ELECTRIC NATION

YOUR ELECTRIC VEHICLE YOUR SMART CHARGE

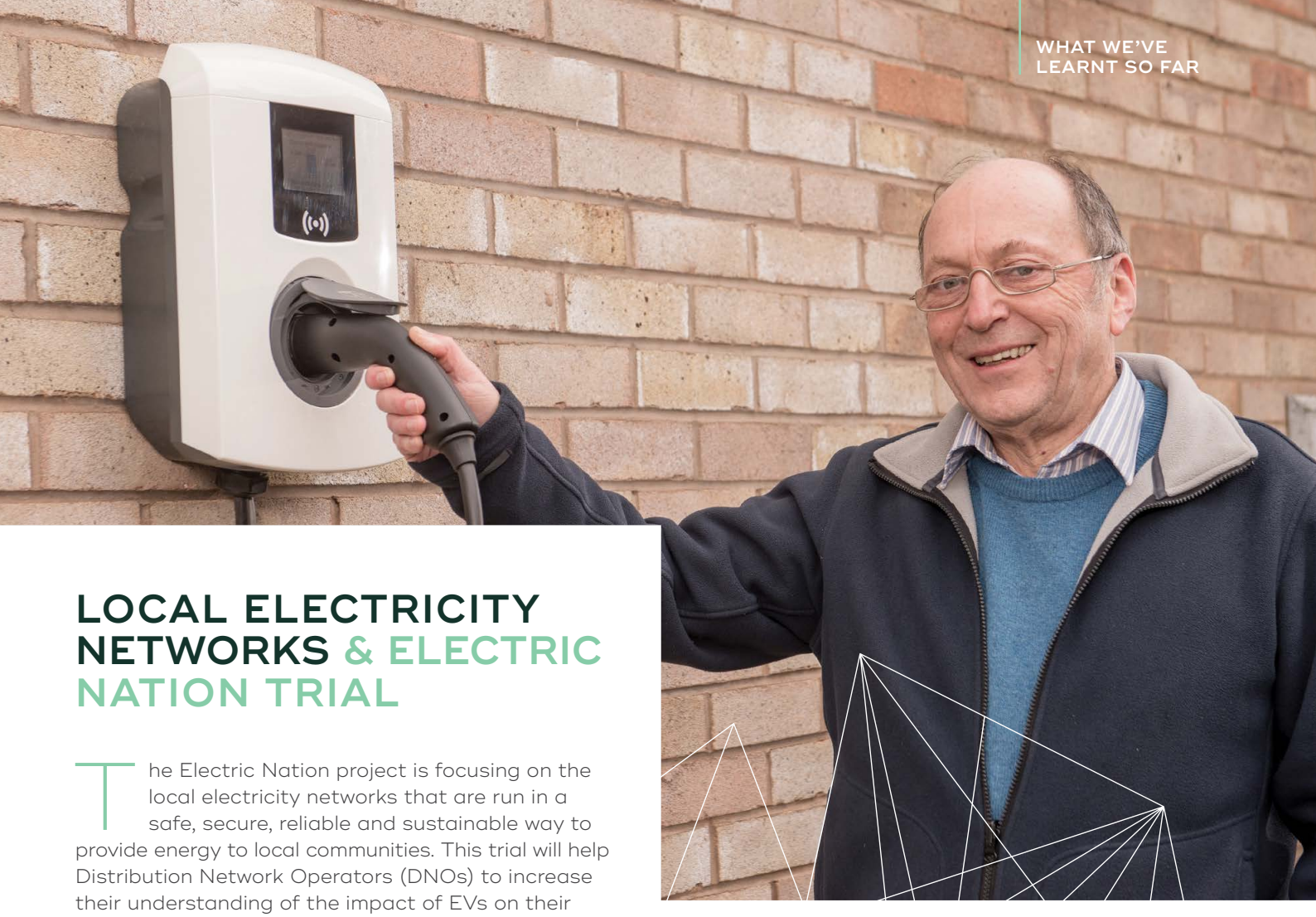
THE REAL-WORLD SMART CHARGING TRIAL – WHAT WE'VE LEARNT SO FAR

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

INTRODUCTION TO ELECTRIC NATION

The growth of electric vehicles (EVs) presents a new challenge for the UK's electricity transmission and distribution network operators. As groups of neighbours acquire EVs, localised clustering is likely to have an impact on electricity networks. It has been proven by the My Electric Avenue project that at least 30% of Great Britain's low voltage networks (the cables and substations nearest to homes and businesses) will require investment by 2050 if adoption of electrified transport is widespread.

