WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

LV CONNECT AND MANAGE

WPD_NIA_014

NIA MAJOR PROJECT PROGRESS REPORT

REPORTING PERIOD: OCT 2017 – MAR 2018

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Prepared by:	Mikhail Prokhnich	11/04/2018
Reviewed by:	Jenny Woodruff	16/04/2018
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11/04/2018	V0.1	Initial Draft
16/04/2018	V0.2	Draft Following Review
10/05/2018	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 Controller
DNO	Distribution Network Operator
EV	Electric Vehicle
GB	Great Britain
HV	High Voltage
IPR	Intellectual Property Register
LCT	Low Carbon Technologies
LV	Low Voltage
NIA	Network Innovation Allowance
PPC	Power Plus Communications
QAS	Quotation Accuracy Scheme
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 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, October 2017 to March 2018.

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 Low Carbon Technologies (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/tCO2e).

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/tCO2e 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 third progress report. It covers progress from October 2017 to the end of March 2018.

During this reporting period, customer engagement activities continued in both trial areas leading to 35 customer sign-ups for the EV Charge Control trials in Nottingham and 40 customer sign-ups for the PV/Battery/Inverter Discharge Control trials in Milton Keynes.

A programme of installations took place resulting in controllable EV charge points being deployed into 30 customers' homes in Nottingham, and controllable battery/inverter systems being deployed into 27 customers' homes in Milton Keynes.

In both trial areas, a cluster of customers has been created (i.e. in each area there is at least one distribution substation that has 17 customers with controllable LCTs deployed into their homes). This has created the platform for 'LV Connect and Manage' active network management trials to take place in the period April 2018 – September 2018. During this time, the import of power to EV customers will be controlled and the export of power from PV/Battery/Inverter customers will be controlled, based on thermal pinch points in the distribution network.

In preparation for the LV Connect and Manage trials with customers, the automated control of EV charge (using a Nissan Leaf), based on the load demand at WPD's Hereford Depot, was demonstrated. Using Nortech's iHost software environment, simulators have been built to represent the connection and control of LCTs at each of the six distribution substations in the LV Connect and Manage trial areas.

Trials of the Broadband-over-Powerline equipment (as a potential solution for communicating data and controls between the distribution substation and the LCT devices in customers' homes) resulted in the following learning: (i) The installation of repeaters in every customer's home would be required to overcome signal attenuation in the LV network (from the distribution substation through to the LCT within the customer's home);

(ii) The BPL equipment was observed to be sensitive to electrical noise, particularly during peak loading times of the day. The installation of BPL repeaters in customers' cut-out fuse boxes was evaluated by WPD's Policy team and deemed not to be viable for implementation across the business. Based on these findings, it was concluded that BPL is not fit-for-purpose, as a communications medium, for the LV Connect and Manage application. As a result, the BPL element of the LV Connect and Manage trials has been terminated.

Project activity updates were disseminated at the LNCI 2017 Conference in Telford. In addition, a technical paper has been accepted for publication and presentation at the 2018 CIRED Workshop (on Microgrids and Local Energy Communities) in Ljubljana, Slovenia in June 2018.

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 for ANM)

- Simon Hodgson (Technical Lead, Technologies and Communications)
- Sid Hoda (Technical Lead, IT and Hosting)

The Big Wheel: Customer Engagement (Nottingham)

- Gary Smerdon-White (Lead)

Power Plus Communications (PPC): BPL communications solution provider

- David Pitcher (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 produced. Delivery scheduled according to customer demand Services: On-going until 31/03/2019
PPC	BPL Communications	Alternative communications for LV ANM	Activities concluded in February 2018
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 and Support	01/06/2017 – 31/03/2019
Stratford	Supply and Install of	Customer	01/06/2017 –

Energy	Battery/Inverters and DLCs	Installations and Support	31/03/2019

Table 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 December 2017, Mikhail Prokhnich and Samuel Jupe presented project updates at the LCNI conference. A technical paper has been accepted for publication in the 2018 CIRED Workshop on Microgrids and Local Energy Communities.

