WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Electric Nation (CarConnect)

WPD_NIA_013

NIA MAJOR PROJECT PROGRESS REPORT

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Contents

Glossary

Term	Definition
BAU	Business as usual
BEV	Battery Electric Vehicle
CRM	Customer Relationship Management
DE	Drive Electric
DECC	(the former) Department for Energy and Climate Change
DG	Distributed Generation
DNO	Distribution Network Operator
EATL	EA Technology Ltd
EV	Electric Vehicle
EVRT	European EV Road Tour
GB	Great Britain
HV	High Voltage
IPR	Intellectual Property Register
LCT	Low Carbon Technologies
LowCVP	Low Carbon Vehicle Partnership
LEGK	Lucy Electric GridKey
LCNI	Low Carbon Networks and Innovation
LCV	Low Carbon Vehicles event (2017 event held 6th to 7th September at Millbrook)
LV	Low Voltage
MEA	My Electric Avenue project
MPAN	Meter Point Administration Number
NAT	Network Assessment Tool
NIA	Network Innovation Allowance
OHL	Over-Head Line
PHEV	Plug in Hybrid Electric Vehicle
PIV	Plug in Vehicle
PIVDCS	PIV Demand Control Services (or Demand Management Services)
PR	Public Relations (activities)
ULEV	Ultra-Low Emission Vehicle
V2G	Vehicle to Grid
WPD	Western Power Distribution

1 Executive Summary

Electric Nation (the customer facing brand of CarConnect) is funded through Ofgem's Network Innovation Allowance (NIA). Electric Nation was registered in April 2016 and is expected to be complete by October 2019.

Electric Nation aims to enable DNOs to identify which parts of their network are likely to be affected by Plug-in Vehicle (PIV) uptake and domestic charging, and whether PIV domestic charging demand management services are a cost effective solution to avoiding or deferring reinforcement on vulnerable parts of their networks, using three methods.

Method 1: Modelling

This project will provide DNOs with an assessment tool to predict where PIV market penetration may cause network problems through increased demand for domestic PIV charging. This tool will, firstly, enable assessment of all (non-meshed) LV networks in a DNO's licence areas to identify those most likely to be affected by increased penetration of domestic PIV charging. Secondly, the tool will enable more detailed assessment of those LV networks to identify the level of domestic PIV charging penetration that would present a problem and trigger reinforcement and enable assessment of domestic PIV charging demand control, and potentially Vehicle to Grid (V2G), as solutions to avoid or defer reinforcement.

Method 2: Monitoring

This project will develop an algorithm deployable on an existing substation monitoring facility that will enable the effect of charging PIVs on a LV network to be retrospectively analysed and allow the measureable impact to be compared against the modelling tool output.

Method 3: Mitigation

This project will adapt existing smart charger technology, potentially including V2G chargers, if state of technology development is sufficiently advanced during the project timeframe, and existing commercial charger management services to deploy these in a mass-market customer trial. The aim of the trial is to prove the technical/economic viability of domestic PIV charging demand control and V2G services, to avoid or defer network reinforcement and to prove that such systems are acceptable to customers. The customer trial will include a wide range of PIVs, with a range of battery sizes and charging rates to assess to what extent such systems can be deployed in a future with a diverse PIV market.

This report details progress of the project, focusing on the period April 2017 to September 2017.

1.1 Business Case

As groups of neighbours acquire PIVs, localised clustering of demand is likely to cause problems for electricity networks, as demonstrated through the (Low Carbon Networks Fund) My Electric Avenue (MEA) project. MEA showed that approximately 30% of GB low voltage networks will need reinforcement by 2050, if adoption of PIVs (and domestic charging) is widespread (i.e. meeting DECC's High EV Market Growth Forecast). This represents a present day cost of £2.2bn to UK customers – Transform Model® analysis, based on UK Government forecasts of nearly 40 million PIVs on UK roads by that time. The UK Government is committed to the electrification of transport – as illustrated by its recent investment into ultra-low emission vehicles (ULEV) such as its extension of grants for PIV chargers, PIV car subsidies and the Go Ultra Low Cities Scheme.

Which parts of distribution networks will be affected by PIV market growth is not understood – the MEA analysis used idealised network types. There is no tool available for assessing real LV networks to identify those at risk from high penetration of domestic PIV charging, and to identify the technical efficacy and economic viability of smart solutions (domestic charging demand control and V2G) against traditional network reinforcement. Through this project, a tool will be developed that will allow the assessment of real LV networks for the susceptibility to excessive demand from domestic PIV charging.

In recent years, "smart" chargers have been developed for domestic and public charging use, which are controllable for access and billing purposes. Alongside these smart chargers, control services have been developed and deployed to carry out this access control and billing services. These smart chargers also give the option to modulate the power taken by PIVs, giving a more refined set of demand control options than trialled in MEA. It is thought that these technologies could be adapted for domestic charger control to provide demand control services to DNOs across LV areas (rather than just single feeders). However, it is not known whether the application of these technologies, for charging PIVs at home, is technically viable and acceptable to customers. The technical challenges include: ensuring secure and reliable communications between the charger and control services; providing customers with information about the charging of their PIV; allowing the customer to state preference as to when they are charged (ensuring the control is as "fair" as possible to all); and investigating what, if any, compensation or incentives customers require to participate in PIV demand control. Also, the PIV market has and will continue to diversify with a range of battery sizes fitted to PIVs and nominal charge rates growing (from 3kW to 7kW+), making possible peak loads higher and adding complexity to the challenge of PIV demand control. Therefore, this project will investigate to what extent it might be possible to utilise domestic PIV charging demand control to defer or avoid some of the £2.2bn cost to UK customers, calculated in the MEA project.

In addition, vehicle to grid (V2G) services and associated technologies are being developed in the UK and abroad. The impact of mass V2G services on LV networks needs to be understood, especially as some V2G services (such as transmission frequency services) may adversely affect distribution network operations, in a similar way to solar PV generation. V2G could be a solution as much as a problem for LV network congestion, in that export mode could be used to address peak PIV demands - but as V2G has not been developed sufficiently at this time this is a poorly understood option. Furthermore, adapting the domestic PIV charging demand control services to utilise V2G export mode to address PIV charging induced peak loads has not been proven. This project aims to explore the technical readiness of V2G technology for domestic use and assess its potential economic feasibility.

1.2 Project Progress

This report covers project progress for the period April 2017 to September 2017.

The majority of project activities in this period have focussed on recruitment of customers into the customer trial and improving charger communications issues:

EA Technology:

- Development of database for collation and analysis of trial data;
- Improvement of CrowdCharge and GreenFlux data reporting;
- Development of charger communications availability analysis and reporting systems to support charger communications issues identification, diagnosis and troubleshooting;
- Development of solutions for charger communications issues and roll out of these solutions;
- Continued engagement with potential suppliers of V2G chargers to bring into the customer trial;
- Information collection for cyber security review of PIVDCS systems; and
- Continued development of the Network Assessment Tool: Data import, cleaning and validation routines complete, first draft of network modelling heuristics completed.

DriveElectric

- Recruitment of customers into customer trial and managing installation of their chargepoint for the project;
- Monitoring and development of marketing activities notably social media and referral from dealers, installers and other trade contacts;
- Continued development of helpdesk function including a robust fault monitoring and reporting database;
- Continued development of qualification points and processes;
- Analysis and development of fixes for chargepoint communications issues; and
- Work to progress understanding of availability of V2G chargers for subsequent stages of project.

Lucy Electric GridKey

- Installation of 21 GridKey units on substations;
- Analysis of EV charging data from Millbrook installation (linked to project outside of CarConnect | Electric Nation); and
- With TTP, development of algorithms to detect signatures of EV charging amongst base demand fluctuations.

TRL

- Continued monitoring of project against Key Outputs, Milestones, Actions, Risks and Issues;

- Provision of regular (monthly, quarterly and six-monthly) reports to WPD describing project progress; and
- Providing technical and project management oversight of project delivery and work being carried out by the delivery team.

1.3 Project Delivery Structure

1.3.1 Project Review Group

The Electric Nation Project Review Group meets on a bi-annual basis. The role of the Project Review Group is to:

- Ensure the project is aligned with organisational strategy;
- Ensure the project makes good use of assets;
- Assist with resolving strategic level issues and risks;
- Approve or reject changes to the project with a high impact on timelines and budget;
- Assess project progress and report on project to senior management and higher authorities;
- Provide advice and guidance on business issues facing the project;
- Use influence and authority to assist the project in achieving its outcomes;
- Review and approve final project deliverables; and
- Perform reviews at agreed stage boundaries.

The last Project Review Group meeting was held on 29th June 2017 and the next is expected to be held in early 2018.

1.3.2 Project Resource

Western Power Distribution (WPD)

Project Manager: Mark Dale

Project Support: Emily Green

Marketing and Data Provision support as required.