This would represent a present day cost of £2.2bn and create disruption to customers as new cables are installed. In addition, battery sizes and charging rates have increased since the My Electric Avenue project so the impact on the electricity network will be greater.



LOCAL ELECTRICITY NETWORKS & ELECTRIC NATION TRIAL

The Electric Nation project is focusing on the local electricity networks that are run in a safe, secure, reliable and sustainable way to provide energy to local communities. This trial will help Distribution Network Operators (DNOs) to increase their understanding of the impact of EVs on their networks and how this impact could be reduced using smart chargers.

OBJECTIVES OF THE PROJECT

The Electric Nation smart charging trial aims to:

+ Expand current understanding of the impact on electricity distribution networks of charging a diverse range of electric vehicles at home. This project is seeking to discover how the impact will be altered by different types of vehicles with different sizes of battery that charge at different rates.
+ Build a better understanding of how vehicle usage affects charging behaviour given diversity of charging rate and battery size.
+ Evaluate the reliability and acceptability to owners of EVs 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?*

Smart charging services in the trial are being provided by CrowdCharge and GreenFlux. The learning from this trial will be used in the development of tools that will help DNOs procure smart charging services to protect low voltage networks from high EV charging demand.

In addition, the data gathered in the trial is being used to develop EV charging profiles for a low voltage network assessment tool that will enable Western Power Distribution to forecast the impact of EV uptake on the low voltage networks across its operational area.

The Electric Nation smart charging trial is nearly complete, ending in December 2018, with the reporting and development of tools and project outputs by October 2019. The following pages give a brief insight into just a few aspects of the customer trial.

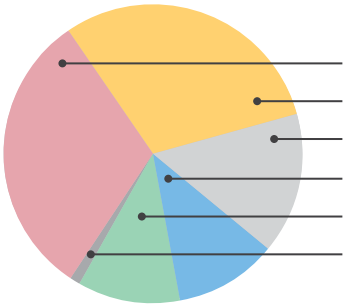
FIND OUT MORE

Further information about the project findings to date can be found on Western Power Distribution's website **www.westernpower.co.uk/Innovation/Projects/Current-Projects**

PARTICIPANT CUSTOMER RESEARCH

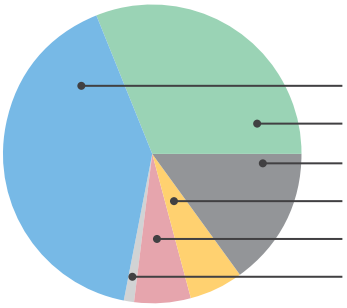
Electric Nation has recruited 673 plug-in hybrid and full electric vehicle drivers into the trial, each equipped with a smart charger at their home. The primary driver of the plug-in hybrid or EV charged using the smart charger is asked to complete customer research surveys at key points in their journey through the trial.

SOME ATTRIBUTES OF EV DRIVERS INVOLVED IN THE TRIAL:



