WESTERN POWER DISTRIBUTION
INNOVATION

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NEXT GENERATION NETWORKS

# LV Connect & Manage

## Project Close-Down Dissemination Event
## 21st May 2019, The IET, Birmingham


**Steve Pinkerton-Clark**
**Innovation & Low Carbon Networks Engineer**

**Samuel Jupe**
**Network Innovation Manager (Nortech)**


# Agenda (Morning Session)

| | |
|---|---|
| 10:00 | Arrival, Registration and Refreshments |
| 10:30 | Introduction, Jonathan Berry |
| 10:45 | Project Overview, Steve Pinkerton-Clark |
| 11:30 | *Short Break* |
| 11:45 | Details of the Work Carried Out, Samuel Jupe |
| 12:30 | *Lunch* |

# Agenda (Afternoon Session)

- 13:30 Results from Trials and Lessons Learnt, Samuel Jupe
- 14:00 Conclusions and Next Steps, Steve Pinkerton-Clark
- 14:15 *Short Break*
- 14:30 Q&A and Open Discussion
- 15:00 Closing Remarks
- 15:15 *Opportunity for Continued Networking*

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LV Connect & Manage

# Introduction

**Jonathan Berry**
**Innovation Manager**
**Western Power Distribution**

# Introduction

WPD's Innovation Strategy and Portfolio

WPD's EV Strategy

WESTERN POWER DISTRIBUTION INNOVATION

# Innovation Portfolio

WESTERN POWER DISTRIBUTION EFFS

WESTERN POWER DISTRIBUTION NETWORK EQUILIBRIUM

WESTERN POWER DISTRIBUTION OPEN LV

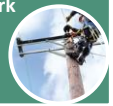
WESTERN POWER DISTRIBUTION SMART ENERGY ISLES

WESTERN POWER DISTRIBUTION PLUGS AND SOCKETS

## Future Networks Programme

### Assets

- Management of distribution assets
- Exploitation of asset & network information
- Developing Smart Grid Technology



### Customers

- Distributed Generation
- Connecting Electric Vehicles
- Adopting Battery Storage
- Facilitating Flexibility

### Operations

- Maintaining Reliability
- Strategic Forecasting
- Transitioning to DSO
- Operational Efficiency

## Network and Customer Data

### Network Improvements and System Operability

- Improved Statistical Ratings for OHL
- DEDUCE
- Primary Networks Power Quality Analysis
- Stochastic Load Flow
- Visual Data Processing
- Network Islanding
- Common Information Model
- Harmonic Mitigation
- Virtual STATCOM

### Transition to a Low Carbon Future

- Heat & Fleet
- Virtual Telemetry
- Solar Storage
- LV Connect & Manage
- FREEDOM
- Electric Nation
- Industrial & Commercial Storage
- Hydrogen Heat & Fleet

### New technologies and commercial evolution

- MVDC
- Next Gen Telecoms
- OHL Power Pointer
- Entire
- LV Fault Location
- On-street EV Charging
- Smart Energy Isles
- Visibility Plugs & Socket
- DEDUCE
- MADE

### Customer and Stakeholder Focus

- Power Electronic FLM
- Power Electronic FCL
- Self System Design
- New Build Standards
- LCT Response
- Carbon Portal

### Safety, Health and Environment

- Simulated Training
- SF6 Alternatives
- Robot Trades
- LV Sensitive Earth Fault Protection
- Wildlife Protection
- Losses Investigation
- Advanced Vegetation Management

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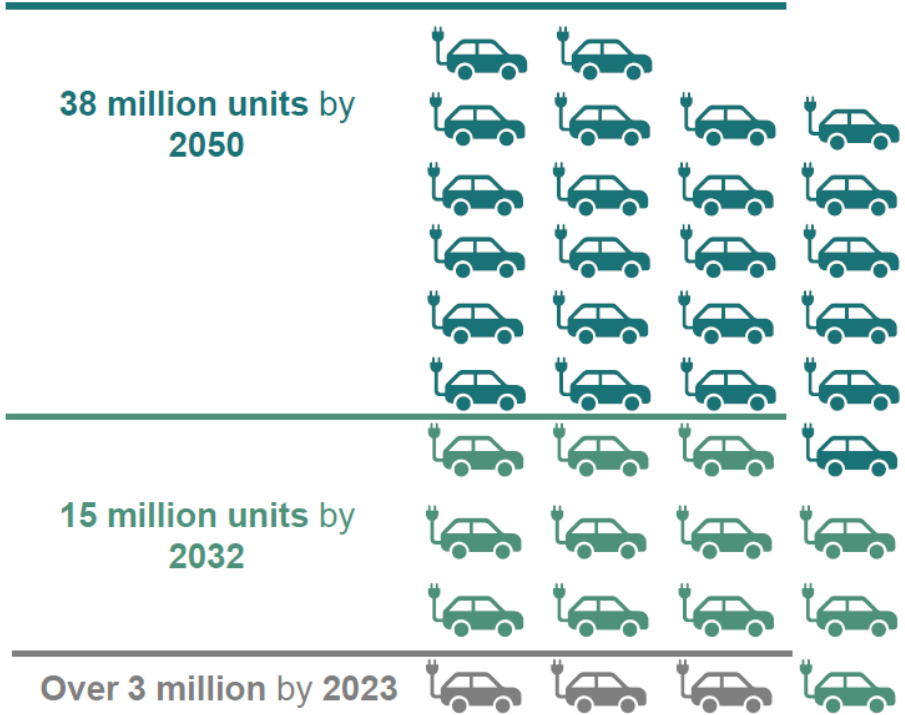
# Electric Vehicle Strategy


## PROJECTED INCREASE IN EVs
(HIGH UPTAKE SCENARIO)



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# Electric Vehicle Strategy

Western Power Distribution

Electric Vehicle Strategy

March 2019

WESTERN POWER DISTRIBUTION

**As outlined table, we have reviewed the size and type of chargers we expect to be deployed across our network, and assessed the cost and complexity of the electricity network required to support each.**

| Charge Point type and power output | Likely installation location | Specific connection requirements | Network considerations | Likely charge time for a 35kWh charge | Approx. connection lead-time | Network costs | Approx. connect-ion cost |
|---|---|---|---|---|---|---|---|
| **Slow up to 3kW** | Domestic | None – connects via household plug/socket | None | 12 hours | Immediate | None | None |
| **Fast 3.7kW** | Domestic or street side | Dedicated household circuit or on street equivalent | In some cases limited local reinforcement is required | 9 hours | Immediate in most cases | Usually none | Usually none |
| **Fast 7kW** | Domestic or street side | Dedicated household circuit or on street equivalent | Likely upgrade to service cable and local mains | 5 hours | 4 to 8 weeks | Likely upgrade to service cable and local mains | £1,000 to £3,000 |
| **Fast 22kW** | Street side or public charging location | Three phase dedicated supply point | Requirement for three phase connection and likely local mains upgrade | 1.5 hours | 8 to 12 weeks | Streetworks and permissions | £3,500 to £12,000 |
| **Rapid 43kW** | Public charging location | Three phase dedicated supply point | Requirement for three phase connection and likely local mains and transformer upgrade | 45 minutes | 8 to 12 weeks | Streetworks and permissions | £3,500 to £12,000 |
| **Super 130kW or multiple rapid chargers** | Public charging location | Supply point from dedicated transformer | In most cases a new transformer will be established | 15 minutes | 16 weeks | Streetworks, permissions and cost of land for transformer | £70,000 to £120,000 |

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Western Power Distribution

Electric Vehicle Strategy

March 2019

WESTERN POWER DISTRIBUTION

# Electric Vehicle Strategy

**Since 2009, we have been leading the charge in developing and trialling technical and flexible solutions to support the EV transition. We are now using the learnings from our projects to transform our operations, whilst also continuing to explore ways in which we can deploy new technologies.**

**2009**

**CABLED**
**ACTION:** UK's first ever demonstrator aimed at understanding public attitudes to EVs.
**OUTCOME:** Findings from the project informed WPD's design policies and customer servicing approach.

**2010**

**2011**

**Electric Boulevards**
**ACTION:** In a UK first, explored the viability of inductive charging for buses.
**OUTCOME:** Inductive charging infrastructure can now be connected cheaper & more quickly.

**2012**

**2013**

**EV Emissions**
**ACTION:** Checked compliance of modern EVs.
**OUTCOME:** Results informed the refinement of engineering standards and provided comfort that the automotive sector is designing EVs within limits.

**2014**

**2015**

**Electric Nation**
**ACTION:** Europe's largest domestic EV charging trial with 673 participants.
**OUTCOME:** Produced a network assessment tool helping identify the most appropriate means of providing capacity on the grid for EV charging.

**2016**

**2017**

**2018**

**2019**

We will produce a **network capacity map** to indicate the capacity available across our network to support local EV charging.

We will use data from our innovation projects to calculate a new **After Diversity Maximum Demand** that includes allowances for EV charging and other low carbon technologies.

We plan to amend our design policies to standardise on three phase **"Superfast Electricity"** service cables.

**Future projects**

**EV Filling stations:** WPD is looking to explore innovative solutions for the provision of network capacity for EV charging stations.

**On Street Charging Solutions:** This project will look at solutions for charging vehicles in residential locations on streets or at communal parking areas.

**Smart Homes:** This will show how domestic chargers can make use of locally generated power and storage.

**Smart Meter Load Control:** We will be working with an energy supplier to determine whether the SMETS2 smart meter can be used for an overload protection function.

**Self-Assessment:** Through the Energy Network Association, we are developing a project to inform DNOs whether a customers service is suitable to accept a domestic charger.

**Hub Charging Solutions:** We are working with a transformer manufacturer to develop a low cost charging hub to reduce network running costs.

**2020**

**V2G Taxi**
**ACTION:** Investigated how vehicle-to-grid technology could be accommodated by the electricity grid.
**OUTCOME:** Directly informed industry design standards and fed learning into subsequent projects.

**Smart Charging and Vehicle Telematics**
**ACTION:** Took data from bus monitoring systems to better understand the recharging requirements.
**OUTCOME:** New smart charging solutions were developed.

**Alternative Connections**
**ACTION:** Investigated a range of alternative connection solutions for customers who wished to connect flexible demand such as EVs and solar PV.
**OUTCOME:** We have been able to offer connections to customers wishing to install charging infrastructure where the cost of connection is prohibitively large.

**First alternative connection** with car dealership in Lincolnshire, following Alternative Connections trial.

**LV Connect and Manage**
**ACTION:** Developing a solution to provide emergency overload protection for the distribution network, to be deployed in areas of high concentrations of EVs.
**OUTCOME:** Customers will be advised that their local distribution network is at capacity at times of peak demand. Reinforcement will take place, securing the network.

**Superfast Electricity**
**ACTION:** This project will install three phase service cables within a housing development (both retrofitting and installing in new homes).
**OUTCOME:** It will demonstrate how these cables can be installed and make the final part of the network resilient to the demands of low carbon technology.

**LCT Detection**
**ACTION:** Undertaking this project with Electralink and IBM to identify whether it is possible to automatically locate the installation of new charging equipment via analysis of metering data.
**OUTCOME:** This will provide WPD with the most up to date information on low carbon technology take-up within our licence area.

**Forecasting and Planning Interface Tool**
**ACTION:** Following on from Electric Nation, this project will provide a visualisation of smart meter data, consumption data and network conditions.
**OUTCOME:** We will understand how much of this data can be used to allow planners to undertake network assessments & identify local constraints.

We plan to create a **design specification for bespoke charging transformer deployments**, helping with the deployment of charging infrastructure in public locations.

Utilising the findings from the LV Connect and Manage project we will roll out a **rapid, standardised resolution to capacity issues.**

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Electric Vehicle Strategy

March 2019

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## LV Connect and Manage

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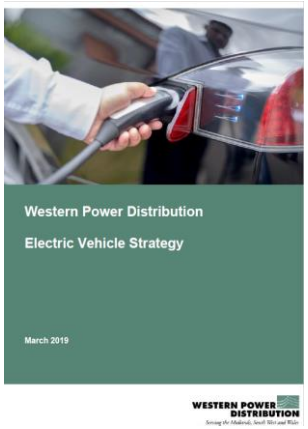
# Electric Vehicle Strategy




**Our approach**
**We want to see a suitable network that exists for *all* charging requirements in *all* situations**

| | | | | | |
|---|---|---|---|---|---|
| Domestically & commercially we will provide **flexibility** so that EV charging is takes place in harmony with local network capacity | We will **reinforce** our network so that users have safe and adequate charging connections | We are changing the way we **plan and design** new networks, using low cost measures to ensure they are future-proof | We are overcoming the three **technical issues** associated with EV connections: thermal capacity; earthing; and, power quality | We are simplifying the **application process** | We are making use of **existing local** capacity to support early adoption |

**1** **For depot-based fleets**
When fleet users return their electric vehicles to a depot location a large electricity supply is required. WPD is offering the connections needed for fleet users and we are looking toward offering flexible solutions to make the most efficient use of our network.

**2** **Where there is existing network capacity**
While our low voltage networks already includes a volume of available capacity we want to make sure that our larger local transformers can accommodate greater capacity for EV charging. In order to indicate what areas can offer greater capacity, WPD is developing a heat map at our local transformers. This will also identify where network constraints are likely.

**3** **At motorway services and major road filling stations**
We will work with motorway services operators to enhance their main electricity supply, making it easier for EV charging. We are working on innovative methods to provide the network capacity needed for the required increasing of the number of charging points at filling stations.

**4** **For smart charging**
WPD is working with the Welsh Housing Association Pobl on a project where all new homes are being built with EV charging cables fitted alongside smart white goods. The technology involved will be connected meaning the EV charging will be able to follow price signals and charge when demand is low, making the network more efficient.

**5** **At workplaces and for off-street charging**
40% of all vehicles on UK roads don't park in an off-street location. WPD is using the Road to Zero Strategy requirements to give local authorities the ability to provide new street lighting installations or bespoke EV charging installations for their streets. This will include installing charging points at various locations from workplaces to retail parks.

