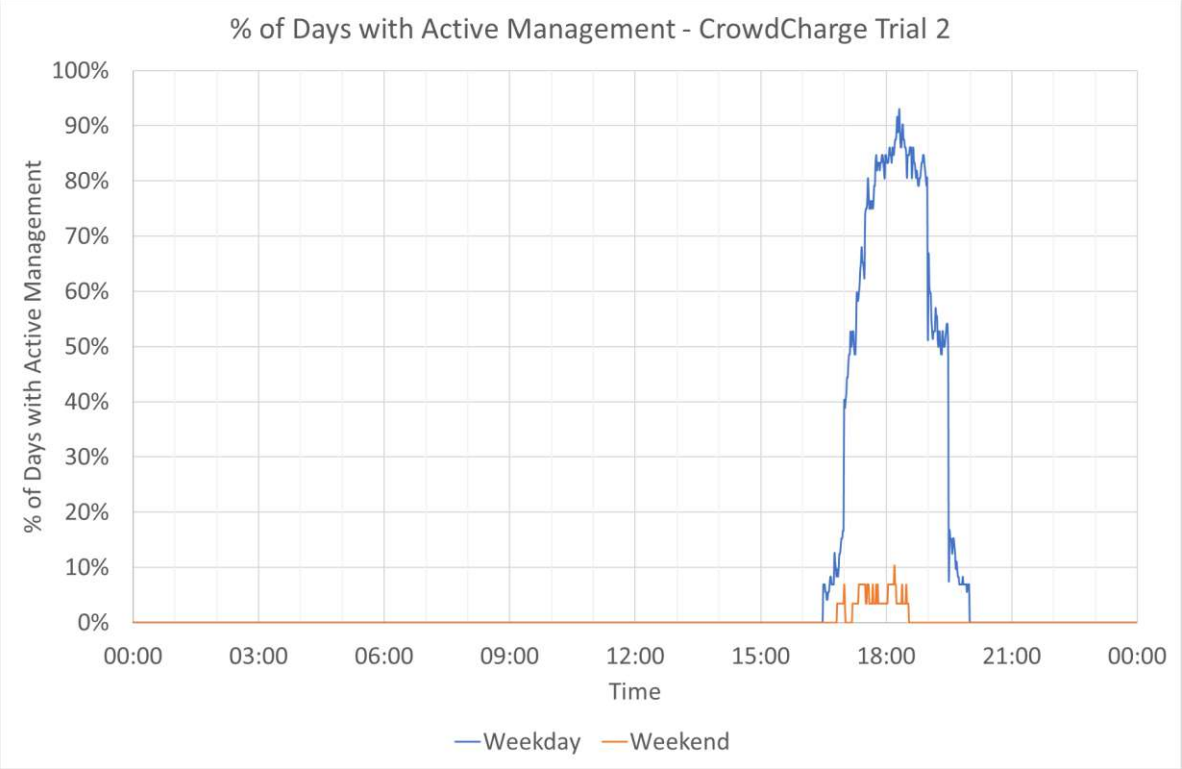
available for EV charging decreases due to increases in other loads. The current allocated to a group of chargers can be compared to the limit which applies to the group to show whether management (curtailment) was active **at a group level.** This quarterly update report considers group level management only. Further details of the management of individual chargers and how this relates to participant satisfaction will be provided later.

4.5.2 CrowdCharge Group Level Management

CrowdCharge begins to curtail the current available from active chargers when there is insufficient capacity available to allocate all active stations at 32A. For example, if the group limit is 300A then no management occurs with nine active chargers, but curtailment will apply once a 10th charger becomes active. During Trial 1 (analysed in previous reports) the current allocated to all chargers during a management event was the same, in this example 30A would be allocated to all active chargers. Trial 2 used information entered in the journey planner to prioritise the current allocated to each charger. For example, a higher current allocation would be given to a vehicle which had another journey planned for the same evening compared to one that was not being used until the following morning.

The level of management at a group level has been calculated by comparing the total current allocated to the capacity limit – management is active when the two values are similar. The duration of trial 2 (16th July to 28th October) has been analysed and the resulting frequency of management at weekdays and weekends is shown below. The combined 'spring/winter' profile was used for the duration of the trial.

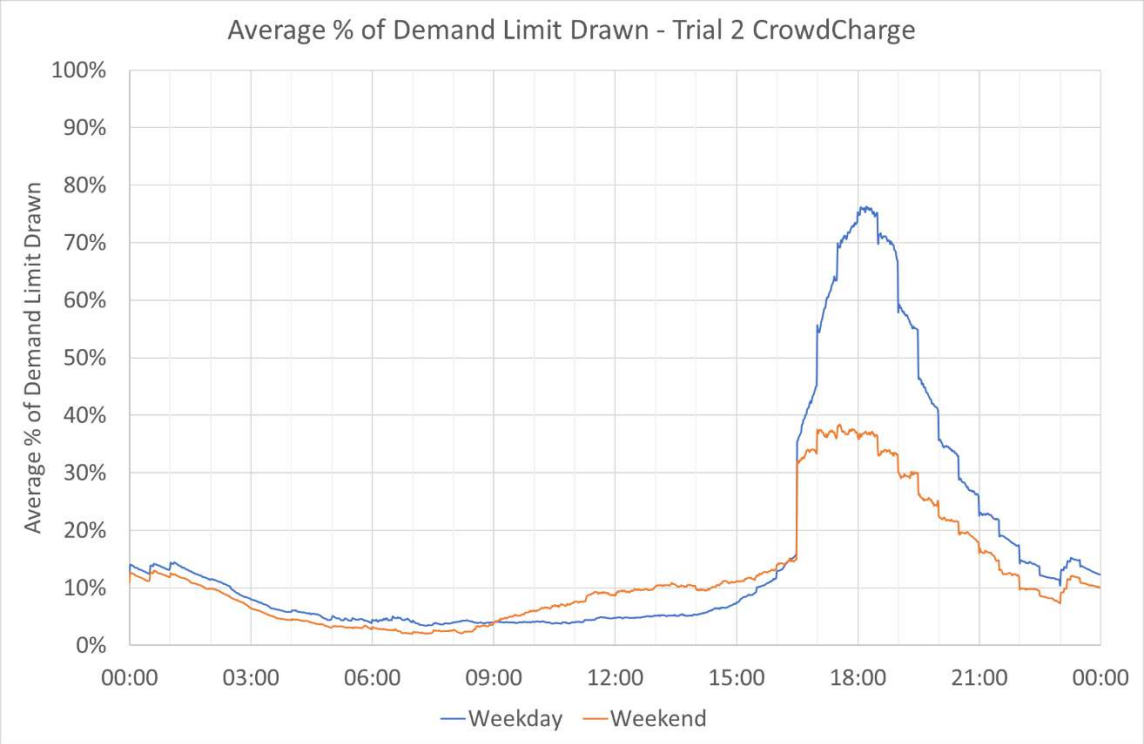
Figure 25: % of Days with Active Management - CrowdCharge Trial 2



Management on the 'spring/winter' profile is required for a shorter period than with a winter profile.

The total current drawn has been compared to the demand limit throughout trial 2, and the average values for weekdays and weekends are shown below.

Figure 26: Average % of Demand Limit Drawn - CrowdCharge Trial 2



Throughout the trial the current drawn remains well below the demand limit (maximum value is 76% of the demand limit at around 18:00 on weekdays). CrowdCharge begin to curtail charging when it is not possible to allocate all active chargers 32A. In fact, a proportion of these chargers will be supplying vehicles with a nominal rating of 16A, so the total current drawn will be below the theoretical maximum (if they all drew 32A).

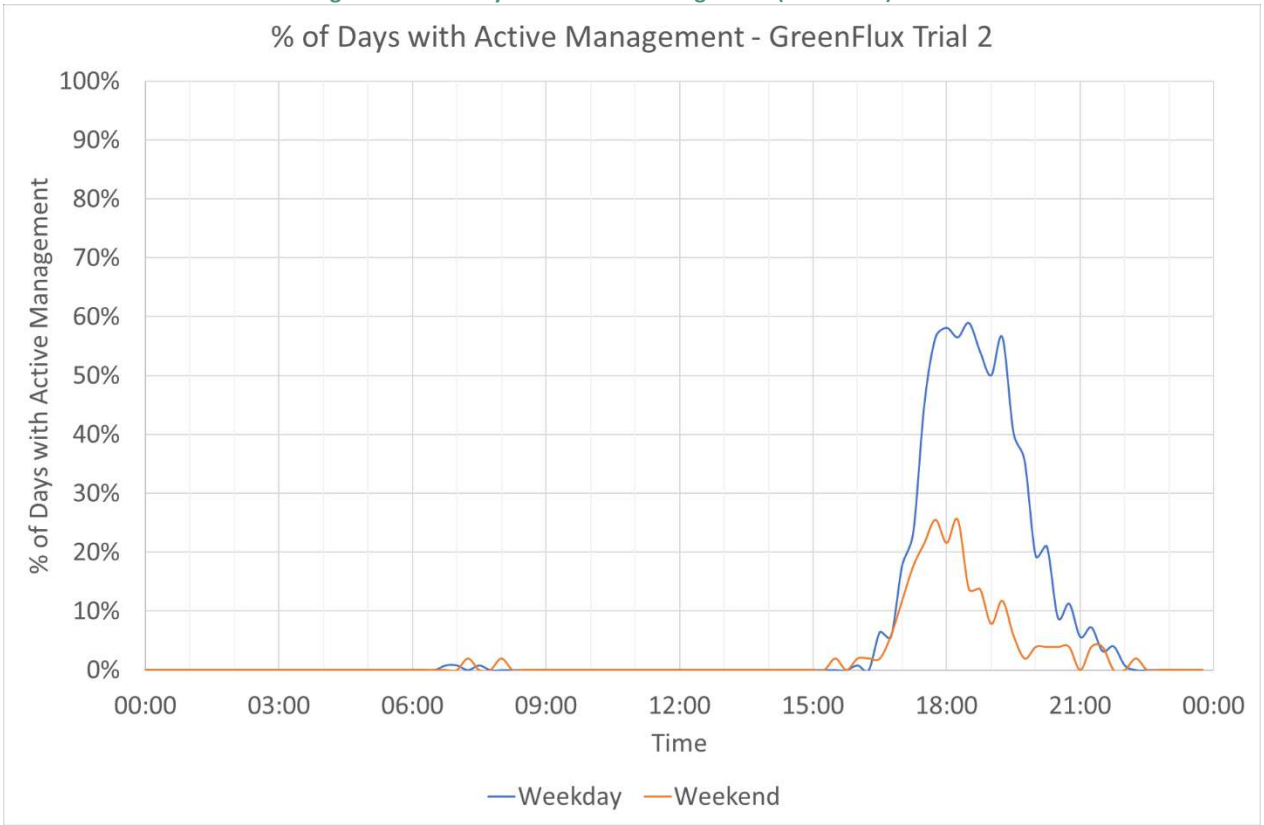
This shows a lower charging load in the evening peak at the weekend, which aligns with the lower frequency of management. Day-time load is slightly different, with higher loading during the day. This may be due to a larger proportion of vehicles being at home, and therefore potentially charging, outside of the traditional Monday to Friday working week.

The graph also illustrates the level of flexibility available for shifting EV charging load, in the period from midnight until six a.m. the charging load is using a maximum of 14% of the available 'spare' network capacity.

4.5.3 GreenFlux Group Level Management

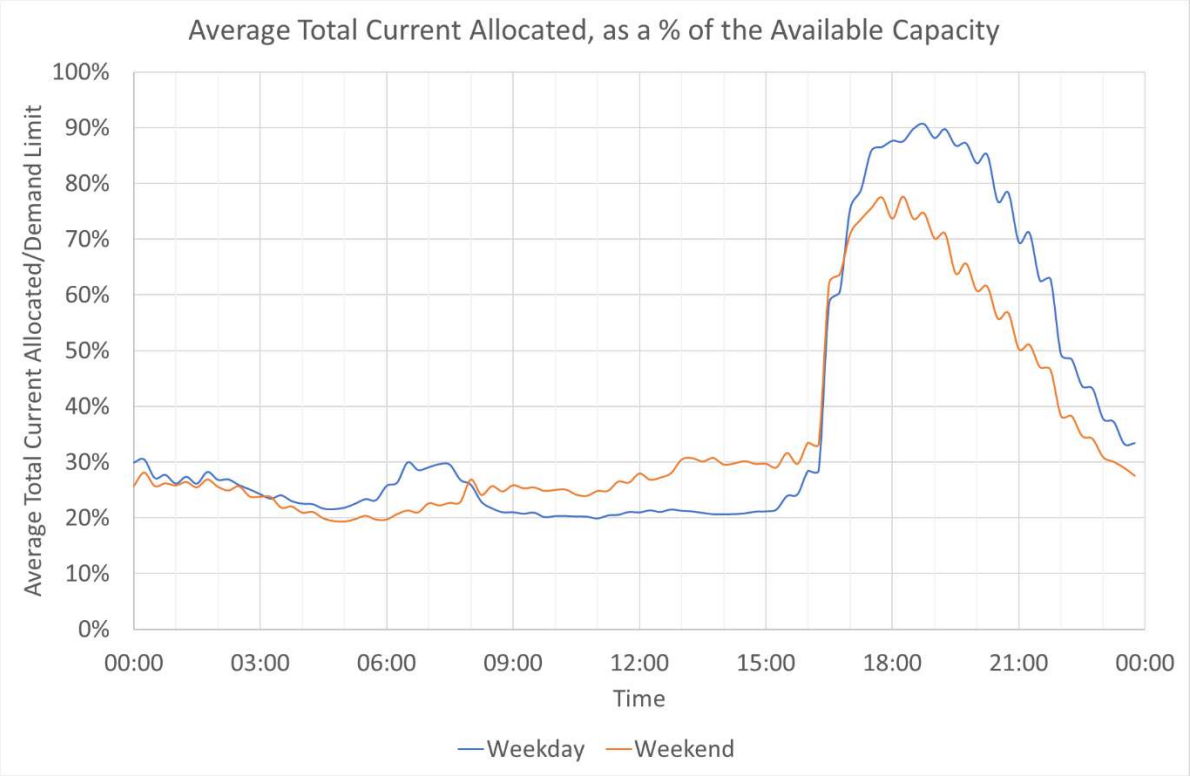
Trial 2 was operational between 4th April and 9th October. Participants were moved from Trial 1 to Trial 2 in batches until 30th May. The graph below shows the % of days when group level management has occurred for the GreenFlux cohort for the duration of Trial 2, split by weekdays and weekends.

Figure 27: % of Days with Active Management (GreenFlux)



The timings of these events are consistent with previous reporting, with the vast majority of management occurring during the evening peak. Management is less likely to occur at the weekend and the period for which management is required is shorter than on weekdays. The periods at which management occurs is similar to CrowdCharge, but events are less frequent on weekdays.

