WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

LV CONNECT AND MANAGE

WPD_NIA_014

NIA MAJOR PROJECT PROGRESS REPORT

REPORTING PERIOD:

APR 2017 – SEP 2017

Report Title	:	SIX MONTHLY PROGRESS REPORT
Report Status	:	FINAL
Project Ref	:	NIA_WPD_014
Date	:	30/10/2017

Document Control

	Name	Date
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Revision History

Date	Issue	Status
09/10/2017	v0.1	Draft
27/10/2017	v0.2	Reviewed
30/10/2017	v1.0	Final

Contents

Glossary

Term	Definition
ANM	Active Network Management
BAU	Business as Usual
BPL	Broadband-over-powerline
DG	Distributed Generation
DLC	Domestic Load Control
DNO	Distribution Network Operator
EV	Electric Vehicle
GB	Great Britain
GSM	Global System for Mobile Communications
HV	High Voltage
IPR	Intellectual Property Register
LCT	Low Carbon Technologies
LV	Low Voltage
NIA	Network Innovation Allowance
QAS	Quotation Accuracy Scheme
VPN	Virtual Private Network
WPD	Western Power Distribution

1 Executive Summary

LV Connect and Manage is funded through Ofgem's Network Innovation Allowance (NIA). LV Connect and Manage was registered in April 2016 and will be complete by March 2019.

LV Connect and Manage aims to demonstrate and prove that LV Active Network Management (ANM) can be used as a short-term measure, whilst network reinforcement takes place, to facilitate the timely connection of customers. The solution can then be redeployed to another area when the need case arises. The ANM solution can also provide a long-term alternative to network reinforcement in cases where the investment in traditional assets is not economically viable or other reasons (such as the disruption to customers) prevents reinforcement taking place. In order to maintain the highest standard to service to its customers, WPD plans to connect them as quickly and cost effectively as possible and then actively manage them, once connected.

This report details progress of the project, focusing on the last six months, April 2017 to September 2017.

1.1 Business Case

This project demonstrates a specific piece of new (i.e. unproven in GB, or where a Method has been trialled outside GB the Network Licensee must justify repeating it as part of a Project) equipment (including control and communications systems and software).

1.1.1 Carbon Benefit

LV Connect and Manage will facilitate the increased uptake of LCTs, enable the potential for higher-powered connections and reduce the time taken to connect customers.

The LV Connect and Manage solution will allow LCTs to connect to the network up to 9 months more quickly than traditional network reinforcement alternatives. This is based on a deployment timescale of up to 3 months for LV Connect and Manage technologies and up to 12 months for traditional network reinforcement. At least £13,500 of carbon savings per customer could be unlocked by the LV Connect and Manage solution. This is based on the LV Connect and Manage technologies enabling a conservative 438kWh of electricity generation from PV, during the nine-month period whilst network reinforcement takes place (i.e. a 3.7kW PV installation with a 10% capacity factor, generating electricity for 4 hours a day, with a conversion factor of 0.49426 and a non-traded price of carbon of £62/tCO_2e).

Based on the expedited connection of several PV clusters (three or more customers), the project will have a major carbon benefit, grading it as 5, as published in the ENA NIA Benefits Guide (i.e. over £30,000/tCO_2e will be saved).

1.1.2 Cost Benefit

LV Connect and Manage will implement a novel control system for demand side response of electric vehicles and battery energy storage, facilitating the control of bi-directional power flows.

Base case cost: £3,300 - £6,600 per LCT customer.

The typical cost of reinforcing an LV feeder is £40,000, based on ground mounted substation and cable upgrades, as published by WPD in the East Midlands Quotation Accuracy Scheme (QAS) (part of the Connection Charging Methodology).
EATL's My Electric Avenue suggests that 44.4kW clusters of LCTs would be sufficient to trigger the reinforcement of an LV feeder. On a per-feeder basis, this is equivalent to:

- 12 EV slow chargers or 12 PV systems (3.7kW per charger or PV installed capacity) or a £3,300/LCT customer reinforcement cost
- 6 EV fast chargers (7.4kW per charger) or a £6,600/LCT customer reinforcement cost

LV feeder reinforcement would not necessarily be financially viable for smaller clusters of LCTs.

Method cost: £1,300 - £3,300 per LCT customer

The cost of deploying the LV Connect and Manage Solution is £1,300 - £3,300 per customer, including communications, controls, installation, operation and maintenance, and assuming the technology is re-deployed at least 3 times (for nine months) during the equipment lifetime.