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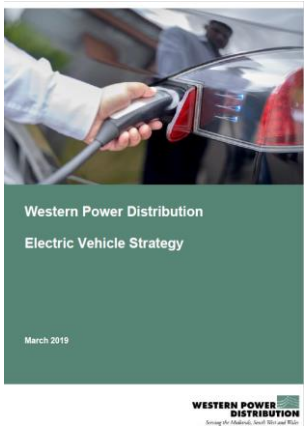
# Electric Vehicle Strategy

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**6** **For on-street charging**
WPD is working to improve the on-street charging facilities across the network area. We are expecting to provide bespoke street lighting mains cables in new streets through our On Street Charging Solutions project. We are also looking to upgrade the existing mains infrastructure within our established networks.

**7** **Where there are constraints on the network**
Where there are locations where the number of new EVs exceeds the capacity of the local network we will identify the constraints and rectify the issues. Using equipment developed through our Electric Nation project, WPD will manage demands and deal with supply interruptions as and when they occur.

**8** **For Vehicle-to-Grid chargers**
WPD will continue to work on vehicle to grid technology, monitoring developments in this area. We helped connect the first domestic V2G charger and we are currently in discussions with an airport and other partners to harness their available potential.

**9** **For new and existing homes**
We are working with developers and local authorities to make sure charging requirements are in place for both current and future homes. We also want to make sure that EV buyers are aware of their domestic charging capacity. Where the existing infrastructure is not in place we will make sure that it is installed with minimal inconvenience to customers.

**10** **Where there is EV clustering**
A clustering effect of EV charging could cause potential problems with the power grid. We are working to mitigate this and identify where clustering is an issue so that we can reinforce our networks.

# Summary

WPD's Innovation Strategy and Portfolio

WPD's EV Strategy

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# Project Overview

## LV Connect & Manage

**Steve Pinkerton-Clark**
**Innovation and Low Carbon Networks Engineer**
**Western Power Distribution**

# Project Overview

- Background
- Outline
- Scope and Objectives
- Success Criteria
- Benefits

# Project Overview

- Work Carried Out (Overview)
- Project Performance
- Lessons Learnt for Future Projects (Overview)
- Project Outcomes (Overview)
- Data and IPR Access

# Project Background

Low carbon technologies (LCT) connections on LV network:

- Trend for clustering of LCTs
- Hard to predict and plan ahead reinforcement
- Traditional reinforcement is expensive and takes time
- Delayed customers' connections
- Reverse Power Flow (RPF) impact on distribution network


# Project Outline

- £1.7m NIA project (April 2016 - March 2019)
- Ability to provide more power during non – peak hours
- Bi-directional power flow control via “Domestic Load Controller” (DLC) hardware
- Accelerate connection of LCTs (storage, EVs, heat pumps)
- Protect WPD assets from overload
- 6 distribution substations and 100 customers in Furzton, Milton Keynes (Energy Storage) and West Bridgford, Nottingham (EV Chargers)

| Customer Propositions | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Cost (£m) |
|---|---|---|---|---|---|---|---|---|---|
| DSR products by customer segment | | | | | | | | | 0.5 |
| DSM tariff structure | | | | | | | | | 0.5 |
| Alternative Connection Agreements | | | | | | | | | 2 |
| Managed Connection Agreements | | | | | | | | | 0.5 |
| Settlement and Billing | | | | | | | | | 2 |

# Scope and Objectives

| |
|---|
| Develop the LV Connect and Manage solution architecture |
| Monitor LCTs and compare aggregated power flows with operational limits |
| Design, build and operate an active management system for LV LCTs |
| Demonstrate the effectiveness of broadband-over-powerline for the bi-directional power flow control of LCTs |
| Demonstrate the optimisation of real-time import and export patterns |
| Demonstrate how the solution can be used as a short-term or long-term intervention to avoid/defer network reinforcement |
| Develop new business processes for the deployment of DLC boxes into customers' homes |

# 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.
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).

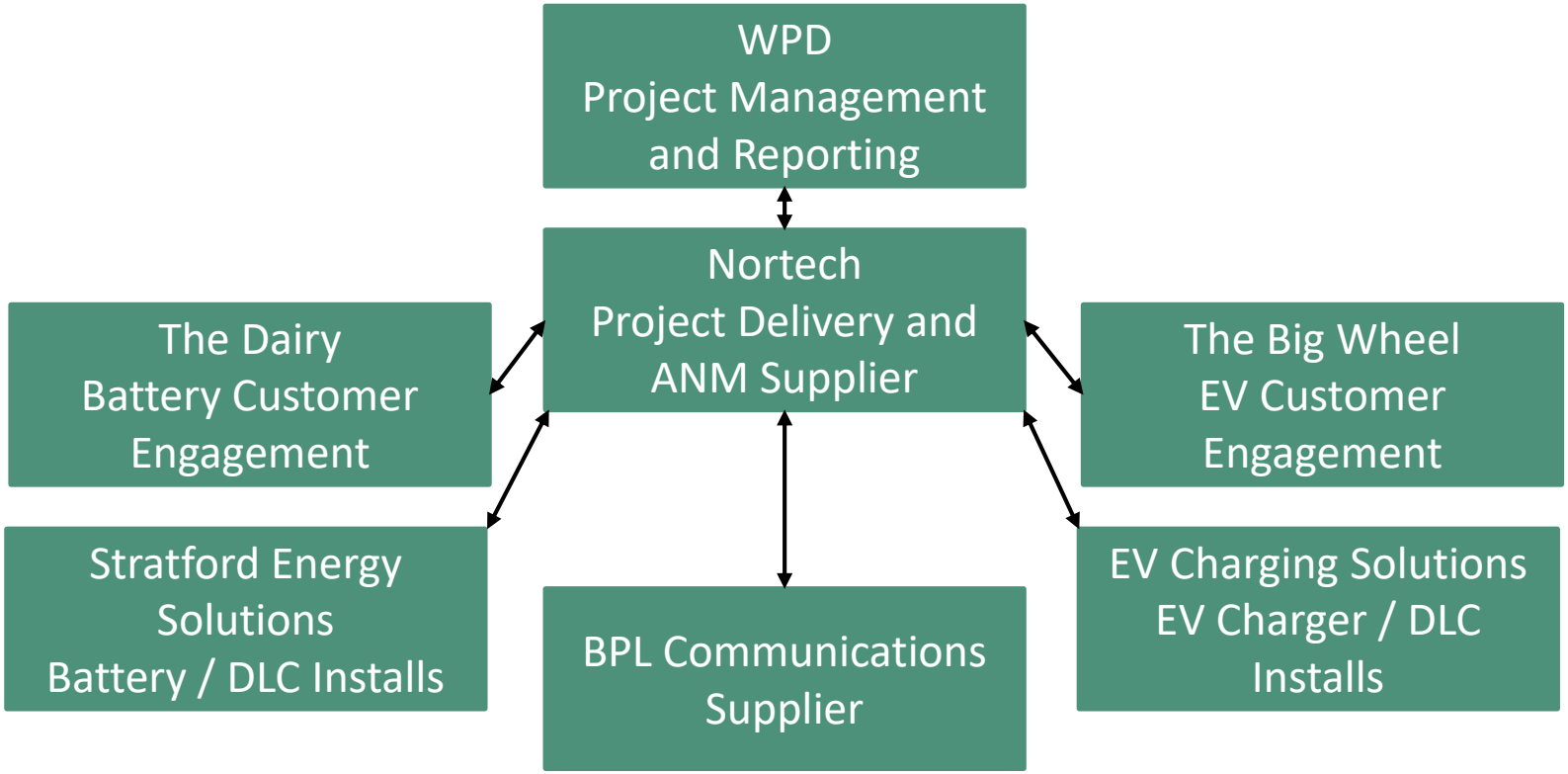
# Customer Benefits

1. Intelligent interface to accelerate connection of LCTs (storage, EVs, heat pumps)
2. Avoid costly reinforcement
3. Reduced amount of street works
4. Provide flexibility to export more power during non – peak hours or/and use stored energy in ‘self consumption’ mode
5. Consume energy in more sustainable, environmentally friendly way, reducing amount of $CO_2$ emissions

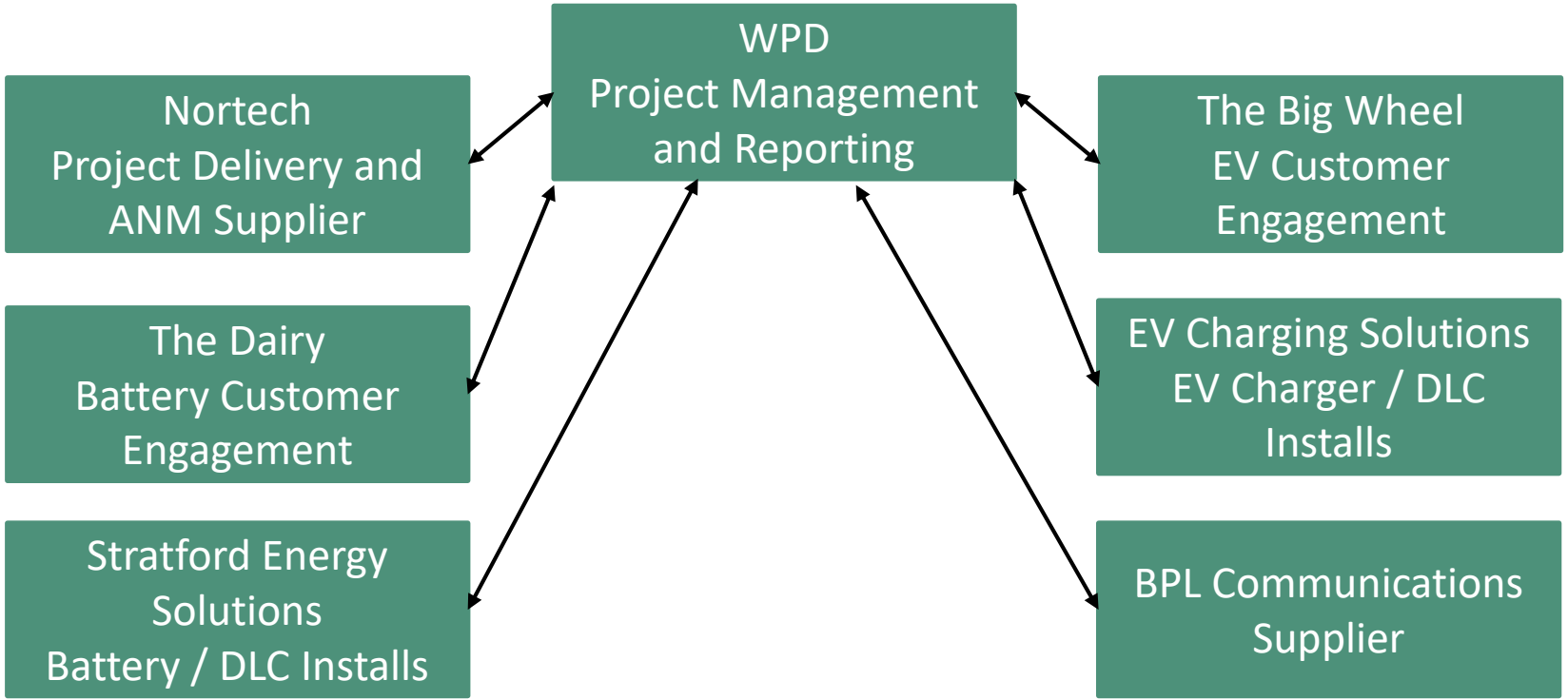
# Work Carried Out (Further detail in next session)

- Solution Architecture
- Domestic Load Controller Design
- Hereford Depot Installations
- Site Selection and Customer Engagement
- Equipment Installations
- ANM Trials

# Work Carried Out (Delivery Structure)



# Work Carried Out (Contractual Structure)



# Performance Against Scope and Objectives

| Objective | Status |
|---|---|
| Develop the LV Connect and Manage solution architecture | ✓ |
| Monitor LCTs and compare aggregated power flows with operational limits | ✓ |
| Design, build and operate an active management system for LV LCTs | ✓ |
| Demonstrate the effectiveness of broadband-over-powerline for the bi-directional power flow control of LCTs | ✓ |
| Demonstrate the optimisation of real-time import and export patterns | ✓ |
| Demonstrate how the solution can be used as a short-term or long-term intervention to avoid/defer network reinforcement | ✓ |
| Develop new business processes for the deployment of DLC boxes into customers' homes | ✓ |

# Performance Against Success Criteria

| Success Criteria | Status |
|---|---|
| 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. | ✓ |
| 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). | ✓ |

# Lessons Learnt (Further detail after lunch)

1. The effectiveness of the demonstrations undertaken
2. Significant problems discovered with the trialled methods
3. Recommendations on how the learning from the project can be exploited further
4. The likelihood the method will be deployed on a wider scale in future
5. Knowledge Dissemination Events

# Project Outcomes (Further detail after lunch)

1. The results from live trials of EV charge management (import limitation)
2. The results from live trials of battery dischargement management (export limitation)
3. Set point response times over mobile communications networks
4. Policies and emerging standards resulting from this work
5. TRL Development

# Data and IPR Access

After project close-down, aggregated LCT profiles will be published on WPD's project data page: [www.westernpower.co.uk/Innovation/Contact-us-and-more/Project-Data.aspx](www.westernpower.co.uk/Innovation/Contact-us-and-more/Project-Data.aspx)

| IPR | Ownership | Access Location |
|---|---|---|
| Business Case metrics for Connect and Manage | WPD | Project Registration Document (Smarter Networks Portal) |
| Project Data | WPD | WPD's Project Data Page |
| The Connect and Manage solution architecture | WPD / Nortech | Close-Down Report |
| Project Dissemination Papers and Presentations | WPD / Nortech | Close-Down Report |
| Policy for the Retrofit of Connect and Manage Equipment in LV Substations | WPD | Close-Down Report |
| Process for Standardising the Installation of DLC Equipment in Customers' Homes | WPD / Nortech | Close-Down Report |
| Technical Specification for Managed EV Charging | WPD / Nortech | Close-Down Report |