EA Technology (EATL)

EA Technology's primary roles in the project are:

- Project management – delivery of project;
- Management of project supporting activities, such as marketing and, PR for customer recruitment, and customer research;
- Development of the Network Assessment Tool;
- Development of the customer trial programme;
- Management of the PIVDCS suppliers and their input to the trial;
- Development of the PIVDCS algorithm(s);
- Management of V2G trial; and
- Production and dissemination of the project deliverables, reports and learning outcomes.

DriveElectric (DE)

Drive Electric's primary roles in the project are:

- Recruitment of customer trial volunteers;
- All practical aspects of operating the customer trial;
- Customer relationship management (including data protection);
- Supply of PIVs to some of the customers volunteering for the trial (not funded by this project);
- Supply and installation of "smart" chargers, through sub-contractor organisations;
- Customer communications and retention in the trial;
- Supply of vehicle related trial data; and
- Supply of V2G chargers.

TRL

TRL's primary roles in the project are:

- Overarching project overseeing role for all three methods, providing WPD deeper insight into how the project is performing from both a Project Management and Technical perspective;
- Provision of feedback, expert advice, technical review and reporting of project approach and milestones;
- Maintaining the project RAID log, Action Log and Key Outputs and Milestones log, alongside EATL and DE;
- Monthly meeting coordination and reporting;
- Monthly and 6 monthly reporting to WPD;
- Escalation of significant issues to WPD; and
- Independent validation of milestones.

Lucy Electric Gridkey (LEGK)

Lucy Electric Gridkey's primary roles in the project are:

- Supply of monitoring equipment;
- Development of a detection algorithm (TTP supporting LEGK); and
- Production of a functional specification for a detection algorithm to detect EV charging.

1.4 Procurement

Table 1-1 details the current status of procurement for this project.

Provider	Services/goods	Area of project applicable to	Anticipated Delivery Dates
CrowdCharge	PIVDCS services	Test System Pilot Installations Customer Trial	August 2016- December 2018
Greenflux	PIVDCS services	Test System Pilot Installations Customer Trial	August 2016- December 2018
ICU Charging	Smart Chargers	Test System	August 2016-

Provider	Services/goods	Area of project applicable to	Anticipated Delivery Dates
Solutions		Pilot Installations Customer Trial	December 2018
APT	Smart Chargers	Test System Pilot Installations Customer Trial	August 2016-December 2018
The Tech Factory	Systems Integration (smart charger communications) equipment, services and support	Test System Pilot Installations Customer Trial	August 2016-December 2018
NCC	Cyber Security Assessment of PIVDCS systems	Customer Trial & Functional Specification	Summer 2019
EV Charging Solutions Stratford Energy Solutions Actemium UK The Phoenix Works	Smart Charger Installation services	Pilot Installations and Customer Trial	November 2016-Spring 2018
Impact Utilities	Customer research services	Customer Trial	December 2016 – January 2019
AutomotiveComms	Marketing & PR services	Project	July 2016-October 2019
TTP	Algorithm development for LEGK	Monitoring	End of project
GEOTAB	Vehicle Telematics	Telematics	July 2017 – March 2018

Table 1-1: Procurement Details

1.5 Project Risks

A proactive approach is taken to ensure effective risk management for the CarConnect | Electric Nation project. A RAID (Risks, Assumptions, Issues, and Dependencies) log is maintained, examined and updated by TRL, EATL, DE, and LEGK. This activity ensures that risks are frequently reviewed, examining: whether risks still exist, whether new risks have arisen, whether the likelihood and impact of risks have changed, for reporting of significant changes that will affect risk priorities, and to deliver assurance of the effectiveness of control.

Risks are reported to WPD within each monthly report. At each monthly meeting, the RAID log is reviewed and updated by the project delivery team, TRL and WPD. TRL provides a critical overseeing role within the meeting to ensure that all risks are being effectively captured and managed.

Contained within Section 7.1 of this report are the current top risks associated with successfully delivering Electric Nation as captured in the RAID log. Section 7.2 provides an update on the most prominent risks identified at the project bid phase.

1.6 Project Learning and Dissemination

A Project Learning Log is maintained. Project lessons learned and what worked well are captured throughout the project lifecycle. These are captured through a series of on-going reviews with stakeholders and project team members, and will be shared in lessons learned workshops at the end of the project. These are reported in Section 5 of this report.

Project Dissemination Activities during this period

The team has attended a number of relevant industry events to raise the profile of the Electric Nation project and to share early learning arising from Algorithm Development and Testing Report:

- The EVRT (European EV Road Tour) event in London on 25th April.
- Urban Mobility Solutions Conference (All-Energy), Glasgow, 10-11 May 2017
    - Dissemination of learning to wide cross-sector industry audience – DNOs, academia, policy

      This was subsequently reported in "Electrical Energy Storage Magazine, June 2017)
- LowCVP Cities event, 22 June 2017, a High profile automotive, energy, Government event.
- Cenex LCV 2017, 6-7 September 2017, supported by the majority of project partners and suppliers. The stand was busy throughout and resulted in 90 leads being captured; interest ranging from smart charging and trial set up to early results and customer acceptance of smart charging. WPD and EA Technology presented at the event to an engaged audience; the 'funnel diagram' showing spare capacity for managed charging was well received.
- Planning for Electric Nation contribution to WPD's Balancing Act event on 5 October and LCNI conference in early December 2017.

2 Project Manager's Report

2.1 Project Background

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2.2 Project Progress

2.2.1 Method 1: Modelling

Activity on development of the Network Assessment Tool (NAT) in this period has focussed on utilising the data provided by WPD to develop the NAT.

Data import, cleaning, collation and validation routines

Data has been provided by WPD from two sources. Cleaning and collating these separate data sets has enabled creation of a single unified data set for the network modelling heuristics.

1. **Cable and over-head line (OHL) asset database:** Which provides transformer location xy co-ordinates, conductor segment beginning and end xy co-ordinates and variable quality conductor data, along with patchy joint, pole and other associated data. The latter has proved unusable, owing to the sparsity of data. The conductor data has proved to be usable, once cleaned, removing duplicates in particular and collated. However, there is no association between transformers and cable/OHL segments in this data set.
2. **Crown**: A database containing customer meter (MPANs, locations and estimated energy consumption data, along with a *dumb* feeder association) and transformer data (location, rating and number of *dumb* feeders associated with the transformer). *Dumb* being that the associations are not associated with cable/OHL segments in the asset dataset, they are notional associations to group customers all supplied by a particular feeder.

Network modelling heuristic techniques

These algorithms build a model of the LV networks associated with each LV substation and associated customer groups with a particular feeder made up from cable/OHL segments.

Simplistically, for each transformer (using the number of *dumb* feeders associated with the substation) the cables/OHLs closest to the transformer are identified. For each nearest cable/OHL, following cable/OHL segments (based on nearest start co-ordinates matching end co-ordinates) are identified to make up a feeder string, sometimes with branches. Where feeder strings lead to another transformer location a note is made that a normally open point will be located somewhere on that feeder for later analysis.

This part of the heuristic builds a map of all LV feeders.

The next part of the heuristic takes customer locations associated with a *dumb* feeder and using Hall-Curve analysis identifies the best match for a dumb feeder with a stitched-together feeder (made up of cable/OHL segments).

Further cleaning is sometimes required to identify miss matched data (customers who are a long distance away from a substation/feeder that must have been miss-assigned to a particular transformer, for example)

Associations of customers to feeders helps to then identify boundaries between LV areas (transformer supply boundaries) that can be used to approximately identify normally open point locations, sometimes validated by cable/OHL specification changes along the feeder string.

This results in a map of transformers, with associated feeders and customers to each feeder which provides the model for load analysis to be used in the NAT. An example is provided in Figure 1.

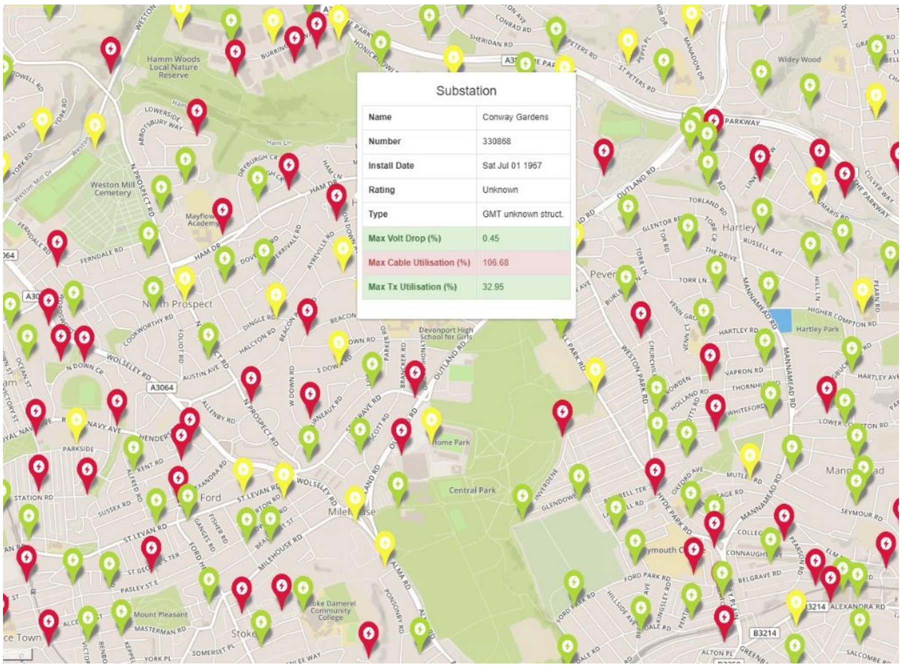

Figure 1 – Example transformer location map from the NAT (mocked up data showing transformer grading by an "EV Impact" rating for illustration purposes)