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

During this reporting period, customer engagement activities continued in both trial areas leading to 35 customer sign-ups for the EV Charge Control trials in Nottingham and 40 customer sign-ups for the PV/Battery/Inverter Discharge Control trials in Milton Keynes.

A programme of installations took place resulting in controllable EV charge points being deployed into 30 customers' homes in Nottingham, and controllable battery/inverter systems being deployed into 27 customers' homes in Milton Keynes.

As seen in Figures 1 and 2, in both trial areas, a cluster of customers has been created (i.e. in each area there is at least one distribution substation that has 17 customers with controllable LCTs deployed into their homes). This has created the platform for 'LV Connect and Manage' active network management trials to take place in the period April 2018 –

September 2018. During this time, the import of power to EV customers will be controlled and the export of power from PV/Battery/Inverter customers will be controlled, based on thermal pinch points in the distribution network.

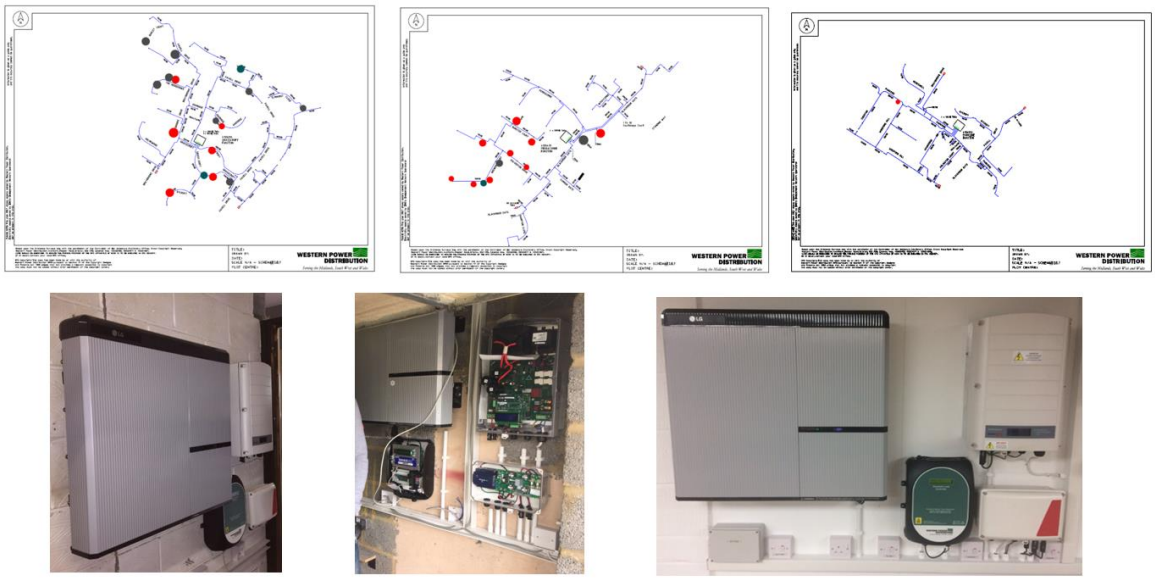

Figure 1: Clusters of customers and example installations of the PV/Battery/Inverter trial equipment in Milton Keynes

Figure 2: Clusters of customers and example installations for the EV trials in Nottingham

Next steps

This phase is now complete.

2.4 Phase 2: Trials

Progress within this reporting period

In October 2017, a customer engagement event was hosted by the Dairy, boosting customer sign-ups by 5 (from 35 to 40) for the Milton Keynes trial area. Preparations for dissemination at the LCNI conference took place. Communications issues with substation monitoring equipment were uncovered, caused by the Westermos crashing during reboot. EV charge point/DLC equipment was installed in 23 customer homes. Battery/inverter/DLC equipment was installed in 9 customer homes.

In November 2017, the Westermo crashing issues was resolved by Nortech, on PPC's behalf, via firmware updates. Customer sign-ups for the Milton Keynes trial area started to reach saturation. EV charge point/DLC installations reached 27 customer homes. Battery/inverter/DLC installations reached 14 customer homes.