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LV Connect & Manage

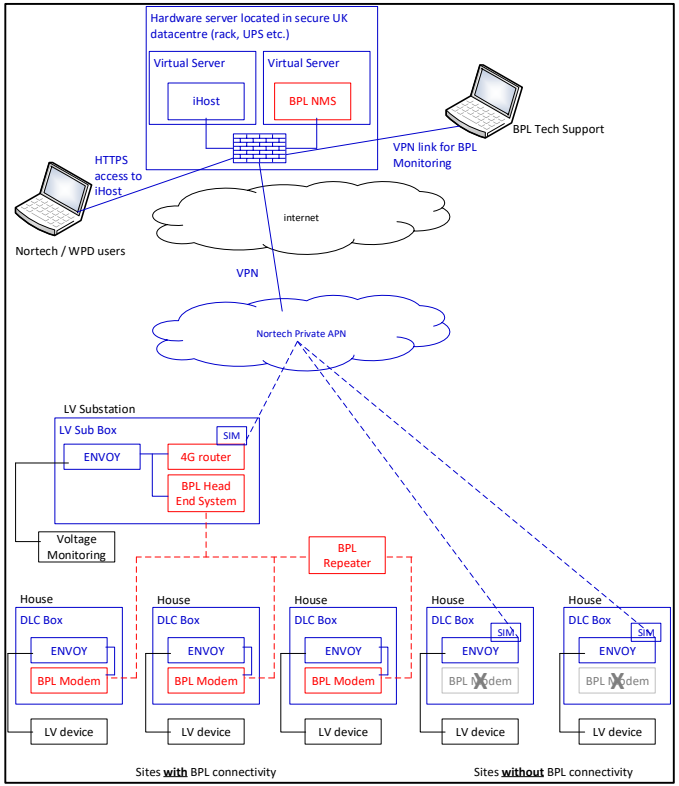
# Details of the Work Carried Out

**Samuel Jupe**
**Network Innovation Manager**
**Nortech Management Limited**

# Work Carried Out (Overview)

- Solution Architecture
- Domestic Load Controller Design
- Hereford Depot Installations
- Site Selection and Customer Engagement
- Equipment Installations
- ANM Trials (after lunch)

# Solution Architecture (Overview)



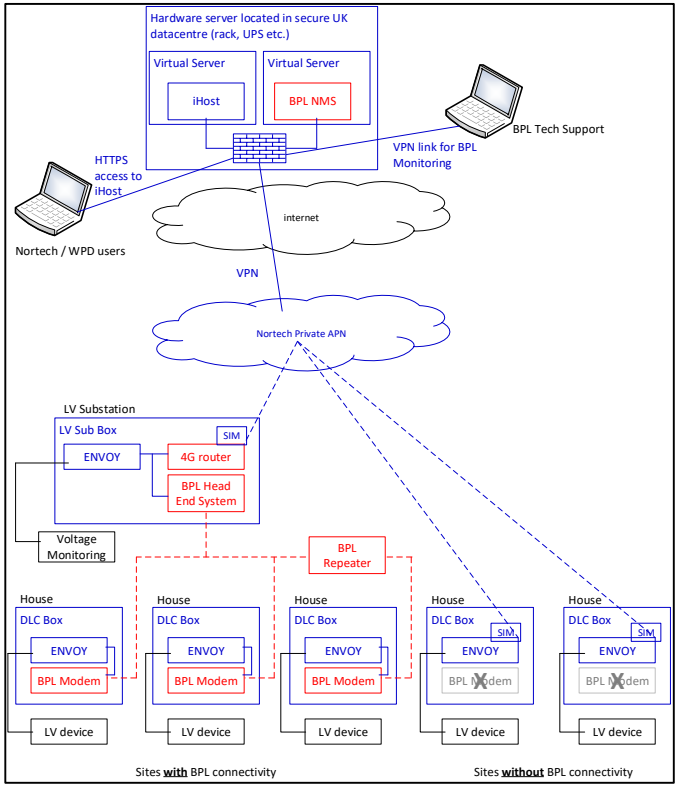

Components:

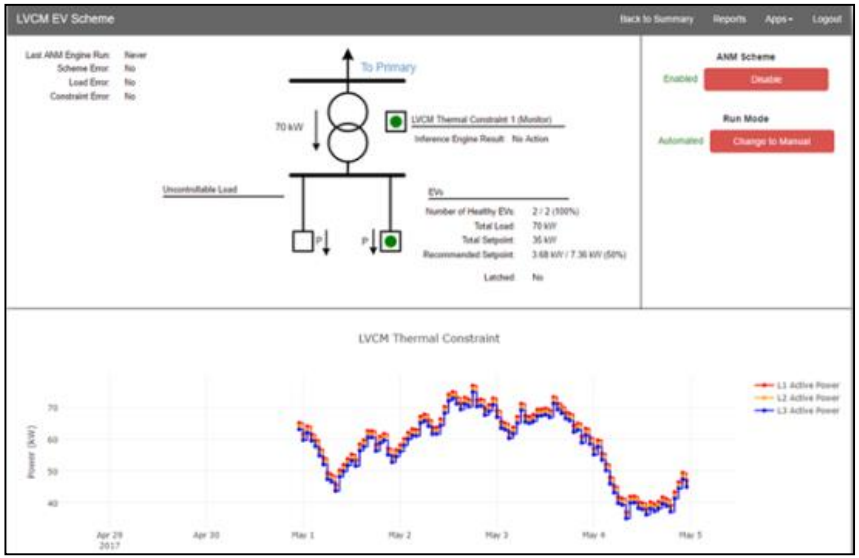
1. iHost
2. Broadband-over-Powerline NMS
3. Substation Monitoring
4. Domestic Load Controller (DLC) box
5. Low carbon technologies (LCTs)

Communications:

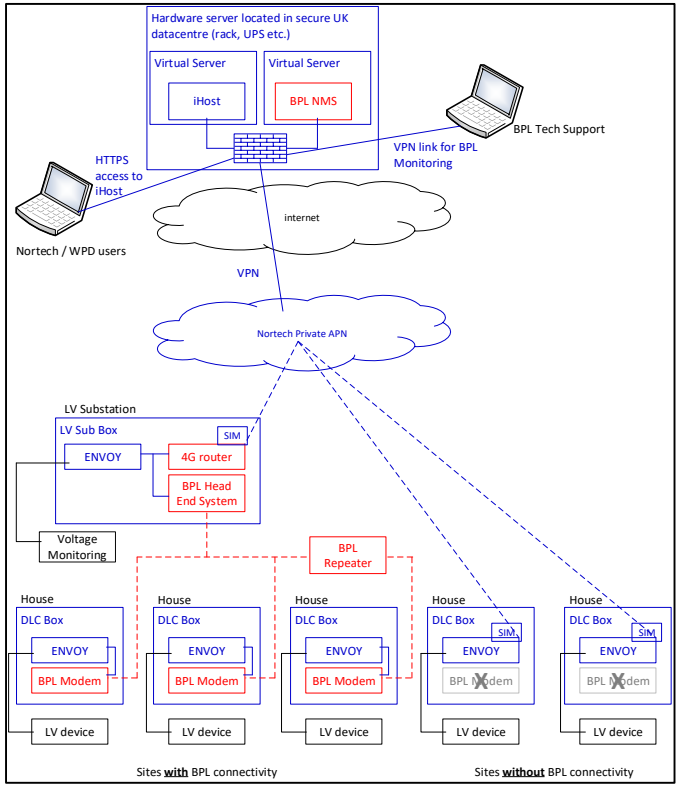
1. DLC to LCT (Modbus, Open Charge Point Protocol over Ethernet)
2. DLC to Substation (DNP3 over BPL then 4G)
3. DLC to iHost (DNP3 over 3G)

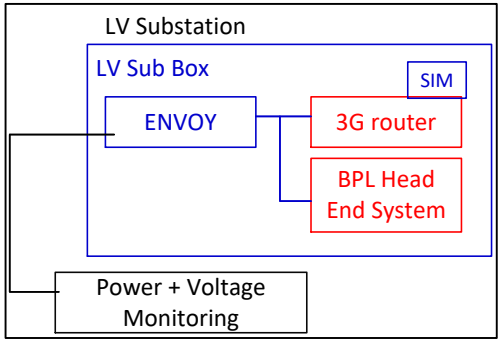
# Solution Architecture (iHost)



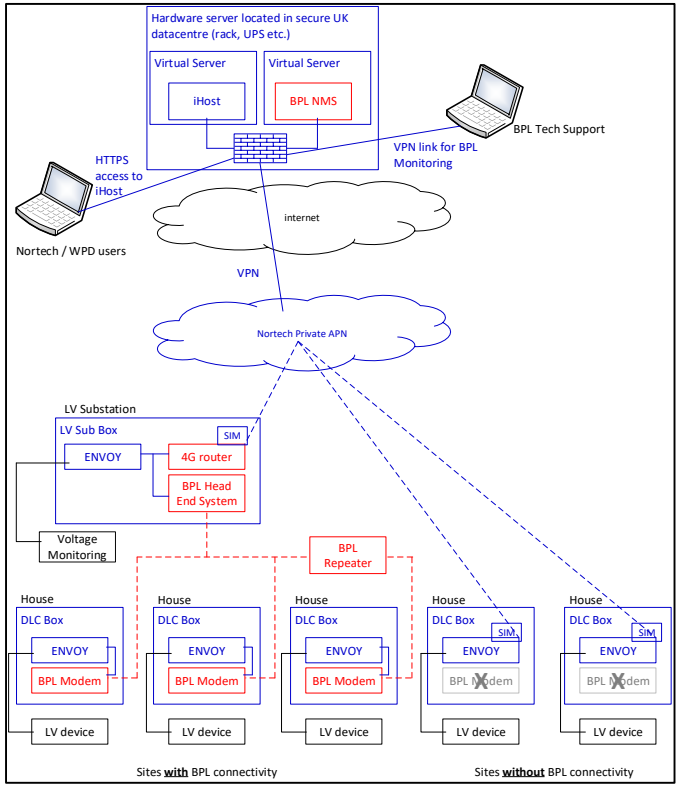
# Solution Architecture (Substation Monitoring)

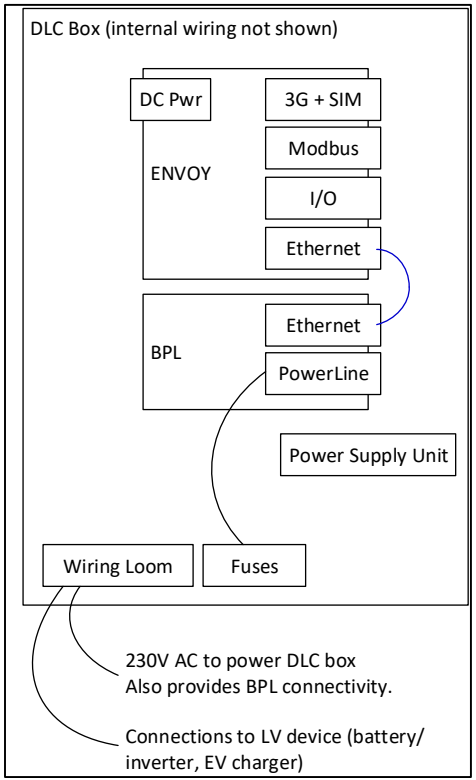




# Solution Architecture (DLC Box)



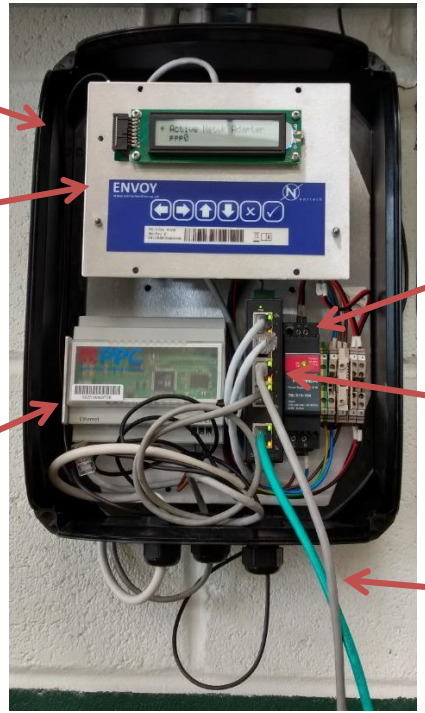




# Domestic Load Controller (DLC) Box Design

Tamper detection switch

Envoy RTU (Decentralised Controller)

Project-specific communications modem (BPL)




230VAC Power supply

Ethernet hub

Ethernet connection to controlled device e.g. EV charge point

# Failure Modes and Effects Analysis

1. Define system components
2. Define system communications
3. Analyse potential failures, risks and causes
4. Analyse the impact and effect on the system
5. Identify severity of risk and commensurate mitigation
6. Design mitigation into product

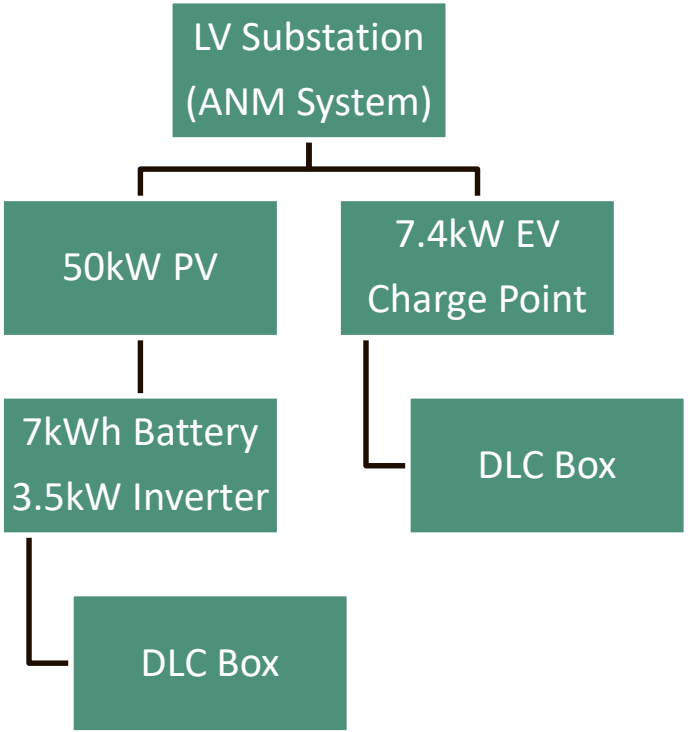
# Failure Modes and Effects Analysis

| Failure (Risk) / Cause | Effect / Impact | Mitigation |
|---|---|---|
| 1. Data Centre / DC equipment failure<br>- Power cut<br>- Internet<br>- Fire<br>- Burgulary<br>- Firewall misconfiguration | Loss of central system | Two data centres<br>Data centre mitigations (redundant power supplies, CCTV etc.) **-> Pulsant**<br><br>Graceful degradation in Envoy in DLC box **-> Nortech**<br><br>Change control process **-> Nortech** |
| 2. BPL NMS Failure<br>- Upgrade, misconfiguration | Loss of monitoring of comms<br><br>Unable to commission system | Tolerate if data is still coming through -> **Nortech**<br><br>Understand recovery times etc. -> **BPL supplier to provide** |