Figure 2 – Example feeder map developed by the heuristics, colours indicate association from the NAT

Validation of network assessment methodology, using the available data

The quality of the data provided by WPD is variable and not ideal, in particular cable routing raw data is not available, so straight line distance between cable section start/end xy co-ordinates can be less than the recorded cable section length. In some cases the actual cable is not available in the records, usually for older records, so the straight line distance is the only available measure. It should be noted that the asset locational data in respect to the mapping background is available

The specified feeder assessment methodology for the NAT is the Debut engine, as used in WinDebut. To test whether the Debut engine would work with the available data a simpler diversified demand algorithm was applied to a sample of feeders produced by the network modelling heuristics, to produce voltage drop assessments at nodes along the feeders. This testing showed that a high proportion of the sample feeder models could be successfully assessed. Further testing is underway to confirm these results applying the Debut engine manually to the sample feeder models.

Feeder models that cannot be assessed by the Debut engine, owing to nonsensical feeder models or that produce nonsensical results would be flagged within the NAT as having a low confidence level or requiring attention.

Development of the NAT to-date

Progress on development of the NAT was reviewed with WPD in early September 2017, overall progress and approach was approved and a roadmap for further development of the NAT was agreed. These include:

- Use of Energy Supply Areas (defined by BSP/Primary substations) as the results aggregation level for the NAT; and
- Identification of source of data for EV growth scenarios within the NAT (via CSE and Regen) to ensure consistency with other WPD initiatives and studies.

Next steps

- Testing and iterative improvement of the data import routines and network modelling heuristics using a larger set of data from WPD;
- Incorporation of Debut assessment engine into the NAT;
- Incorporation of EV growth models into the NAT; and
- Development of NAT user interface, including on screen reports of specific and aggregated results (data and report exports will be provided).

2.2.2 Method 2: Monitoring

Progress within this reporting period

All thirty of the required GridKey LV monitoring units have been delivered to WPD along with the associated ancillary parts (sensors, mounting kits etc.). Of the thirty available units, 21 have been installed across WPD's network with the remaining 9 are due to be installed once locations have been identified and installation teams are available.
In addition to the monitoring equipment for the Electric Nation project, an additional unit was also installed at Millbrook Proving Ground. This particular unit was used to capture EV resistive load signatures on LV feeders during a variety of charging cycles with a variety of commercial vehicles. This data gathering exercise is now complete, and the monitoring equipment has been removed.

Using the data captured from both the GridKey units on WPD's network and the unit installed at Millbrook, development of the EV detection algorithm has made good progress. An initial statistical approach has been carried out, combining general load of a substation and injecting vehicle load signatures to produce a probability of detecting an EV on the network.

Further development has been focused on improving the performance of the algorithm through the use of a neural net approach. By supplying additional background substation data, the algorithm is able to learn and recognise patterns to improve detection probability and lower false detection rates.

Next steps

The final stage of development is to validate the performance of the algorithm by providing blind data where it is known whether or not EVs are present. In order to achieve this, additional data has been provided from ~2011 where the likelihood of EVs being present is much lower.

The aim is then to use the vehicle charging signatures gathered at Millbrook and inject these into the background data from ~2011. Two sets of data will be created, one set with injected signals and one without any signals. The algorithm will then be measured to determine the performance.

The validation tests will be conducted during two periods: one test will be for peak load hours (early evening) when demand is high; and the other validation test will look at the middle of the night, typically during low load demand. The performance of the algorithm will then be published to the project team alongside the functional requirements specification for the algorithm.

2.2.3 Method 3: Mitigation

Progress within this reporting period

Table 2.1 Trial Recruitment Activities

	Last Month	As of 25th September 2017	Added in month
Total Responses	2452	2630	178
Total EOI received	696	781	85
Total Surveys sent	672	764	92
Total Approved	398	469	71
Total Installed	335	393	58
WPD Participants	6	6	0

Recruitment of customers has been a great success with the engagement team now two months ahead of target. Effort required for qualification of leads has increased with average qualification call lasting 24 minutes. Based on pipeline figures the target of 700 participants is now very achievable.

The Engagement Team are fully trained and active, there have been some staff changes including exit of the engagement manager and additional staff have been brought-in to help on the helpdesk.

Marketing channels have been monitored to focus on the most effective – these being referrals from dealers and other partners. Social media has continued to play a part in the success of recruitment. A paid search campaign was also used during this period. Table 2-2 shows the effectiveness of marketing channels.

Table 2-2 Table showing effectiveness of marketing channels (August 17)

Referred By	Total Leads	Surveys Approved	Conversion
Trade Referral	3	2	67%
Customer	14	6	43%
Fleetdrive	21	9	43%
Installer	47	20	43%
Dealer	158	49	31%
Customer Referral	18	5	28%
Recommendation	221	42	19%
Affiliate	35	6	17%
Search Engine	655	112	17%
Social Media	508	82	16%
Media	79	9	11%

Referred By	Total Leads	Surveys Approved	Conversion
DriveElectric	10	1	10%
Electric Nation	555	48	9%
Mailer	25	2	8%
Networking / Exhibition / Seminar	14	1	7%
WPD	18	1	6%
Email	3		0%
Telephone	2		0%
Web DriveElectric	17		0%
Web Fleetdrive Electric	2		0%
Work	1		0%
Youtube	2		.
Total	**2408**	**395**	**16%**

Customer Support System Development & Delivery

Helpdesk fault tickets have exceeded 150% of charger installs compared to planned estimate (taken from charging equipment installers estimates) of 7%. The majority of faults do not directly affect customers' ability to charge vehicles. Communications issues reported via systems integration have produced the majority of faults. The team now has new resources with industry specific experience to help with qualification and diagnosis of faults and the helpdesk / fault reporting system has been expanded and adapted to assist with management of faults and analysis. Reporting has been expanded to include logging of long term fixes.

PIV Telematics Selection, Procurement and Delivery

- OEM telematics solutions are now in place for Tesla and Nissan. Renault's system is yet to be implemented on the project, as there are currently very few Renault vehicles in project;
- The GeoTab third party telematics solution has been developed and is now being installed, although some vehicle types are still not able to be accessed via this system, notably BMW;
- A new process for installation of telematics, including re-iterating customer data protection processes and sign-off, has been developed and implemented;
- Some customers are reticent to share telematics data;
- The project Data Protection strategy has been reviewed and a minor alteration has been proposed to explicitly cover collection of the position of the car (GPS coordinates); and
- Based upon current OEM and GeoTab vehicle compatibility/agreement to access, it is likely that telematics coverage will be around 30% of vehicles on the project.

Marketing and PR

Progress has been made engaging with the Go Ultra Low city of Milton Keynes and some progress with Bristol. The project has an existing and ongoing relationship with Go Ultra Low Nottingham. Example results of engagement are:

- Milton Keynes: Press release and extensive social media coverage celebrating first smart charger installation in the City.
- Nottingham: Press release and extensive social media coverage of Electric Nation at the Clean Air Roadshow.
- Nottingham: Press release and extensive social media coverage of first Nottingham smart charger install in conjunction with national Clean Air Day.

EA Technology provided marketing support to the Electric Nation presence at the Swansea Clean Air Roadshow in April and the FUTURE CAR:Diff event in July.

EA Technology is developing a positive relationship with the Office for Low Emission Vehicles, which is supportive of Electric Nation, with smart charging being on the UK Government policy's agenda under the new Automated and Electric Vehicle Bill[1]

As the project moves into the demand management phase with its customers, management of trial participants' expectations is critical. EA Technology is supporting DriveElectric's engagement with trial participants through provision of timely and appropriate letters and email communications. For example, in this reporting period EA Technology delivered:

- Letter to customers: Notification of software update;
- Updated Customer Information Pack;
- Updated Customer Welcome Pack;
- Updated Website FAQs; and
- Produced Customer Newsletter for circulation to trial participants by DriveElectric.

Social media

Twitter

To date, the Electric Nation Twitter account has more than 1,000 followers; the account has delivered 500+ tweets, has tweeted 400+ times, and achieves a good level of retweet activity, including regular retweets by WPD, the Office for Low Emission Vehicles, and project partners and suppliers.

[1] The Automated and Electric Vehicle Bill is expected to go through Parliamentary process this year, as a successor to the Vehicle Technology and Aviation Bill.

