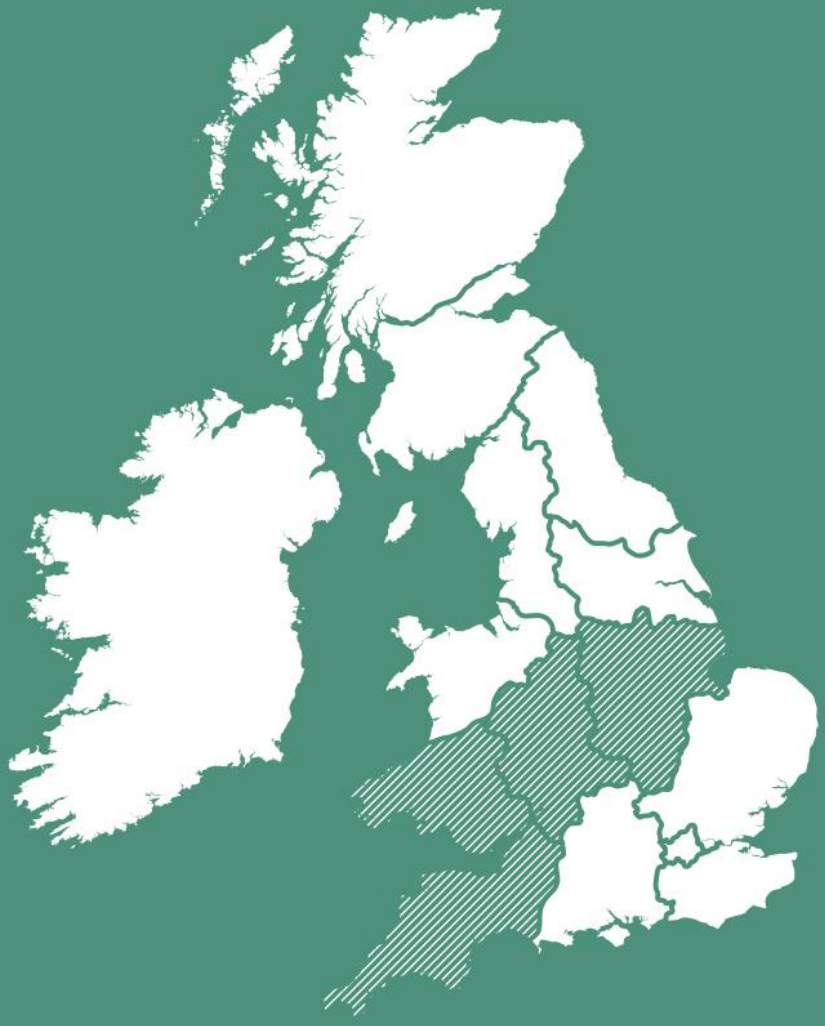
WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS



First Tier Portfolio Reward

Application

LCN Fund
Low Carbon Networks

Contents

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Executive Summary

This document demonstrates how WPD's First Tier LCNF portfolio of projects has delivered exceptional benefits to customers in support of our application for the First Tier Portfolio Reward. The reward process is a further opportunity for us to share the success of our projects across the key criteria.

Our LCNF projects were designed to achieve particular learning outcomes set out in our Future Networks Strategy. The overall programme has delivered learning and benefits greater than we expected from the original objectives of each project. The LCNF Tier 1 mechanism has allowed us to accelerate the rollout of additional new learning beyond the planned outputs, with specific focus on smart grids and the facilitation of Low Carbon Technology connections through our increased understanding of available capacity headroom.

Our portfolio of projects has not only made differences to the localities we serve (e.g. Smart Hooky & Electric Boulevards) but also informed our broader approach to community engagement (e.g. Community Energy Action). The portfolio has also challenged our thinking relating to technology (e.g. SVC Phase 1 & AFLMS). In some cases it has proven that long served technical assumptions and modelling tools were incorrect. In every case we capture the learning, embed it into our business and disseminate to our peer DNOs.