In December 2017, the project was disseminated at the LCNI conference. EV charge point/DLC installations reached 28 customer homes. Battery/inverter/DLC installations reached 15 customer homes.

In January 2018, automated control of EV charge based on depot demand was demonstrated at the Hereford test site using a Nissan Leaf. Following supply chain difficulties, systems integration testing with SolarEdge's new StorEdge inverter model, SE3680H, was completed. Electrical contractors were instructed to procure the balance of equipment for customer installs. Installation of the first 5 BPL repeaters was completed at Grasscroft. Recruitment of customers reached 35/50 for the charge point trials and 34/50 for the inverter trials. Battery/inverter/DLC installations reached 20 customer homes.

In February 2018, the performance of the BPL communications system was evaluated, leading to the termination of this element of the LV Connect and Manage project. The LV Connect and Manage paper abstract was selected for presentation in the CIRED 2018 Workshop, Ljubljana. Simulators were built to test the automated control of EVs and battery/inverters at all 6 substations. Battery/inverter/DLC installations reached 23 customer homes.

In March 2018, the LV Connect and Manage paper was produced for presentation in the CIRED 2018 Workshop, Ljubljana. Preparations for LV Connect and Manage equipment control trials took place and the current loading levels of the distribution substations in the trial area were evaluated.

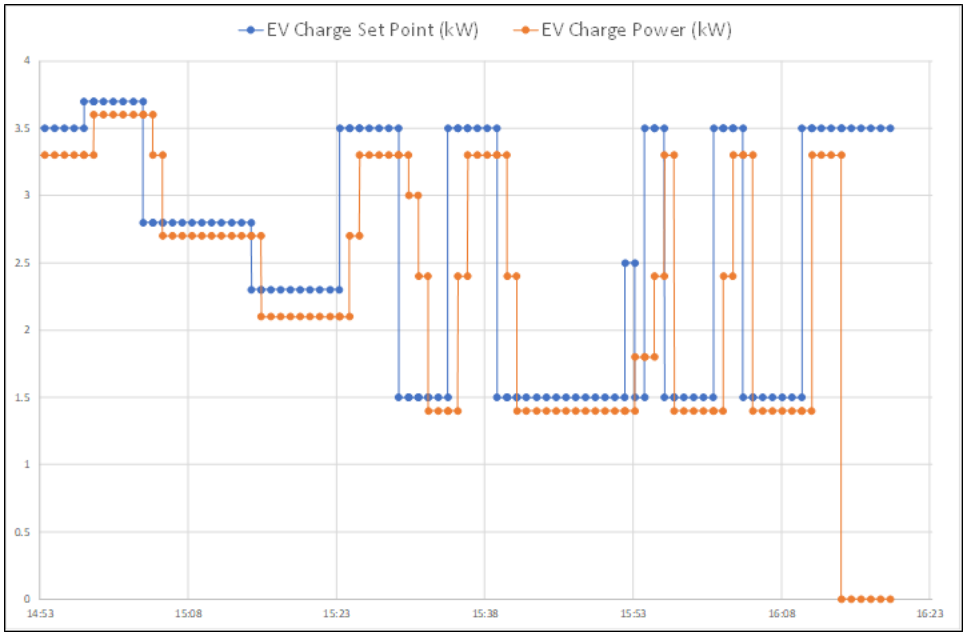

Figure 3: Demonstration of EV Charge Point Control at WPD's Hereford Depot

Figure 4: The Nissan Leaf used for demonstration of EV Charge Point Control at WPD's Hereford Depot