The total current allocated to active chargers in each quarter hour has been compared to the demand limit to produce the graph below:



This pattern is to be expected. The large peak between 16:00 and 21:00 arises from both an increase in the number of vehicles connected, and a decrease in available capacity (due to household and other loading at this time). The graph shows the extent of the available capacity throughout the rest of the night and day, indicating substantial 'spare' capacity which EV load could be moved into via the use of smart charging (or other measures which encourage off-peak charging, such as time of use tariffs). Weekend demand differs slightly to the weekday, with a later and more gradual pick-up (compared to the increase at 6:00 for weekdays), and increased loading during the day.

5 Algorithm Iteration 2 Update

The 1st algorithm iteration from both smart charging providers did not provide a means by which participants could interact with the smart charging systems. From July 2017 participants were moved into 'trial 1' (algorithm iteration 1). Testing of this algorithm was reported in the Algorithm Development and Testing Report[8]. Relatively simple algorithms were used by both CrowdCharge and GreenFlux to share the available current between active chargers. Most participants who have experienced this type of management have been surveyed to assess the customer acceptability of this type of system and results were reported in previous versions of this report[9].

The second algorithm iteration for both demand management providers introduced a method by which participants could interact with the system, allowing prioritisation of current to those drivers who had the most immediate need (based on their expressed preference).

This section of this report briefly describes the 2nd algorithm iteration for each demand management provider, gives a final update on the roll-out process, and summarises the level to which these have been used by trial participants.

5.1 CrowdCharge

The second algorithm introduced a web-based app, whereby participants can enter journey plans. The system allows participants to enter three different types of information:

- Current state of charge of their vehicle
- Regular journey plans (e.g. a Monday – Friday commute)
- Occasional journeys

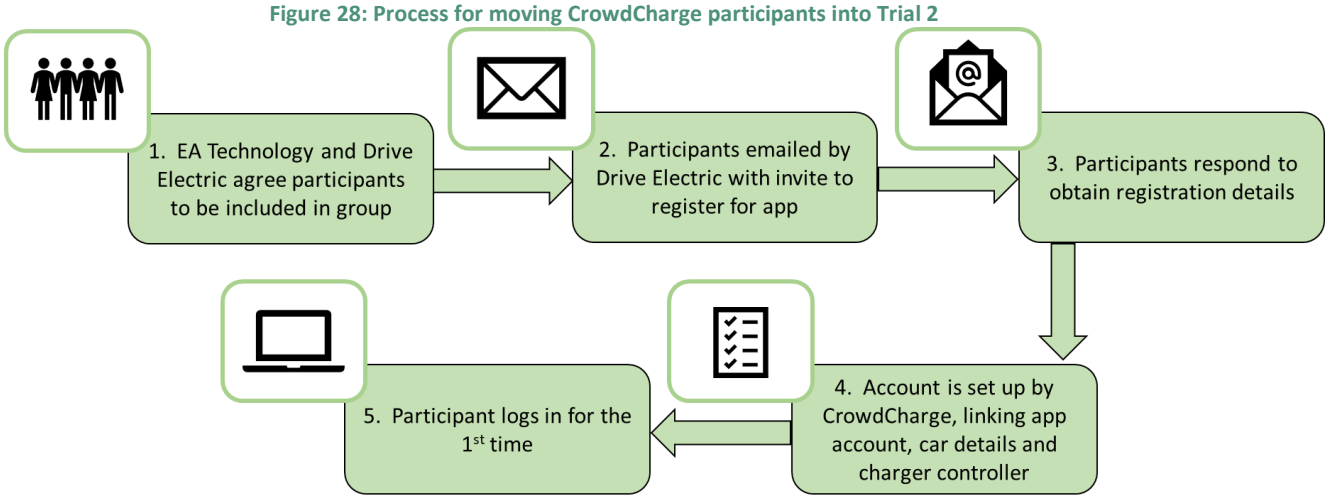
Journeys are specified in terms of a start and end point, and time of departure. This then provides the CrowdCharge system with an estimate of the energy required to meet the participant's requirements (using a starting state of charge value from either telematics, user entry via the web app, estimation from historical data, or a conservative assumption). If demand management is required (i.e. if there is insufficient capacity to allocate 32A to all active chargers) then the available current is shared based on relative energy requirements. For example, if demand management was active at 16:30, then a vehicle with a planned journey of 80 miles departing at 20:30 that evening would receive a larger current allocation than one travelling 20 miles at 7:30 the next morning. Chargers receive a full allocation (32A) when demand management is not required, so most vehicles would be fully re-charged overnight, regardless of their journey plans.

[8] Available from: https://www.westernpower.co.uk/docs/Innovation/Current-projects/CarConnect/CarConnect-Algorithm-Development-and-Testing.aspx Accessed April 2018.
[9] Available from: https://www.westernpower.co.uk/innovation/projects/electric-nation (under 'Documents and Links')

5.1.1 Invitation/Sign-Up Process

As described above, the 2nd iteration of the CrowdCharge algorithm aimed to estimate the energy requirements of vehicles in order to prioritise them when constraints become necessary. Final testing of this 2nd algorithm was completed in late May 2018. Participants were invited to sign-up to the app using the process shown below:

Figure 28: Process for moving CrowdCharge participants into Trial 2



All participants who were invited to register for the app (i.e. those identified in Step 1) were moved into a separate 'Trial 2' management group. These participants came from two sources:

- All those who had taken part in Trial 1, except where the charger was persistently offline, and it was therefore not possible to complete the necessary CrowdCharge controller software update (this applied to 18 participants)
- Participants who were not part of Trial 1, but subsequently passed the tests and moved into routine management.

After the initial invitation had been sent, reminder emails were issued to participants who did not respond at Step 2 to encourage them to register. All participants identified at Step 1 are being invited to complete a Trial 2 survey – including those who did not respond, in order to understand the reasons behind this.

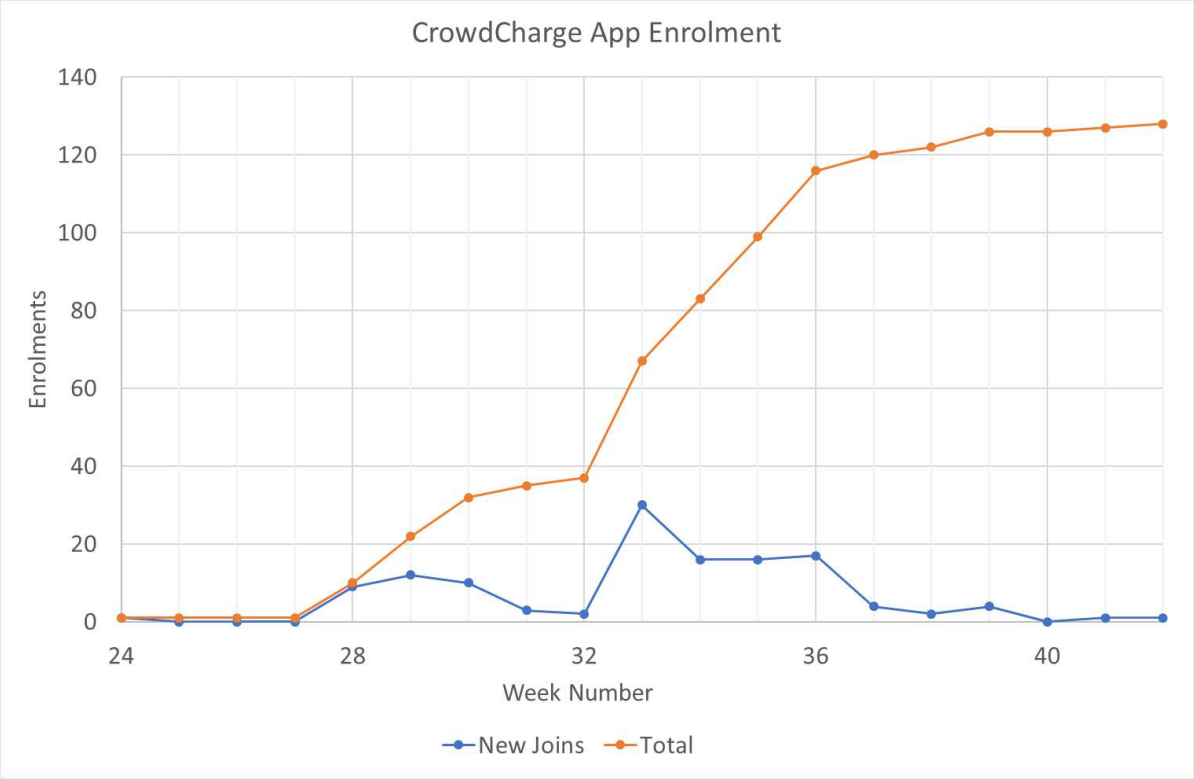
The number of customers who signed up or declined the invite are summarised in the table below:

Response	Number of Participants	% of Participants Invited
Replied to decline invite	2	0.8%
No response from participant	108	45.4%
App setup complete	128	53.8%
Total	**238**	**100%**

Table 6: Level of Uptake of CrowdCharge App for Algorithm 2

The process of signing participants up to the app is shown graphically below.

Figure 29:CrowdCharge App Enrolments (Algorithm 2)



This shows a moderate level of interest in signing up for the app. The number of new enrolments varies in each week due to the batch process used to invite participants to join the second trial.

The level of interaction with the system for these participants is explored in more detail below. Those participants who did not respond to the invitation for algorithm 2 will be given a further opportunity to sign-up as part of Trial 3, in order to investigate whether the offer of a financial reward linked to their charging behaviour incentivises greater take-up.

5.1.2 Level of Interaction with the App

As described above, once the process of linking participants with the app is complete, they have the option to enter various pieces of information:

- Regular journey plans (e.g. entering a Monday – Friday commute)
- Occasional journeys for a particular date/time
- State of charge information on each login

CrowdCharge have provided a summary of app interaction, as follows:

- Number of regular journeys entered by each participant
- Number of 'one off' journeys entered by each participant

- Number of state of charge entries from each participant
- Number of state of charge entries per week

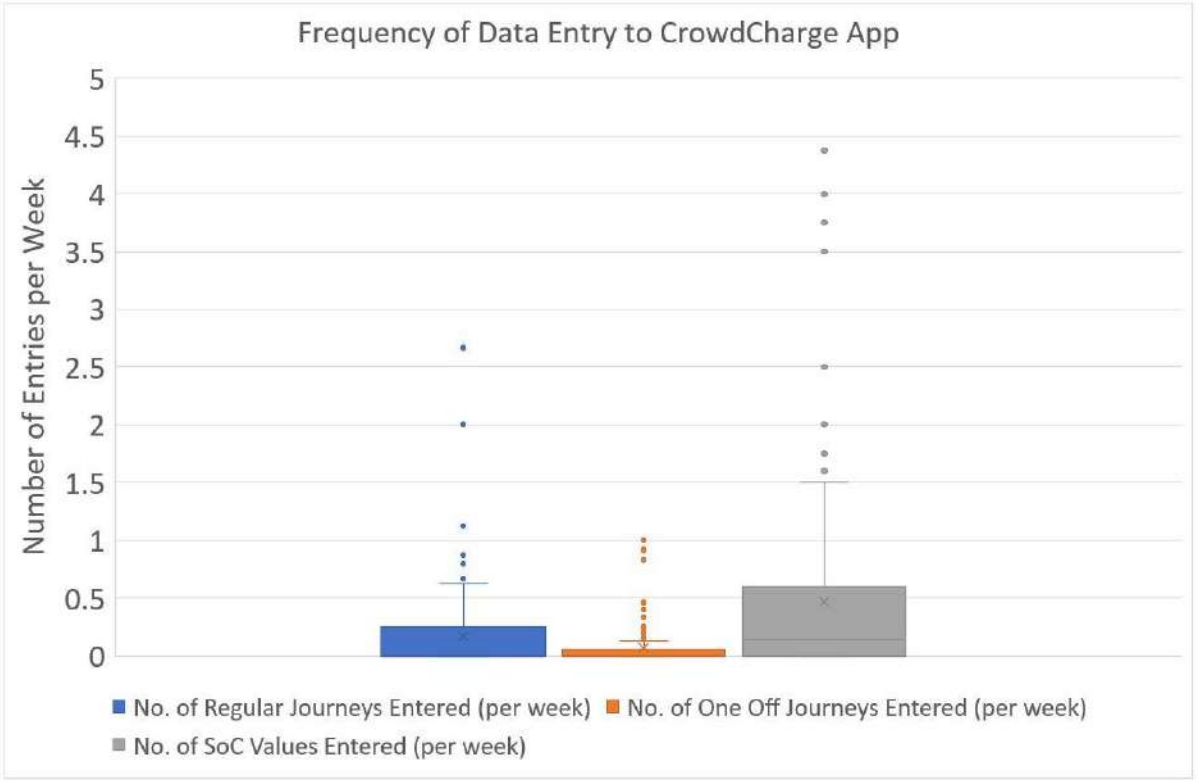
This report was provided in Week 41, at which point 127 participants had full access to the app. Of these 127 participants, 47 (37%) have entered no information (no journeys, no state of charge). The total number of entries of each type of information, and the number of participants (from 127) who have entered this information at least once, is shown in the table below.

Data Entry	Number of Entries (from 127 participants)	Number of Participants Entering Information at Least Once
Regular Journeys	145	52
One Off Journeys	84	32
State of Charge	485	70
Total	**714**	**21 participants have entered all three types of information**

Table 7: Data Entry to the CrowdCharge App

Participants have had access to the app for varying periods of time, as the enrolment process was spread over several weeks (as shown in Figure 29). Therefore, the analysis shown below uses the number of entries made per week for each participant (based on the number of weeks between the individual's setup and when the data export was supplied).