Considering only a single deployment of the LV Connect and Manage solution, the equipment would cost £3,900 - £10,000 per LCT customer. Taking into account the carbon savings enabled by an expedited connection, the solution would generate benefits in excess of the Method cost in 3 – 7 months.

If the LV Connect and Manage equipment is re-deployed only three times during its lifetime (i.e. once the network has been reinforced, the LV Connect and Manage equipment is available to be re-deployed elsewhere), the equipment costs would reduce to £1,300 - £3,300 per LCT customer. In this case, the solution generates carbon saving benefits, in excess of the Method cost, in 1 – 2.5 months. This is significantly quicker than the expected time to reinforce the LV network.

Financial benefit: The financial benefit ranges from £2,000 per customer (low base case cost and method cost with 12 LCT customers per feeder) to £3,300 per customer (high base case cost and high method cost with 6 LCT customers per feeder).

1.2 Project Progress

This is the second progress report. It covers progress from April 2017 to the end of September 2017.

In April 2017, the project was handed over from Ben Godfrey to Mikhail Prokhnich. Customer Engagement material was produced. Installation of the ANM equipment at the Hereford Depot was completed using GSM communications for commissioning. Lucy Electric completed modifications to the Gridkey product to incorporate Ethernet modules and increase the granularity of measurement data from 1 minute to 10 seconds to implement more timely control algorithm response. The ICU Eve Mini was integrated with Nortech's Envoy via the Open Charge Point Protocol (OCPP). Technology and equipment procurement processes for EV charge point and battery energy storage technologies were initiated.

In May 2017, the project was disseminated at WPD's Balancing Act Conference. At the Hereford Depot demonstrator, BPL repeaters were installed and the BPL commissioning was completed. Installation of LV substation monitoring equipment commenced in the Nottingham trial location. A contract was put in place with EV Charging Solutions for charge point installs. Early learning suggested that BPL would require more repeaters installed in each substation to increase signal strength (depending on the feasibility of back-feeding customers to install the repeaters).

In June 2017, a promotional video for the project was produced and a Customer Engagement event took place in Furzton. A contract was put in place with Stratford Energy for battery equipment installs. LV substation equipment installation was completed at all three Nottingham sites, which were chosen for trial due to big numbers of EV owners. Although several charge points were recorded in WPD's systems, it was found that only two customers actually owned an EV.

In July 2017, end-to-end integration testing was carried out for the EV DLC box, via a charge point, to an electric vehicle. Installation guidance was produced for the electrical contractors. LV substation equipment installation was completed at all three Milton Keynes sites. The Project Review Group Meeting with WPD Senior Management took place. It was uncovered that charge points were being supplied by the manufacturer (ICU) with incorrect settings, introducing the need to reconfigure and bench test all devices for validation. The installation of the first 3 EV charge points and DLC boxes in customer's homes was completed.

In August 2017, testing of the Battery/Inverter DLC box was carried out at the Hereford Depot with a Tesla PowerWall1 and SolarEdge inverter, using BPL. The first SolarEdge/LG Chem installation was completed at Stratford Energy. During this process, it was uncovered that the settings and documentation supplied by the manufacturer (SolarEdge) did not align. This issue was subsequently resolved. The installation of the first 9 EV charge points and DLC boxes in customer's homes was completed.

In September 2017, end-to-end testing of the Battery/Inverter DLC box was carried out with an LGChem battery and SolarEdge inverter, demonstrating the controlled charge/discharge

capability of the ANM system. Recruitment of customers reached 33 of 50 for the battery trials and 25 of 50 for the charge point trials. The installation of the first 18 EV charge points and DLC boxes in customer's homes was completed.

1.3 Project Delivery Structure

1.3.1 Project Review Group

The LV Connect and Manage 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.

1.3.2 Project Resource

WPD: Project Lead

- Mikhail Prokhnich (Project Manager)

Nortech Management Limited: Project Delivery Support and Active Network Management Control System Equipment supplier

- Samuel Jupe (Project Delivery Manager and Technical Lead, Power Systems)
- Simon Hodgson (Technical Lead, Technologies and Communications)
- Sid Hoda (Technical Lead, IT and Hosting)

Power Plus Communications: Communications solution provider

- David Pitcher (PPC Lead)

The Big Wheel: Customer Engagement (Nottingham)

- Gary Smerdon-White (Lead)

The Dairy: Customer Engagement (Milton Keynes)

- Nigel Rowlson (Lead)

EV Charging Solutions: EV charge point supplier and electrical installer

- Chris Everitt (Lead)

Stratford Energy Solutions: Battery/Inverter supplier and electrical installer

- Jason Savidge (Lead)

1.4 Procurement

The following table details the current status of procurement for this project.