LinkedIn

Managed by EA Technology, Electric Nation has a LinkedIn Group that currently has 44 members from across automotive / energy / DNO stakeholder groups. It is used on a relatively infrequent basis to deliver news items and event details at which the project and its partners will be appearing. The Group will become more active once the project starts to deliver trial results and learning.

Facebook

Electric Nation has a Facebook page that is customer-facing and is therefore managed by DriveElectric, albeit its set up was supported by AutomotiveComms to ensure branding and message were in line with strategy.

Project PR

In this reporting period, a further six press releases have been issued (eight in total since project inception).

- EA Technology produced an article on project milestone of hitting 100 installations ahead of schedule that was widely distributed to the press;
- UK's Electric Nation Project Recruits New EV Owners with Free Smart Chargers (Milton Keynes) [4 April 2017];
- EA Technology comment on Green Alliance report 'People power – How consumer choice is changing the UK energy system' [21 April 2017];
- Smart electric car charge point trial arrives in Nottingham [15 June 2017];
- Electric Nation talk about the UK charging infrastructure [10 July 2017]; and
- Electric Nation at LCV [1 September 2017].

All press releases are uploaded to the Electric Nation website and shared extensively via Twitter @ElectricNation_.

Project Website

In this reporting period EA Technology has produced:

- 14 x News items produced for project website – project news
- 11 x News items produced for project website – EV industry news

Project newsletter

Produced by EA Technology and circulated via Hubspot to the project contacts' list (comprising 400 stakeholders across automotive, utilities, academia and Government). Newsletters were circulated in June and in August (in co-ordination with the LCV event).

Dissemination

EA Technology has attended relevant industry events to raise the profile of the Electric Nation project and to share early learning arising from Algorithm Development and Testing Report.

- The EVRT (European EV Road Tour) event in London on 25th April;

- Urban Mobility Solutions Conference (All-Energy), Glasgow, 10-11 May 2017;

  This involved dissemination of learning to wide cross-sector industry audience – DNOs, academia, policy. This was subsequently reported in "Electrical Energy Storage Magazine, June 2017);

- LowCVP Cities event, 22 June 2017, a High profile automotive, energy, Government event;

- Cenex LCV 2017, 6-7 September 2017, supported by the majority of project partners and suppliers. The stand was busy throughout and resulted in 90 leads being captured; interest ranging from smart charging and trial set up to early results and customer acceptance of smart charging. WPD and EA Technology presented at the event to an engaged audience; the 'funnel diagram' showing spare capacity for managed charging was well received; and

- Planning for Electric Nation contribution to WPD's Balancing Act event on 5 October and LCNI in early December 2017.

Customer research

The customer research activities of the project aim to provide qualitative evidence of customer driving and PIV charging behaviours, and acceptance of PIV charging demand management during the customer trial. This will be measured through a series of questionnaires that customers involved in the trial will be asked to complete (electronically, over the phone and in some cases, face to face).

The following types of questionnaires are included:

- Baseline questionnaire – post-recruitment, pre-installation of smart charger – developed and deployed to customers as they are recruited into the trail. This is aimed at gathering recruit socio-economic data and vehicle usage data.
- Post installation questionnaire developed. This is aimed at gathering data on attitudes to charging their PIV after a few months, in some cases before they

experience demand management in some cases where demand management is imposed on their charger from the day they join the trial.

Both questionnaires have been used to survey trial participants as recruitment into the trial has progressed in this period. Customer response rates to surveys to date are set out in Table -2.

Table 2-3 - Customer response rates to surveys to date

	Recruitment		Baseline	
Month Sent	N sent	% complete	N sent	% complete
December (pilot)	8	88%	na	na
February	15	93%	na	na
March	33	76%	23	61%
April	41	78%	33	82%
May	44	80%	41	78%
June	92	76%	70	81%
July	52	83%	66	65%
August	54	33%	52	33%
September	26	58%	23	70%

July's Baseline responses are still being pursued by Impact along with August's very poor response rate, which appears to be wholly due to the holiday season.

Trial Questionnaire Development

This questionnaire follows up the post installation questionnaire to investigate whether customers in the trial have changed their charging behaviours and attitudes the charging, driving and journeys having experienced charging demand management. This questionnaire will be used in the final quarter of 2017 and onwards into the second year of the trial. At the time of writing, based on survey returns the trial cohort has the age and socio-economic profile shown in Table 2-3.

Table 2-4 - age and socio-economic profile

	Surveys sent	Surveys completed	Gender		Car Type	
			Males	Female	Electric	Hybrid
%	100%	75%	87%	13%	50%	50%
n	391	292	266	40	152	154
Total Base	391	391	292	292	292	292

	Age					
	18-25	26-35	36-45	46-55	56-65	65+
%	1%	11%	28%	32%	18%	10%
n	3	33	87	99	55	29
Total Base	292	292	292	292	292	292

	Social Economic Grade					
	A	B	C1	C2	D	E
%	33%	41%	15%	4%	1%	6%
n	100	125	47	13	4	17
Total Base	292	292	292	292	292	292

Test System design and Build

The project test system, built and operated at EA Technology's offices in Capenhurst, Chester has served and continues to serve several purposes for the project:

a) To provide a test environment for the smart chargers selected for the customer trial and to ensure they have the required functionality for PIVDCS and data reporting (complete);
b) To provide a test environment for the system integration components and services required to ensure secure and reliable communications between the smart chargers and PIVDCS servers (complete);
c) To test the Greenflux and CrowdCharge PIVDCS configurations prior to deployment into the customer trial and provide an ongoing test environment for further configuration improvements as the customer trial produces results that highlight need for improvement (ongoing);
d) To provide a facility for investigating equipment and PIVDCS performance issues and failures arising in the customer trial (ongoing); and
e) To enable testing of PIV charging performance under demand management conditions (ongoing).

The test System has been used throughout this period to:

- Test new vehicle models' ability to charge under both CrowdCharge and GreenFlux demand management regimes;
- Troubleshoot communications issues identified in customer trial installations, testing improvements to systems and software/firmware updates before they are issued to customer trial systems; and
- Troubleshoot CrowdCharge and GreenFlux system issues that have been identified through customer trial activities. This included developing a method to avoid customers that use an in-car timer to set charging time after they have plugged in

(for economy 7 primarily) being assigned a low priority for charging and so being assigned lower charge rates when timer does switch on board charger on.

PIVDCS Configuration Testing and Improvement (Algorithm Development)

EA Technology worked with both PIVDCS providers, CrowdCharge and Greenflux to test and improve their system configurations to ensure the PIVDCS are fit for purpose for the customer trial. This entailed numerous tests of each PIVDCS:

- With a variety of PIVs: numbers, types (e.g. BEVs and PHEVs) and models; and
- Under steady state and varying capacity limits

Both PIVDCS in their initial configurations, having been tested sufficiently, have now been deployed to monitor and manage smart chargers in the customer trial.

- Firstly, monitoring customer EV charging behaviour without demand management being applied; and
- Secondly, to apply demand management to customers who have experienced charging at will and then a second group who enter the trial under a demand management regime from the beginning of their EV driving experience.

Demand management is only applied where communications to and from the smart chargers in the trial are good (90%+ availability), so deployment of demand management has been slightly hampered by the communications problems with smart chargers (mostly CrowdCharge/APT system, though some GreenFlux/ICU systems are included). These delays in getting customers into demand management will not adversely affect the outcome of this first year of the trial as the recruitment into the trial is well ahead of schedule and is making up the shortfall by weight of numbers in the trial.

A problem was identified in the GreenFlux system as early trial data was analysed; this is that a small number of customers in the trial set their EVs to charge on a timer to take advantage of Economy 7 tariffs – in the GreenFlux system an EV being plugged in and taking no charge is assigned a low priority for demand management, this priority assignment persists and is applied even when the EV then starts charging – resulting in the majority of EVs set on timers receiving reduced power allocation from the smart charger. This problem has been diagnosed and a temporary fix put in place with customer support; that is to set the timer after plugging the EV in to the charger. A more permanent fix is being written into the GreenFlux system and will be tested in October before being released to the customer trial.
EA Technology has continued to work with both PIVDCS providers to improve data supplied from their systems to enable PIVDCS performance evaluation in the customer trial, as the trial data database used to carry out this analysis and reporting has evolved.

EA Technology has worked with WPD to define a PIVDCS control regime, based on HV feeder demand control. These are 11kV feeders supplying a number of LV (distribution) transformers in an area. WPD has provided sample HV feeder data that has been used by EA Technology to develop model feeder demand profiles for use in the initial stages of the customer trial by the PIVDCS. These demand profiles are then used to create capacity profiles used by the demand management systems, suitably scaled for the number of EVs in a trial group and varied by weekday/weekend-day and season.

EA Technology has worked with WPD, DriveElectric, GreenFlux, CrowdCharge and Impact Utilities to develop a customer trial specification. This is necessarily adaptive owing to the complexity of the trial population and the uncertainty of the ultimate make-up of the trial population.