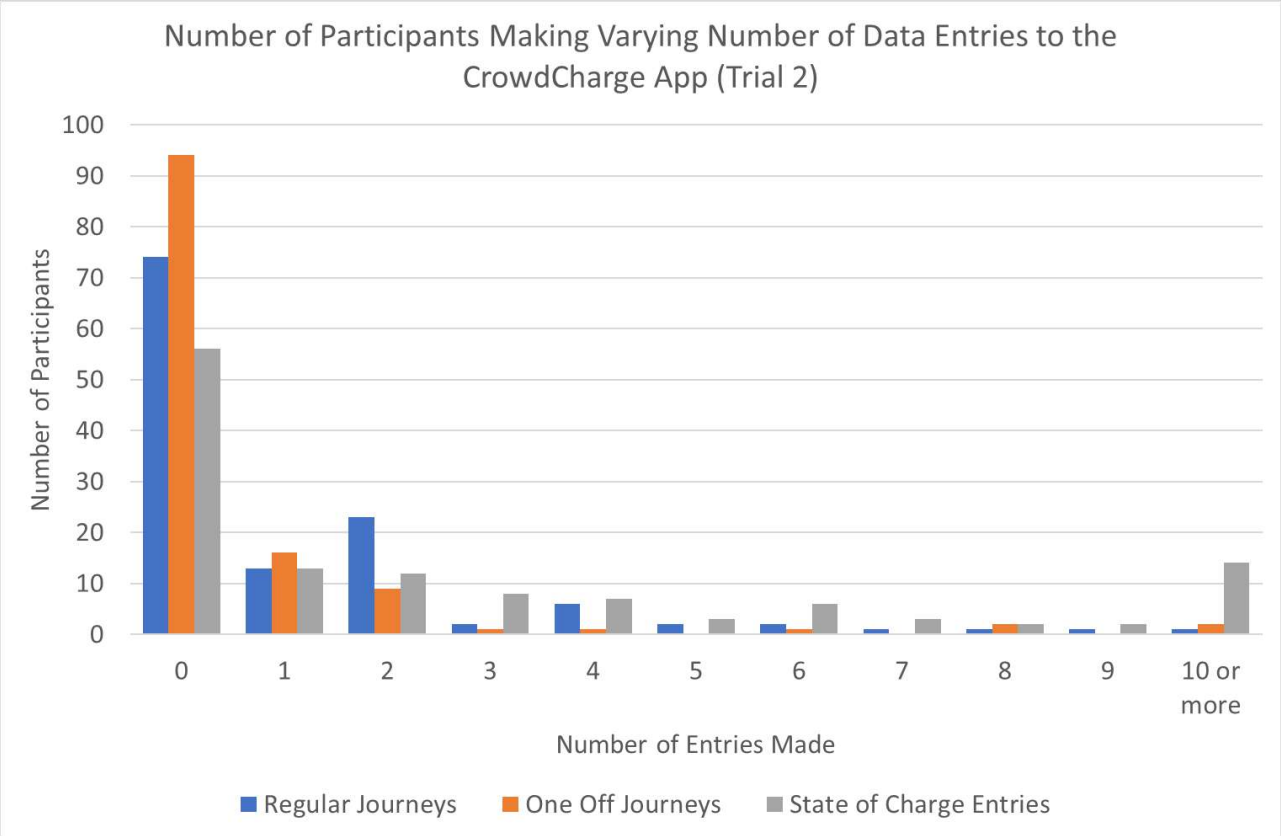
Figure 30: Frequency of Data Entry to the CrowdCharge App



This shows that state of charge is the most frequently entered piece of information, although even for this, the median frequency is 0.15 entries per week, and only 34 participants enter this information more than once a fortnight.

The frequency of information entered about journeys may be as expected – participants may be logging in once and setting up regular trips (e.g. their commute) and then not using it again. The plot below shows a histogram of the number of each data type entered by participants (not accounting for the length of time they have had access to the app).

Figure 31: Number of Participants Entering Varying Numbers of Regular Journeys



As demonstrated in the box and whisker plot, the most entered piece of information is state of charge, followed by regular journeys (grey column taller than either blue or orange for the larger number of entries). The majority of participants have not entered any journeys plans. The trial 2 survey (underway at the time of writing) will explore the reasoning behind these results.

The data can also be analysed to show whether the type of PIV owned by the participant, or its battery capacity impacts the frequency with which they interact with the app.

	Category	Average Number of App Entries (any type) per Week
	All Vehicles	0.72
Plug-in Vehicle Type	BEV	0.86
	REX	0.65
	PHEV	0.54
Battery Capacity	Less than 10kWh	0.51
	10 to 25kWh	0.93
	25 to 35kWh	0.71
	35kWh and above	0.68

Table 8: Average Number of Data Entries to App per Week (by PIV Type and Battery Capacity)

This appears to show that information is entered more frequently by drivers of electric only (BEV) vehicles when compared to range extender or plug-in hybrid vehicles. Drivers with relatively small battery capacities (10 to 25kWh) are entering information most often. The reasons for these differences may be clearer once the results of the trial 2 survey are received.

5.2 GreenFlux

The 2nd algorithm iteration introduced a customer app. The app provided a simple interface which allowed the user to request 'high priority' for the current charge session. In the GreenFlux system available current is allocated to high priority chargers first, before trickling down to 'normal' and 'low' priorities respectively (low priority occurs at the end of a charge cycle, or where a vehicle is on a timer and not yet actively charging). Therefore, if all the participants with active sessions choose to enact the request for high priority, all chargers will have the same priority and will be treated equally.

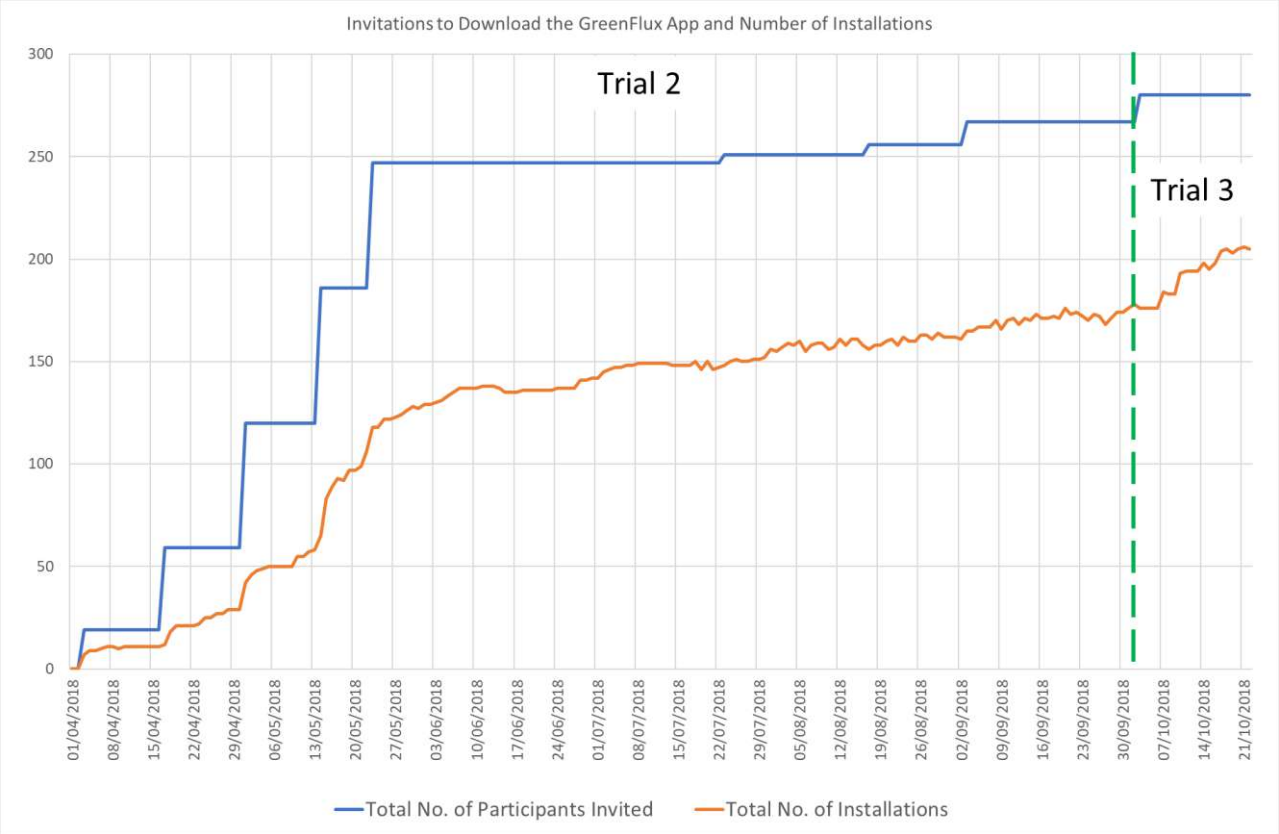
Participants were transferred from 'trial 1' (routine management, no app) to 'trial 2' in a series of five batches during April and May. In addition, a total of 42 participants went straight into 'trial 2' as their first experience of management.

5.2.1 Downloads of the App

Batches of GreenFlux participants were emailed by DriveElectric inviting them to download the app and providing login details and a link to instructions. Participants who had been removed from smart charging (e.g. due to the BMW 330e issue – described in section 7.4.2) were not invited to download the app, as it is only relevant to those participants who are under demand management.

The app is available for both Android and iOS devices. Participants can choose whether they want to download the app. The number of downloads during the course of trial 2 (and the beginning of Trial 3) is shown below.

Figure 32: Downloads of GreenFlux App - April to October 2018



The number of participants who had been invited to download the app is shown in blue – clearly showing each batch of invites at intervals of approximately two weeks at the start of trial 2, with small increases later in the trial as new participants were able to join routine management. The resulting running total of app installations is shown in orange. Increases are shown which align with each batch of invitations, suggesting that most participants either respond quickly to the invitation, or not at all.

At the time of writing, the app has been downloaded 205 times, compared to 280 invitations (73%). The reasons why participants have not downloaded the app are explored in the results of the trial 2 survey, detailed in Section 3.3 of this report.

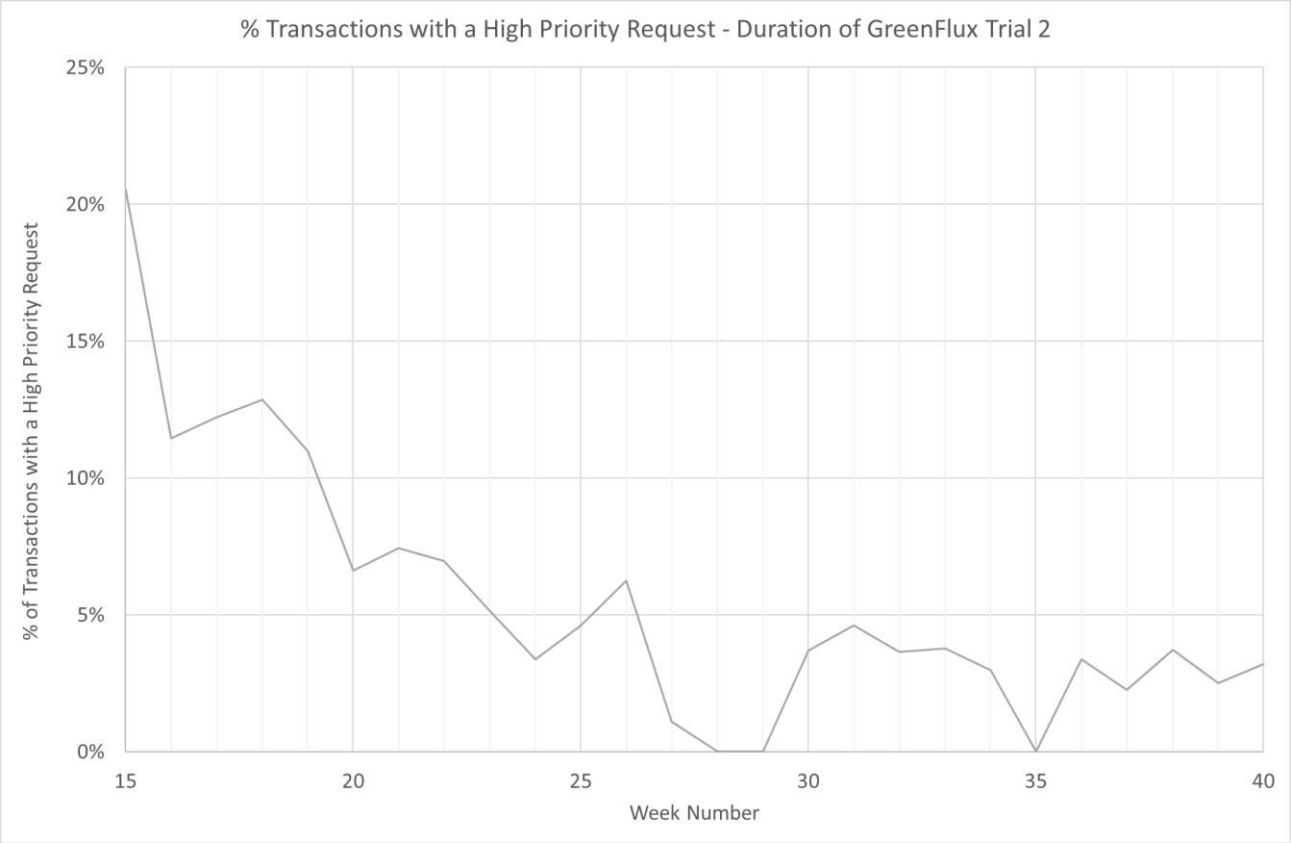
5.2.2 High Priority Requests

Once participants had downloaded the GreenFlux app they were able to request 'high priority' for their current charge session. At a group level current is made available to all 'high priority' chargers first, before any remaining current (relative to the demand limit) is trickles down to 'normal' and then 'low' priority charging sessions. Selecting 'high priority' therefore greatly reduces the potential of an individual charging session being affected by demand management.

267 participants were transferred to the app group in batches during Trial 2 (April to early October), as shown in Figure 32. At least one transaction record exists for 239 of these participants since they moved into the app group. The remaining 28 chargers may be

offline, or not using their charger. A total of 18,587 transactions occurred during Trial 2 where the participant had access to the app, and a request was made for 787 of these charge events (4.2%). These were distributed across the duration of trial 2 as shown below.

Figure 33:% of Transactions with a High Priority Request - Trial 2 GreenFlux



The first week is an anomaly, as the first batch of participants were asked to use the app to test it, as a pilot group. The level of high priority requests declined after the first few weeks of the trial and did not exceed 5% of charge events after Week 27 (w/c 2nd July). This suggests that use of a high priority feature is likely to be relatively infrequent. Survey responses indicate that the availability of a high priority feature alleviates some of their concerns relating to smart charging (47% of participants responded that the app alleviated either “all”, “most” or “some” of their concerns regarding smart charging, see Figure 15).

App use by an individual participant may occur occasionally (either to experiment with the new feature, or when their journey plans mean that demand management would be particularly inconvenient) or become habitual. For each participant the percentage of their transactions with a high priority request (during trial 2) has been calculated. The distribution of this data is shown below for different types of plug-in vehicle, and by battery capacity.