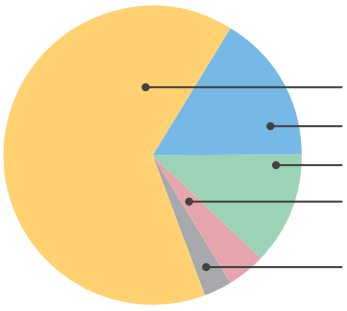
AGE

31% 46-55
30% 36-45
15% 56-64
11% 26-35
11% 65+
1% 18-25



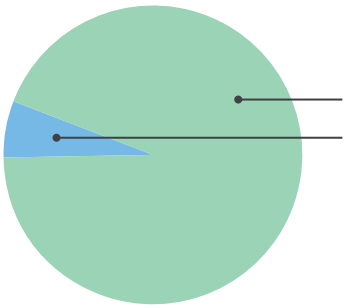
SOCIO-PROFESSIONAL CATEGORY

41% B
31% A
15% C1
6% E
6% C2
1% C1



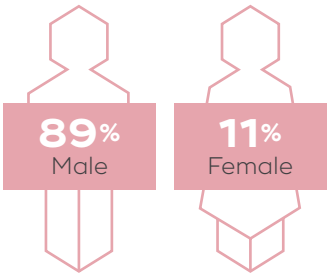
EMPLOYMENT CHARACTERISTIC

64% Employed over 30 hours
16% Self employed
12% Retired
4% Employed part-time 15-30 hours
3% Employed part-time less than 15 hours (1%), Looking after children (1%), Other (1%)



WORKING PATTERN

93% Mainly daytime work
6% Shifts that change from day to day or week to week



51% Owned **Pure Electric Vehicles**

49% Owned **Plug-in Hybrid Vehicles**

38% Live in an **urban** area
35% Live in a **suburban** area
26% Live in a **rural** area

86% Mostly **home** charge
8% Mostly **work** charge
3% Mostly **service station** charge

While they are not representative of the driving population as a whole, they will enable the project to draw observations and conclusions relating to driver attributes, charging behaviours and acceptance of smart charging.

THROUGHOUT THE TRIAL, IN SPITE OF MANY DRIVERS EXPERIENCING REGULAR EV DEMAND MANAGEMENT, 95% OF THE TRIAL PARTICIPANTS REMAIN NEUTRAL OR SATISFIED WITH THEIR CURRENT CHARGING ARRANGEMENTS.

The project is learning a lot about drivers' charging behaviours by using data from their smart chargers to understand the potential mass impacts on electricity distribution networks, and how these might change depending on plug-in vehicle types and battery sizes in the future. This enables the results of the trial to look to the future as battery EVs evolve and the mix of plug-in hybrids vs battery EVs changes.

The time of day when EV drivers plug in to charge and the amount of energy they consume (how long they charge for) is vitally important to understanding EV charging load diversity.

Figure 1 illustrates the difference between weekday and weekend EV start-of-charging (includes delayed charging through use of timers).

If unrestricted charging was allowed as soon as an EV is plugged in then the predicted increase in peak domestic electricity demand on weekdays due to EVs is obvious.

However, Electric Nation has found that EV drivers do not charge their EVs every day and nor do they all wait until their battery is empty before charging.

Figure 2 shows the spread of average proportion of the battery capacity consumed by each participant in charging their EV (e.g. a charge session consuming 20kWh of electricity for a vehicle with a 40kWh battery capacity = 50%).

Trial data suggests that the bigger the vehicle battery, the less likely that it will require a full charge when it is plugged in.

This significantly contributes to the diversity of EV charging behaviour.

A significant number of the Electric Nation trial participants use their EV's on-board timer to take advantage of Economy 7 type tariffs. Figure 3 illustrates use of timers by trial participants.

Trial participants with dual-rate meters (who can use Economy 7 type tariffs) are more likely to use a timer to charge overnight than those who have single rate meters – pointing to time of use tariffs as a way to incentivise EV charge management, and reduce charging during the current evening peak in domestic demand.

This understanding of how simple time of use tariffs, like Economy 7, impacts charging behaviour indicates how smart meter-enabled time of use tariffs could contribute to avoiding EV charging at the peak domestic electricity demand period.