- The trial population is complex owing to the variety of models (manufacturers), types (BEV and PHEV), battery sizes and nominal charging rates of vehicles that may be involved in the customer trial, as well as demographic-based vehicle usage (e.g. the difference between commuter use, stay at home parents, retired people and other types of vehicle use) that complicates the population further.
- While the project has specified target proportions of type, battery size and charging rates, the actual proportions of each recruited will be defined by customer willingness to participate in the trial, customer vehicle preference and the rapidly evolving PIV market (the range of models of PIVs and the rise in battery sizes in new models changes month by month). This gives rise to uncertainty in the actual mix of population the project will ultimately achieve.

The initial phase of the trial is designed to accommodate the gradual growth in trial participants from January 2017:

- Trial participants entering the trial will be equally assigned to each PIVDCS
- Initially customers entering the trial will be assigned to a control group of PIV owners who can charge at will, i.e. not subjected to PIV demand management.
- Subsequently, customers entering the trial will be subjected to PIV demand management as soon as they enter the trial.
- As soon as possible, depending on growth in the trial population, PIVDCS performance and customer research data will be used to identify the significant factors affecting charging behaviour, such as PIV type, battery size, charging rate, vehicle usage and so on. This analysis will be used to determine population splits further into the trial, at least in the second year of the trial in 2018.

No changes have been made to the trial plan in this period, to date The GreenFlux system has 64 customers under demand management (expected to reach 100 in early October) and CrowdCharge 45 (expected to reach 100 later in October).

To date, apart from the previously mentioned charging timer issues, the project has not received any adverse feedback regarding demand management regime or demand management events through the project's customer helpline. Although it should be noted that, up to the beginning of September, a summer capacity profile was used for demand management, when EV charging demand management is unlikely to be required as there is virtually no early evening peak demand. From September, an autumn capacity profile is being used; this is more likely to create demand management events on days where a higher proportion of EVs in the trial groups are plugging in to charge in the early evening.

Some 5,500 charging events have now been captured by the PIVDCS, this includes plug in/out events and charging duration. Figure 3 uses this data to illustrate the potential flexibility for demand management of EV charging in the early evening period.

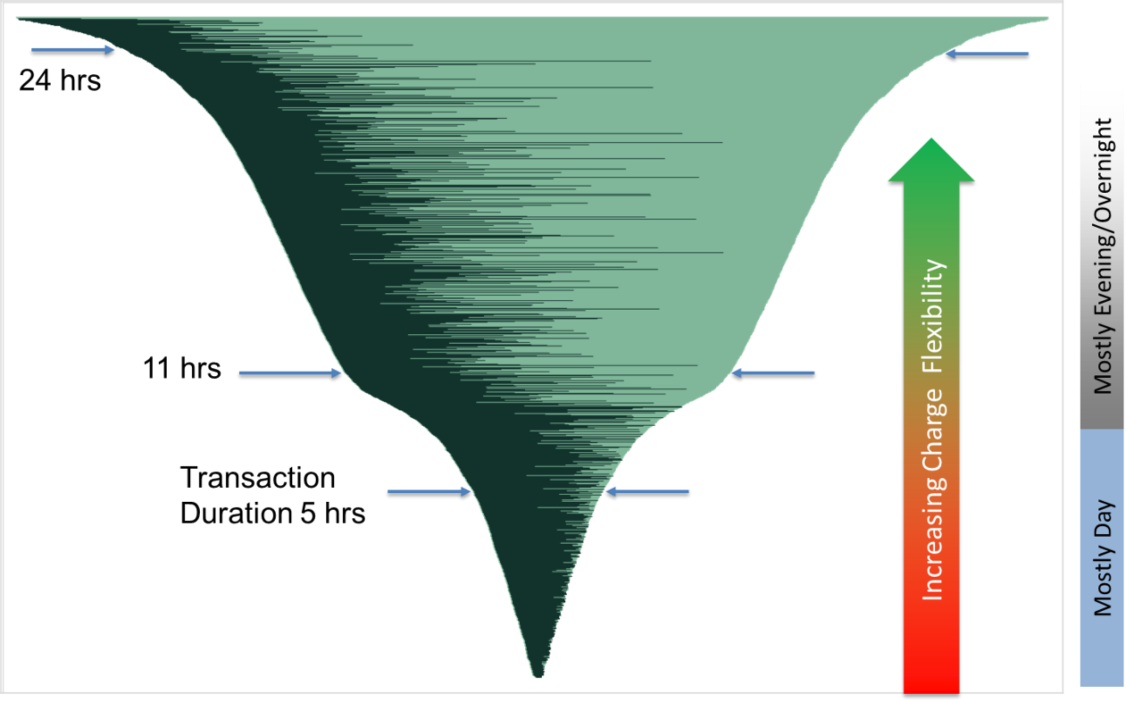

Figure 3 – potential flexibility for demand management of EV charging in the early evening period

Figure 3 shows a stack of all charging transactions recorded from the very beginning of the trial in January 2017 to the end of August 2017, the width of each line in the stack is the transaction duration, the black section being the duration of charge, green the duration the EV remained plugged in after the battery was fully charged.

During this period the number of trial participants was growing, from the first participant joining the trial to more than 200 actively charging their vehicles on a regular basis across both the Greenflux and CrowdCharge PIVDCS.

The vast majority of these charging events occurred while trial participants were allowed to charge at will, before charging demand management is imposed on them. A small number of these participants, and so a small number of these charging events, will have been under the demand management regime in this period.

However, as a summer-time network capacity profile was being used in this period demand management was highly unlikely and has been ignored for the purposes of this illustrative analysis (if demand management had been imposed then some charging durations will be slightly longer than they should have been at full power); future analysis will include demand management events, as autumn and winter demand profiles are more likely to produce demand management events.

Some observations can be drawn from this graph:

- Shorter charging transactions tend to occur in the daytime and are mostly completed shortly after the battery is fully charged – giving very little flexibility for demand management.
- Longer transactions, 10+ hours tend to occur from late afternoon to morning, average charging duration is ~2 hours, providing plenty of flexibility for charging demand management, shifting charging load to late evening and overnight.
- Long transactions tend to occur at weekends, where vehicles are left plugged in long after charging is complete, whilst providing demand management flexibility it is not necessarily usable as use of vehicles at weekends tends to be more random than weekdays.

Other observations that can be drawn from this early data are**:**

- Very few people plug in every day, or even most days;
- The majority plug in fewer than 4 times a week; and
- PHEV drivers (so far) appear to charge less frequently. This is shown in Figure 4, which is based on analysis of the early trial data.

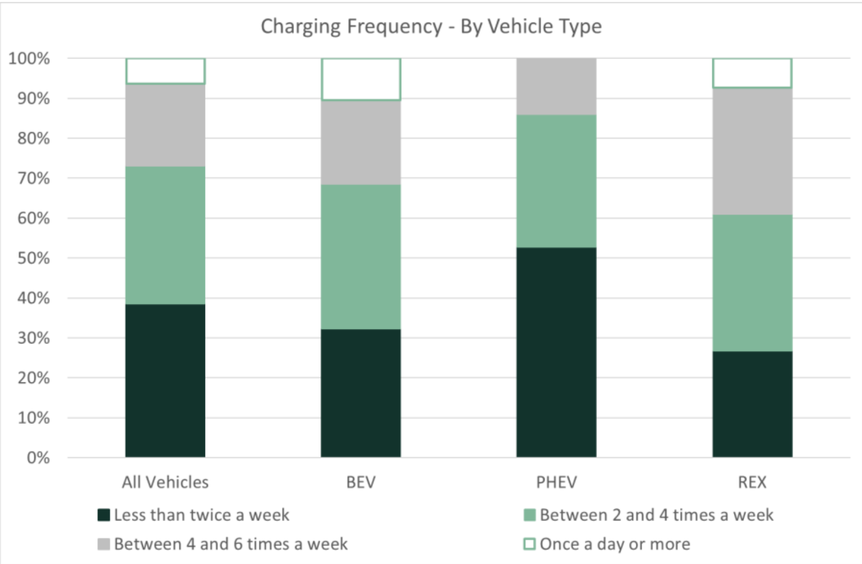

Figure 4 – charging frequency by vehicle type

Examples of provisional findings from charging data analysis can be seen are described below and shown in Figure 5:

- Peak of charging events occurring in the early evening; and
- Some charging begins at night – mainly using timers (plug-in is earlier).

Some charging begins in the middle of the day, as shown in Figure 5.