Provider	Services/goods	Area of project applicable to	Anticipated Delivery Dates
Nortech	Project delivery and ANM Equipment	All	Goods: All goods delivered by 31/12/2017 Services: On-going until 31/03/2019
PPC	BPL Communications	LV ANM	Core BPL equipment: Delivered by 31/08/2017 Repeaters: To be determined
The Big Wheel	Customer Engagement	Engagement in Nottingham	01/01/2017 – 31/03/2019
The Dairy	Customer Engagement	Engagement in Milton Keynes	01/01/2017 – 31/03/2019
EV Charging Solutions	Supply and install of EV chargers and DLCs	Customer Installations	01/06/2017 – 31/03/2018
Stratford Energy	Supply and Install of Battery/Inverters and DLCs	Customer Installations	01/06/2017 – 31/03/2018

Table 1-1: Procurement Details

1.5 Project Risks

A proactive role in ensuring effective risk management for LV Connect and Manage is taken. This ensures that processes have been put in place to review whether risks still exist, whether new risks have arisen, whether the likelihood and impact of risks have changed, reporting of significant changes that will affect risk priorities and deliver assurance of the effectiveness of control.

Contained within Section 7.1 of this report are the current top risks associated with successfully delivering LV Connect and Manage as captured in our Risk Register. Section 7.2 provides an update on the most prominent risks identified at the project bid phase.

1.6 Project Learning and Dissemination

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.

In May 2017, the project was disseminated at WPD's Balancing Act Conference. In June 2017, a promotional video was produced and a Customer Engagement event took place in Furzton. In September 2017, The Dairy distributed leaflets to the trial area to increase interest. On 30th September 2017, The Big Wheel hosted a drop-in event for customers.

2 Project Manager's Report

2.1 Project Background

The LV Connect and Manage Method involves the deployment of communications and control infrastructure to allow LCTs to connect to the network in a timely manner and be managed in an active way. This will involve, limiting the power exported by LCTs to the network at times of LV network congestion or increasing the power demand of LCTs (heat pumps, energy storage and/or EVs) to keep the network within technical limits.

2.2 Project Progress

LV Connect and Manage is being delivered in three phases:

1. Mobilisation (including the procurement of equipment and services, and production of the customer engagement and data protection plans). This phase runs from April 2016 to September 2017.
2. Connect and Manage Trials (including the recruitment of customers to participate in the trial and the installation of equipment in customers' premises and WPD's distribution substations). This phase runs from May 2017 to September 2018.
3. Analysis and Close Down (including the analysis of results from trials and an evaluation of the LV Connect and Manage solution). This phase runs from January 2018 to March 2019.

2.3 Phase 1: Mobilisation

Progress within this reporting period

In April 2017, the project was handed over from Ben Godfrey to Mikhail Prokhnich. Customer Engagement material was produced. Lucy Electric completed Gridkey modifications to incorporate Ethernet modules and increase the granularity of measurement data from 1 minute to 10 seconds. The ICU Eve Mini was integrated with Nortech's Envoy via the Open Charge Point Protocol (OCPP). Technology and equipment procurement processes for EV charge point and battery energy storage technologies were launched.

In May 2017, a contract was put in place with EV Charging Solutions for charge point installs.

In June 2017, a promotional video for the project was produced. A contract was put in place with Stratford Energy for battery equipment installs.

In July 2017, installation guidance was produced for electrical contractors. The Project Review Group Meeting with WPD Senior Management took place. It was discovered that ICU charge points were being supplied with incorrect settings, introducing need to reconfigure and bench test all devices for validation.

In August 2017, commissioning guidance for the DLC Box and charge point was produced. A problem was identified with one of the Solar Edge inverters having different Modbus settings and was subsequently resolved.

In September 2017, commissioning guidance for the DLC box and battery inverter was produced.

Next steps

- Meet for Quarter 6 review meeting.