FIGURE 1

% of Charging Events Starting in Each Hour – Weekdays and Weekends

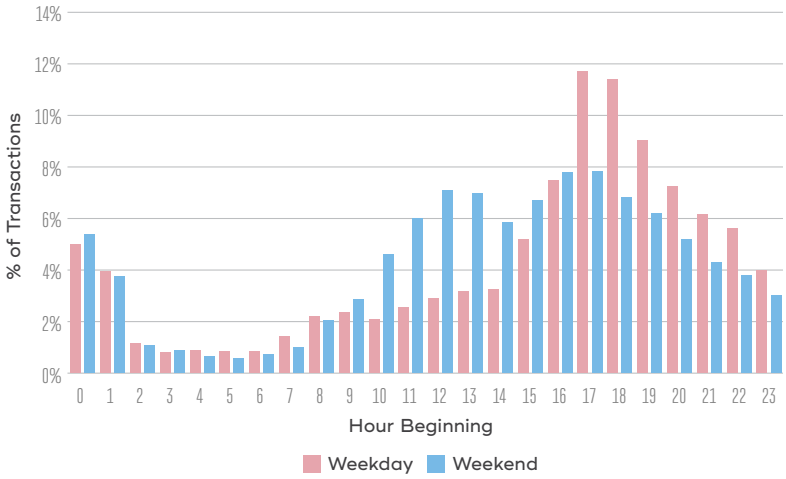


FIGURE 2

Average % of Battery Capacity Filled by Each Participant – by Battery Size

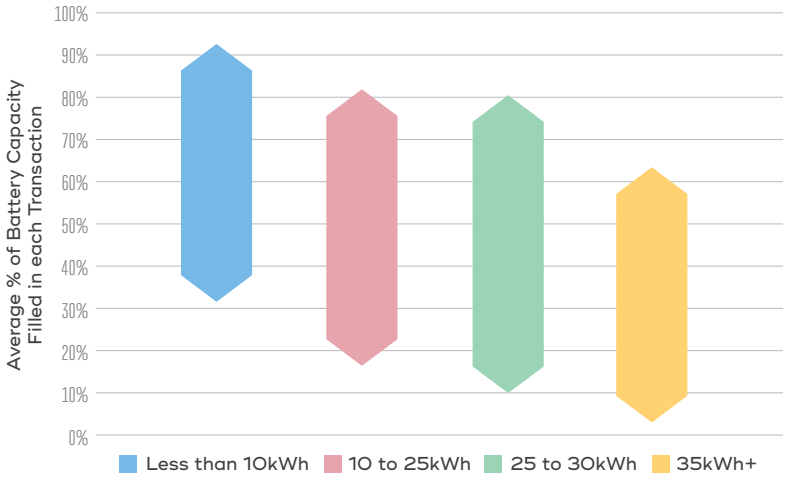


FIGURE 3

Use of Timers – by Time of Plug-in

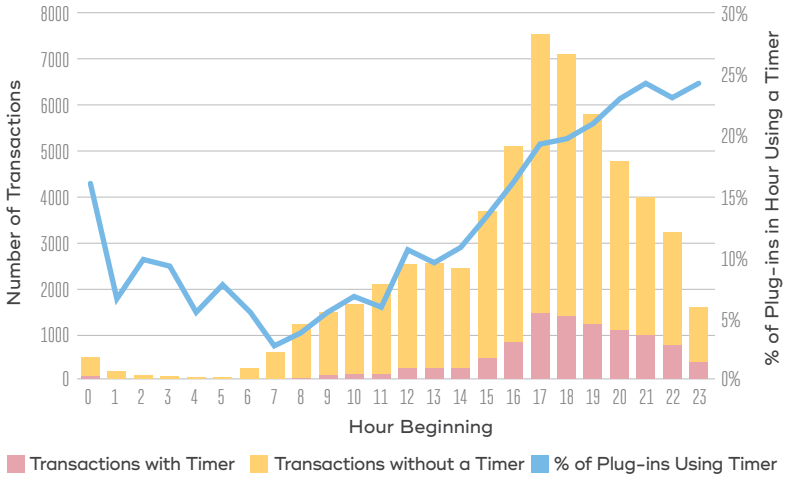
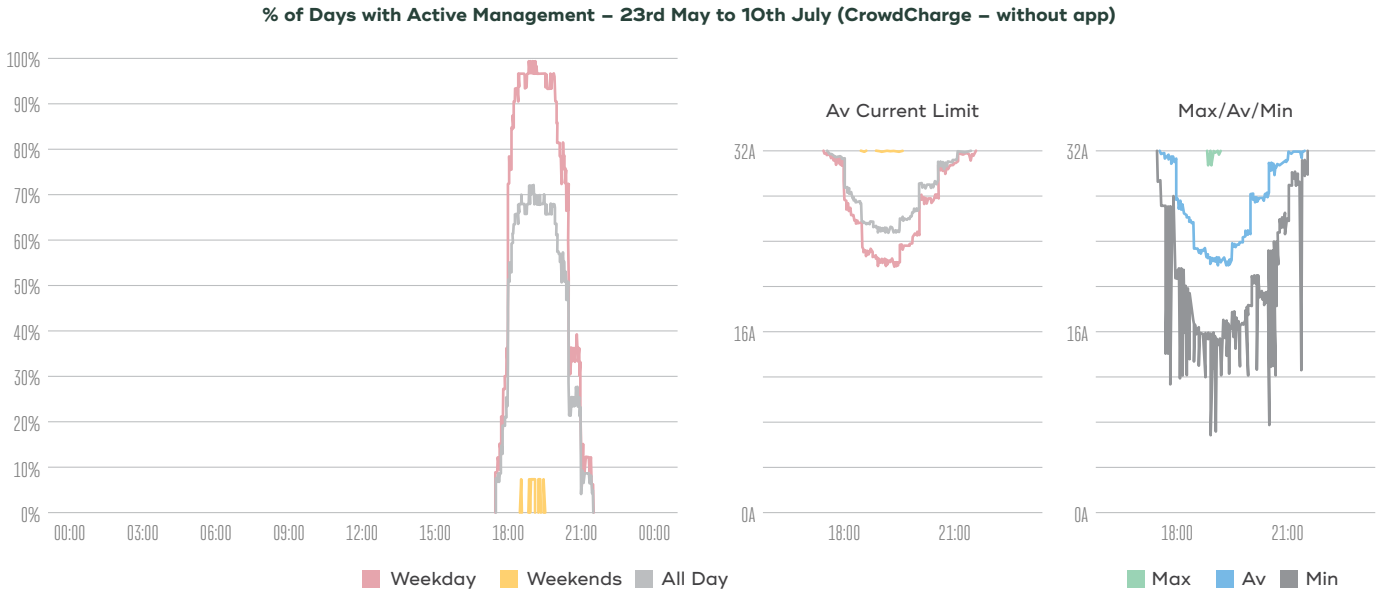


FIGURE 4



SMART CHARGING IN ACTION

Figure 4 is an example of analysis of the CrowdCharge smart charging system in action. The main graph shows the percentage of days (and weekdays