The improved engineering assumptions and technical policies resulting from the Tier 1 projects have delivered considerable benefits in the form of:

- **making network capacity available** to customers through testing of PV output & testing of LV Sensor technologies
- T1 portfolio part of **integrated Future Network Programme of work** (leverage)
- **Structured approach to innovation** (rapid scaling)
- **Challenged established thinking**, and proven that achievement of specific Carbon Plan targets can be achieved (electrification of transport)
- **Tangible outputs** (Carbon & Financial)

The projects have also delivered benefits measured against the Government Carbon Plan, most notably 110, 044 $kgCO_2e$ saved through the Electric Boulevards project and the ongoing use of the electric buses. Moreover this will continue as Milton Keynes moves to all electric buses and securing 20% additional headroom capacity as a direct result of our network monitoring and Isles of Scilly projects, this has then be further enhanced through the exceptional work on LV Network Templates.

The management processes for our Innovation Projects goes significantly beyond the minimum requirements set out in Ofgem's LCNF Governance document. Our internal reporting is designed to ensure that every pound of LCNF funding we spend delivers valuable new learning and insight. Strong governance is embedded into the programme to deliver each project to time, cost and quality, but with that key focus on benefits management.

WPD has a track record of rapidly rolling out solutions that are found to work across our whole business. Where appropriate we have invested additional money into our projects, for example, our additional investment of £461,000 in the Isles of Scilly project.

We have mobilised, executed and delivered exceptional value from our Tier 1 portfolio during DPCR5. The Portfolio Reward process is an opportunity for us to demonstrate that it has delivered a tangible return on investment for our customers and is helping them to connect low carbon technologies cheaper and quicker. It has also provided us with a strong foundation to maintain our industry leading position in network innovation during ED1.

Robert Symons
C.E.O. Western Power Distribution

1. Portfolio Description

Our portfolio of projects for LCNF Tier 1 had 12 projects of the 40 eligible projects. Three transitioned into NIA in their final stages when this replaced LCNF. WPD has embraced the need to innovate in order to deliver the best service that we can to customers but also to do so in a way that delivers a service fit for the changing energy industry. We provide a description of each project in the next section.

All of our innovation projects will help WPD to maintain our position as Number 1 performer and enable us to fulfil our role in the future. They will allow us to remain the UK's top performing DNO however it is measured. Customer service is at the heart of our business and our projects have allowed us to address the wider energy "trilemma", ensuring that further improved performance in key areas such as CO_2 reductions, cost reductions and network performance improvements (e.g CML's/CI's/Broad Measures). All of our Innovation Projects have outputs which are mapped against our key business output areas.

The Tier 1 portfolio of projects are just one component of our Future Networks Programme. Our five LCNF Tier 2 projects, UK/EU funded projects and internal R&D initiatives are fully coordinated making the overarching programme fully optimised to deliver best value. The Future Networks Programme has three areas of focus or "pillars". These pillars underpin our Innovation Strategy.

Strategy Pillar	Description	Projects
Assets	Projects in this category collect data from the network to enhance modelling. They also test new equipment and alternative investment strategies that can postpone or negate conventional investments.	SGD, SVC Phase 1, LV Sensors, ALFMS, Electric Boulevards
Customers	These projects develop new solutions to enable customers to connect low carbon technologies. They may also involve testing of new customer tariffs or working with communities to provide local energy solutions.	Smart Hooky, CEA, Isles of Scilly, PV Suburbia, ECHO
Operations	This category of projects demonstrate direct benefits to network operations from the application of technology. More advanced control results in a better performing and a higher capacity network.	Early Learning, Interconnection of WPD and NGC SCADA, ECHO, PV Suburbia

There were 12 projects under the Tier 1 mechanism. They were mapped to the Innovation pillars as shown above. Project acronyms and descriptions are contained within the table further within this section. As shown, the First Tier portfolio contained projects that were balanced across our innovation pillars. Where our Tier 1 projects demonstrated significant learning but needing to be tested at a larger scale, we sought to further develop the concept under the Tier 2 mechanism. For example, AFLMS was scaled up under Method Beta of the larger Tier 2 project, FlexDGrid which will conclude this year.

Our underlying process ensures that we test ideas in a small and confined trial first and only scale up if we believe that the trial has worked. This would also apply for solutions with a lower TRL. IFI and R&D projects only became Tier 1 projects because the modelling or laboratory work had promise and merited further work.