# Hereford Depot Trial Installations

- Trial project solution in real life environment
- De-risked customers installations
- Develop business processes for substation installations

# Hereford Depot: Testbed Architecture





DLC Box

Domestic Load Control Box – incorporates modules for load control and communication

# Hereford Depot Trial Installation (Part 1)

## LV substation installation

# Hereford Depot Trial Installation (Part 2)

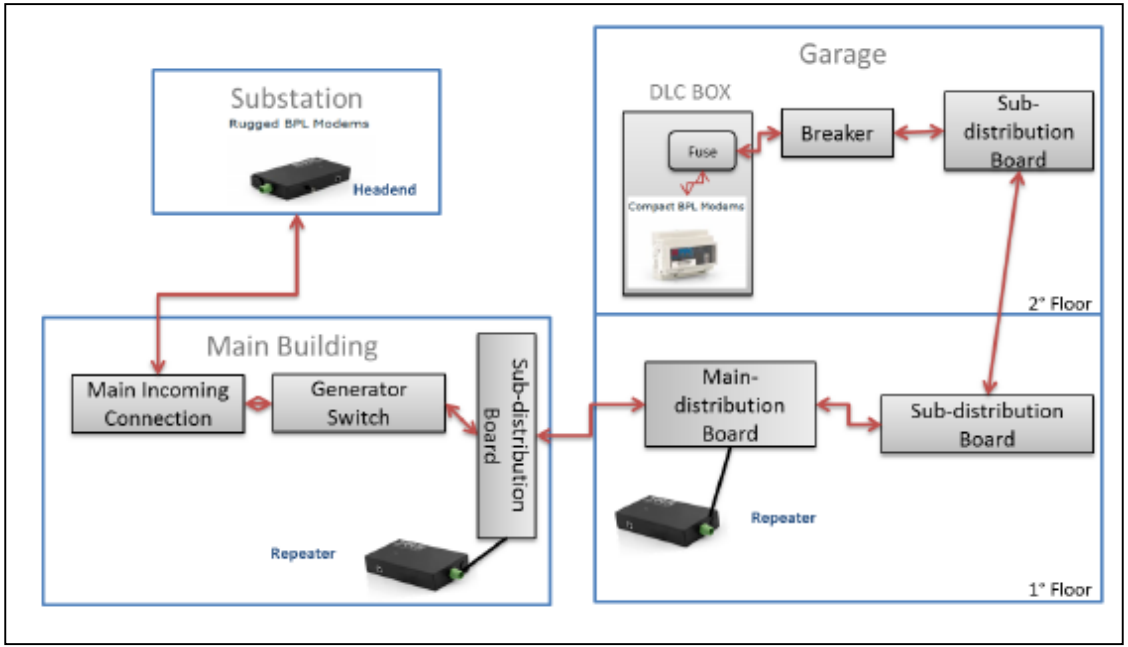
## Customer side


PV/battery export limitation

EV charge import limitation

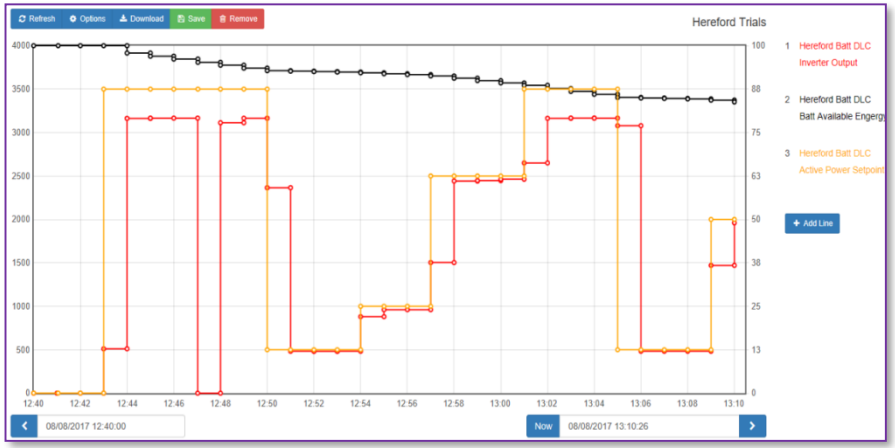
# Hereford Depot Trial Installation (Part 3)

## BPL Commissioning

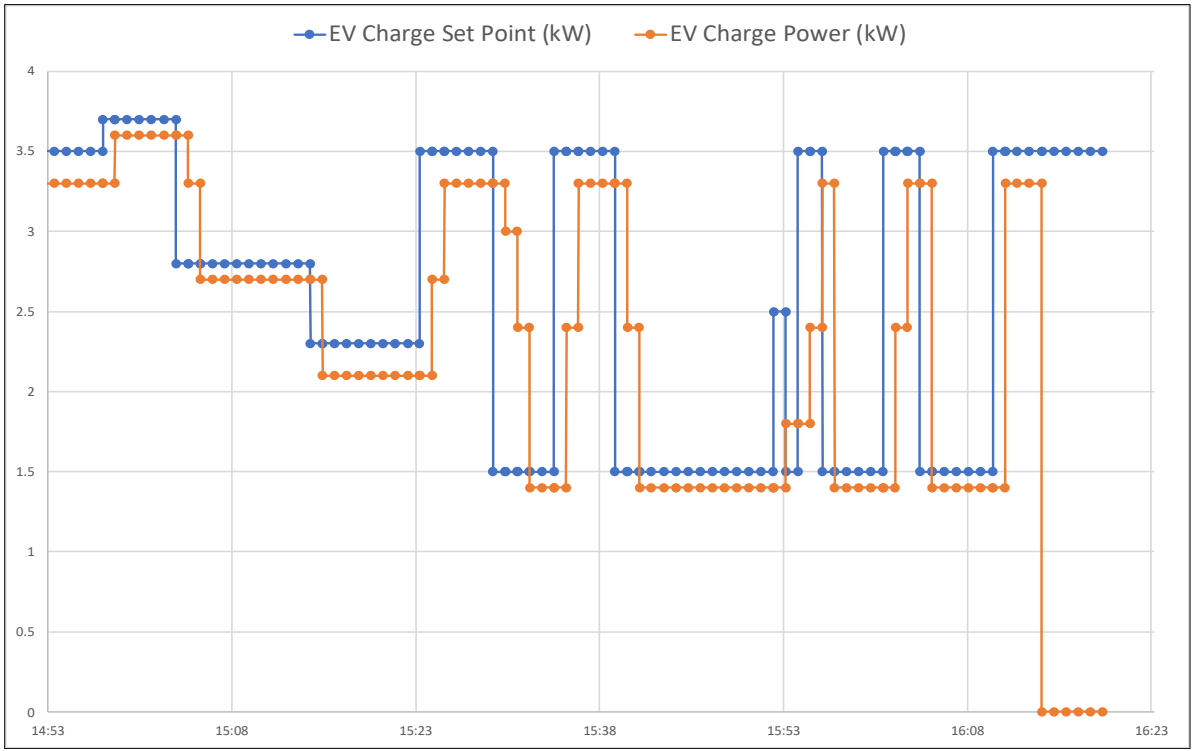


# Hereford Depot Trials

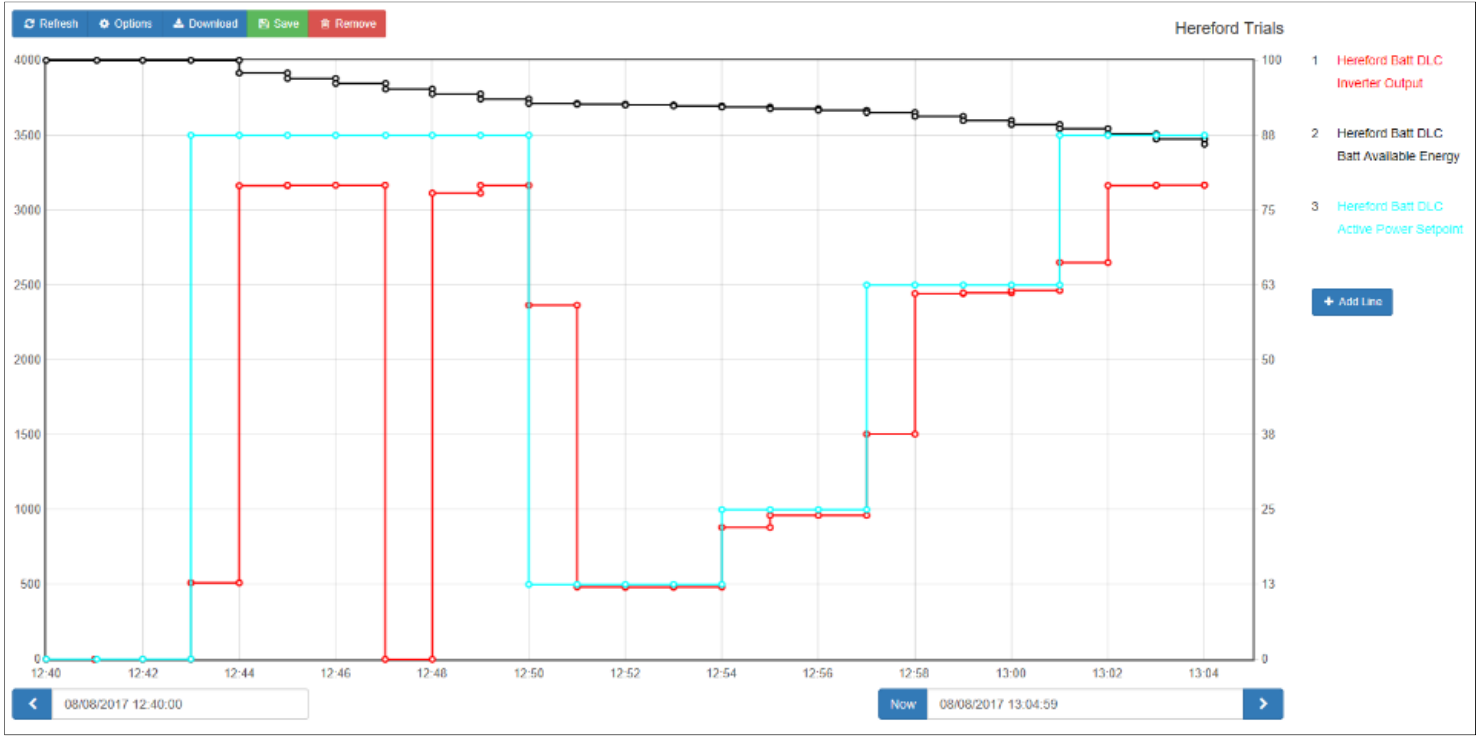
- Technical tests:
  - Proved feasibility to manage EV charging rate (0-16-32A) via BPL/GSM
  - Proved feasibility to manage rate of PV/Energy Storage discharge via BPL/GSM
  - Tested auto failover of communications
  - Confirmed iHost demand / export management

# Hereford Depot Trials: EV Charge Management (Import Limitation)



# Hereford Depot Trials: PV/Battery Charge Management (Export Limitation)



# Site Selection and Customer Engagement

- Control & monitoring equipment is installed in 6 distribution substations:

| | | | |
|---|---|---|---|
| 942197 | GRASSCROFT BLETCHLEY (FURZTON) | 881417 | WEST BRIDGFORD RUGBY ROAD |
| 942196 | PARKSIDE FURZTON | 881418 | WEST BRIDGFORD COMPTON ACRES |
| 942183 | PERRACOMBE FURZTON | 881089 | WEST BRIDGFORD HAWTHORNE PARK |

- Customers engagement activities:
  - Customer engagement meetings
  - Leaflets
  - Social networks
  - Customer engagement video
  - Website: www.wpdconnectandmanage.co.uk