Figure 34: % of Transactions with a High Priority Request - by Plug-In Vehicle Type

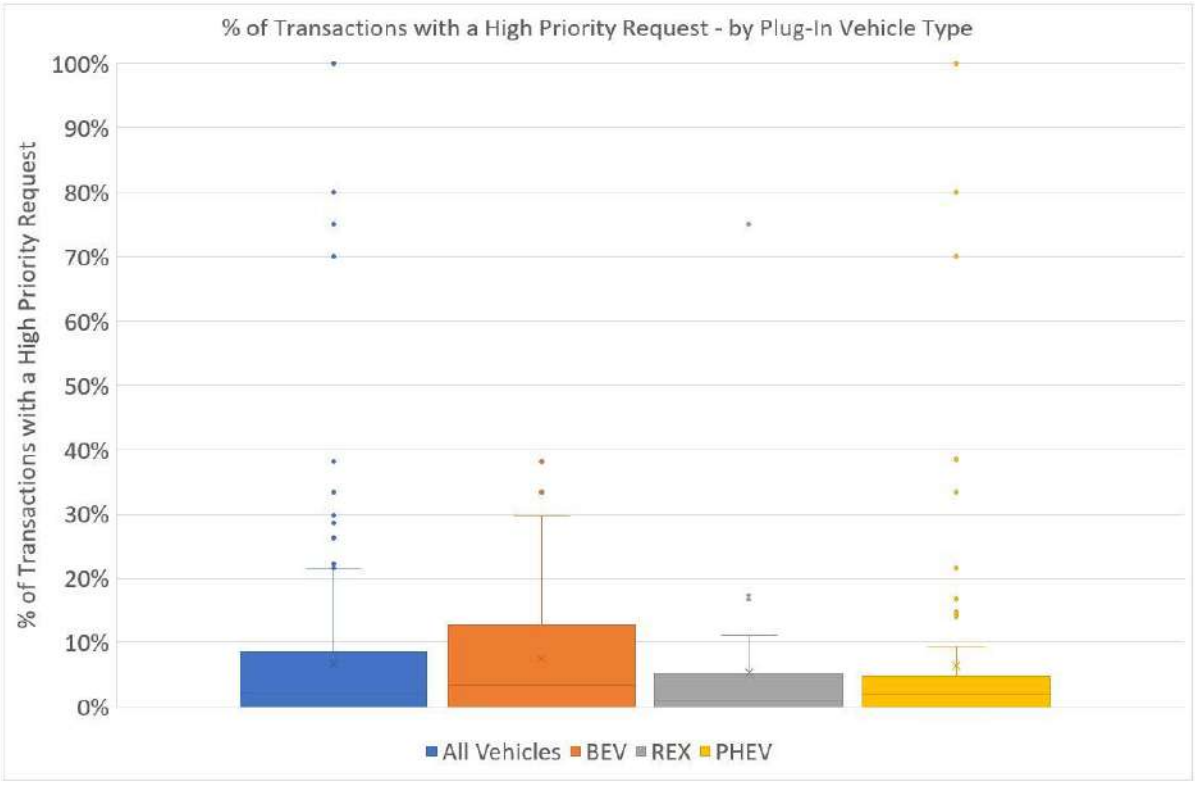
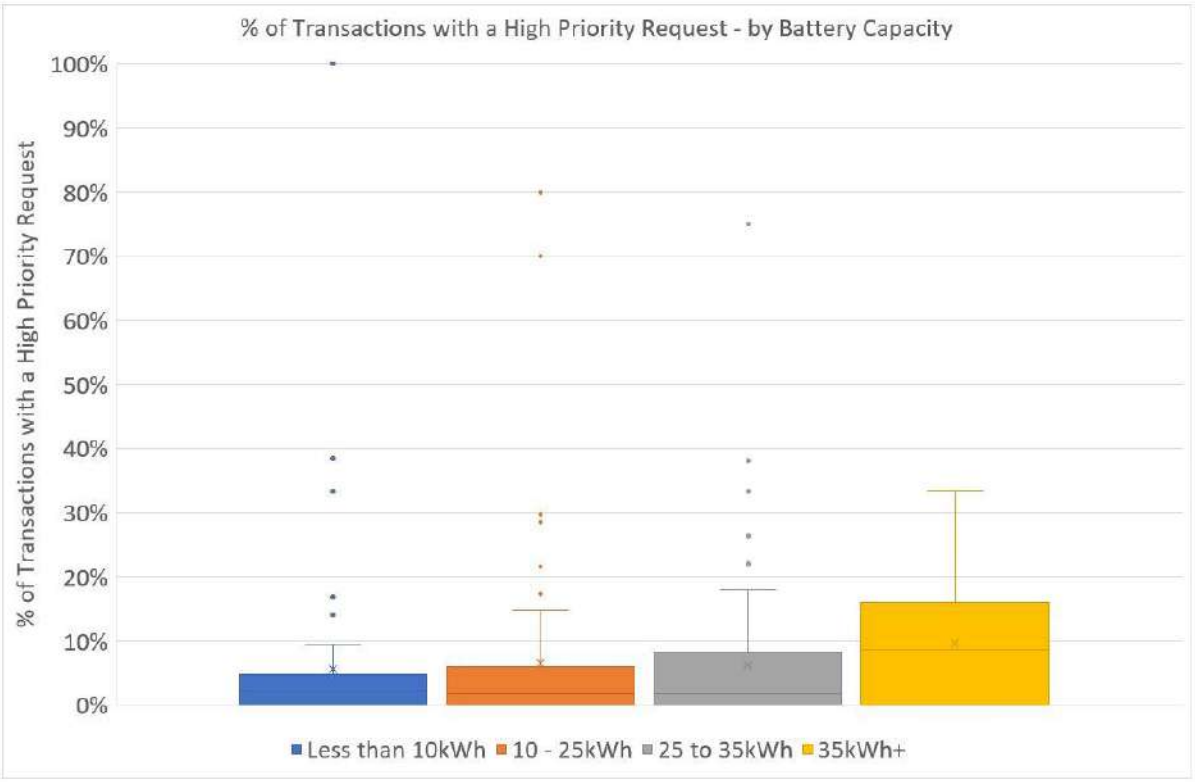


Figure 35: % of Transactions with a High Priority Request - by Battery Capacity



This data is also summarised in the table below, showing the percentage of participants who have never made a high priority request, and the median value in each category.

	Category	% of Participants with no high priority requests	Median % of transactions with a high priority request
	All Vehicles	38%	2.04%
Plug-in Vehicle Type	BEV	37%	3.39%
	REX	47%	1.01%
	PHEV	36%	1.91%
Battery Capacity	Less than 10kWh	35%	2.08%
	10 to 25kWh	40%	1.67%
	25 to 35kWh	42%	1.69%
	35kWh and above	33%	8.59%

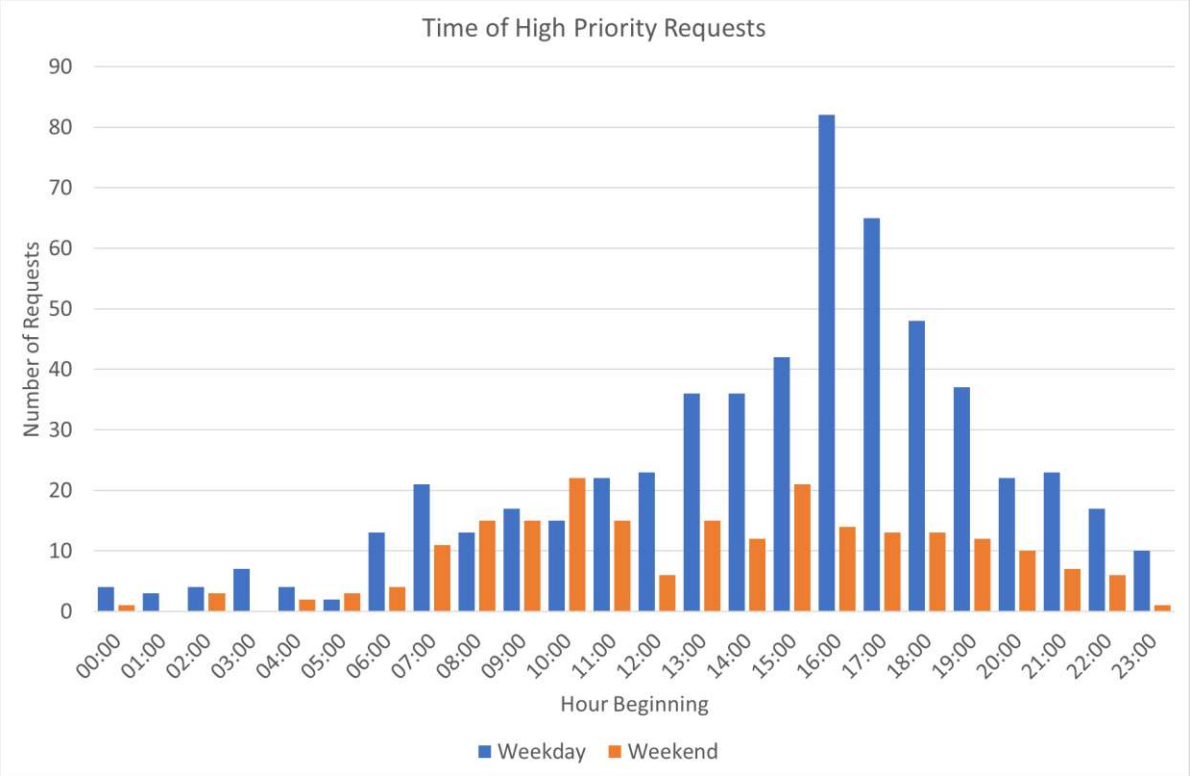
38% of participants have never requested high priority – this is to be expected, as there had only been 176 downloads of the app (relative to a trial population of 267), so 34% did not access to the feature, and some others may not have used it.

Use of high priority is more common for battery only vehicles than either range extended or plug-in hybrid vehicles. This is understandable as the potential consequences of demand management are more severe for those without an alternative fuel source.

High priority requests occur much more frequently by participants with the largest battery sizes. Demand management reduces the average current available to a car across a charging session (e.g. instead of 32A being available for three hours there may be two 15-minute pauses, reducing the average rate to 27A). In most cases the reduced rate is still sufficiently fast to fully recharge the vehicle before it is unplugged. However, this may not be the case during shorter transactions, or where a large amount of energy is required. The second of these scenarios is more likely to occur for participants with vehicles with larger batteries.

The app interface during trial 2 showed participants the current that their vehicle was drawing, and the amount available from their charger in real time. Participants may be requesting high priority either in response to demand management being active (i.e. observing that smart charging is reducing the current available), or in anticipation that management may occur during the charging session. The timing of the requests can provide some insight to this, particularly when compared to the times of day when management is active (see Figure 27).

Figure 36: Time of High Priority Requests



This shows a clear increase in high priority requests in the times when demand management is more likely to be active (weekdays, evening peak). Fewer requests are received at the weekend, but this may be due to fewer transactions occurring as well as a lower likelihood of demand management, or fewer time pressures on drivers. A significant proportion of participants are requesting high priority for charging sessions which are unlikely to be constrained – as shown by the number of requests received during the daytime.

6 Algorithm Iteration 3 Updates

A third and final algorithm iteration will be rolled out to both sets of trial participants during the autumn. In both cases an element of Time of Use pricing is introduced, which will allow customers to be financially rewarded for moving their charging load away from times of peak electricity demand.

This section summarises the changes being made to each system, describes the testing completed, and where relevant the progress with rolling out the updated systems to trial participants.

6.1 CrowdCharge

6.1.1 Description of Update

The CrowdCharge system will operate using a time of use tariff and aim to optimise charging based on a combination of driver requirements (using app entries as per trial 2), capacity management, and delivering the required energy at the lowest overall cost. Trial participants will be incentivised to take part via receiving at cash reward (Amazon voucher) based on the price achieved by the CrowdCharge system compared to the cost of supplying the energy required on a flat rate tariff. Example scenarios are described below:

- A participant connects their vehicle when they arrive home in the evening peak. They enter a journey plan with a time of departure of 7:30 the next morning. The system will therefore increase the charging which is done overnight, as the energy is not required until the following morning. By entering a journey plan the participant will increase the reward they earn for this charge event, as energy will be taken at during the lowest price overnight.
- A participant connects their vehicle when they arrive home in the evening, but no journey plans have been entered. The CrowdCharge system assumes the vehicle is required a few hours later, so peak time energy is used, decreasing the reward balance.
- A participant connects their vehicle when they arrive home in the evening peak. They enter a journey plan with a departure time of later that evening. In this case the CrowdCharge system would use peak time energy to ensure that the energy requirement is met. By entering a journey plan the system will prioritise charging this vehicle if demand management is required.

6.1.2 Testing Completed

Testing began in October 2018, and has included scenarios including:

- Ensuring that demand limits are given the highest priority (i.e. if capacity is constrained but energy is ‘cheap’ then charging should be curtailed).
- Confirming that charging is moved to periods of lowest price whilst still ensuring that energy requirements are met.

- Showing that changes to journey plans are reflected in the current allocated to each charger, including where these changes are made after the charge session has begun.
- Demonstrating how the system will behave if charge sessions take place without a journey plan being made.
- Testing the behaviour of the system (current allocated) if communications are not available when vehicles are charging.

6.1.3 Roll-Out to Trial Participants

The update to the CrowdCharge system is due to be released in late October/early November. Documentation is being prepared at the time of writing to describe the change to participants. This will be followed by a 'soft launch' to approximately 20 regular users of the app. This will be followed by releasing the update to all the remaining CrowdCharge participants who are in routine management.

6.2 GreenFlux

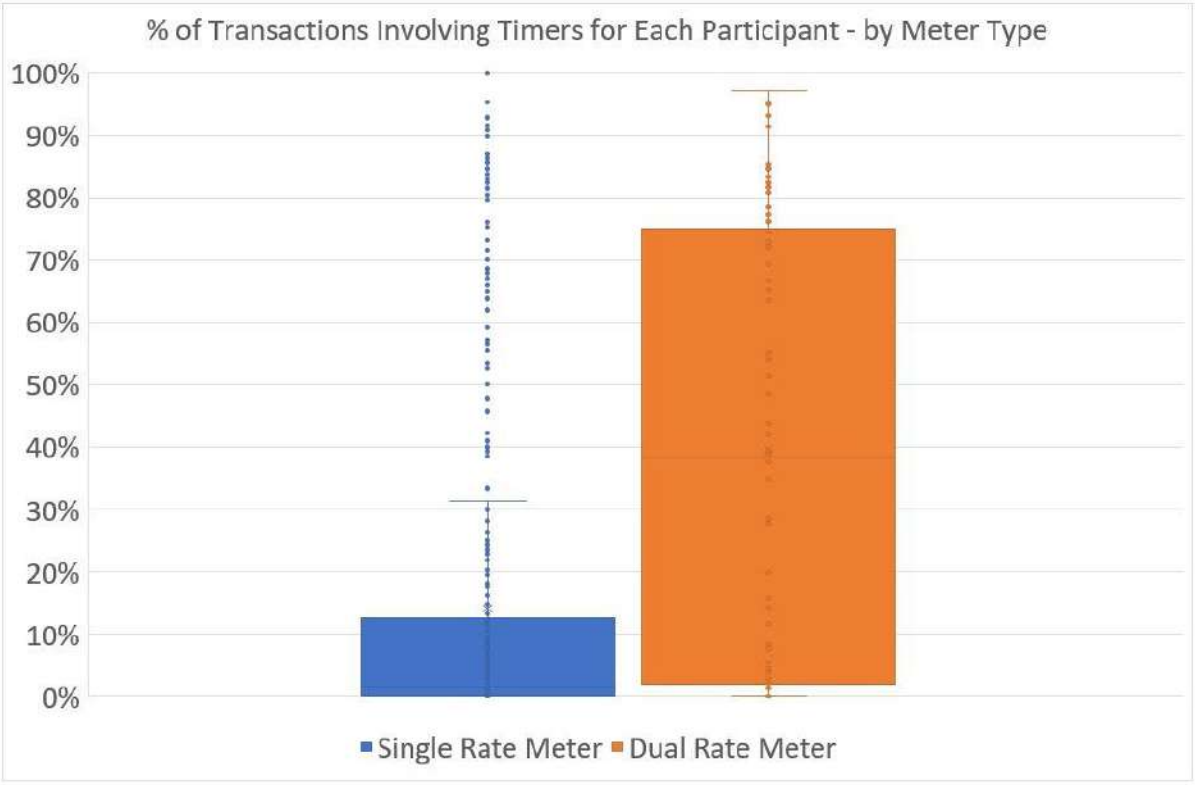
6.2.1 Description of Update

The previous version of the GreenFlux app allowed participants to request 'high priority' for their charge session, which greatly reduces the probability that their charge session will be constrained at any point. There was no disincentive applied to discourage participants from requesting high priority, and no other mechanisms encouraging participants to change the time they charged their cars (apart from those already on a time of use tariff).