Project	Short Name and short description
Interconnection of WPD and NGC SCADA	Trial to test the potential to connect WPD and NGC SCADA systems and support transmission and distribution coordination.
Isles of Scilly	A test of new technology measuring network conditions whilst supporting the community.
HV Voltage Control (SVC Phase 1)	Trial of a control device on the HV network on a long rural network.
Early Learning of LV Network Impacts from estate PV cluster	Small housing estate with PV installs and some trials on the cable sizing.
Seasonal generation Deployment	SGD-a trial of diesel generation at times of high demand to manage constraints.
LV Sensor Evaluation	A lab and field trial of 7 LV Monitoring devices in collaboration with UKPN.
Active Fault Level Management Scheme	AFLMS- a trial of fault level monitoring devices in Birmingham.
Community Energy Action	CEA- a domestic demand side response trial.
Electric Boulevards	A trial of Inductive Power Transfer charging devices to test “on the move” charging of buses.
Energy Control for Household Optimisation	ECHO-domestic demand side response trial using intelligent devices.
PV Suburbia	A trial to investigate the impact of increased domestic PV in a suburban environment.
Hook Norton (Smart Hooky)	Community trial to engage customers around energy usage.

The following table details each project costs and provides a hyperlink to the Closedown Report.

Ref No.	Tier 1 Project Name	Licensee	Project summary	Tier 1 funding £k	Licensee compulsory contribution £k	Other contributions £k	Link to Close-Down Report
WPDT1001	Interconnection of WPD and NGC SCADA	Western Power Distribution (South West)	There is a view that the industry will require a greater level of coordination of T&D systems in the future. The project developed the interface between Transmission and Distribution systems and tested information sharing.	72	8		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/NGC-Interconnection.aspx
WPDT1002	Isles of Scilly(IoS)	Western Power Distribution (South West)	The project sought to assist the IoS community in their aspiration to be more energy self-sufficient. This was an opportunity to test innovative technology to measure network conditions whilst supporting the community.	1,125	161		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Isles-of-Scilly.aspx
WPDT1003	HV Voltage Control (SVC Phase 1)	Western Power Distribution (South West)	The project sought to address the impact of DG on long distribution lines and the resultant fluctuations that occur in voltage levels. This was tested via the use of innovative Static VA-r Compensators (SVCs) which control voltage.	525	90		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/HV-Voltage-Control.aspx

WPDT1004	Early Learning of LV Network Impacts from estate PV cluster	Western Power Distribution (South Wales)	The project sought to look at the impact of high density solar PV on the LV network. In particular looking at the impact from using different sizes of LV cable.	16.2	1.8		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Early-Learning.aspx
WPDT1005	Seasonal generation Deployment (SGD)	Western Power Distribution (West Midlands)	This Demand Side Response project sought to use temporary generation units at a substation as means of addressing seasonal network constraints. This included the negotiation of commercial arrangements required.	300	33		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Seasonal-Generation.aspx
WPDT1006	LV Sensor Evaluation	Western Power Distribution (South Wales)	This was a collaborative project with UKPN to assess various LV Sensors which can improve the visibility of LV networks. There were many technologies coming to the market and undertaking a coordinated trial of all variants was determined to be best way forward.	250	37		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/LV-Sensors.aspx
WPDT1007	Active Fault Level Management Scheme (AFLMS)	Western Power Distribution (West Midlands)	The project explored the accommodation of distributed generation within the 11kV network. It also looked at the potential to alleviate constraints due to fault level.	646	71		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Active-Fault-Level-Management-Scheme.aspx

WPDT1008	Community Energy Action (CEA)	Western Power Distribution (East Midlands)	The project engaged domestic customers in energy efficiency initiatives to reduce/shift demand in a community model. This enabled WPD to determine the level of engagement required and the impact that coordinated effort could have on the network.	435	48		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Community-Energy-Action.aspx
WPDT1009	Electric Boulevards	Western Power Distribution (East Midlands)	DNO's need to better understand the power requirement for connecting various devices for running an electric bus fleet. There was an aim to understand the impact of inductive charging.	550	61		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Electric-Boulevards.aspx
WPDT1010	Energy Control for Household Optimisation-(ECHO)	Western Power Distribution (East Midlands)	The project trialled plug in Domestic Demand Side Response (DDSR) technology with real customers. The use of direct control, price signals and planned load shifting were used to test the potential use of DDSR and its impact on customers and DNO's.	350	35		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Echo.aspx
CNT1001	PV Suburbia	Western Power Distribution (East Midlands)	This project installed monitoring into substations where 800 homes had had PV Panels installed. The project then assessed the impact this new generation had on the distribution network.	100	11		https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Suburban-PV-Impact.aspx