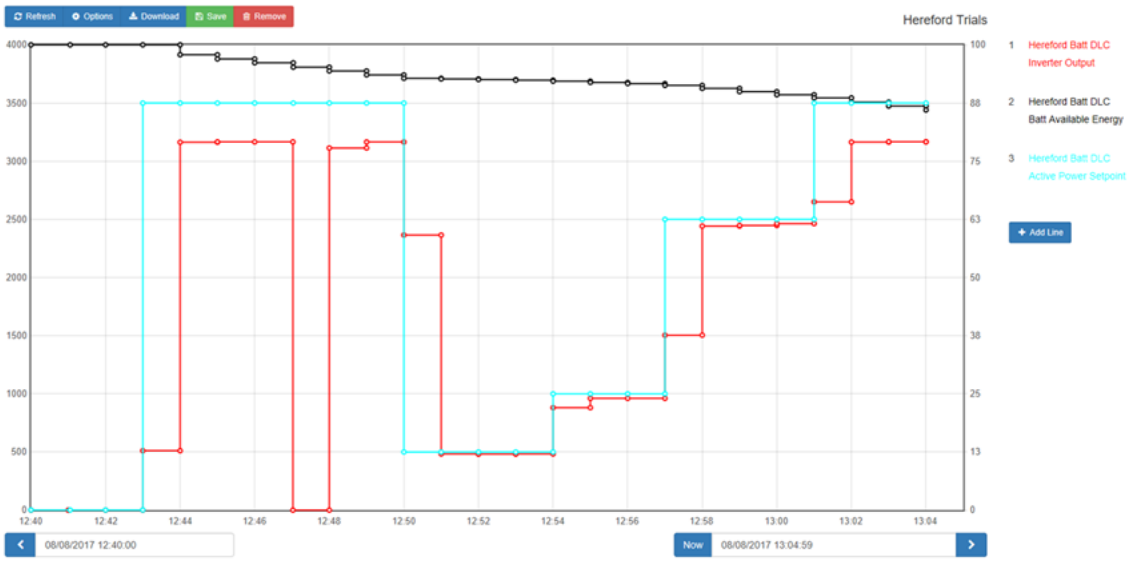

Figure 5: Demonstration of Battery/Inverter Discharge Control at WPD's Hereford Depot

Next steps

- Complete installation and commissioning of equipment in remaining customer's homes
- Begin trialling battery/inverter control in Furzton trial area

2.5 Phase 3: Analysis

Progress within this reporting period

In January 2018, it was observed that the BPL network is very sensitive to noise with limited connectivity and data communications particularly during peak loading times of the day.

From February 2018, the results from simulations have been analysed to evaluate the need case for, and performance of, the LV Connect and Manage solution. This analysis is ongoing.

Next steps

- Analysis of results from battery/inverter trials in Furzton area

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	158.924	158.924	0	0
Communications equipment	120	142.225	120	22.225	18[1]
Monitoring	40	54.62	54.62	14.62	36[2]
Control	400	320.937	320.937	0	0
Batteries and inverters	250	92.728	92.728	0	0
EV charge points	25	25	0	0	0
Customer engagement and dissemination	200	115.675	115.675	0	0
Equipment installation	100	87.347	87.347	0	0
WPD PM + Installation	100	93.4	93.4	0	0
Dissemination Modelling	20	17	17	0	0
Contingency	220	0	0	0	0
TOTAL	**1,675**		**1,055**		

Comments around variance

1. Overspend due to significant change in GBP/EURO exchange rate.
2. Overspend due to additional investments in Gridkey units upgrade for trial purposes.

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).

The project continues on track to meet all its success criteria.

5 Learning Outcomes

5.1 Phase 1: Mobilisation

The market for domestic LCTs (including EVs and batteries) is rapidly changing. As a result, the equipment supply chain has changed, which is outside of WPD's direct control. Specific to this project, a new SolarEdge inverter model, the StorEdge SE3680H was released and the previous model (SE3500) discontinued. The new model successfully integrates with the same version of the DLC box configuration as used for the previous SE3500 model so no changes are required. Installations can move forward with the new model. A batch of ICU Eve Minis were supplied with three-phase power terminals. The in-rush current for these variants was found to cause standard RCDs to trip. As a result, a dedicated 'MCB' protection switch is required for safe testing.

Although the appetite was identified for up to 50 customers to participate in the LV Connect and Manage trials in Milton Keynes, the installation of battery energy storage systems in several customers' homes was not deemed to be viable due to factors such as space limitations and the current location of customers' distribution boards.