In the future, energy suppliers may introduce time of use (ToU) tariffs which vary the cost of electricity throughout the day. A range of tariffs of different complexities are likely to be available, for example, some may follow the same pattern and prices every day, whilst others may be much more variable. The structure of these tariffs will be driven by the needs of energy suppliers, rather than local networks. However, they may result in changes in charging behaviour which have either a positive or negative impact on the network. A positive network impact could be achieved if the tariff structure shifts charging demand away from the evening peak and allows this to be accommodated at other times, within the capacity of the local network. There is also a risk of a "feed forward" effect, where the unit price drop stimulates additional demand, creating new peaks at times when demand traditionally falls, and this is outside of the capacity of the network (although this is not possible within Electric Nation, due to the use of demand management).

From data already collected as part of the project, the charging behaviour of customers who may be on a time of use tariff (i.e. they have a dual rate meter capable of recording night and day time consumption separately) has shown to vary, as demonstrated by the graph below, where each dot represents the percentage of charge events for which each participant has used a timer. The box shows the inter-quartile range of the data.

Figure 37: Differing Charging Behaviour by Customers with ToU Tariffs

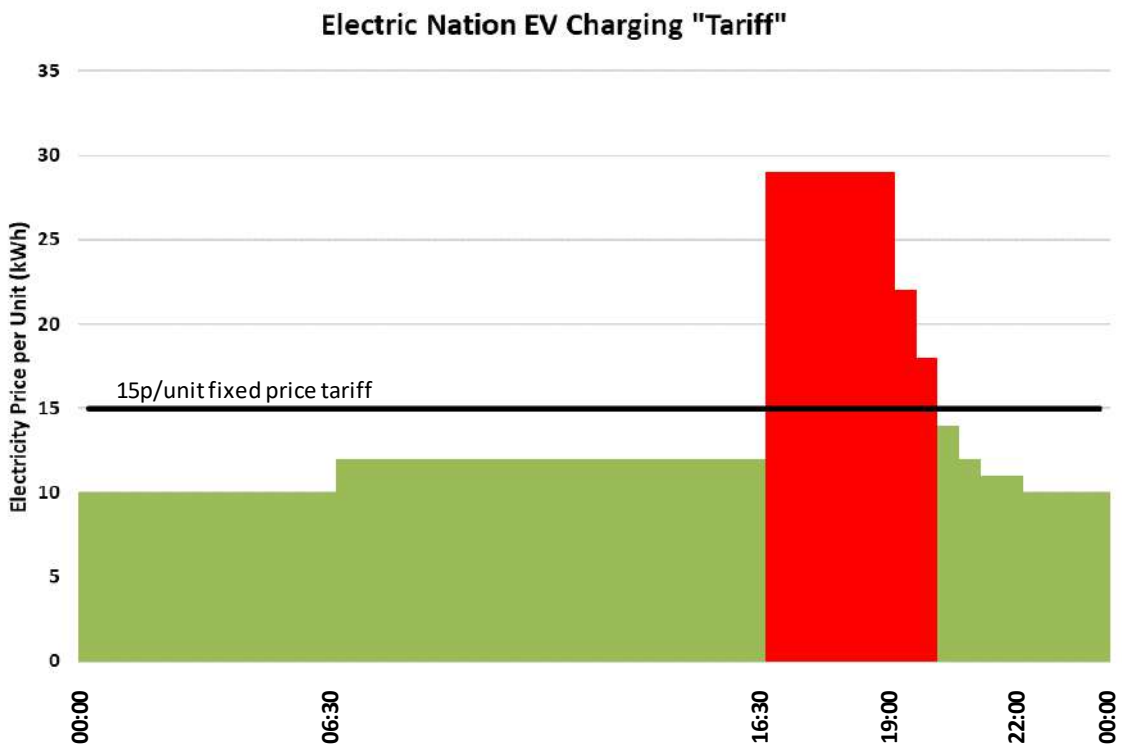


This shows that the use of timers to delay the start of charging is much more prevalent among those participants with a dual rate meter, compared to those with a single rate meter. For participants with a single rate meter, half the participants use a timer for less than 2% of their charge events. The equivalent figure for those on dual rate meter is 38%. These customers are incentivised towards charging overnight by their tariff, and this may change their charging profile compared to the general (non-ToU) population.

The third trial introduces an element of time of use pricing, which may encourage participants to move consumption away from the peak, reducing the need for curtailment actions. The trial enables this to be managed within the GreenFlux system, or the participant may achieve this by using a timer on their car to delay charging until the off-peak rate begins.

Participants are being incentivised via a simulated ToU tariff, which applies only to their EV charging, and will be converted to a reward voucher value at the end of the trial. All participants will begin the trial with a £10 reward. The tariff is shown below:

Figure 38: GreenFlux Simulated ToU Tariff



All consumption which takes place when the price per unit is above 15p/kWh will reduce the value of the participant's reward (e.g. each kWh consumed between 16:30 and 19:00 will reduce the reward value by 13p). However, consumption when the price is less than 15p/kWh will increase the value of the participant's reward. The tariff has been based on a ToU tariff currently being offered in the UK (Octopus Agile tariff) and is therefore representative of the likely reward (saving in energy costs) which a driver could obtain by changing the time of their charging.

During Trial 3 group demand will be managed against the available network capacity, using the same scaled profiles which have been used in previous stages of the trial. Demand management will continue if necessary (i.e. if it is not possible to give all chargers either 16A or 32A, depending on the nominal rating of the vehicle). If customers respond to the time of use tariff by moving their charging away from the peak periods then management should be used less often, or for shorter periods of time, or involve fewer participants.

Participants can manage their preference for when their vehicle charges using an upgraded version of the GreenFlux app, via by selecting one of three options:

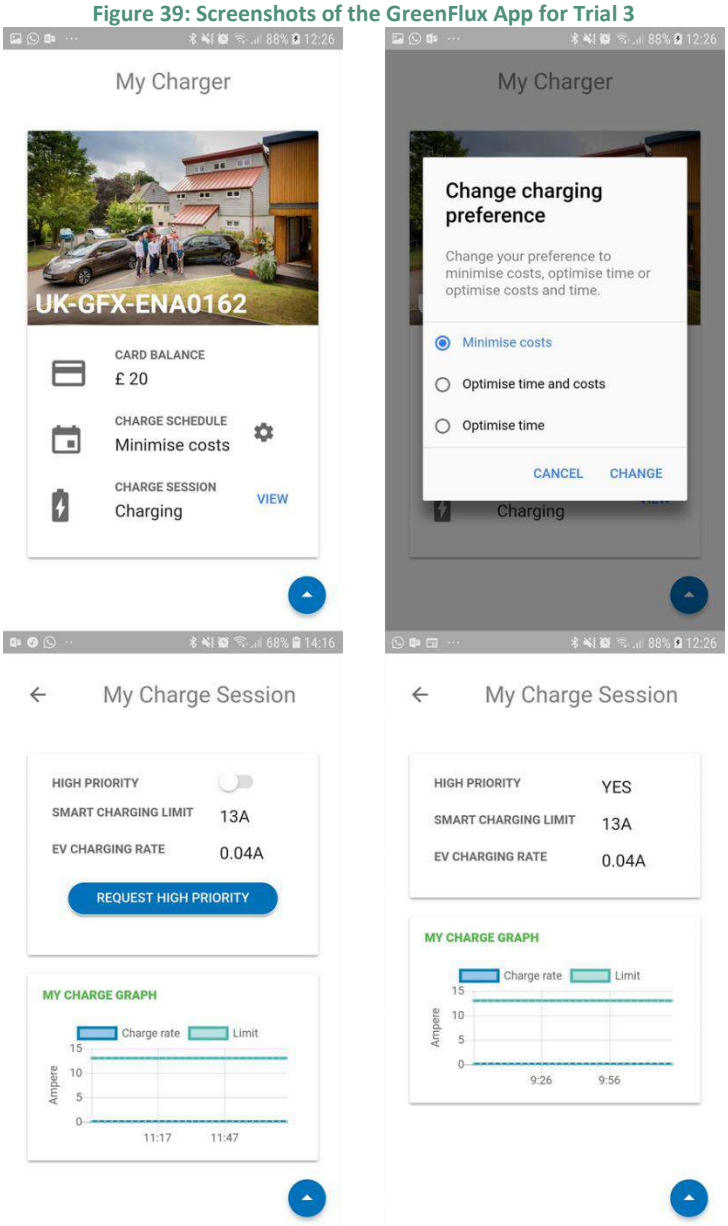
- To "minimise charging cost"
  - In which case the system will pause charging during peak and taper tariff period (only charging between 22:00 and 16:30)
- Or "optimise time and cost"
  - In which case the system only pauses during peak tariff period but will bring a charger on to charge during taper tariff (charging from 19:00 to 16:30)
- Or "optimise time" (default option, to prevent unexpected changes to charging)

- In which case system treats the charger as normal priority and charging starts immediately and is not paused at any time (except where WPD capacity limit smart charging action is required)

The app also records details of recent charging sessions – the amount of energy consumed and the resulting change in reward balance. Participants can also use the app to request high priority. If participants prefer not to use the app to manage their charging they can also ensure their reward balance increases by using a timer.

Screenshots of the app are shown below:

Figure 39: Screenshots of the GreenFlux App for Trial 3



6.2.2 Testing Completed

Prior to launching the upgraded app to trial participants, a series of tests were completed using the Electric Nation test system, at EA Technology's office. The aim of these tests was to confirm:

- The app interprets customers preferences correctly and this is reflected in the current available from the charger.
- Reward values are calculated correctly, including where the customer doesn't use the app (i.e. they change their plug-in time, or use a timer).
- Capacity limits continue to be enforced (i.e. if there isn't enough capacity for all participants who have selected 'optimise time' to charge at once then they are still managed) and demand management is still shared fairly amongst all active chargers.
- High priority requests still function correctly
- How charge events during offline periods are handled (what time do they start charging, what happens to the reward value etc.)

These tests were completed successfully during August and September 2018 and a selection of results are shown below. A 'testing' version of the tariff was implemented, to ensure that the peak, taper and off-peak periods all occurred during the working day, when testing was completed. The tariff was:

[TariffStart]	[TariffEnd]	[Tariff]	[TariffCategory]
00:00	10:00	0.12	0
10:00	12:00	0.3	2
12:00	12:15	0.22	1
12:15	12:30	0.18	1
12:30	12:45	0.14	1
12:45	13:00	0.12	1
13:00	16:00	0.1	0
16:00	00:00	0.12	0

Table 9: Testing Version of GreenFlux Tariff

(Tariff Category: 0 = Off-Peak, 2 = Peak Rate, 1 = Taper)

Test Results - Example 1

A demand management schedule was implemented which would require the charging rate of the vehicle to be reduced or paused. 'Optimise time and cost' was selected. The aim of the test was to prove that charging would be paused until the start of the taper period (12:00) and also follow the demand limit profile.

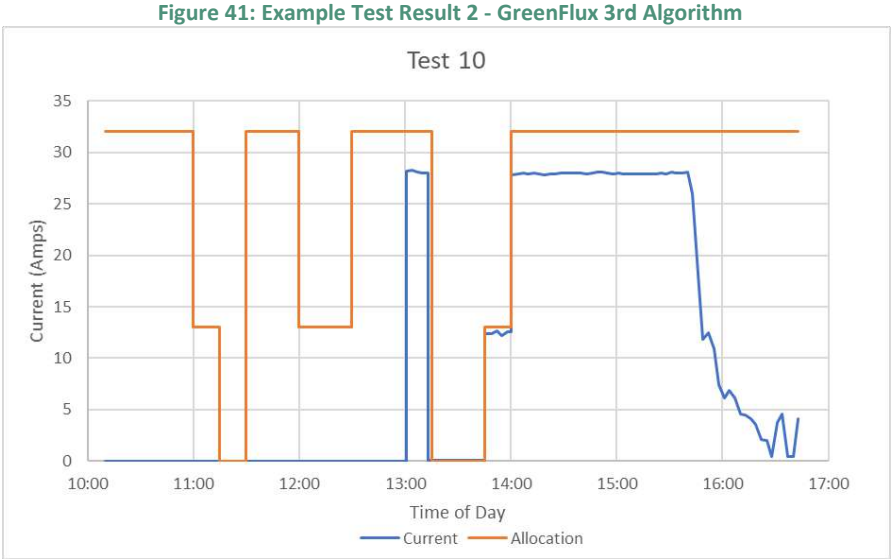
Figure 40: Example Test Result 1 - GreenFlux 3rd Algorithm

The vehicle was plugged in at 10:15. Charging was paused until 12:00 as expected. The demand limit was followed – for example only charging at 13A from 12:00 until 12:30 and pausing between 13:15 and 14:15.

Test Results – Example 2

A demand management schedule was implemented which would require the charging rate of the vehicle to be reduced or paused. 'Minimise cost' was selected. The aim of the test was to prove that charging would be paused until the start of the off-peak period (13:00) and also follow the demand limit profile.