CNT1002	Hook Norton (Smart Hooky)	Western Power Distribution (West Midlands)	This project tested domestic demand response and the provision of a portal to engage the community around energy usage. Also a number of other technologies were trialled as part of a test in a rural community around a smarter grid.	350	39	58.1	https://www.westernpowerinnovation.co.uk/Projects/Closed-Projects/Smart-Hooky.aspx
Total				**4719.2**	**595.8**	**58.1**	

Table 1: All Eligible Tier 1 LCNF projects

1. Project Descriptions

1.1 Interconnection of WPD/NGC SCADA(WPDT1001)

EXCEPTIONAL BENEFITS

- We jointly developed with NG the Inter- Control Centre Communications Protocol (ICCP) link between DNO and National Grid control rooms , this is a great example of an innovation funded project becoming a 'business as usual' enabler.
- Additional initiatives have since been undertaken on the back of the dialogue that was started under this project, namely South West Operational Tripping and the ANM CG system.
- Other industry initiatives are also using the technology and we think that this project is helping to unravel some of the complexities of delivering DSO.
- This technology has been scaled up to be used on a Tier 2 project and is now part of business as usual.

1.1.1 Background and the challenge

Western Power Distribution continues to see an increase in the amount of generation connecting to the network at all voltage levels. This includes large scale wind farms, photo voltaic arrays, Combined Heat and Power (CHP) and biomass plants. This trend creates operational challenges with load management for WPD and system balancing for NGC.

Due to this increasing volume of distributed generation, it was identified that Transmission and Distribution needed greater visibility of each other systems and tested real time data sharing using Distributed Generation output data as an example. This project sought to see if it was feasible technically and operationally to give National Grid this visibility. The learning from the project remains highly relevant and will support the DNO transition to DSO.

WPD recognises the need for creating "information sharing" between T&D networks. Being able to provide National Grid with more visibility of the local network had never been attempted before yet had considerable potential benefit for both parties.

We scoped a project that would address this by creating and trialling innovative techniques to create a highly resilient and secure link between the SCADA systems of both NGC and WPD.

The project was collaboration between WPD, NGC and GE. GE was used because their systems are used by both NG and most DNOs. Their engineers and software programmers could provide the technical expertise in order to be able to link the two corporate control systems in a way that would keep to a minimum any security risk. The security risks being the key assessment factor for the project.

1.1.2 Approach taken

There are areas of the electrical network across the UK where information on the configuration is of mutual interest to both NGC and DNO's, but currently are only visible to one or the other. As an example, WPD has visibility in real time of Extra High Voltage (EHV) and significant High Voltage (HV) connection distributed generation data. NGC does not have this visibility but it would be of use for them to do so.

Such visibility would aid NGC's forecasting which would clearly be of benefit to both parties. The project had a series of phases the first being the Design and Discovery phase. The second was the Build and Test phase, and finally, consolidate. The first phase was wholly about the design of what we needed to meet the project objectives. The second phase, the part where the bulk of the work was to be undertaken

was building and testing the solution and then the final phase being the one where we brought everything together.

The agreed approach for this project was to utilise the Inter-Control Centre Communications Protocol (ICCP) contained within GE's PowerOn Control System and National Grid's XA21 system.

There were a number of hurdles to achieving what was needed and in particular pertaining to the version of PowerOn that WPD was running at that time. We also needed to purchase additional servers that would act as the interface between the ICCP and the data transfer process, one of the servers being for resilience purposes.

Testing of the system was successfully completed and we did this by using dummy data packets that were then viewed by NGC. It was extremely encouraging that we were able to establish the link with data being transferred between the systems in real time and more importantly in a secure manner. An initial assessment of the cyber security risks did identify a potential risk with links from multiple parties (ie other DNO's) through ICCP to NGC. Further assessment of these risks is being assessed and learning shared through the Centre for the Protection of National Infrastructure (CPNI).

1.1.3 Results

The direct benefits of the project were proving the ICCP link with potential for future CO2, capacity or financial benefits to WPD. However, the further implications of the trial could go much wider with the application of further DNO / NGC links.

Currently 13 out of the 14 DNO licence areas are utilising GE software to manage the control of their network, although some of these systems would require upgrading to the current version of PowerOn to allow ICCP to be enabled. This would deliver an increased benefit to NGC in terms of visibility of the end to end electricity system and deliver reduced system risk to the UK as a whole. This would need further discussion and significant security testing before this could be considered as business as usual.