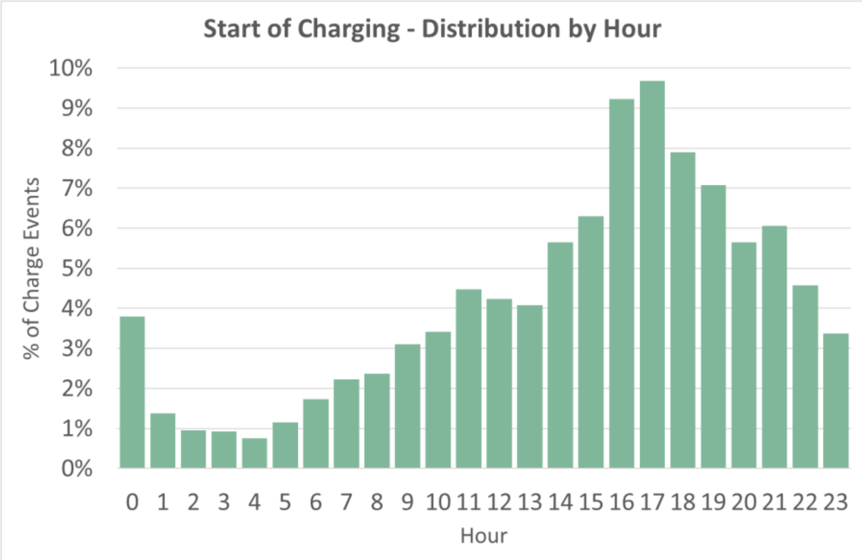

Figure 5 – start of charging, distribution by hour

Systems Integration

Despite rigorous testing of the smart charger communications systems, on both the Capenhurst test system and the pilot installations, a variety of issues have arisen during the customer trial roll-out of smart chargers. Each of the PIVDCS has suffered common issues and those unique to their own systems.

Considerable effort has been required to monitor and analyse both GreenFlux/ICU and CrowdCharge/APT system communications availability during this period to assist in the diagnosis of the communications issues and developing and rolling out solutions with supplier The Tech Factory. It should be noted that these communication issues did not prevent customers from charging their EVs. However, these issues would impact the ability of the project to undertake PIVDCS and therefore, the project team is working to resolve them prior to commencing PIVDCS with affected customers.

Common problems

Poor/no connectivity on the Wi-Fi bridge used to connect smart charger to customer's home broadband internet router

This is a device that uses a radio frequency outside of home Wi-Fi frequencies, partly for added security, partly as it has better hard surface penetration capabilities. In some instances, the distance between the smart charger and home broadband router has proved to be beyond the range of the Wi-Fi units. In others, obstacles, such as garage doors, metal clad appliances and aluminium backed wallboard, or the sheer number of walls in the signal path, have blocked the signal.

To some degree these problems have been created by poor installation practices, the majority of installers are electricians and not telecoms-savvy. The project has held a training event to overcome these weaknesses.

A number of solutions to this problem have been identified and are being rolled out:

- A Wi-Fi bridge repeater unit has been developed to bridge the gap between transmitter and receiver;
- Use of power line carrier, home internet extenders, though these in themselves are not always reliable;
- Hardwire the connection with Ethernet cable – though this is not desirable owing to the household fabric damage and perhaps unsightliness of cables running through rooms created by this method of connection.

Customers switching off smart charger and/or communications equipment, when not in use
Customer education and communications, impressing on the customer the need to keep equipment turned on at all times has been partially successful. The primary impact on this customer behaviour is that smart charger communications can take up to an hour to re-establish when the customer switches the system on (if they turn on communications equipment and smart charger at the same time). For the project, this leads to lower quality transaction data being captured (energy consumed in communications outage period, versus power consumed on a time basis); this is not a critical issue so long as this is a relatively small number of customers. For the customer, the impact can be higher, as under demand management control the customer could suffer reduced charging power outside of demand management events for at least the period until communications are established, or in some circumstances for the whole charging transaction. To date the project has concentrated on educating customers to avoid switching their systems off and has not put these customers under demand control to date.

- A very small number of customers switch off their broadband router at night (either manually or automatically through the router control interface) – again education of the customer is the only way to overcome this problem.
- Poor home broadband internet service has been observed in some instances – a problem that is outside of the control of the project – where internet access is lost for minutes/hours at a time. For the Greenflux/ICU system this is overcome if the onboard mobile data SIM can activate, as the ICU charger switches to mobile data communications automatically on loss of broadband internet access. The CrowdCharge/APT system does not have the option of mobile data connectivity.

Unique issues for GreenFlux/ICU system
The GreenFlux/ICU system has dual connectivity (broadband internet and mobile data). However, in some instances mobile phone signal strength is so poor the mobile data SIM does not activate and this option is not available. Combined with no broadband internet connection (as with Wi-Fi bridge faults) the charger has no connectivity.

In some circumstances, the mobile data SIM can be forced to activate by switching the charger to mobile data communications only. In this circumstance the SIM can sometimes activate and register on the local mobile data network and then retains this connectivity after being switched back to dual communications. However, this requires a site visit from a technician to resolve.

The dual connectivity of the GreenFlux/ICU system has proved worth its while, proven by the 80+% availability of these chargers compared with that of CrowdCharge, which until recently was only 40%, rising to 60% at time of writing this report.

GreenFlux also suffered a number of failures of their websocket servers in the spring, which provide the secure internet connection for the smart chargers to their back office. This caused at least three incidents where almost all Electric Nation smart chargers controlled by GreenFlux lost connection to the GreenFlux system for several hours and in some cases a couple of days. This was a Europe-wide problem that GreenFlux has now resolved and this problem has not re-occurred since June.

Unique issues for CrowdCharge/APT system

The CrowdCharge/APT system differs from the GreenFlux/ICU system in that CrowdCharge use a proprietary controller external to the APT charger, made up of a communications circuit board and a mini- computer board. This communications board has proved to be the primary cause of poor communications for the CrowdCharge system.

It has taken some time to identify that the communications board's firmware had a fault that meant that when switched off and then back on a number of times the firmware would get corrupted and all communications would be lost. The manufacturer has now solved this problem and a new version of the firmware is being installed on the system.
Where the system communications are working this was done remotely, though the final batch of controllers being updated remotely failed to restart correctly and had to be manually restarted by the customers to complete the update.

Where the communications board firmware is corrupted and communication is lost a site visit is required, which has proved to be difficult to arrange with customers, but progress is being made, illustrated by the marked improvement in CrowdCharge/APT communications availability from ~40% to 60% during August/September.

The Tech Factory now has a complete set of solutions for all of the technical communication problems listed above and are working with DriveElectric and the project's other suppliers to implement the solutions to improve communications availability.

Cyber Security

Effective cyber security in the future deployment of PIVDCS is essential as "internet of things" type devices have already proved to be gateways to subversive internet attacks; smart chargers are, by the fact that they require internet connectivity, "internet of things" devices. Weaknesses in smart charger communications could provide threats to PIVDCS systems that could be used to disrupt electricity demand (e.g. rapid simultaneous switching of active charger could cause faults or disrupt frequency locally or even wider afield). It is likely, in future, that real time demand control may be required, where connectivity between Distribution Network Operator systems and PIVDCS is required. In which case, PIVDCS systems could even act as a gateway to Distribution Network Operator data/control systems and provide more avenues to electricity distribution, transmission and generation systems.

While it is recognised that the PIVDCS systems deployed in this project are likely to be obsolete within a few years, replaced by evolving/new technologies, the principles of effective cyber security and learning from this project could and should be used in the procurement of future PIVDCS.

As there is no physical connectivity between WPD systems and the project's PIVDCS, and the fact that the number of smart chargers deployed in the customer trial is relatively small (in terms of maximum electricity load that can be disrupted in comparison to GB wide electricity loads) the consequences of disruption of the project's systems are extremely small. So, cyber security threat analysis of the PIVDCS is not an immediate issue and is not a risk to the project.

This project has procured the services of NCC to undertake cyber security threat modelling of both the Greenflux/ICU and CrowdCharge/APT PIVDCS systems to identify immediate threats to the customer trial (that the suppliers will be required to address within the lifetime of the project, if the consequences to the success of the project are significant) and less urgent threats that should be considered within the functional specification of PIVDCS that will be produced as an output of the project. This functional specification being developed for future Distribution Network Operator procurement of PIVDCS into the 2020s.

Activity this period has focussed on additional information gathering from GreenFlux and CrowdCharge that will enable NCC to build the threat models for the PIVDCS. GreenFlux has provided the required information. However, CrowdCharge has, as yet, to complete their documentation and submit it.

V2G Market Research

The project has an aim to bring household scale vehicle to grid systems into the customer trial – that is single phase, G83/G59 compliant V2G system – to assess whether V2G, alongside smart charging/PIVDCS can be used to meet the project aims of providing mitigation to PIV charging growth. V2G chargers could be switched to export mode at times of peak electricity demand to support local PIV charging when required, supporting local voltage and reducing LV substation loads.