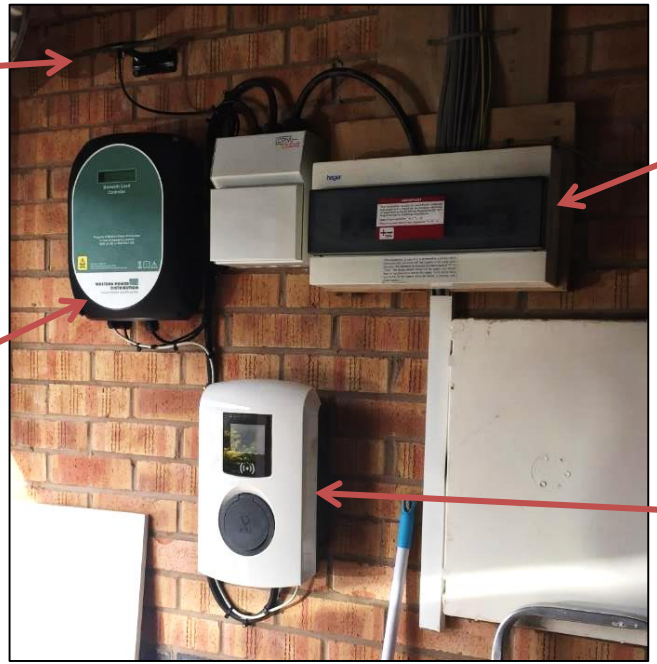
# Customer Engagement Video


https://youtu.be/ypTlHl9vs5o

# Project Equipment Installations in Customers' Homes

External GSM antenna

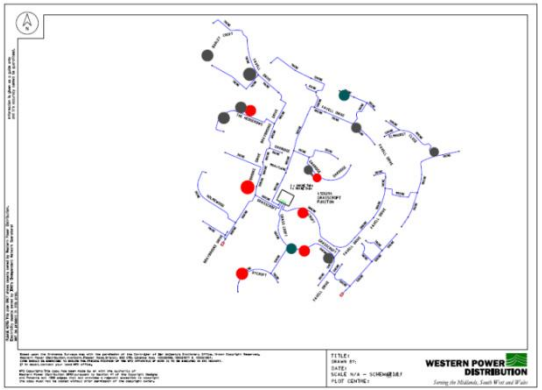
Domestic Load Controller (DLC) box

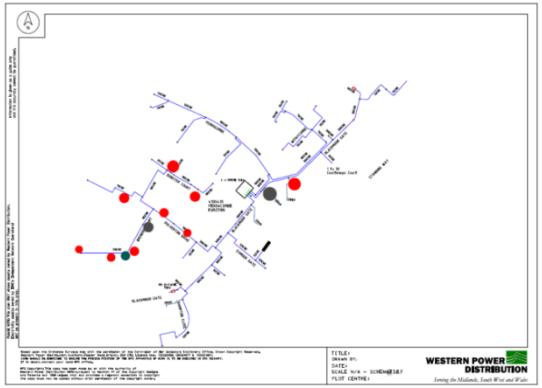


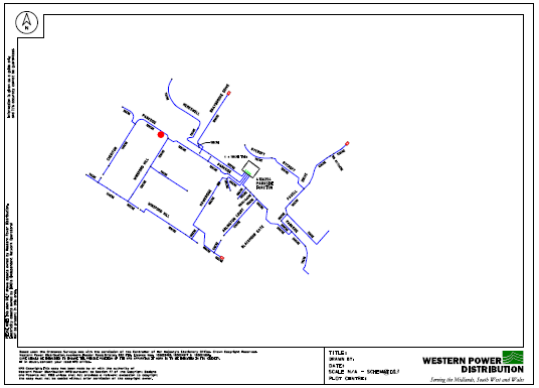
Consumer unit

Charge point under control

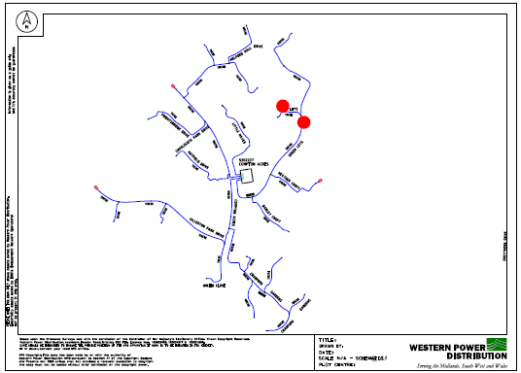
# Customer Installations: Milton Keynes Clusters

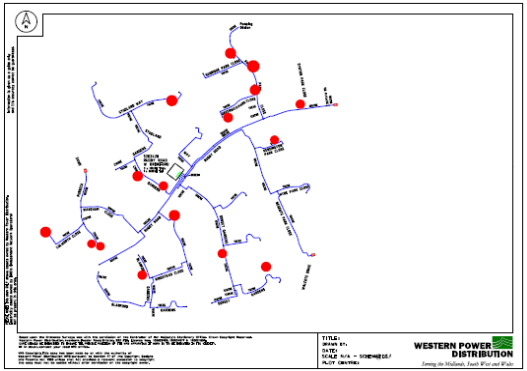


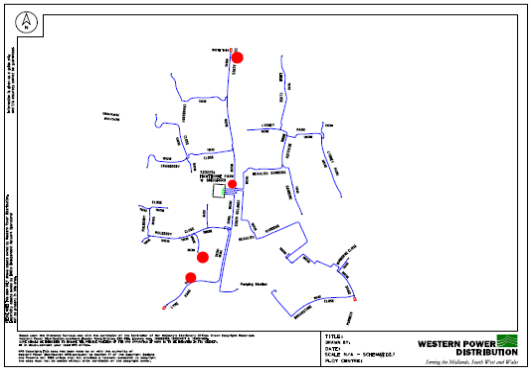




# Customer Installations: West Bridgford Clusters




# Work Carried Out (Summary)

- Solution Architecture
- Domestic Load Controller Design
- Hereford Depot Installations
- Site Selection and Customer Engagement
- Equipment Installations
- ANM Trials (after lunch)

WESTERN POWER DISTRIBUTION
INNOVATION

nortech

NEXT GENERATION NETWORKS

LV Connect & Manage

# Trial Results and Lessons Learnt

**Samuel Jupe**
**Network Innovation Manager**
**Nortech Management Limited**

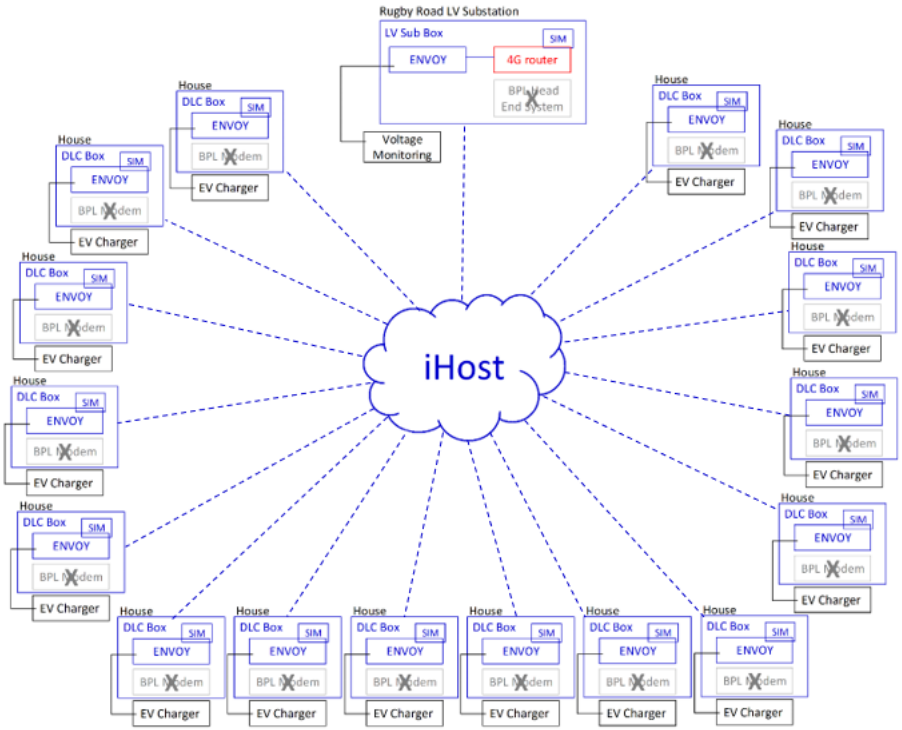
# Results and Lessons Learnt (Overview)

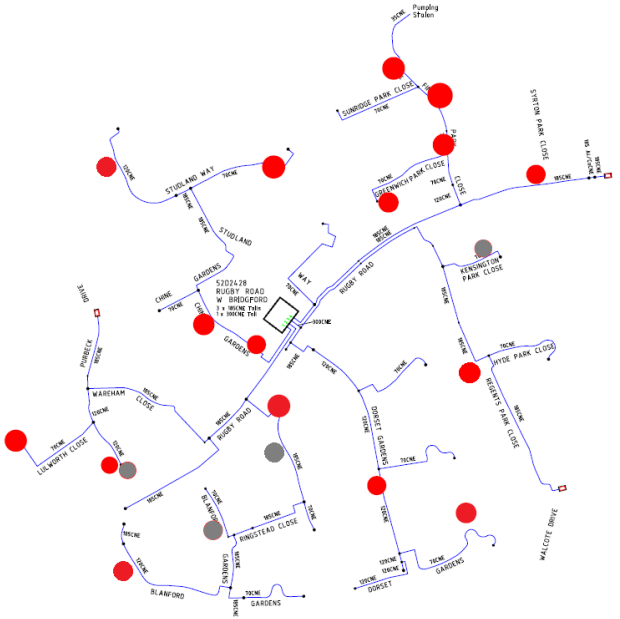
1. Project Outcomes: Live Trial Results and Setpoint Response Times (over GSM)
2. Modifications During the Course of the Project
3. Lessons Learnt
4. Knowledge Dissemination Activities

# Project Outcomes (Overview)

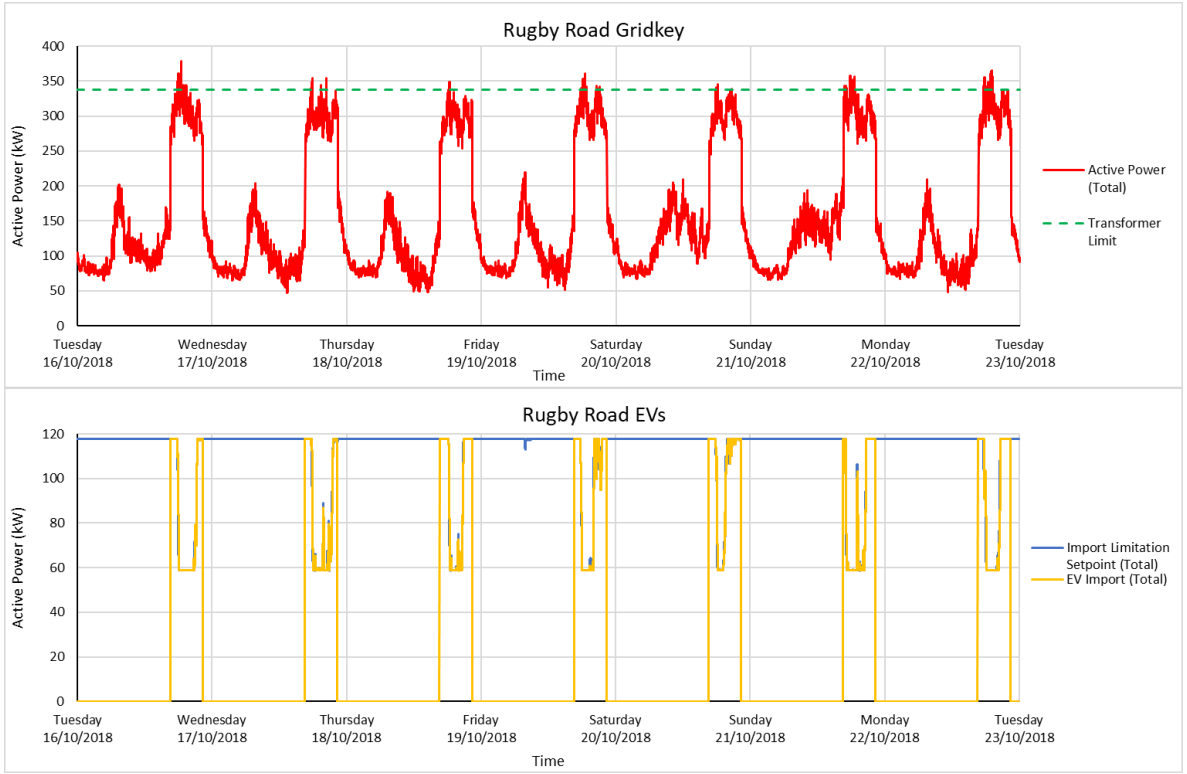
1. The results from live trials of EV charge management (import limitation)
2. The results from live trials of battery dischargement management (export limitation)
3. Set point response times over mobile communications networks
4. Policies and emerging standards resulting from this work
5. TRL Development

# Live Trials: EV Charge Management (Import Limitation)

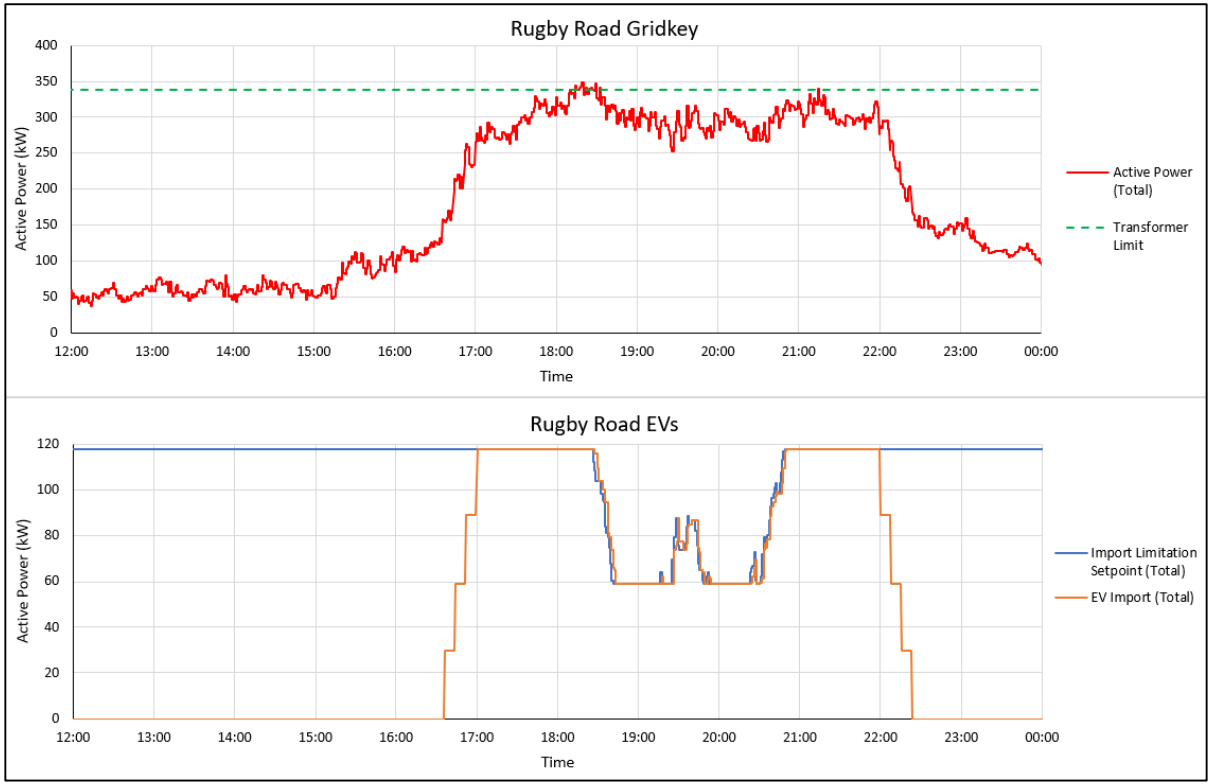


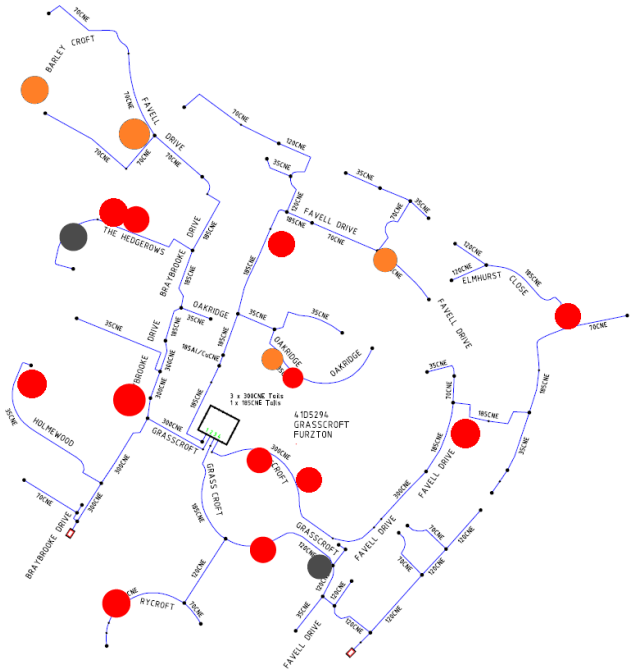
# Live Trials: EV Charge Management (Import Limitation)