Below we detail the objectives of the project and their completion status:

Measure	Status
Objective 1 : Establish the link.	✓
Objective 2: Establish access to the data and methods of viewing the data.	✓
Objective 3: Establish the security measures required to ensure the security of the link to both of the systems against Cyber attack.	✓

1.1.4 Outcomes

Whilst this was a relatively small project, it was a successful project with some powerful learning for the industry, some of which are exceptional due to their potential to provide the industry some insights into how the DSO/TSO interaction required for the future could be made to work. This is a significant advance for WPD and its stakeholders.

The industry faces significant change and being able to provide greater visibility to National Grid, subject to the appropriate security and controls, is a great outcome. More work needs to be done but we continue to maintain dialogue with National Grid and other stakeholders about the "whole energy system" and DSO topics. We believe that in the future more information sharing will be a fundamental part of our role and so therefore this project provides us with more insight as to how we could share that information with various parties. We also continue to explore other ways to share less confidential and critical data in tandem with our work with National Grid.

It is also encouraging that we have been able to extrapolate the learning to roll out solutions developed as a result of this project and since this project WPD and NGC have been working on a number of business

as usual initiatives to increase the amount of sharing and working together including Reverse Power Flow ANM and South West Operational Tripping Scheme.

Collaborative working with industry participants to ensure an effective operation of the system is , in our view, a potentially significant aspect of the new energy model to which we are moving.

Knowledge Dissemination

No specific events were undertaken on the outputs of this project as this was a feasibility study only.

Event	Knowledge shared
LCNI 2011	Background to the project and some early thoughts.
LCNI 2012	Project update and results.

In addition to this SDRC9 on the LV Network Templates project also included some of the findings and results from this project.

We also presented some background and progress at LCNI in 2011 and 2012 as part of a general highlight of the work that we were doing. As this was a short project we then decided that the most appropriate next event should be the publication of the results. The Closedown Report does contain sufficient detail about the approach undertaken and we have discussed the findings with interested parties.

The project Closedown Report was initially published after project closure and this has recently been refreshed to reflect up to date thinking. The report can be found via the link in Section 1.

Follow On Projects

- South West Operational Tripping and ANM CG system.
- ICCP is also being used as part of the SVO element of our Tier 2 project, Network Equilibrium. In addition ICCP has been used on the CLASS by ENWL and KASM by UKPN projects by other DNO's.

Policy changes

- This was a feasibility study but new policies have since been implemented from it around cyber security and people.

1.2 Isles of Scilly (WPDT1002)

EXCEPTIONAL BENEFITS

- Enabling the connection of more Low Carbon technologies - 15 new DG Connections have occurred as a direct result of this project.
- Capacity release of between 6% & 8%on the back of increased headroom
- Local Action Fund - on the back of this project we have invested in a local action fund and saved customers £53k.
- LV Monitoring now embedded into Policy and helping to deliver benefits for customers through hotspot modelling ahead of reinforcement.
- Platform developed for Research, Development and Demonstration which is being implemented as part of our ERDF project, Smart Energy Islands .

1.2.1 Background and the challenge

This project sought to help the residents of the Isles of Scilly (IoS) in their aspiration to be more energy self-sufficient. The deployment and use of various low carbon technologies was key to this aspiration.

The overall climate on the islands afforded by its location provides a large potential for energy to be supplied using renewable low carbon technologies, such as photovoltaic (PV) generation, wind turbines or tidal power schemes. This project deployed and assessed several technological solutions to form an overarching smart grid covering all of the substations on the Isles. On completion it had produced a platform for further low carbon related research and development activities which is in operation still.

Due to its islanded position, the Isles of Scilly provided a discrete platform to study the effect of low carbon technologies on an electrical network and learning from this could be applied onto other electrical networks in the UK.

As can be seen by the results, the Isles of Scilly provides a useful insight into how a network could conceivably be made to work in the future with the use of technology leveraging benefits to customers and WPD alike. This has provided us with a useful basis from which to progress ideas and as such the Isles of Scilly is proving an essential platform for us from both operational and practical perspectives.

The remoteness of the Isles of Scilly and the difficulties in accessibility for the off-islands also provided a good business case for assessing the suitability of a variety of communication techniques, which could further automate data collection and control around the Islands. Data communications will play an increasingly important part in our role into the future.