5.2 Phase 2: Trials

The Westermos, installed at the distribution substations for BPL communications, were found to lock-up during their software reboot process, causing the substation monitoring equipment to lose communications for extended periods of time (in the order of days/weeks). This means that the DLC boxes will not be able to communicate via BPL. Power cycling the Westermo provided a short-term solution until a firmware update was deployed to fix the issue.

Electrical contractors should be issued with additional guidance on where to install DLC units for optimal communications.

Automated control of EV charge is achievable and has now been demonstrated in LV Connect and Manage. EV responded within 10s to set point signals. Towards the end of the charge (when the EV battery is reaching 98% capacity), the charge rate drops off automatically – this is controlled by the car itself.

5.3 Phase 3: Analysis

The key conclusion during this period of the project was that BPL is not fit-for-purpose for the LV Connect and Manage application. This is because it is not feasible to install repeater equipment in customers' cut-outs and so connectivity cannot be established. Even if connectivity could be established, the number of repeaters required to overcome attenuation in the network is not viable. Also, the data communications are unstable with poor BPL communications/connectivity during peak loading times of the day.

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.

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 8 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 **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
Delays with EV customer installations	Moderate	Close engagement with customers	30 installed. Delays due to customer unavailability
Delays with battery/inverter procurement	Minor	Identify alternative suppliers / equipment	Procurement up to date with eligible customers
Take up of LCTs is less than expected	Minor	Simulate LCT activity as a fallback Use battery installations in place of EVs for EV charge control trial	Capability built into ANM system to simulate LCT customers
Delays with PV customer installations	Minor	Close engagement with customers Bench test equipment	27 installed, risk reducing
Data is not protected as required	Minor	Data protection insurance Robust data protection systems Data project plan	Customer Engagement Contractors and Electrical Installers aware of their obligations.

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

Table 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)	2	1	0	0	0
	Less likely to occur/Mid to long term (6-10)	2	1	0	0	0
	Very unlikely to occur/Far in the future (1-5)	0	1	1	0	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				
	Minor	Moderate	Major	Severe		
Legend	7	1	0	0	No of instances	
Total	8				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.

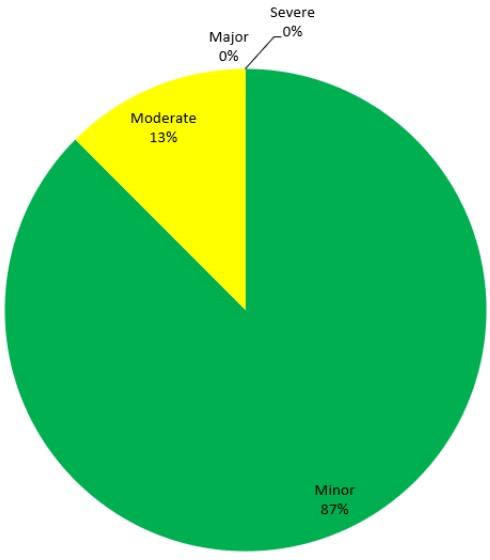

Table 7-3: Percentage of Risk by category

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 7-2 with updates on their current risk status.

Details of the Risk	Previous Risk Rating	Current Risk Rating	Mitigation Action Plan	Progress
BPL technology does not transfer data as expected / Technology is not compatible with substations	Moderate	Closed	N/A	Closed as BPL part of project terminated
Commissioning EV charge point needs an EV	Moderate	Closed	N/A	Closed as charge point control can be completed without EV
LCT take up less than expected	Moderate	Minor	Simulate LCT activity as a fallback Use battery installations in place of EVs for EV charge control trial	Capability built into ANM system to simulate LCT take up
Delays with EV equipment procurement	Minor	Minor	Identify alternative suppliers / equipment	Procurement up to date with eligible customers
Delays with EV customer installations	Minor	Moderate	Close engagement with customers Bench test equipment	30 installed Delays caused by lack of customer availability

Table 7-2: 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.westernpower.co.uk/Innovation/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.