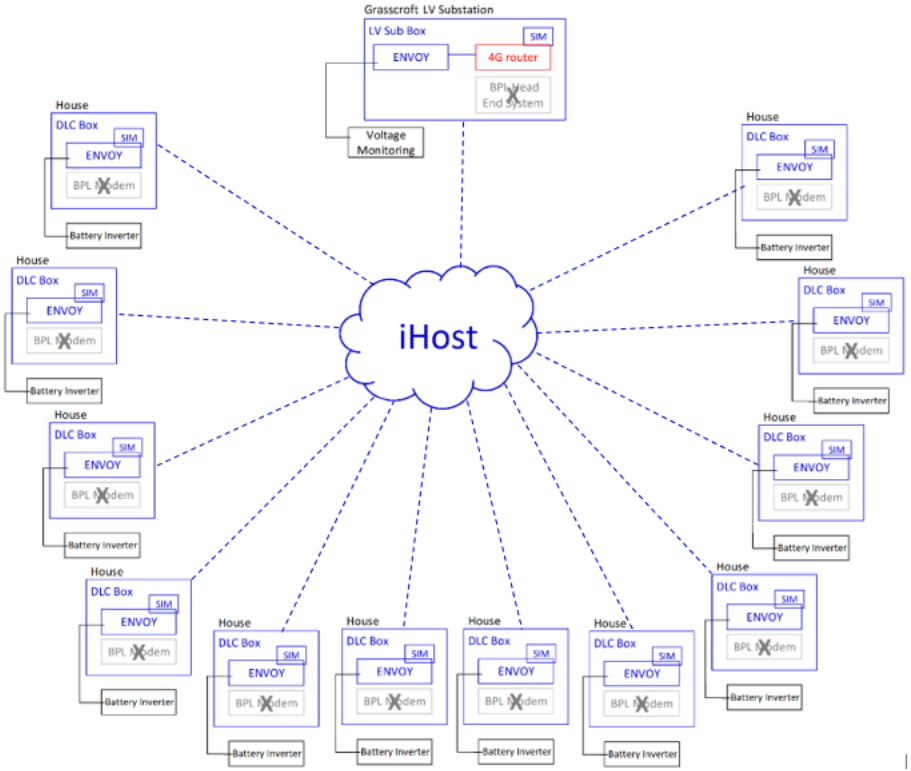


# Live Trials: EV Charge Management (Import Limitation)

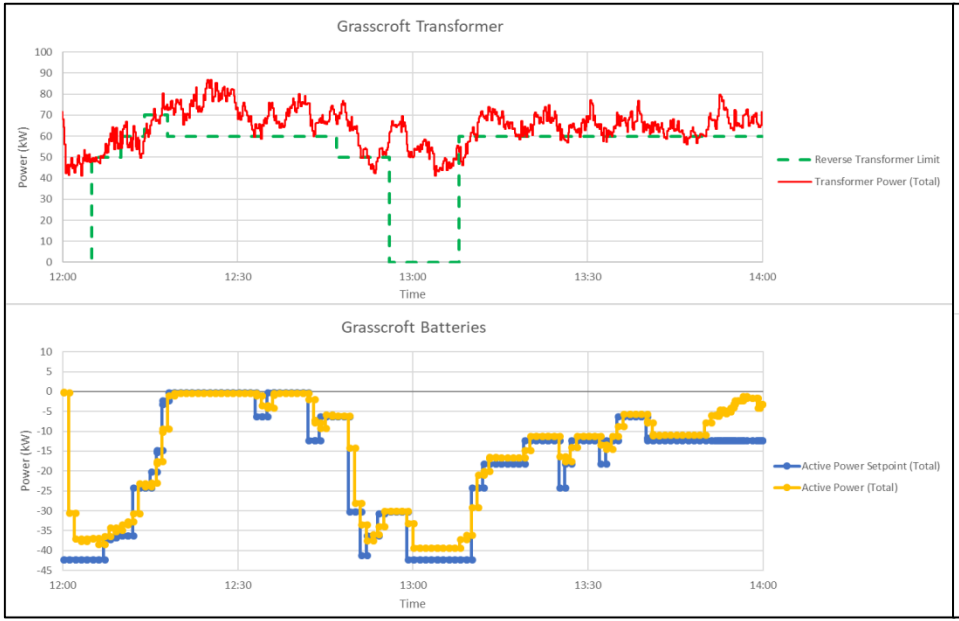


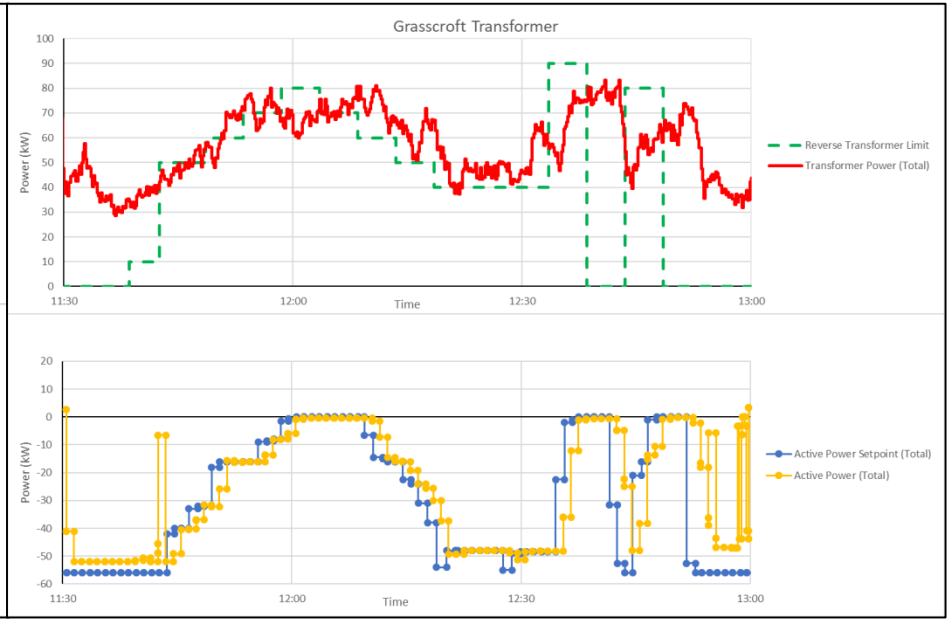
# Live Trials: PV/Battery Charge Management (Export Limitation)



# Live Trials: PV/Battery Charge Management (Export Limitation)



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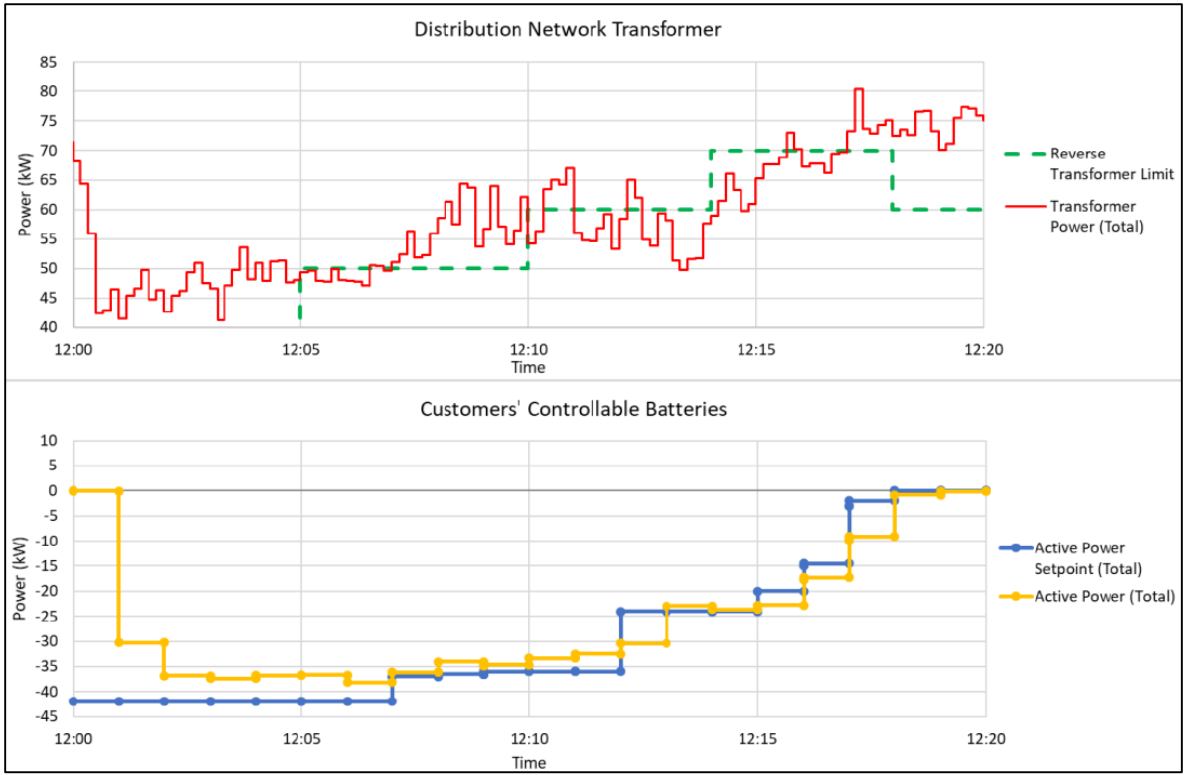


# Live Trials: Set Point Response Times (over GSM)

| Time for readback confirmation of setpoint | Number of setpoint controls | Percentage out of 288 controls |
|---|---|---|
| Less than 1 minute | 276 | 95.8 % |
| 1 - 2 minutes | 8 | 2.8 % |
| 2 - 3 minutes | 3 | 1.0 % |
| 3 - 4 minutes | 1 | 0.3 % |

| Time for readback confirmation of setpoint | Number of setpoint controls | Percentage out of 7573 controls |
|---|---|---|
| Less than 1 second | 891 | 11.77% |
| 1-2 seconds | 4126 | 54.48% |
| 2-3 seconds | 1156 | 15.26% |
| 3-4 seconds | 1151 | 15.20% |
| 4-5 seconds | 169 | 2.23% |
| Longer 5 seconds | 80 | 1.06% |

# Project Outcomes (Summary)

1. The results from live trials of EV charge management (import limitation)
2. The results from live trials of battery dischargement management (export limitation)
3. Set point response times over mobile communications networks
4. Policies and emerging standards resulting from this work
5. TRL Development

# Learning Outcomes (Overview)

1. Planned Modifications and Problems Encountered
2. Effectiveness of Demonstrations
3. Recommendations for Further Exploitation
4. Deployment on a Wider Scale

# 1. Problems Encountered and Planned Modifications

## 1. Broadband-over-PowerLine

- Original ambition to deploy BPL at 6 substation sites
- BPL not fit-for-purpose for LV Connect and Manage
- Sensitive to electrical noise
- Attenuation in LV network and through consumer units
- Alternative installation methods considered
- Impacted commissioning

## 2. Pre-pairing LCTs with DLCs

- LCTs required site-specific communications configuration (due to BPL)
- In Nortech's comfort zone
- Configuration delivered by Nortech rather than electrical contractors
- Reduced time in customers' homes needed for set up and commissioning

## 3. Technology Maturity

- Support for technologies stopped
- Changed battery supplier
- Changed inverter type
- Battery state-of-charge on delivery (unable to commission)
- EV charge point config. bugs
- EV charge point default maximum charge

# 2. Effectiveness of Demonstrations

## 1. Hereford Depot Installs

- System integration in low-risk environment
- De-risked customer installations

## 2. Customer Engagement

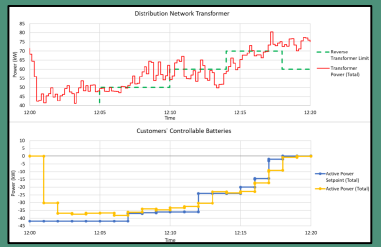
- Use of marketing companies (local to customers) worked very well
- WPD well-regarded – reinforced with engagement video

the big wheel
turning transport around
www.thebigwheel.org.uk

The Dairy Creative Agency

## 3. Data Protection

- Assigning a unique ID
- Aggregation of data



# 2. Effectiveness of Demonstrations

## 4. Remote Commissioning

- Reduced cost of commissioning
- Protected customers' data
- GSM removed dependence on BPL

nortech

## 5. Quantification of LCT Response Times

- Comprehensive demonstration of mobile technology for LV control applications

| Time for readback confirmation of setpoint | Number of setpoint controls | Percentage out of 288 controls |
|---|---|---|
| Less than 1 minute | 276 | 95.8 % |
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| Longer 5 seconds | 80 | 1.06% |