and weekend days) that charge management occurred during May/June 2018. The inset graphs show the average (weekday and weekend) and maximum/average/minimum weekday current limits during charge management events.

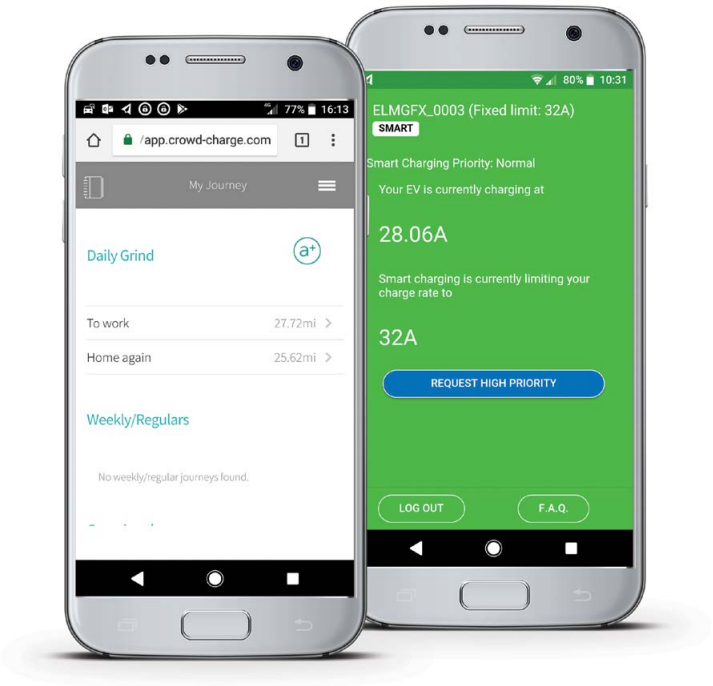
This type of analysis allows Electric Nation to quantify the impact of smart charging on individual customers and reference this back to the customer research and other customer interactions with the project team, to fully assess the acceptability of smart charging for low voltage network protection.