Figure 41: Example Test Result 2 - GreenFlux 3rd Algorithm

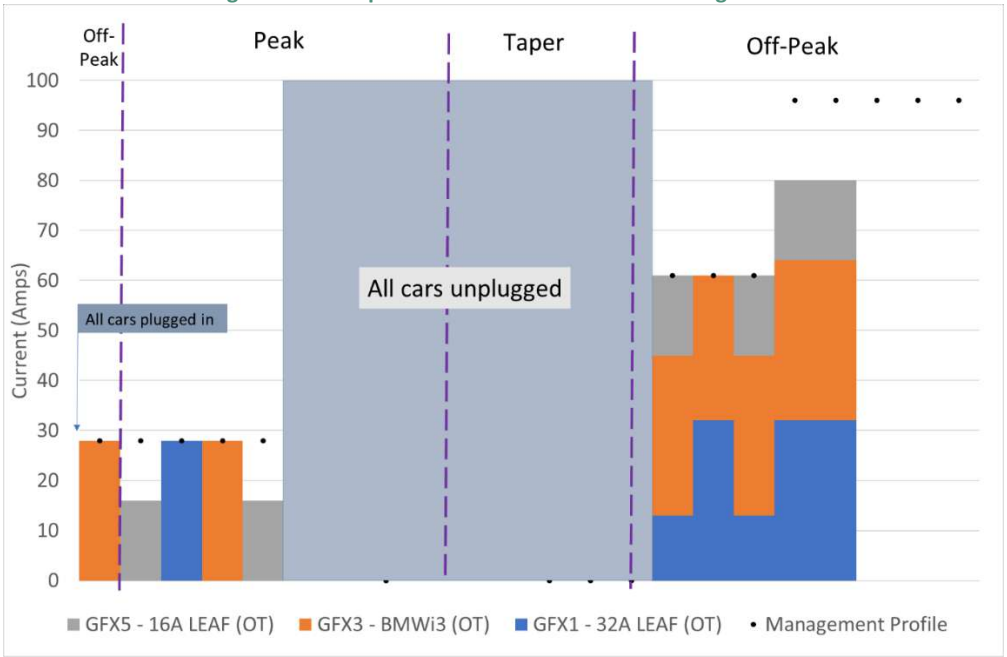


The vehicle was plugged in at 10:15. Charging was paused until 13:00 as expected. The demand limit was followed – for example pausing between 13:15 and 13:45 and reducing the rate between 13:45 and 14:00.

Test Results – Example 3

In this multi-vehicle test a demand limit was implemented which would require management between three cars (all on 'optimise time'). The aim of the test was to confirm that the restriction was shared fairly amongst all three vehicles.

Figure 42: Example Test Result 3 - GreenFlux 3rd Algorithm

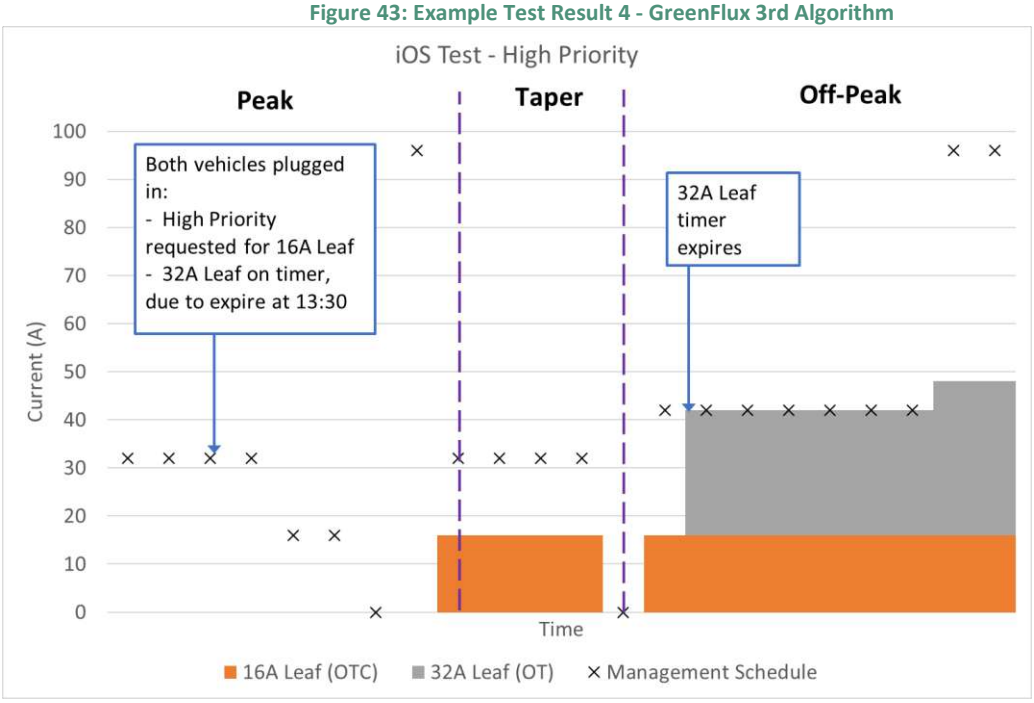


This shows correct operation of the demand management system, as the management profile is followed, and the restriction is shared amongst all three vehicles.

Test Results – Example 4

This test was completed with the iOS version of the app (previous tests used Android). The main aims were to confirm that high priority requests were operational and reward balances were calculated correctly.

Figure 43: Example Test Result 4 - GreenFlux 3rd Algorithm



In this test a timer was used, which prevented the 32A Leaf (grey fill) from charging until 13:30 despite being set to 'optimise time'. This is equivalent to a participant who chooses not to use the app but achieves off-peak charging via use a timer on their vehicle. A high priority request was made for the 16A Leaf immediately after it was plugged in.

The test was successful – the 16A Leaf on 'optimise time and cost' began charging at the beginning of the taper period. It received its full allocation during the management period at the start of the off-peak time. The remaining current was allocated to the 32A Leaf. The reward balances before and after the test are shown below:

Car	Initial Reward Balance	Final Reward Balance	Change
16A Leaf	£20.48	£20.70	+ 22p
32A Leaf	£19.74	£20.11	+ 37p

Table 10: Reward Balances from Test (GreenFlux Algorithm 3)

These increases are correct. All the charging completed by the 32A Leaf was off-peak, so increasing the reward balance by 5p/kWh used. The 16A Leaf used some units of energy which decreased the reward balance (energy consumed in the first half hour of the taper period). However, the increase in reward due to consumption in lower priced periods lead to an overall increase.

6.2.3 Roll-Out to Trial Participants

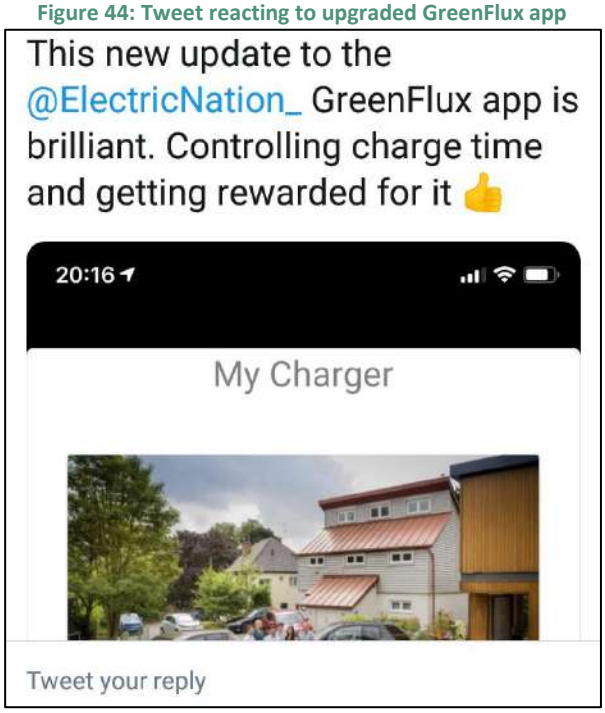
The app upgrade was released on 10th October. Prior to this the app help documents (frequently asked questions) on the Electric Nation website were updated[10]. The app release was controlled as follows:

- Updated app released to Google Play (Android) and App Store (iOS). The proportion of installations which would 'auto update' each day was initially limited in order to prevent a large influx of contact to the participant support line.
- All participants were moved into a new group for the purposes of demand management.
- All participants were emailed with details of the new app, including instructions for how to download it, and their login details.
- After one week the limits on automatic upgrading of the app were removed. In the intervening period reward balances were calculated for all participants, including those who could not yet use the app to control the time their EV charged. To remove this disadvantage all reward balances of less than £10 (the starting value) were reset. Any increases in reward balance were maintained.

Initial feedback from participants has been positive, including a tweet sent by one of the first users to upgrade the app.

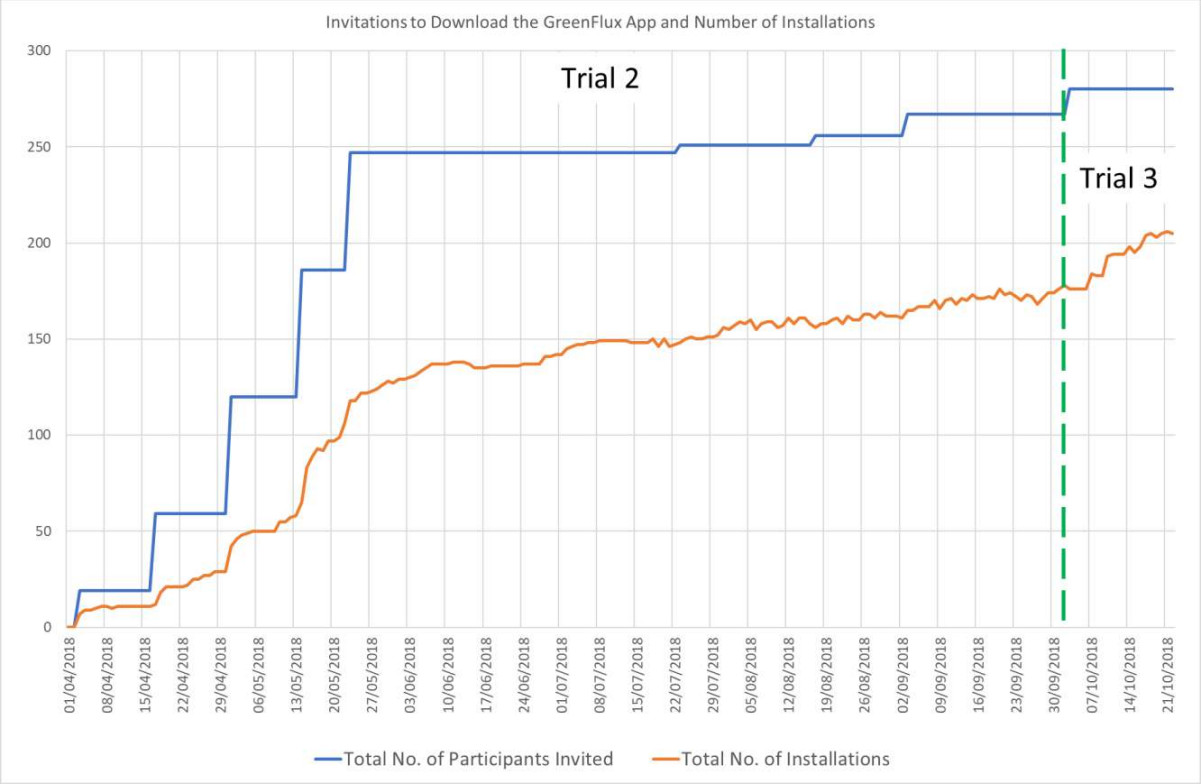
[10] http://www.electricnation.org.uk/greenflux-help/greenflux-app-2/ Accessed 17/10/2018

Figure 44: Tweet reacting to upgraded GreenFlux app



The downloads of the GreenFlux app since its release as part of Trial 2 are shown below:

Figure 45: Downloads of the GreenFlux App



This shows a further increase in the of installations after the launch of Trial 3, when participants could use the app to control their own charging, view details of past charge events and monitor their reward value.

7 Next Steps

7.1 Customer Research

Customer research surveys are still being distributed to and collected from trial participants who received the Crowd Charge app as part of Trial 2. Collection of these surveys is expected to be complete by the end of October 2018

The Baseline survey is being updated to include questions specific to the incentivisation apps that are trialled as part of Trial 3. It will be issued to participants once they have had access to the new version of the apps for approximately four weeks. This is expected to be around the end of November for Greenflux participants. The timing for CrowdCharge participants will be dependent on when their app is ready for release.

In January 2019, following the completion of the final trial, an End of Project survey will be issued to all trial participants. This survey will enquire about the participants involvement in the trial and whether their attitude to demand management has altered after their trial experience. It will also ask broader questions about owning an EV and using the GB public charge point infrastructure.

Final analysis of all the trial surveys will be included in end of project reports. This analysis will include the statistical quantification of the impact of demand management on individual participants to allow a ranking of their experience.

7.2 Smart Charging Trials – Algorithm Iteration 3 Activity for November 2018 to January 2019

7.2.1 CrowdCharge

As described above, preparation of the launch of trial 3 is underway at the time of writing, this includes producing all necessary documentation for participants and completing final testing. This will be followed by a pilot launch to around 20 participants for one week. Once this is stage has been completed successfully then the updated system will be launched to all participants. The trial will then run until the Christmas break, including monitoring the level of management and interaction with the app, and participants will be surveyed as described above.

7.2.2 GreenFlux

All customers have access to the final iteration of the GreenFlux app. Over the coming remaining months of the trial (until mid-December) the level of demand management will be monitored. Increases in downloads of app will also be tracked, as this may show further downloads by some participants who decided not to use the app during Trial 2.

7.3 Decommissioning Chargers

The smart charging element of Electric Nation will be completed just before Christmas. Chargers will then be taken out of smart charging. After this point the current available will no longer be constrained and they will not provide any further data. Plans for removing chargers from smart charging are already underway with both CrowdCharge and GreenFlux. This process will be staggered and will begin prior to Christmas for those chargers which are not part of Trial 3 (i.e. those which did not enter routine demand management, or which have subsequently been removed). This will allow the processes to be tested before the majority of chargers are processed.

Appendix 1 – Recruitment Survey

Electric Nation Recruitment Questionnaire

December 2016

568 Electric Nation	ONLINE SCRIPT DRAFT 14/12/16	Susie Smyth, Michael Brainch, Lucy Upshall, Helen Rackstraw

INTRODUCTION TO THE RESEARCH AND ADHERENCE TO MRS CODE OF CONDUCT

CATI ONLY: Hello, may I speak to **NAME FROM SAMPLE** please?

C1. I am calling from Impact Research about the Electric Nation project that you recently agreed to take part in. We recently sent you a survey link by email, can I check whether you received that email?
Yes
No – **CONFIRM EMAIL ADDRESS WITH RESPONDENT MATCHES SAMPLE**

C2. We would be really grateful if you would be able to complete this survey as soon as possible, I can take you through the questions now on the phone, or if you prefer you can complete it online? The survey should take no longer than 10 minutes.
Phone - **CONTINUE**
Online – **CHECK IF NEED LINK RE-SENDING, THANK AND CLOSE.**

Thank you for agreeing to participate in this important project about the future of electric vehicles. This is the first of a number of surveys you will be asked to take part in during the trial and should take no more than 10 minutes to complete, depending on the answers you give us. The purpose of this survey is to check the information we hold about you and gather some background about your household before you start the trials. This information will be used in combination with that from the other trial participants to understand how perceptions might vary by different groups.

This is a genuine market research study and no sales call will result from our contact with you. The interview will be carried out in strict accordance with the Market Research Society's Code of Conduct. Your identity and any information you provide to us will be kept confidential and will not be used for any purposes other than this research. Your details

were provided to us by DriveElectric and only Impact Research and DriveElectric will have access to your personal contact information so that we can keep in touch with you throughout the trials.