## 6. Solution Portability

- Quick and easy to swap-out DLC boxes

# 2. Effectiveness of Demonstrations

## 7. Dual Tariff Customers

- Business case to install battery, even though no PV

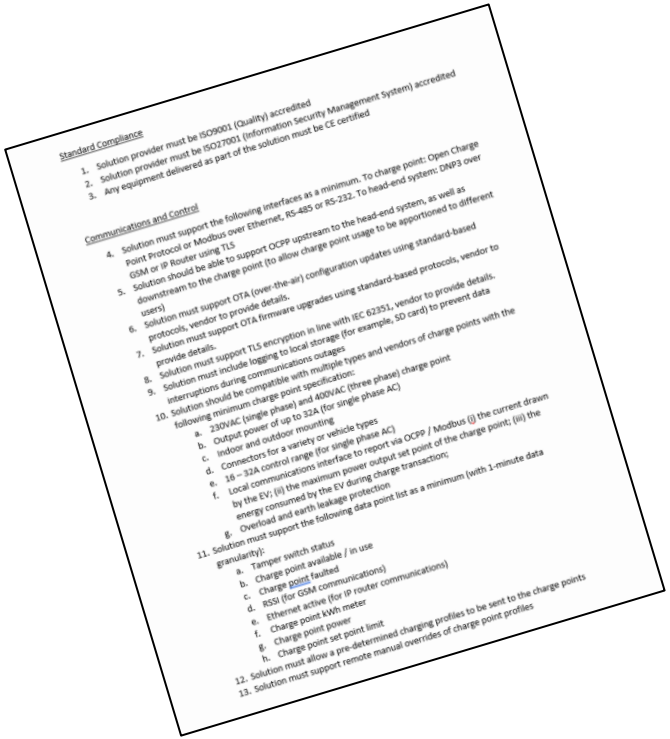
## 8. Battery Operating Modes

- Self-consumption vs grid export

## 9. Customer Benefits

- 20% reduction in annual bill

# 3. Recommendations for Further Exploitation

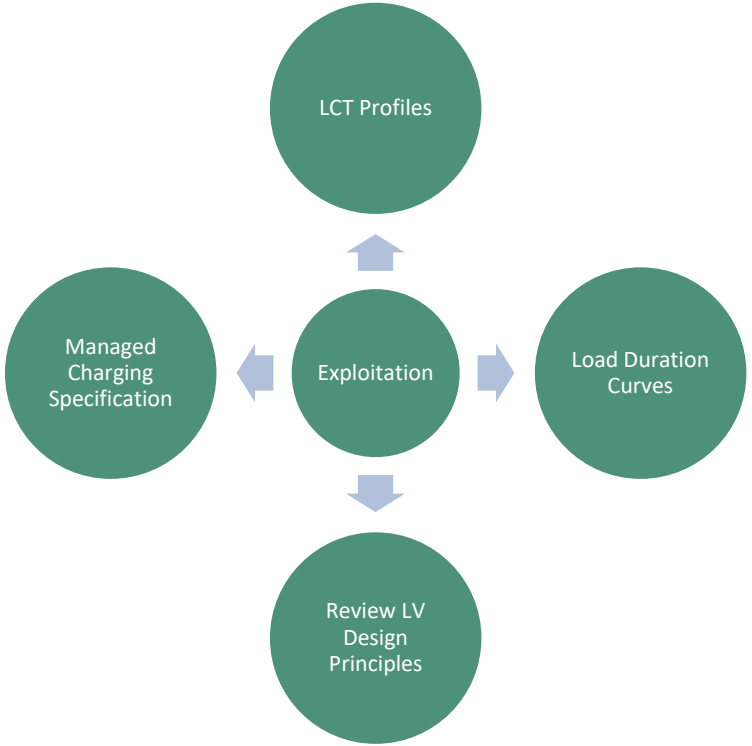


Standard Compliance

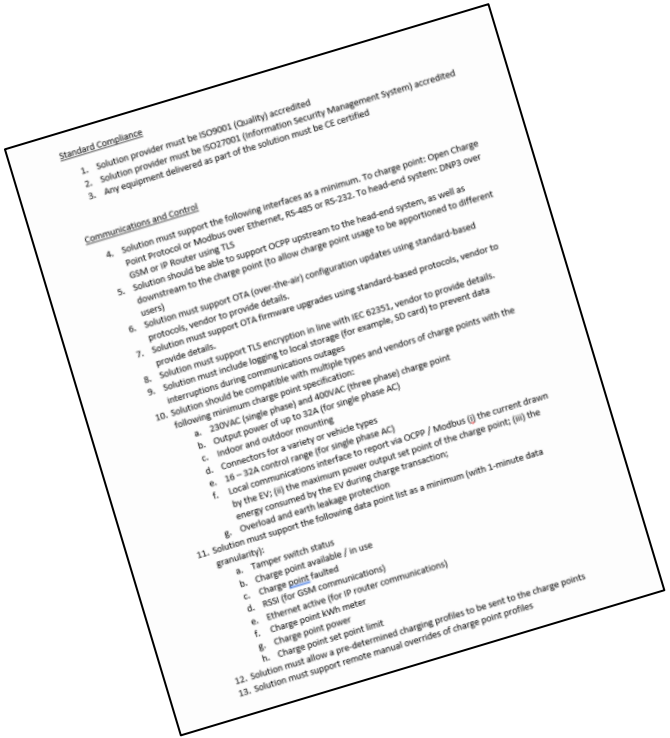
1. Solution provider must be ISO9001 (Quality) accredited
2. Solution provider must be ISO27001 (Information Security Management System) accredited
3. Any equipment delivered as part of the solution must be CE certified

Communications and Control

4. Solution must support the following interfaces as a minimum. To charge point: Open Charge Point Protocol or Modbus over Ethernet, RS-485 or RS-232. To head-end system: DNP3 over GSM or IP Router using TLS
5. Solution should be able to support OCPP upstream to the head-end system, as well as downstream to the charge point (to allow charge point usage to be apportioned to different users)
6. Solution must support OTA (over-the-air) configuration updates using standard-based protocols, vendor to provide details.
7. Solution must support OTA firmware upgrades using standard-based protocols, vendor to provide details.
8. Solution must support TLS encryption in line with IEC 62351, vendor to provide details.
9. Solution must include logging to local storage (for example, SD card) to prevent data interruptions during communications outages
10. Solution should be compatible with multiple types and vendors of charge points with the following minimum charge point specification:
    a. Output power of up to 32A (for single phase AC)
    b. 230VAC (single phase) and 400VAC (three phase) charge point
    c. Indoor and outdoor mounting
    d. Connectors for a variety or vehicle types
    e. 16 – 32A control range (for single phase AC)
    f. Local communications interface to report via OCPP / Modbus (i) the current drawn by the EV; (ii) the maximum power output set point of the charge point; (iii) the energy consumed by the EV during charge transaction;
    g. Overload and earth leakage protection
11. Solution must support the following data point list as a minimum (with 1-minute data granularity):
    a. Tamper switch status
    b. Charge point available / in use
    c. Charge point faulted
    d. RSSI (for GSM communications)
    e. Ethernet active (for IP router communications)
    f. Charge point kWh meter
    g. Charge point power
    h. Charge point set point limit
12. Solution must allow a pre-determined charging profiles to be sent to the charge points
13. Solution must support remote manual overrides of charge point profiles



# 4. Wider-scale Deployment



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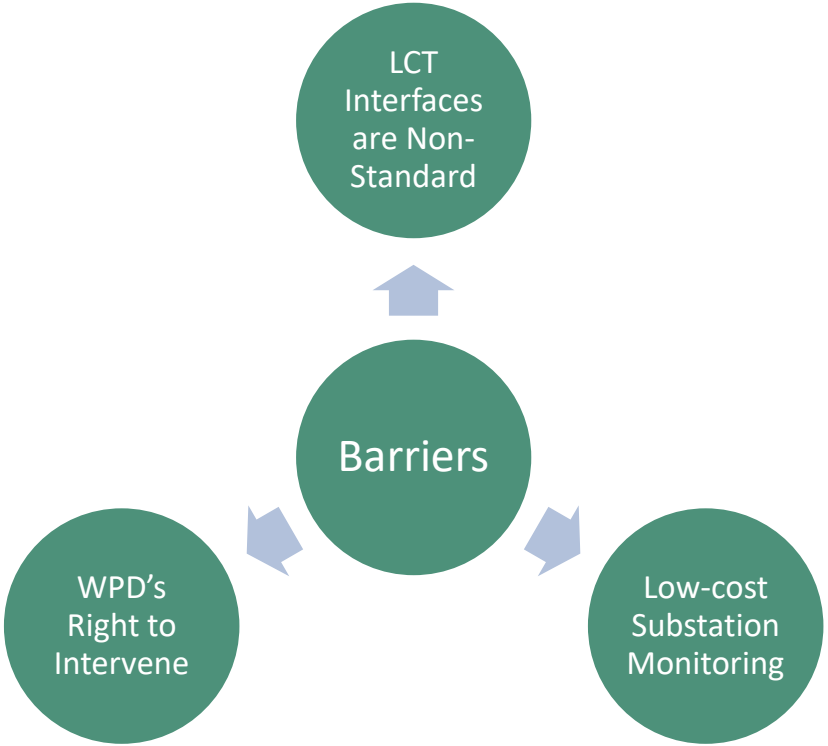
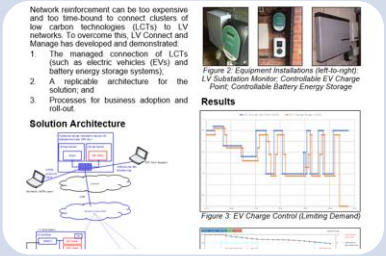


# Learning Outcomes (Summary)

1. Planned Modifications and Problems Discovered
2. Effectiveness of Demonstrations
3. Recommendations for Further Exploitation
4. Deployment on a Wider Scale

# Knowledge Dissemination Activities


LCNI Conferences


Network reinforcement can be too expensive and too time-bound to connect clusters of low carbon technologies (LCTs) to LV networks. To overcome this, LV Connect and Manage has developed and demonstrated:

1. The managed connection of LCTs (such as electric vehicles (EVs) and battery energy storage systems);
2. A replicable architecture for the solution; and
3. Processes for business adoption and roll-out.

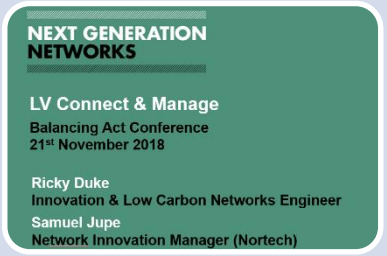
Solution Architecture

Figure 2: Equipment Installations (left-to-right): LV Substation Monitor; Controllable EV Charge Point; Controllable Battery Energy Storage

Results

Figure 3: EV Charge Control (Limiting Demand)

CIRED Workshop 2018



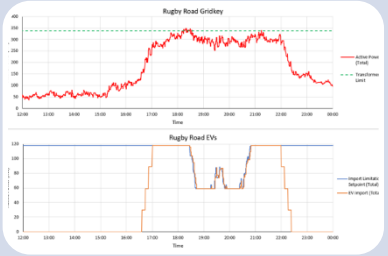

Balancing Act 2018

# Knowledge Dissemination Activities

CIRED 3-6 JUNE 2019 MADRID, SPAIN

| CIRED 2019 | Customer Engagement Events | MP Visit to Furzton |
| --- | --- | --- |

# Knowledge Dissemination Activities





Industry Dissemination

Project Brochure

Close Down Report

# Results and Lessons Learnt (Summary)

1. Project Outcomes: Live Trial Results and Setpoint Response Times (over GSM)
2. Modifications During the Course of the Project
3. Lessons Learnt
4. Knowledge Dissemination Activities

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NEXT GENERATION NETWORKS

LV Connect & Manage

# Conclusions and Next Steps

**Steve Pinkerton-Clark**
**Innovation and Low Carbon Networks Engineer**
**Western Power Distribution**

# Project Outcomes (Overview)

1. The results from live trials of EV charge management (import limitation)
2. The results from live trials of battery dischargement management (export limitation)
3. Set point response times over mobile communications networks
4. Policies and emerging standards resulting from this work
5. TRL Development

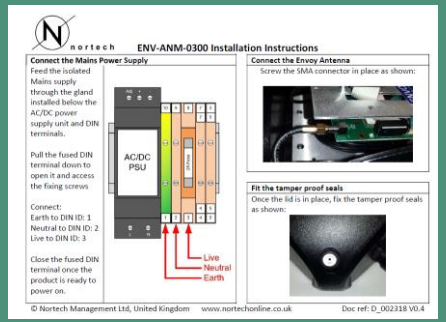
# Policies and Emerging Standards

## Retrofitting Equipment within LV Substations

- WPD Standard Technique

## Standardising Installations in Customers' Homes

- Electrical Contractor Standard Technique



ENV-ANM-0300 Installation Instructions

**Connect the Mains Power Supply**

Feed the isolated Mains supply through the gland installed below the AC/DC power supply unit and DIN terminals.

Pull the fused DIN terminal down to open it and access the fixing screws

Connect:
Earth to DIN ID: 1
Neutral to DIN ID: 2
Live to DIN ID: 3

Close the fused DIN terminal once the product is ready to power on.