Almost all V2G charging systems that the project has identified to date are three phase systems designed for commercial charging scenarios (e.g. offices/car parks). Furthermore, most of these systems are bespoke or pre-production systems. The project is now in negotiations with two suppliers of single phase V2G chargers

Nichicon (which has a partnership agreement with CrowdCharge)

- Nichicon are in the process of manufacturing a pre-production prototype for despatch to the UK in October 2017;
- This unit is a modified production model of Nichicon's Vehicle to home charger, with some 7,000 units in operation in Japan – the unit will require 110V/240V transformers to be fitted to enable this unit to be connected to the Capenhurst test system for testing and evaluation;
- Additionally, the unit will not be G59 certified (production units will be, as well as CE marked, also 240V rated and so suitable for installation in customer homes) –

this will require the test unit being G59 tested by a test house, which is difficult as there is no UK based test house capable of G59 certification, or fitting a G59 relay between the V2G charger and mains supply, this is likely to be the most expedient solution to the problem;
- CrowdCharge are working with Nichicon to develop a control systems software interface to enable CrowdCharge to send charge/discharge commands to the charger through Nichicon's back office system; and
- Nichicon has made a commitment to provide production units by mid-summer 2018, for deployment into the customer trial, on successful testing at EA Technology.

Unnamed Supplier (owing to an NDA EA Technology are unable to name this potential supplier at this time)

- This supplier has a V2G charger that has been tested in the USA;
- A pre-production 3-phase prototype is being offered for testing by Electric Nation with a commitment to produce single phase units in summer of 2018;
- The supplier is unwilling to allow CrowdCharge to provide control interface system with their system, owing to their partnership with Nichicon. So, GreenFlux are investigating whether their back office could be adapted to interface with this supplier's charger control interface; and
- As with the Nichicon unit, G59 certification will not be available for the prototype unit and so will either have to be independently tested or fitted with a G59 relay when fitted to the Capenhurst test system.

To mitigate the risk of being tied to a single supplier for this element of the project it was decided to attempt to get two V2G chargers installed on the test system, with a view to selecting one to supply chargers into the customer trial upon successful testing. At time of writing the Nichicon unit appears to be further ahead on a timescale basis, if they hold to their commitment to despatch in October their unit could be on the test rig before the end of the year, the other supplier has yet to make a formal offer of supply.

Next steps

- Manage expectation of prospective participants, as the project begins to reach full recruitment (700 participants);
- Improve further quality systems for installation;
- Begin to manage the feedback from a controlled charging environment, which may impact on vehicles' state of charge at the end of charging events, particularly as autumn and winter tariffs are applied;
- Further roll out of telematics solutions;
- Introduction of user charging portal and app for customers;
- Help customers to use charging apps and portals;
- Systems Integration supply of equipment for Customer Trial installations – ongoing;
- Work with Systems Integration provider, charger manufacturers and PIVDCS suppliers to support to installers and DriveElectric trial support team to ensure maximum communications uptime of chargers in trial – ongoing;

- Continue development of trial data database, incorporating data returns from Greenflux/CrowdCharge/Impact Utilities and developing queries and reports for analysis and project reporting purposes – ongoing;
- Use Greenflux/CrowdCharge data returns to watch out for potential early issues with PIVDCS implementation in the customer trial – e.g. overly severe demand management actions or customers left with inactive chargers at the outset of the trial could lead to unnecessary customer dissatisfaction – ongoing;
- Continue progressing Cyber Security analysis – ongoing;
- Continue management of Customer Research supplier and liaison with DriveElectric to ensure customer research activities cover expected growth in trial population (demographic of participants and vehicle mix);
- Continue pursuit of V2G options with at least one V2G charger installed on test system by early 2018; and
- Continued development of the NAT.

3 Progress against Budget

TRL does not have access to the partner project budgets for this project and therefore this section has been completed with information provided by WPD.

Spend Area	Budget (£)	Expected Spend to Date (£)	Actual Spend to Date (£)	Variance to expected (£)	Variance to expected %
WPD Project Management	96,000	34,250	59,396	25,146 overspend	73.4% overspend
TRL	226,802	113,402	113,402	0	0
EA Technology	3,094,359	1,411,568	1,645,172	233,604 overspend	16.5% overspend
Drive Electric	2,129,375	936,898	936,898	0	0
Lucy GridKey	255,480	156,000	238,900	82,900 overspend	53.1% overspend
Equipment Requirements	5,000	N/A	2,760	N/A	N/A
Depot WPD Installs	10,363	N/A	1,263	N/A	N/A
TOTAL	5,917,379		3,102,554		

Comments around variance

1. WPD Project Management costs have been front loaded for early project start up and also include management of depot installs
2. EATL cost includes Q6 payment due on 31/10/17. This will be corrected by next report
3. Lucy Grid Key invoiced early .No overspend expected at project end

4 Progress towards Success Criteria

The success criteria of the project are defined through successful delivery of the following:

1. An LV Network Assessment Tool for DNOs (an add-on to the widely used WinDEBUT LV design tool) that:
   a. Analyses and quantifies PIV related stress issues on LV networks (to LV area scale), including:
      a. Heuristics enabling rapid assessment of PIVs on LV networks through “topological” modelling of LV networks.
      b. Ability to include known PIV charger installations.
      c. Ability to forecast future PIV charger installations based on PIV market growth and forecasts.

d. Flexibility allowing for future charger rating and PIV battery size developments.

b. Identifies best economic PIV solution: Demand Control/V2G/Reinforcement.

Progress on development of the NAT, once data availability and limitations were agreed with WPD, has been good; draft data import and network modelling routines have been developed and have, using a sample dataset to date, proved to produce network models that can be used to assess EV impacts on LV networks across whole license areas.

2. A functional specification for a technique to monitor and understand the effects of electric vehicle charging on LV networks across different levels of penetration (to be delivered by others)

   Lucy Electric GridKey will publish and supply a functional requirements document for the output of the EV detection algorithm.

3. A functional specification and commercial framework for future procurement and deployment of PIV/V2G Demand/Export Control Services by DNOs to delay or avoid network reinforcement in cases where PIV installation numbers create network stress.

   Progress on recruitment of customers into the trial and getting equipment installed in customer homes has been excellent. Various issues with communications with the smart chargers installed is reducing the quantity of data being produced by the trial – However, this is unlikely to impact on the objectives of the first year of the trial, which is to compare customer satisfaction for those who experience charge at will before demand management is applied to their charger with those who enter demand management from the very start of their EV ownership and to identify what other factors affect customer charging behaviour, such as battery size, PHEV vs BEV ownership or lifestyle (e.g. retired vs stay at home parent vs daily commuter, etc).

5 Learning Outcomes

Lessons learned during this period revolve around the communications issues that have arisen during the customer trial installation process.

A review of these lessons is being undertaken in October with the aim of documenting them properly for future use and reporting purposes.

These lessons include:

- The need for smart charger manufacturers to consider fitting robust wireless connectivity functionality in their designs to avoid the need for third party devices to enable wire-less internet connection; or, a requirement for wired Ethernet connection;
- The need for installers to have (better) skills and understanding of communications systems for future mass adoption of smart chargers;

- The need for more thorough testing of integrated systems/communications in similar projects in future, the project's test system and pilot installations were not sufficient to identify the problems incurred in the customer trial roll-out; and
- The need for agreements from vehicle manufacturers and customers to provide telematics data from their plug-in vehicles for use by PIVCDS algorithms (those that require such data). Some vehicle manufacturers seem reluctant to provide access to such data and some customers are reluctant to share it with PIVCDS providers.

6 Intellectual Property Rights

A complete list of all background IPR from all project partners has been compiled. The IP register is reviewed on a quarterly basis.

No foreground IP has been identified to date.

7 Risk Management

Our risk management objectives are to:

- Ensure that risk management is clearly and consistently integrated into the project management activities and evidenced through the project documentation;
- Comply with WPDs risk management processes and any governance requirements as specified by Ofgem; and
- Anticipate and respond to changing project requirements.

These objectives will be achieved by:

- ✓ Defining the roles, responsibilities and reporting lines within the Project Delivery Team for risk management;
- ✓ Including risk management issues when writing reports and considering decisions;
- ✓ Maintaining a risk register;
- ✓ Communicating risks and ensuring suitable training and supervision is provided;
- ✓ Preparing mitigation action plans;
- ✓ Preparing contingency action plans; and
- ✓ Monitoring and updating of risks and the risk controls.

7.1 Current Risks

The CarConnect | Electric Nation risk register is a live document and is updated regularly. There are currently 33 live project related risks. Mitigation action plans are identified when raising a risk and the appropriate steps then taken to ensure risks do not become issues wherever possible. In Table 7-1, we give details of our top five current risks (by risk rating score). For each of these risks, a mitigation action plan has been identified and the progress of these are tracked and reported.