SAMPLE CONFIRMATION

We already have some details about you that were passed to us by DriveElectric that we would like to check all are correct before we continue.

S ASK ALL
A1 Can we check your full name is **INSERT FROM SAMPLE** .....
Correct
Wrong – **INSERT NAME HERE**

S ASK ALL

A2 And is this your home address where your charging point is installed? **INSERT FROM SAMPLE** .....
Correct
Wrong – **INSERT CORRECT ADDRESS HERE**

Is your postcode?
INSERT FROM SAMPLE .....
Correct
Wrong – **INSERT CORRECT POST CODE HERE**

QHIDDNO
AUTOCODE DNO FROM POSTCODE LIST:

1) WPD (East Midlands)
2) WPD (South West)
3) WPD (Wales)
4) WPD (West Midlands)
5) Electricity North West
6) Guernsey Electricity
7) Jersey Electricity
8) Manx Electricity Authority
9) Northern Ireland Electricity
10) Northern Powergrid
11) Scottish Hydro
12) Southern Electric
13) SP Distribution
14) SP Manweb
15) UKPN

S ASK ALL

A3 Is this the best telephone number on which we can contact you on for the duration of the trials?

Correct
Wrong – **INSERT CORRECT NUMBER HERE**

S ASK ALL

A5 And is this your preferred email address?
Correct
Wrong – **INSERT CORRECT EMAIL ADDRESS HERE**

A6 And can I confirm your vehicle is…
FROM SAMPLE:
FULL EV OR HYBRID
CAR MAKE AND MODEL

(ALLOW EDITING FOR ANY FIELDS THAT ARE WRONG)

S ASK ALL

A7 Does your household have regular access to any other vehicles apart from the electric/hybrid vehicle registered for this trial?

Yes **(SPECIFY MAKE AND MODEL)**
No

S ASK IF YES AT A7

A8 How many other vehicles does your household have regular access to?

1
2
3+

S ASK ALL

A9 Which of these best describes how you personally use the electric/hybrid vehicle registered for this trial?

I am the main driver
I drive the car regularly but am not the main driver
I rarely or never drive the vehicle **CONFIRM WITH RESPONDENT, CLOSE, AND CONTACT IMPACT AS ALL DRIVERS SHOULD BE REGULAR DRIVERS OF THE VEHICLE.**

M ASK ALL

A10 Apart from you, who else is likely to drive the electric/hybrid vehicle registered for this trial?

Please select all that apply.

My partner
Another household member
Someone who does not live in the household
Only me EXCLUSIVE

Thank you for confirming that information. We will now ask you some questions about your household.

DEMOGRAPHICS AND HOUSEHOLD INFORMATION

S ASK ALL,

B1 Please record your gender below.

1) Male
2) Female

S ASK ALL

ADD VALIDATION RULE NO YOUNGER THAN 16 AND UP TO 99 YEARS OLD

B2 Please record your age below.

……. Years old

AUTOMATICALLY CODE INTO THE FOLLOWING AGE BREAKS (HIDDEN VARAIBLE]

IF CODE 1 CLOSE

QHIDAGE Please record **age** below

1) Under 18
2) 18-25
3) 26-35
4) 36-45
5) 46-55
6) 56-64
7) 65+

S ASK ALL

B3 Which of the following best describes ***your*** employment?

1) Self employed
2) Employed over 30 hours a week
3) Employed part time, 15-30 hours a week
4) Employed part time, less than 15 hours a week
5) Full time Student
6) Unemployed- seeking work
7) Unemployed- other
8) Looking after the home/children full time
9) Retired
10) Unable to work due to sickness or disability
11) Other (please specify)

S **ASK IF CODE 1, 2, 3, 4 AT B3**

IF CODE 5, 6, 7, 8 SKIP TO B5

B4 Is your work…

1. Mainly daytime work
2. Mainly evening work, from 7pm to 11pm
3. Mainly night work, 11pm to 5am
4. Shifts that change from day to day or week to week

B5 How many people (including children) are there in your household altogether (that is currently living at home with you)?

Please include yourself in the total.

ENTER NUMBER 1-20

IF 2 OR MORE AT B5 ASK B6

B6 How many children live permanently in your household?

ENTER NUMBER 0-20

S ASK ALL

B7 Which ONE of the following categories best describes the employment status of the ***Chief Income Earner*** (CIE) in your household?

1) Semi or unskilled manual *worker (e.g. Caretaker, Park keeper, non-HGV driver, shop assistant etc.)*
2) Skilled manual worker *(e.g. Bricklayer, Carpenter, Plumber, Painter, Bus/ Ambulance Driver, HGV driver, pub/bar worker etc.)*
3) Supervisory or clerical/ junior managerial/ professional/ administrative *(e.g. Office worker, Student Doctor, Foreman with 25+ employees, salesperson, etc.)*
4) Intermediate managerial/ professional/ administrative *(e.g. Newly qualified (under 3 years) doctor, Solicitor, Board director of small organisation, middle manager in large organisation, principle officer in civil service/local government etc.)*
5) Higher managerial/ professional/ administrative *(e.g. Doctor, Solicitor, Board Director in a large organisation 200+ employees, top level civil servant/public service employee etc.)*
6) Student
7) Casual worker – not in permanent employment
8) Housewife/ Homemaker
9) Retired and living on state pension
10) Retired and not living on state pension
11) Unemployed or not working due to long-term sickness
12) Full-time carer of other household member

S ASK IF CODE 10 AT B7

B8 Which ONE of the following categories best describes the employment status of the Chief Income Earner ***before*** they retired?

SHOW THE SAME LIST AS B7, EXCLUDING CODES 9 AND 10

AUTOMATICALLY CODES OF QUESTIONS B7 AND B8 INTO SOCIAL ECONOMIC GRADE AS FOLLOWS:

CODE 1	**D**
CODE 2	**C2**
CODE 3 OR 6	**C1**

CODE 4	**B**
CODE 5	**A**
CODE 7 OR 8 OR 9 OR 10 OR 11 OR 12	**E**

S GRID ASK ALL

B9 Which of these best represents your **total** household income before tax and other deductions, either per month or per year.

This information will only be used to check that we have surveyed a mixture of different customers.

ONLY ALLOW ONE ANSWER IN ONE COLUMN

	PER MONTH	PER YEAR
1	Up to £539	Up to £6,499
2	£540 - £789	£6,500 - £9,499
3	£790 - £1289	£9,500 - £15,499
4	£1290 - £2079	£15,500 - £24,999
5	£2080 - £3329	£25,000 - £39,999
6	£3330 - £4999	£40,000 - £59,999
7	£5000 - £7499	£60,000 - £89,999
8	£7500 and over	£90,000 and over
98	Don't know	Don't know
99	Prefer not to say	Prefer not to say

S ASK ALL

B10 Which of the following do you have in your main charging address?

Mains electricity only
Mains electricity and mains gas
Mains electricity and another fuel source such as oil

S ASK ALL

B11 Do have solar panels (photovoltaics) at your home address?
Yes
No
Not sure

S GRID ASK ALL

B12 On average, how much is your combined spend, on gas **and** electricity?

ONLY ALLOW ONE ANSWER IN ONE COLUMN

	PER MONTH	PER YEAR
1	Less than £35 per month	Less than £400 per year
2	£35 - £49	£400 - £599
3	£50 - £65	£600 - £799
4	£66 - £85	£800 - £999
5	£86-£100	£1,000 - £1,199
6	£101 - £115	£1,200 - £1,399
7	£116 - £130	£1,400 - £1,599
8	£131-£149	£1,600 - £1,799
9	Over £150 per month	£1,800 or more per year
98	Don't know	Don't know
99	Prefer not to say	Prefer not to say

QHIDFUELPOV:
1 FUEL POOR – IF MORE THAN 10% OF INCOME SPENT ON FUEL BASED ON RESPONSE AT B9 AND B12
2 NON-FUEL POOR – IF LESS THAN 10% OF INCOME SPENT ON FUEL BASED ON RESPONSE AT B9 AND B12

C1 Finally, have you experienced any technical difficulties while taking the survey?

1. No
2. Yes (Please specify)

Thank you for the information you have provided today. We will be in touch again once you have had your vehicle and been charging it for a few weeks to understand a little more about how you use and charge you vehicle.

If you have any questions in the meantime about the survey you have just done, or future surveys, please contact Impact Research on 01932 226 793 and ask for a member of the Electric Nation team. Our full contact details and those of the Electric Nation project partners such as DriveElectric were provided to you in your welcome pack. Please do not hesitate to get in touch if you have any questions.

Thank you.

Appendix 2 – Baseline Survey

Electric Nation Recruitment Questionnaire

February 2017

568 Electric Nation	ONLINE SCRIPT FV 22/02/17	Susie Smyth, Michael Brainch, Lucy Upshall, Helen Rackstraw

INTRODUCTION TO THE RESEARCH AND ADHERENCE TO MRS CODE OF CONDUCT

CATI ONLY: Hello, may I speak to **NAME FROM SAMPLE** please?
C1. I am calling from Impact Research about the Electric Nation project that you recently agreed to take part in. We recently sent you a survey link by email, can I check whether you received that email?
Yes
No – **CONFIRM EMAIL ADDRESS WITH RESPONDENT MATCHES SAMPLE**

CATI ONLY: C2. We would be really grateful if you would be able to complete this survey as soon as possible, I can take you through the questions now on the phone, or if you prefer you can complete it online? The survey should take no longer than 5 minutes.
Phone - **CONTINUE**
Online – **CHECK IF NEED LINK RE-SENDING, THANK AND CLOSE.**

ASK ALL
Thank you for agreeing to participate in this important project about the future of electric vehicles. This is the second survey that you will be asked to take part in during the trial and should take no more than 5 minutes to complete, depending on the answers you give us. The purpose of this survey is to gauge how you are currently charging your electric vehicle. This information will be used in combination with that from the other trial participants to understand how behaviour might vary by different groups.

This is a genuine market research study and no sales call will result from our contact with you. The interview will be carried out in strict accordance with the Market Research Society's Code of Conduct. Your identity and any information you provide to us will be kept confidential and will not be used for any purposes other than this research. Your details were provided to us by DriveElectric and only Impact Research and DriveElectric will have

access to your personal contact information so that we can keep in touch with you throughout the trials.

USE

We have some details about you we would like to check are correct before we continue.

M ASK ALL

A1 Firstly, what do you use your electric vehicle for? Please select all that apply.

1) Social
2) Business
3) Commuting

S ASK ALL

A2 Does your household have regular access to any other vehicles apart from the electric/hybrid vehicle registered for this trial?

1) Yes
2) No

S ASK IF A2=YES

A2a How many other vehicles does your household have regular access to apart from the electric/hybrid vehicle registered for this trial?

1) ……. **(SPECIFY MAKE AND MODEL FOR EACH)**

M ASK IF A2 = YES PLEASE SHOW ON SAME PAGE AS A2

A3 Is your other vehicle(s)… Please select all that apply.

1) Electric
2) Range extended electric
3) Plug in Hybrid
4) Hybrid
5) Petrol
6) Diesel
7) Other (please specify)

Thank you for confirming this information. We will now ask you some questions about your electric vehicle.

CHARGING BEHAVIOUR

M ASK ALL, ROTATE ALL

B1 To what extent do you agree or disagree with the following statement, where 1 is strongly disagree and 5 is strongly agree.

1) My charging behaviour varies considerably from day to day
2) My charging behaviour has a regular routine
3) Whenever I have access to a charger, I plug in, regardless of the level of charge of the vehicle
4) I will only plug in to charge when the battery is too low to complete my current/next journey

M **ASK ALL, MULTICODE**

B2 Where do you charge your electric vehicle? Please select all that apply.

3) Home
4) Service station (motorway) / Petrol station
5) On street charge point
6) Work
7) Supermarket/Shopping centre car parks
8) Other Car parks (please specify)
9) Friend/relative's house
10) Other (please specify)
11) Don't know

S **ASK ALL, SINGLE CODE**

B3 And, where do you charge your electric vehicle most often?

INSERT ALL SELECTED AT B2

S **ASK ALL, SINGLE CODE BY ROW**

B4 How often do you charge your electric vehicle in the following locations?

	1)	2)	3)	4)	5)	6)	7)	8)
Location	More than once a day	Once a day	5 -6 times a week	3-4 times a week	Once – twice a week	Once a fortnight	Less than once a fortnight	I don't have charging routine / Don't know
INSERT ALL SELECTED AT B2								

M **ASK ALL, MULTICODE**

B5 When do you typically charge your electric vehicle at the following locations? Please select all that apply to each location.

	1)	2)	3)	4)	5)
Location	Morning	Afternoon	Evening	Overnight	I don't have a standardised charging routine
INSERT ALL SELECTED AT B2					

S ASK ALL

B6 Thinking about when you charge your electric vehicle in the following locations, how long do you charge your electric vehicle for on each occasion?

	1)	2)
Location	**PROGRAMMER: NUMERIC BOX** _____ hours	I don't have a charging routine / Don't know
INSERT ALL SELECTED AT B2		

S ASK ALL

B7A How do you tend to judge when to charge your electric vehicle?

1) Number of miles left
2) Percentage of battery left
3) Other (please specify)

S ASK IF B7A = 1

B7B At what point would you feel like you need to charge the battery of your electric vehicle?

1) 10 miles or below
2) 20 miles or below
3) 50 miles or below
4) 100 miles or below
5) 150 miles or below
6) More than 150 miles

7) Other (please specify)

S ASK IF B7A = 2

B7C At what point would you feel like you need to charge the battery of your electric vehicle?

1) Below 75% charge
2) Below 50% charge
3) Below 25% charge
4) Other (please specify)

S ASK ALL

B8 On a scale of 1 – 10, where 1 is completely unacceptable and 10 is completely acceptable, how **acceptable** are your current charging arrangements?

1) 1 – Completely unacceptable
2) 2
3) 3
4) 4
5) 5
6) 6
7) 7
8) 8
9) 9
10) 10 – Completely acceptable
11) Don't know (Please specify why)

S ASK ALL

B9 On a scale of 1 – 10, where 10 is very satisfied and 1 is very dissatisfied, how **satisfied** are you with your current charging arrangements?

1) 1 - Very dissatisfied
2) 2
3) 3
4) 4
5) 5
6) 6
7) 7
8) 8
9) 9
10) 10 – Very satisfied
11) Don't know

S ASK ALL

B10 Which statement best describes your attitude to changing your charging behaviour

1) I am very willing to continue with this current charging arrangement indefinitely
2) I am willing to continue with this current charging arrangement for a limited time only
3) I would prefer alternative charging arrangements
4) I cannot continue with these current charging arrangements

OE ASK IF CODES 2 – 4 SELECTED AT B10

B11 Why do you say that?

S ASK ALL

B12 How do you feel about having your charging arrangements managed as part of the trial?