2.4 Phase 2: Trials

Progress within this reporting period

In April 2017, installation of equipment at the Hereford Depot and the GSM commissioning were completed.

In May 2017, the project was disseminated at WPD's Balancing Act Conference. At the Hereford Depot demonstrator, repeaters were installed, the BPL commissioning was completed and EV charge control and PV/battery export control were demonstrated. Installation of LV substation monitoring equipment commenced in trial locations. It was discovered that BPL required more repeaters installed in each substation to increase signal strength.

In June 2017, a Customer Engagement event took place in Furzton. A contract was put in place with Stratford Energy for battery equipment installs. LV substation equipment installation was completed at all three Nottingham sites. It was identified that only two of the customer's signed up for the EV charge point trials actually owned EVs.

In July 2017, integration testing of the DLC box charge control with a charge point and an EV was carried out. LV substation equipment installation was completed at all three Milton Keynes sites. Recruitment of customers reached 25/50 in both trial areas (50/100 for the overall project). The installation of the first 3 EV charge points and DLC boxes in customer's homes was completed.

In August 2017, integration testing of the DLC box battery output control with a Tesla PowerWall battery and a SolarEdge inverter was carried out at the Hereford Depot. The BPL system and communications fail-over were tested at the Hereford Depot. The installation of the first 9 EV charge points and DLC boxes in customer's homes was completed.

In September 2017, integration testing of the DLC box battery output control with an LG Chem battery and a SolarEdge inverter was carried out at Stratford Energy in conjunction with charge/discharge profiles on the SolarEdge Portal. Recruitment of customers reached 33/50 for the battery inverter trials and 25/50 for the charge point trials (58/100 for the overall project). A £25 incentive refer-a-friend scheme was introduced to increase customer numbers. Two EV charge point installations were postponed due to late delivery of charge

points from ICU by courier, highlighting requirement for slack to be built in. The installation of the first 18 EV charge points and DLC boxes in customer's homes was completed.

Gridkey MCU with Ethernet Adapter

DLC Box / EV Charge Point Testing with a Tesla Model S

ICU Charge Point with 7.4kW set point

Battery/Inverter system installed as a test rig at Stratford Energy

Typical EV charger customer installation

Next steps

- Complete installation and commissioning of battery storage equipment in two champions' homes;
- Complete installation and commissioning of EV charging equipment in remaining customers' homes; and
- Nortech Management Ltd to produce a report on initial learning from BPL deployment.

2.5 Phase 3: Analysis

This phase runs from January 2018 to March 2019, based on the data stored in iHost from 6 distribution substations and trial results.

3 Progress against Budget

Spend Area	Budget (£k)	Expected Spend to Date (£k)	Actual Spend to Date (£k)	Variance to expected (£k)	Variance to expected %
Project Delivery	200	151	151	0	0
Communications equipment	120	133	142.26	9.26	7[1]
Monitoring	40	47.8	47.8	0	0
Control	400	305.1	305.1	0	0
Batteries and inverters	250	29.3	29.3	0	0
EV charge points	25	20	20	0	0
Customer engagement and dissemination	200	113.47	113.47	0	0
Equipment installation	100	32.8	32.8	0	0
WPD PM + Installation	100	73.8	73.8	0	0
Dissemination Modelling	20	17	17	0	0
Contingency	220	0	0	0	0
TOTAL	**1675**		**932.484**		

Comments around variance

1. Due to GBP/EURO exchange rate variation

4 Progress towards Success Criteria

1. Demonstration of the active management of low carbon technologies (energy storage and electric vehicles) by controlling load profiles and alleviating electricity network constraints;
2. Development of a replicable architecture for the LV ANM solution, which can be utilised by WPD in their other Licence Areas and by other DNOs, more generally; and
3. Development of novel business processes for deploying ANM technologies into LV networks. (This will include the specification and development of an installation guide for the LV ANM technologies).

Project is on track to meet all the success criteria.

5 Learning Outcomes

5.1 Phase 1: Mobilisation

- Successful production of project video helps to engage customers and families them with project background and objectives;
- Appendix to Policy (Retrofitting equipment in LV substations) worked very well for project installs. Hereford dry run of installation massively helped with policy amendment and de-risked the installation process ;
- ICU required accredited installers to install their equipment. However, the accredited installers are not trained on how to use ICU software for diagnostics / reconfiguration. It's possible that any electrical installer could install charge point as there is no specialist skill/knowledge required; and
- When arranging installations, extra time needs to be factored in to account for potential delays by couriers.