INVESTIGATING CUSTOMER INTERFACES

Electric Nation is investigating whether customer interaction with smart charging systems through 'apps' improves driver satisfaction with charging and acceptance of smart charging.

GreenFlux and CrowdCharge (the two smart charging providers in the trial) have taken different approaches to customer interaction while managing overall EV charging demand within network capacity limits:

+ GreenFlux provides a simple function to request High Priority during a charge session – effectively overriding any demand management that might occur. This is completed via a native application available for Android and Apple devices.
+ CrowdCharge uses journey plans inputted by drivers to ensure enough charge is delivered to each EV. This is entered via a web interface.



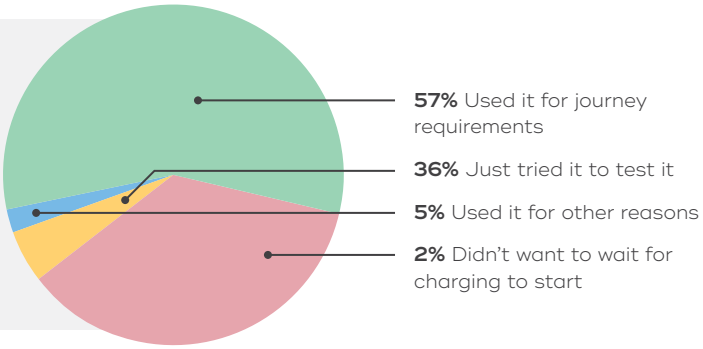
Early indications of app usage suggest that about 50% of trial participants are not interested in using the apps (maybe they are unconcerned by smart charging demand management?). **The following early conclusions can be drawn from those who do use the apps:**

GreenFlux App

248 Customers invited to use app

+ **53%** of the group didn't use the app at all
+ **15%** only used it once

149 customer surveys returned

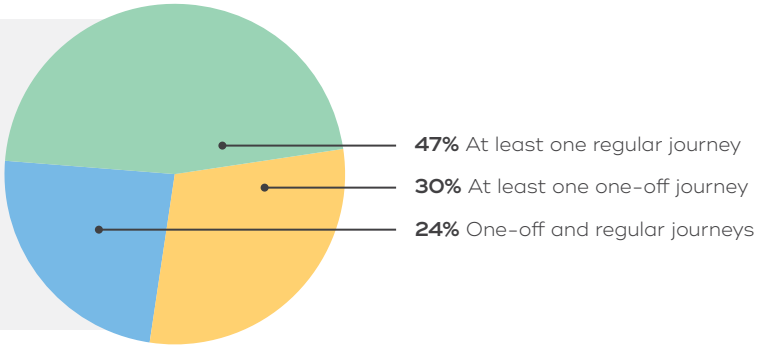


CrowdCharge App

(early indications)

209 Customers invited to use app

+ **62%** not interested yet
+ **38%** set up and operational



INVESTIGATING CUSTOMER INTERFACES WITH INCENTIVES

So far, the Electric Nation project has not rewarded EV drivers for accepting charge management to protect low voltage networks.