1) Not at all concerned
2) Slightly concerned
3) Quite concerned
4) Very concerned
5) Not sure

OE ASK ALL

B13 Why do you say that?

INSTALLATION QUESTIONS (DE)

Thinking back to when you had your charge point installed….

G ASK ALL

I1 Overall can you tell us what you thought of your experience with DriveElectric in terms of… **ROWS**

a) Contact with DriveElectric
b) Information provided to you about the project
c) Administration of your application for the charger

COLUMNS

1) Very poor
2) Poor
3) Neither poor nor good
4) Good
5) Very good

S ASK ALL

I2 How was your experience of the install itself?

1) Very poor
2) Poor
3) Neither poor nor good
4) Good
5) Very good

S ASK ALL

I3 Did the installer explain how safety would be managed as part of the installation?

1) Yes
2) No
3) Can't remember

OE ASK ALL

I4 Is there anything you feel you need more information on regarding the project?

OPEN ENDED

Thank you for providing that information. I would just like to confirm your contact information is up to date.

CONTACT INFORMATION

S ASK ALL

C1 Can I confirm that this is still the best number to contact you on?

1) Yes
2) No

S ASK IF C1 = 2

C2 Please provide the best number to contact you on in the future?

_____

C3 Finally, have you experienced any technical difficulties while taking the survey?

1. No
2. Yes (Please specify)

Thank you for the information you have provided today. We will be in touch again once the first trial is underway and you have had few weeks to charge your vehicle.

If you have any questions in the meantime about the survey you have just done, or future surveys, please contact Impact Research on 01932 226 793 and ask for a member of the Electric Nation team. Our full contact details and those of the Electric Nation project partners such as DriveElectric were provided to you in your welcome pack. Please do not hesitate to get in touch if you have any questions.

Thank you.

Appendix 3 – Trial 2 survey app questions – Greenflux cohort

Electric Nation Trial 2 Questionnaire

July 2018

568 Electric Nation	ONLINE SCRIPT FV 05/07/17	Helen Rackstraw, Evelin Roberts, Nicole McNab

INTRODUCTION TO THE RESEARCH AND ADHERENCE TO MRS CODE OF CONDUCT

CATI ONLY: Hello, may I speak to **NAME FROM SAMPLE** please?
C1. I am calling from Impact Research about the Electric Nation project. We recently sent you a survey link by email, can I check whether you received that email?
Yes
No – **CONFIRM EMAIL ADDRESS WITH RESPONDENT MATCHES SAMPLE**

CATI ONLY: C2. We would be really grateful if you would be able to complete this survey as soon as possible, I can take you through the questions now on the phone, or if you prefer you can complete it online? The survey should take no longer than 5 minutes.
Phone - **CONTINUE**
Online – **CHECK IF NEED LINK RE-SENDING, THANK AND CLOSE.**

ASK ALL
Thank you for agreeing to participate in this important project about the future of electric vehicles. This is the fourth survey that you will be asked to take part in during the trial and should take no more than 5 minutes to complete, depending on the answers you give us. The purpose of this survey is to gauge how you are currently charging your electric vehicle. This information will be used in combination with that from the other trial participants to understand how behaviour might vary by different groups.

This is a genuine market research study and no sales call will result from our contact with you. The interview will be carried out in strict accordance with the Market Research Society's Code of Conduct. Your identity and any information you provide to us will be kept confidential and will not be used for any purposes other than this research. Your details were provided to us by DriveElectric and only Impact Research and DriveElectric will have access to your personal contact information so that we can keep in touch with you throughout the trials.

App Usage

S **ASK ALL**

B14 Are you aware that you can access an app to interact with your smart charging system?

1) Yes
2) No
3) Not sure

S **ASK IF CODE 1 AT B14**

B15 Have you used the app?

1) Yes
2) No

OE **ASK IF CODE 2 SELECTED AT B15**

B16 Why have you not used the app?

S **ASK IF CODE 1 AT B14 AND ASK GREENFLUX ONLY**

B17a Are you aware that you can use the app to request high priority charging?

1) Yes, and I have used it
2) Yes, but I have not used it
3) No
4) Not sure

OE **ASK IF CODE 1 AT B17a**

B17b What were your reasons for requesting high priority charging?

OE **ASK IF CODE 1 AT B14**

B20 Are there any other functions that you expected to see on the app?

S **ASK ALL**

B21 How likely are you to use the app going forward?

1) Very likely
2) Slightly likely
3) Neither likely nor unlikely
4) Slightly unlikely
5) Very unlikely

S **ASK IF CODE 1 AT B14**

B22 To what extent does the app alleviate your concerns about managed charging?

1) I had **no** concerns regardless of the app
2) I had concerns and the app alleviates **some** of them

3) I had concerns and the app alleviates **most** of them
4) I had concerns and the app alleviates **all** of them
5) Not sure

S **ASK IF CODE 1 AT B15**

B23 How easy do you find using the app?

1) Very Easy
2) Easy
3) Neither easy or hard
4) Hard
5) Very hard

OE **ASK ALL**

B24 Is there anything else that you would like to share about your experience of being part of the Electric Nation project so far that hasn't already been covered in this interview?

Appendix 4 – Recruitment Survey Invitation

Dear

You are receiving this survey invitation based upon you signing up to the **Electric Nation** research project. Your details were given to us by our project partner **Drive Electric**.

This initial survey will collect some background information about yourself and your electric vehicle, which will be used throughout the duration of the project. All details collected will be kept confidential and only be used for the purpose of this research as outlined in the welcome back. The information you provide for us is important to help us understand how different electric vehicle users' experiences might vary.

To take part in the survey, please read the following and click on the relevant link below:

<SURVEY LINK>

This survey should take approximately 10 minutes to complete. Please aim to complete the survey within the next seven days, after which time we may be in contact with you to remind you to complete the survey as soon as you can.

As part of this research you will be asked to complete up to seven further surveys throughout the next two years as previously explained.

If you have any queries about the Electric Nation surveys we send you please contact us at Impact Research on 01932 226 793 or electricnation@impactmr.com. If you have any other questions about the research then please refer to your welcome pack for relevant contact details. We look forward to receiving your feedback.

Kind regards,

Impact Utilities

Appendix 5 – Baseline Survey Invitation

Email subject: Electric Nation Survey 2

Dear

Thank you for completing the first survey as part of the **Electric Nation** research. **Now you have had your charger for a few weeks** we would like to ask you about your experience so far.

This survey is to understand your initial charging habits before the demand management trial begins. All details collected will be kept confidential and will only be used for the purpose of this research, as outlined in the Welcome Pack. The information you provide for us is important to help us understand how different electric vehicle users' experiences might vary.

To take part in the survey, please read the following and click on the relevant link below:

<SURVEY LINK>

This survey should take approximately 5 minutes to complete. Please aim to complete the survey within the next seven days, after which time we may contact you to remind you to complete the survey as soon as you can.

As part of the Electric Nation project you will be asked to complete up to six further surveys throughout the next two years, as previously explained.

If you have any queries about the Electric Nation surveys we send you, please contact us at Impact Research on 01932 226 793 or electricnation@impactmr.com. If you have any other questions about the Electric nation project then please refer to your Welcome Pack for relevant contact details. We look forward to receiving your feedback.

Kind regards,

Impact Utilities

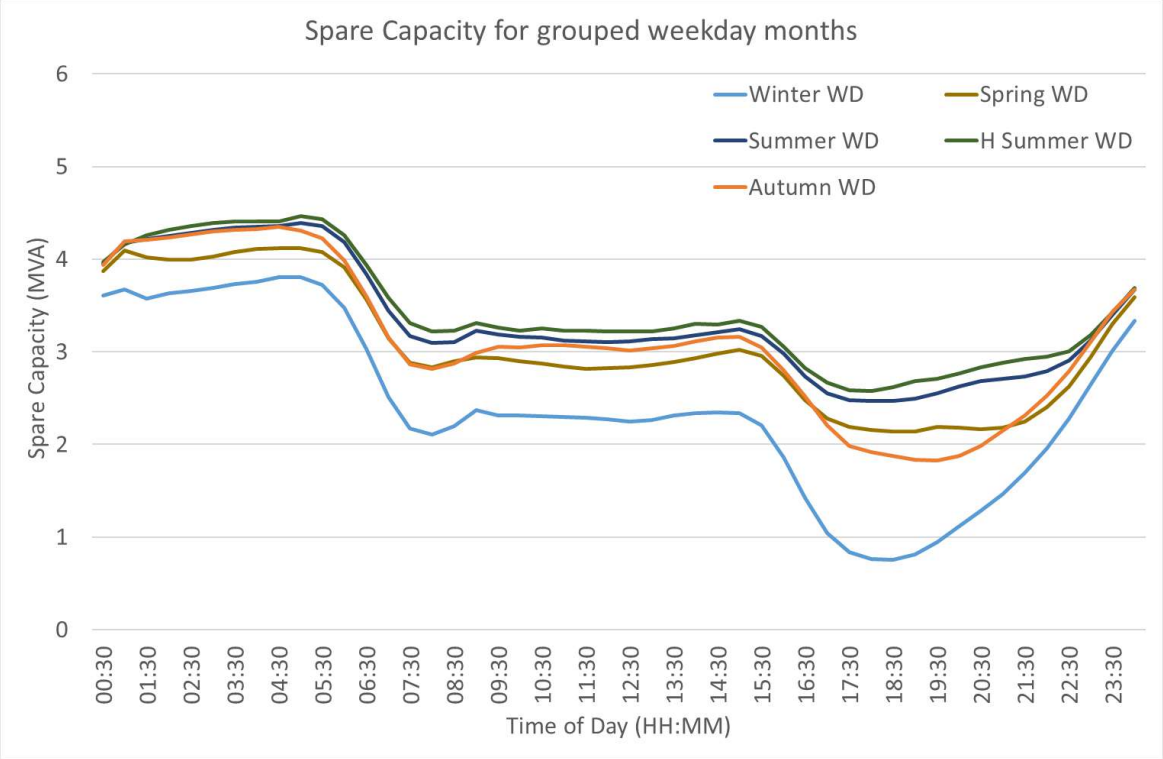
Appendix 6 – Smart Charging Roll-Out Process

Analysis of Network Data to Show Available Network Capacity

Electric Nation is trialling the use of demand management (smart charging) to avoid or defer network reinforcement. To achieve this the additional load from EV charging must be accommodated within 'spare' network capacity. This available spare capacity will vary depending on the network in question and by time of year, weekend/weekday and time of day.

In the first year of the Electric Nation trial 'spare capacity' profiles have been generated for a high voltage (HV) feeder in the East Midlands, for five seasons, for weekdays and weekends. The resulting profile is shown below.

Figure 46: Spare Capacity Profile



This spare network capacity is equivalent to the amount of power which could be drawn by EV charging (or other load growth) on the network without exceeding the networks design limits. However, it requires scaling to be used within the trials – for example, the winter profile above has a minimum spare capacity of 0.75MW in winter at 18:30. This is equivalent to 107 chargers drawing 7kW (or slightly less than a third of each cohort when all participants are under demand management). The project is therefore scaling the capacity profiles so that participants experience a similar amount of demand management as the number of participants under management grows.

Identify Chargers Ready for Demand Management

As set out above, there are two routes in demand management:

- Charge at Will: Approximately 100 participants in each cohort (GreenFlux and CrowdCharge) who will be allowed unrestricted charging for approximately 90 days before demand management is imposed.
- Straight into Management: once the charger is in use approximately two weeks is permitted to prove the reliability of the communications from the charger, then the charger enters the managed group.

By using these routes, it should be possible to show whether there is any difference in the acceptability of demand management depending on whether participants have prior experience of unrestricted charging. The results of the 'baseline' surveys between the two populations can also be compared to show whether participants have different satisfaction levels with their charging at this stage, or whether their charging behaviour changes once they enter routine management (if they are aware of this), or once they have experienced some curtailment. This analysis will be completed later in the trial and the results shown above include participants from both populations.

Regardless of the route to management, chargers must satisfy several conditions before they entered the 'managed' group. Prior to this they provide data to the trial which will inform the project's understanding of charging behaviour for different types of PIVs. These criteria are set out below:

- Confirm the charger is in use: the date on which the first significant transaction occurs is recorded for each charger (i.e. excluding small transactions which occur during testing when the charger is installed). There can be delay between charger installation and the first use of the charger, for example if there is a delay in the delivery of the vehicle. For the charge at will group approximately 90 days is required between the date of first transaction and their entry into demand management. This measure is purely based on the time since they start charging and does not include the number of transactions. However, it is a sufficient period of time for drivers to develop a charging routine.
- Charger configuration is ready for demand management: this is undertaken in conjunction with GreenFlux/CrowdCharge as appropriate and any issues are remedied as necessary.
- Ensure reliable communications: poor communications between the charger and demand control provider could negatively affect the participant's experience of smart charging or make smart charging impossible (in the case of no communications). If a participant is more harshly affected by demand management due to a communications failure this could be reflected in their acceptability of the concept of smart charging, when it does not represent a realistic scenario. For this reason, participants are only being transferred into demand management after two to three weeks of good (85%+ reliability) performance.
- Test of controllability: this stage confirms that each individual charger is controllable before it is placed in a group. For CrowdCharge participants this is routinely carried out during each transaction and involves a very short reduction in the current available (no participant impact). GreenFlux participants pass through a 'test card'

phase in which the charger behaves as it will during management, but full capacity is available at all times. Performance in the test card phase is then evaluated and recorded before the charger passes to routine management.

Batches of chargers which are ready to enter demand management are being identified approximately fortnightly, made up of a mix of participants who have been through the 'charge at will' and 'straight to management' routes. The output from this stage is a list of charger IDs which will form the managed group and the total number of chargers involved. An update on the number of participants which have passed this stage is provided in Section 4.4 below.

Scale Available Network Capacity Based on Number of PIVs in the Managed Group

The profiles of spare capacity (current limit) set out above are scaled based on the number of EVs in the managed group. This scaling factor is applied so that the participants experience a similar level of demand management to that which would apply when 30% of vehicles in the area are electric. This 30% figure was selected based on the findings of My Electric Avenue, and to be representative of a "2030 scenario". The proportion chosen could be altered in one of the later stages of the trial. The level of management that participants experience should stay consistent as the group is expanded (within the same season) as the current limit profile (demand limit) is re-scaled with each expansion.

Issue Group and Profile Definitions to GreenFlux/CrowdCharge

A data format has been agreed between EA Technology and both DCS providers to show the participants who make up a managed group and the weekday/weekend profile they should be managed to. This is issued by EA Technology and then implemented. Participants are not informed when the switch is made into demand management, to avoid prejudicing their survey responses. Impact Utilities are also notified of the date when each participant enters demand management to allow their survey to be issued at the appropriate time.

Monitor Performance

Throughout the trial (both before and after the implementation of demand management) all chargers should supply transaction records and meter values (current drawn and current allocated). These are being supplied to EA Technology by both demand management providers.