5.2 Phase 2: Trials

- Project has proven that communication and control via both BPL system and GSM are achievable. Charge point and battery inverter power output were each successfully controlled via both BPL and GSM during testing at Hereford;
- BPL modems required at Hereford to increase signal strength for transfer through distribution boards – PPC would like to install additional repeaters in the LV fuse board in the distribution substations. Benefits undetermined at this stage;
- Need to express BPL 'reach' in terms of attenuation rather than distance;
- Requirement to review settings applied to devices by manufacturer. Even though the same firmware was applied, the configuration settings for the EV charge points were different. This meant that charging was limited to a maximum of 16A, not 32A. One battery inverter had different Modbus settings to the others; and
- Very few customers identified using Crown records actually own an EV.

5.3 Phase 3: Analysis

This phase runs from January 2018 to March 2019.

6 Intellectual Property Rights

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

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 LV Connect and Manage risk register is a live document and is updated regularly. There are currently 11 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**Error! Reference source not found.**, we give details of our top five current risks by category. 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
BPL technology does not transfer data as expected / Technology is not compatible with substations	Moderate	De-risk by demo installation De-risk by site surveys Redundant comms (GSM) Install more repeaters	BPL system at Hereford depot tested and connectivity achieved
Commissioning EV charge point needs an EV	Moderate	Borrow, lease or purchase an EV for commissioning. Separate install and commissioning	Companies contacted happy to lend an EV
LCT take up less than	Moderate	Simulate LCT activity as a	Capability built into ANM

expected		fallback	system do to this
Delays with EV equipment procurement	Minor	Identify alternative suppliers / equipment	Charge points delivered by courier late resulting in two postponed installations
Delays with EV customer installations	Minor	Close engagement with customers Bench test equipment	18 installed

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	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
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)	1	5	0	0	0
Less likely to occur/Mid to long term (6-10)	1	1	0	0	0
Very unlikely to occur/Far in the future (1-5)	0	2	1	0	0
	Impact				

	Minor	Moderate	Major	Severe	
Legend	6	5	0	0	No of instances
Total	11				No of live risks

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.

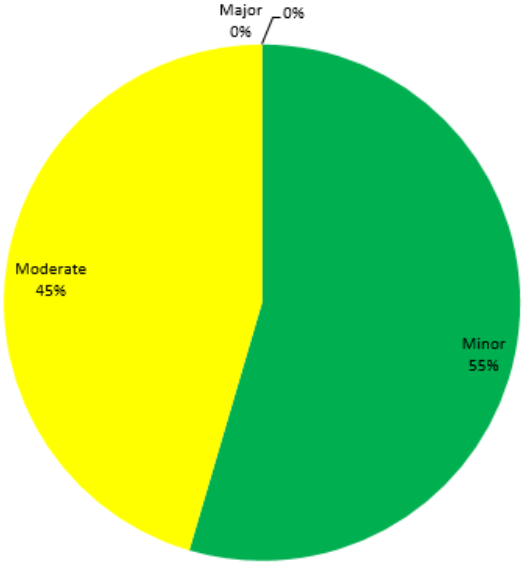

Table 7-3: Percentage of Risk by category

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
Delays with substation monitoring equipment procurement	48	0	Identify alternative suppliers	Substation monitoring equipment is installed
BPL technology does not work as expected / is not compatible with substations	40	30	De-risk by demo installation De-risk by site surveys Redundant comms (GPRS) built into solution) Introduction of signal repeaters / adopting PPC deployment plan	Demo installation in progress DLC boxes are equipped with GPRS modems
WPD resources unavailable	24	8	Close working relationship between WPD and Nortech with	Close working relationship between WPD and Nortech are

			Nortech making WPD's life as easy as possible (within responsibility boundaries)	established WPD staff is booked in advance
Nortech resources unavailable	24	8	Nortech to allocate dedicated resource to project	All project tasks have allocated member of staff
Fewer customers subscribe to trial than expected	18	10	Good quality customer engagement, use local firms, extend length of trials	Good quality customer engagement firms procured Customer engagement process has started

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/LV-Connect-and-Manage.aspx

9 Accuracy Assurance Statement

This report has been prepared by the LV Connect and Manage Project Manager (Mikhail Prokhnich), reviewed 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.