Details of the Risk	Risk Rating	Mitigation Action Plan	Progress
R045: In selection and procurement of project sub-contractors" there may be increases in costs c.f. outline costs quoted during proposal development.”	Major	- Ensure clearly Defined scope of works for each sub-contractor. - Scrutiny of potential sub-contractor offers. - Negotiation on costs vs input vs deliverables to find an optimal scope of work that meets project requirements.	Following the departure of installer Actemium from the project, some installations in the far south west proved difficult to serve using other installers on the project and there was insufficient demand to bring in a new installer for this area for a very small number of installations.
R027 / I001: the Pound may significantly fall in value against the Euro from project development period in late 2015	Major	- Nothing can be done about currency market changes - to a certain degree cost increases can be managed within the existing project budget (e.g. drawing on systems Integration budget) - WPD have agreed to cover currency exchange rate related budget over-run if required - EA technology have a Euro account and do trade with European customers in Euro, can use this account to hedge against small currency fluctuations	Continue to monitor
R046: Customers will switch off chargers	Moderate	Customers are being instructed to not switch chargers off as part of trial participation instructions Customers have also been given detailed instructions to allow them to reset their charger system after a	Much work has been done communicating with customers and asking them to leave chargers switched on. However, reality is that some will always do this and this will need to form part of project results.

Details of the Risk	Risk Rating	Mitigation Action Plan	Progress
		loss of communications (or power failure/charger switched off event) ICU charger Data SIM comms backup addresses this issue, when they work.	This is of increasing importance due to the impact on the need to maintain chargepoint communications in order to operate demand management, which is now in operation on the project.
R012: during Trial there may be interface issues with the vehicles (e.g. vehicles do not respond to requests for information) [telematics]	Moderate	- One key contractor has experience in this area and, where necessary, vehicle choice will be limited to those we have confidence are controllable and contactable for data access purposes. - an alternative data capture system independent of manufacturer and vehicle type (GeoTab) is being used with some vehicles as an alternative when OEM systems fail to provide data. However, not all OEM's systems can be accessed or fully accessed using the GeoTab system.	OEM telematics solutions are now in place for Tesla and Nissan. The GeoTab third party telematics solution has been developed and is now being installed, although some vehicle types are still not able to be accessed via this system, notably BMW.
R019: possible delay in handover of NAT	Moderate	- ongoing communications with relevant WPD staff about specification, interface and data requirements - application of additional programming staff to catch up on delays	Activity on development of the Network Assessment Tool (NAT) in this period has focussed on utilising the data provided by WPD to develop the NAT. Data has been provided by WPD from two sources: 1. Cable and over-head line (OHL) asset database; and 2. Crown database.

Details of the Risk	Risk Rating	Mitigation Action Plan	Progress
			Cleaning and collating these separate data sets has enabled creation of a single unified data set for the network modelling heuristics. Progress on development of the NAT was reviewed with WPD in early September 2017,the overall progress and approach was approved and a roadmap for further development of the NAT was agreed.

Table 7-1: Top five current risks (by rating)

Table 7-2 provides a snapshot of the risk register, detailed graphically, to provide an on-going understanding of the projects' risks.

Likelihood = Probability x Proximity	Certain/Imminent (21-25)	0	0	0	0	0
	More likely to occur than not/Likely to be near future (16-20)	0	0	0	0	0
	50/50 chance of occuring/ Mid to short term (11-15)	0	1	2	0	0
	Less likely to occur/Mid to long term (6-10)	1	4	7	4	0
	Very unlikely to occur/Far in the future (1-5)	2	2	9	1	0
		1. Insignificant changes, re-planning may be required	2. Small Delay, small increased cost but absorbable	3. Delay, increased cost in excess of tolerance	4. Substantial Delay, key deliverables not met, significant increase in time/cost	5. Inability to deliver, business case/objective not viable
		Impact				

Table 7-2: Graphical view of Risk Register

Table 7-3 provides an overview of the risks by category, minor, moderate, major and severe.This information is used to understand the complete risk level of the project.

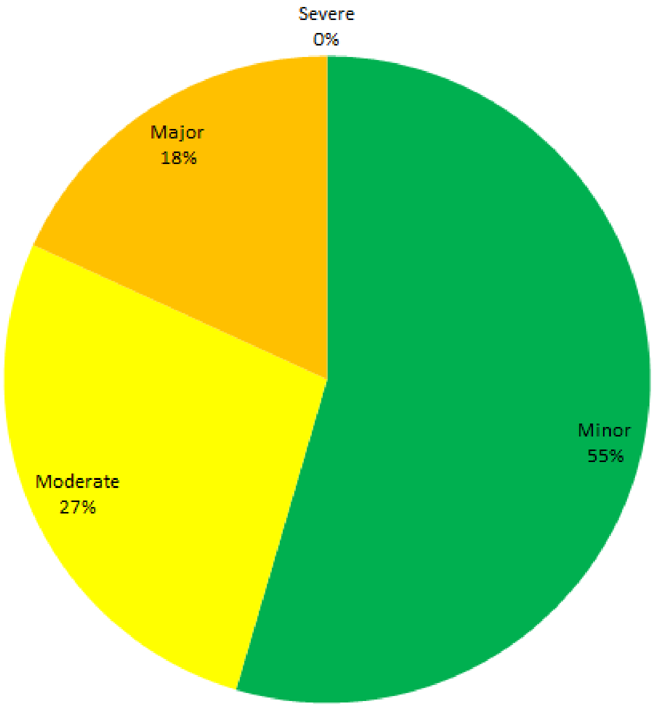

Table 7-3: Percentage of Risk by category

7.2 Update for risks previously identified

Descriptions of the most significant risks, identified in the previous six monthly progress report are provided in Table 7-4 with updates on their current risk status.

Details of the Risk	Previous Risk Rating	Current Risk Rating	Mitigation Action Plan	Progress
R046 Customers switch off chargers resulting in spurious loss of communications events - wasting project team time investigating;	Major	Moderate	Customers are being instructed to not switch chargers off as part of trial participation instructions Customers have also been given detailed instructions to allow them to reset their charger system after a loss of communications (or power failure/charger	Much work has been done communicating with customers and asking them to leave chargers switched on. However, reality is that some will always do this and this will need to form part of project results. This is of increasing importance due to

Details of the Risk	Previous Risk Rating	Current Risk Rating	Mitigation Action Plan	Progress
and potential loss of data if customer does not restart system correctly to get communications working again.			switched off event) ICU charger Data SIM communications backup addresses this issue, when they work.	the impact on the need to maintain chargepoint communications in order to operate demand management, which is now in operation on the project.
R006: During Trial the data captured from the vehicles is incomplete or of poor quality due to insufficient data resolution of the vehicle's on-board telematics systems or poor signal quality prevent data transmission.	Major	Major	Liaison with OEMs regarding use of their telematics systems is ongoing and some OEM systems are now working on the project. Alongside this, third party providers of telematics systems (Geotab) are providing and adapting their telematics system for vehicles for which an OEM solution is not available.	A small number of vehicles' telematics information is now being collected via either OEM or Geotab systems. But there ae some vehicle types for which neither solution is currently available, most notably BMW. The next reporting period will be key for ascertaining the effectiveness of the combined OEM and Geotab solutions for demand management system input.
R007: prior to Trial the vehicle data capture systems/technology may not be ready in time for vehicle delivery.	Major	Major	Additional post-vehicle delivery communications and installation of telematics system to participants' vehicles will be undertaken.	
R016 EA Technology or DriveElectric poor delivery	Major	Moderate	- Selection of experienced sub-contractors, with potential for	The delivery of the project to-date has shown the resilience of partner

Details of the Risk	Previous Risk Rating	Current Risk Rating	Mitigation Action Plan	Progress
may occur			overlapping scope. - Regular update / progress meetings will be conducted to identify issues early. - Contract cover will be appropriate for all areas of work.	organisations to manage a complex large scale project of this type.
R012: during Trial there may be interface issues with the vehicles (e.g. vehicles do not respond to requests for information) [telematics]	Moderate	Moderate	- One key contractor has experience in this area and, where necessary, vehicle choice will be limited to those we have confidence are controllable and contactable for data access purposes. - an alternative data capture system independent of manufacturer and vehicle type (GeoTab) is being used with some vehicles as an alternative when OEM systems fail to provide data. However, not all OEM's systems can be accessed or fully accessed using the GeoTab system.	OEM telematics solutions are now in place for Tesla and Nissan. The GeoTab third party telematics solution has been developed and is now being installed, although some vehicle types are still not able to be accessed via this system, notably BMW.

Table 7-4: Risks identified in the previous progress report

8 Consistency with Project Registration Document

The scale, cost and timeframe of the project has remained consistent with the registration document, a copy of which can be found here:
https://www.westernpowerinnovation.co.uk/Projects/Current-Projects/CarConnect.aspx#FAQLink142;javascript:void(0);

9 Accuracy Assurance Statement

This report has been written and compiled by the CarConnect | Electric Nation Project Manager from TRL (Andy Wells) with input from the Project Managers from EA Technology Limited (Nick Storer), DriveElectric (Mike Potter), and Lucy Electric Grid Key (Craig Holahan). This report has been checked by Denis Naberezhnykh of TRL. This report has reviewed by Mark Dale and approved by the Future Networks Manager (Roger Hey).

All efforts have been made to ensure that the information contained within this report is accurate. WPD confirms that this report has been produced, reviewed and approved following our quality assurance process for external documents and reports.