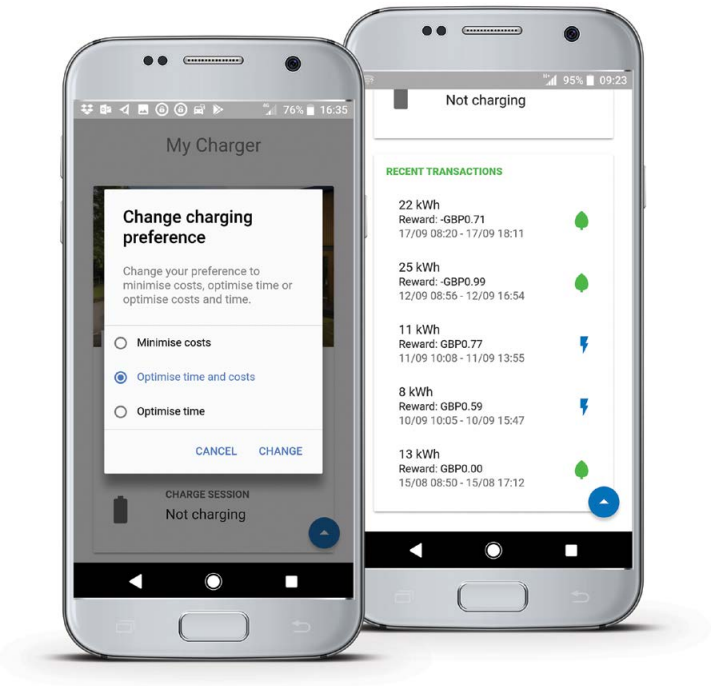
Both CrowdCharge and GreenFlux have incorporated a time of use tariff mechanism into their apps and smart charging algorithms. These will be tested during the final phase of the trial. Both systems are using tariffs that have a form of daytime, peak and night time unit costs.

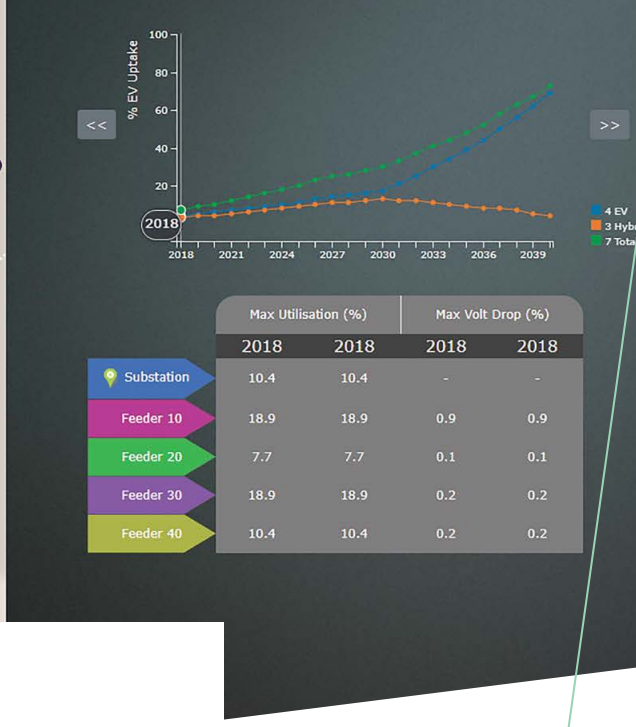
CrowdCharge's app will now calculate how to minimise charge costs while ensuring a car gets the required charge for the next planned journey input by the driver.

GreenFlux's app gives the driver three options for charging preference:

+ Minimise cost – only charges at lowest cost periods
+ Optimise time – charge starts as soon as the EV is plugged in, ignoring price signals
+ Optimise time and cost – avoids charging at the most expensive peak price period

In both cases app users will be able to access historical data that includes cost of charge for each session. These savings will be passed to trial participants via a reward voucher at the end of the trial.





NEXT STEPS

The Electric Nation smart charging trial ends in December 2018.

During 2019 the Electric Nation project team will be analysing the trial data and reporting on findings and conclusions.

Electric Nation will be using project learning to develop a technical specification for smart charging services to protect low voltage networks and consulting with market stakeholders on how such a service might be delivered practically and commercially.

Electric Nation will also be finalising a low voltage network assessment tool that will help Western Power Distribution to quantify the impact of future EV home charging growth on low voltage networks and assess when using a smart charging service is an option to avoid or delay the need for network reinforcement works.

COLLABORATION PARTNERS

Electric Nation is the customer-facing brand of CarConnect, a Western Power Distribution (WPD) and Network Innovation Allowance funded project. WPD's collaboration partners in the project are EA Technology, DriveElectric, Lucy Electric GridKey and TRL.

ea technology
driveelectric electric car leasing
Lucy Electric
TRL

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