AC/DC PSU

Live
Neutral
Earth

**Connect the Envoy Antenna**

Screw the SMA connector in place as shown:

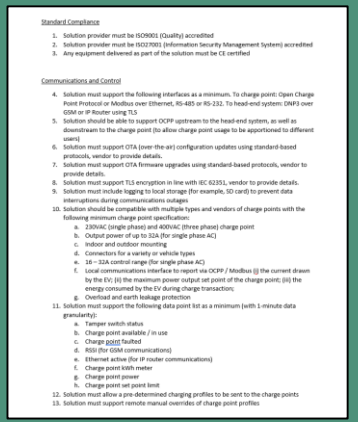
**Fit the tamper proof seals**

Once the lid is in place, fix the tamper proof seals as shown:

 www.nortechonline.co.uk Doc ref: D_002318 V0.4

## Managed Charging Technical Engineering Specification

- UK DNOs and Equipment Manufacturers



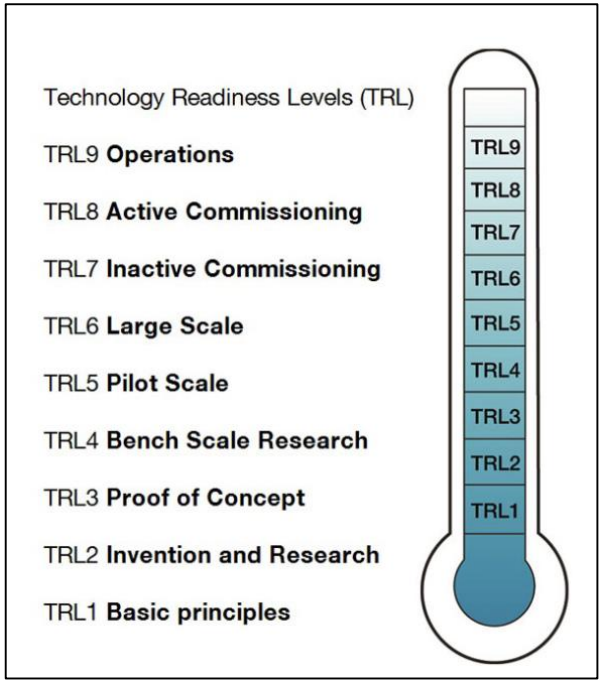
Standard Compliance

1. Solution provider must be ISO9001 (Quality) accredited
2. Solution provider must be ISO27001 (Information Security Management System) accredited
3. Any equipment delivered as part of the solution must be CE certified

Communications and Control

4. Solution must support the following interfaces as a minimum. To charge point: Open Charge Point Protocol or Modbus over Ethernet, RS-485 or RS-232. To head-end system: DNP3 over GSM or IP Router using TLS
5. Solution should be able to support OCPP upstream to the head-end system, as well as downstream to the charge point (to allow charge point usage to be apportioned to different users)
6. Solution must support OTA (over-the-air) configuration updates using standard-based protocols, vendor to provide details.
7. Solution must support OTA firmware upgrades using standard-based protocols, vendor to provide details.
8. Solution must support TLS encryption in line with IEC 62351, vendor to provide details.
9. Solution must include logging to local storage (for example, SD card) to prevent data interruptions during communications outages
10. Solution should be compatible with multiple types and vendors of charge points with the following minimum charge point specification:
    a. 230VAC (single phase) and 400VAC (three phase) charge point
    b. Output power of up to 32A (for single phase AC)
    c. Indoor and outdoor mounting
    d. Connectors for a variety or vehicle types
    e. 16 – 32A control range (for single phase AC)
    f. Local communications interface to report via OCPP / Modbus (i) the current drawn by the EV; (ii) the maximum power output set point of the charge point; (iii) the energy consumed by the EV during charge transaction;
    g. Overload and earth leakage protection
11. Solution must support the following data point list as a minimum (with 1-minute data granularity):
    a. Tamper switch status
    b. Charge point available / in use
    c. Charge point faulted
    d. RSSI (for GSM communications)
    e. Ethernet active (for IP router communications)
    f. Charge point kWh meter
    g. Charge point power
    h. Charge point set point limit
12. Solution must allow a pre-determined charging profiles to be sent to the charge points
13. Solution must support remote manual overrides of charge point profiles

# TRL Development




*Courtesy of GOV.UK*

Start of Project:

- Level 5
- Pilot Scale
- Technology validation in a relevant environment

End of Project:

- Level 9
- Operations
- Technology ‘flight-proven’ through successful operations

# Project Outcomes (Summary)

1. The results from live trials of EV charge management (import limitation)
2. The results from live trials of battery dischargement management (export limitation)
3. Set point response times over mobile communications networks
4. Policies and emerging standards resulting from this work
5. TRL Development

# Summary of Project Conclusions

- ✓ Demonstrated managed charging of EV clusters (through peak loading times of day)
- ✓ Demonstrated export limitation of PV/battery customers (through peak generation times of day)
- ✓ Dual tariffs create a tangible business case for customers to connect batteries into their homes (even without PV)
- ✓ Designing interoperability into the project allowed for supply chain technology changes, outside of the project's control
- ✓ Different LCTs have different control response times:
  - ✓ Battery inverters: 96% of controls achieved within 1 minute
  - ✓ EV charge points: 99% of controls achieved within 5 seconds
- ✓ GSM has proven to be fit-for-purpose for LV ANM, providing flexibility for commissioning and reliable control

# Next Steps (Within WPD's Business)

*Business as Usual Transition Pathway*

Develop Load Indices for LV Substations

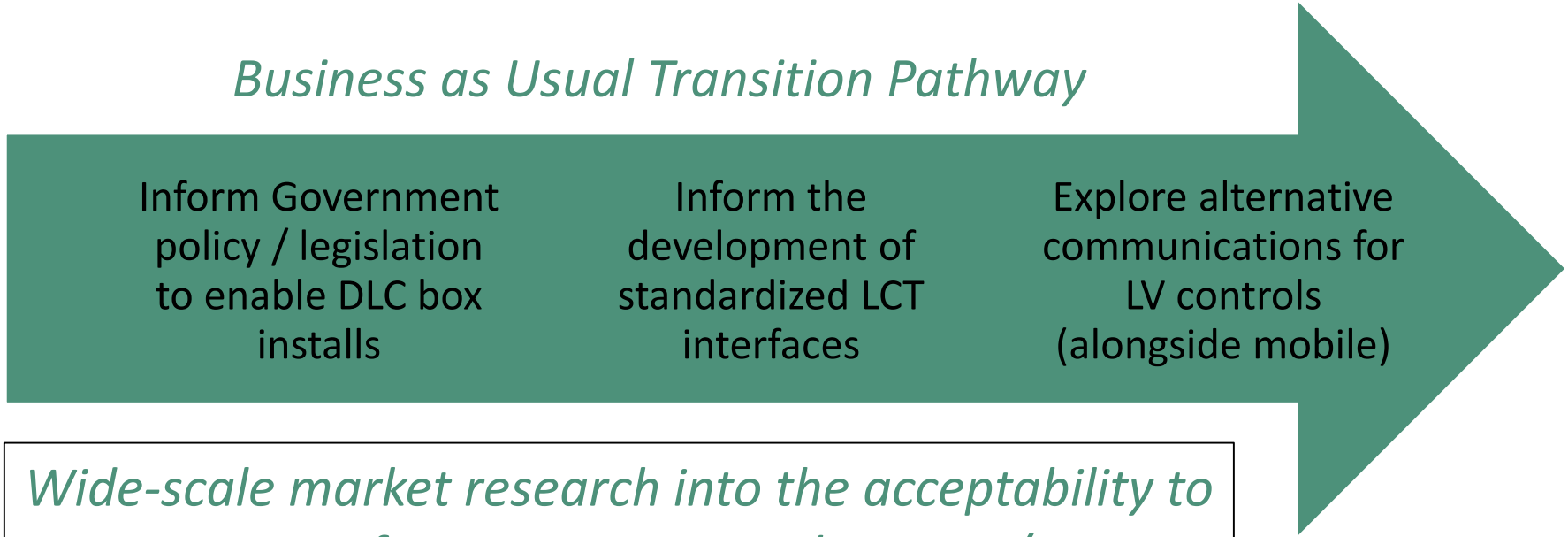
Develop "Compact" DLC Box

LV C&M Policies for wide-scale roll-out

*Small-scale market research into the acceptability to customers of LCT management by DNOs/DSOs*

# Next Steps (Involving the Wider Industry)

*Business as Usual Transition Pathway*




*Wide-scale market research into the acceptability to customers of LCT management by DNOs/DSOs*

# Acknowledgements

WPD's thanks goes to:

- Residents of West Bridgford and Furzton
- Nottingham and Milton Keynes Councils
- Nortech Management Limited
- The Dairy
- The Big Wheel
- Stratford Energy Solutions
- EV Charging Solutions

# Summary of LV Connect and Manage

- Introduction, Jonathan Berry
- Project Overview, Steve Pinkerton-Clark
- Details of the Work Carried Out, Samuel Jupe
- Results from Trials and Lessons Learnt, Samuel Jupe
- Conclusions and Next Steps, Steve Pinkerton-Clark

# THANKS FOR LISTENING

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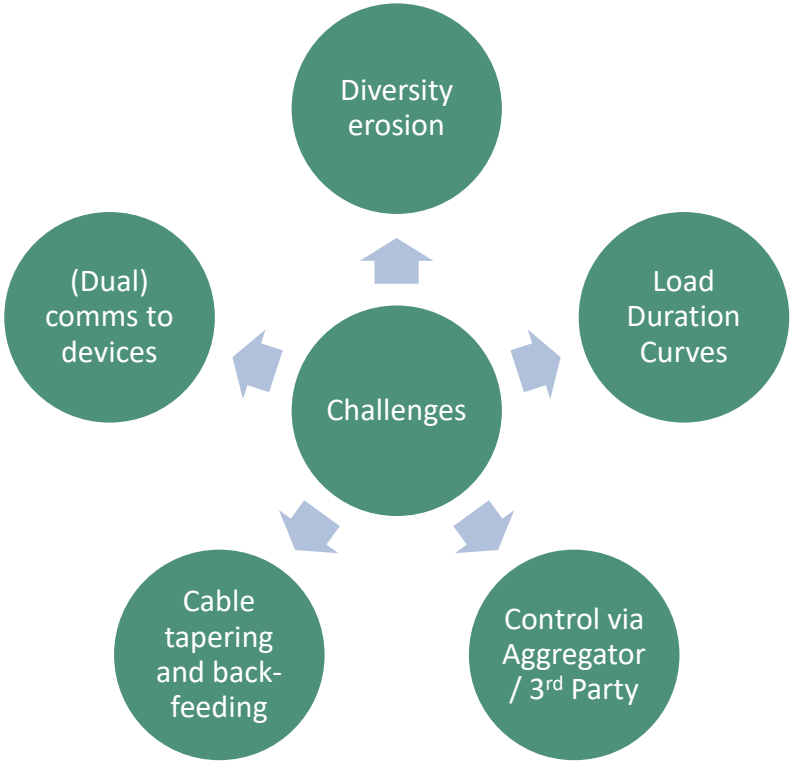
NEXT GENERATION NETWORKS

# Q&A
# Open Discussion

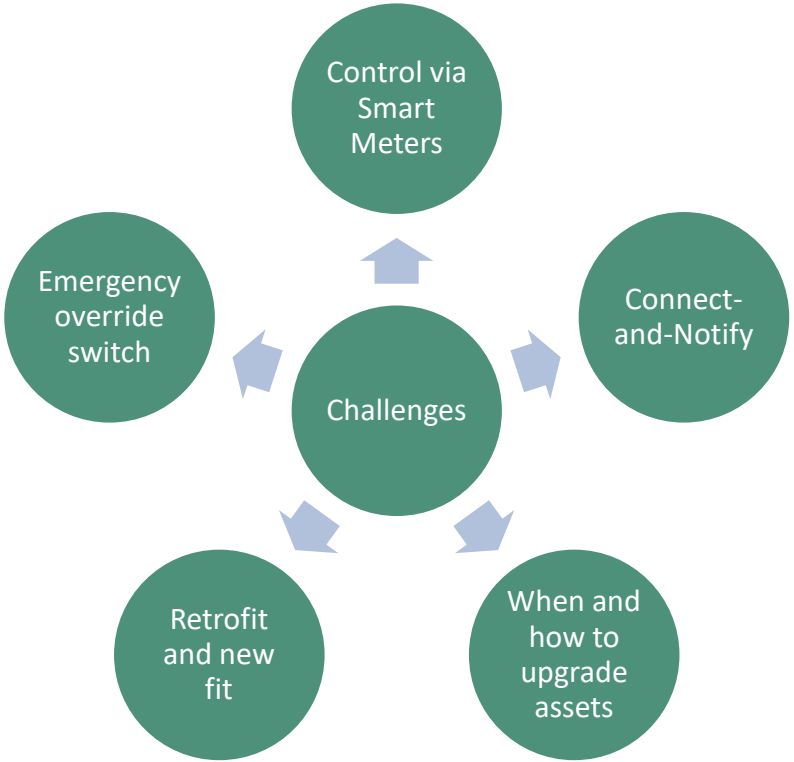
## LV Connect & Manage

**Exploring the technical issues regarding electric vehicle and PV/battery storage connections on to the LV network**

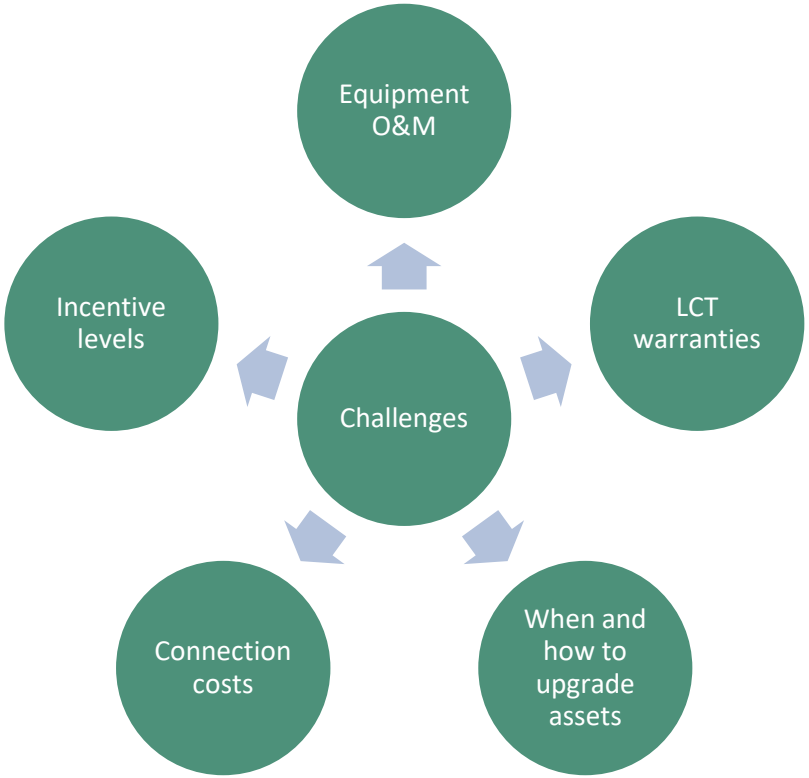
# Technical Issues



# Technical Issues



# Commercial Issues



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# Closing Remarks

## LV Connect & Manage

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**Nortech Management Limited**

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# THANKS FOR ATTENDING

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