1.2.2 Approach taken

The project management approach was a traditional waterfall one with a Project Review Group supporting the WPD project manager. Given the scale and awareness of the project locally it was important to ensure that the project had strong support internally within WPD.

A number of key principles were agreed at the outset namely that this was a community engagement and secondly cooperation with the IoS Council was key.

The project has a series of objectives and desired learning outcomes as follows:

- The establishment of real time monitoring equipment to all substations on the Isles.
- Ensure that generation facilities on the islands could be maximised to secure supplies to customers.

- Trials of the new methods might impact customers on the off islands through control and management of the generation and this was an opportunity to see how this could be best managed.
- We wish to support localised generation as much as possible.
- Through this project WPD was supporting the Council and the residents aspirations around energy self-sufficiency.

Under the project, all of the substations on the Isles of Scilly were fitted with low voltage monitoring to determine the aggregate load across all phases (LV monitoring being part of the portfolio and various trials throughout our Tier 1 programme of work). This has allowed the distribution of load across the network to be more accurately assessed and will aid future network investment. The implemented system was a bespoke design due to limited available off-the-shelf systems when the project was initially scoped. This landscape has of course changed since then.

High Voltage automation was also installed adjacent to the off-island generation so that the load sections they supplied could be altered for the maximum benefit. Sequenced switching routines within our GE PowerOn Distribution Management System enable this to be an automated process and also enable routines to be configured to respond to monitored network changes. This provides flexibility for when the load and generation balance in the area changes. This is a real benefit for the Islanders and WPD as it gives us the opportunity to provide them with a better service and it is providing us with a much richer view of what is going on within the network and as such has a direct benefit to the Islanders by allowing them to connect LCTs in order that they achieve their aspiration of energy self-sufficiency.

Measure	Status
Objective 1: To establish real time monitoring on all of the distribution substations on the Isles of Scilly.	✓
Objective 2: The use of the generation facilities on the islands can be maximised to secure supplies to the islands.	✓
Objective 3: to determine if the control and management of the generation on the off islands will be effected using the new methods as they have not been used in WPD before.	✓
Objective 4: Monitoring to be supplemented by controls where appropriate to manage and accommodate localised generation.	✓
Objective 5: Support localised generation (Photovoltaic) through increased monitoring and control.	✓
Objective 6: Initiative will support the council's published goal of energy self-sufficiency.	✓
Success criterion 1: The effective management of off island generation and monitoring & control of distributed generation on a network with periods of high impedance.	✓
Success criterion 2: The use of Power Line Carrier techniques on higher voltage networks.	✓
Success criterion 3: Demonstration of Synchrophasor Generator Control.	✓

1.2.3 Results

The project was able to meet all of its success criteria and objectives as detailed above, but more than that we were able to provide a platform for the Islanders that will make their transition to energy self-sufficiency easier. This is a good outcome for both the Islands, WPD and the whole of GB and its transition to a low carbon economy.

Moreover on the back of our successful community engagement we undertook a fuel poor scheme on the Isles and the results are shown below. We think that being able to not only help the Islanders with their aspirations on energy independence as well as their energy efficiency is a great outcome and this project

is one that we are immensely proud of. We continue to watch developments on the islands and want to be able to use the monitoring to better effect so that more of the islanders can adopt Low Carbon Technologies as and when they wish to.

1.2.4 Outcomes

The outcomes of this project have been clear and beneficial. Whilst these projects can be challenging, the results provide a tremendous opportunity for the Islanders and WPD. It is our belief that whilst the Islands are unique they do offer us and other DNO's some valuable insights into how to engage with a community around the adoption of LCT's and how to maximise the opportunities for adoption of these technologies. This will be increasingly a factor of the network of the future, engaged communities and a smarter grid.

The project met all of its objectives and criteria and we have been able to disseminate our learning through a series of events.

Since the monitoring has been installed we have been able to connect an additional 15 embedded low carbon generators across the Isles. By using the monitoring information, coupled with the learning from the Tier 2 project LV Network Templates, an additional 20% of headroom PV generation capacity was identified increasing from 1.2MW to 1.44MW. This is explained more in Section 2.2.

Knowledge Dissemination

Below we detail the various knowledge sharing activities undertaken as part of the Isles of Scilly project:

Event	Knowledge shared
LCNI 2011	General update on progress.
LCNI 2012	Provided some background to the project with some insight into the anticipated design and benefits.
LCNI 2013	Part of an update on the lessons from a number of projects where communications and security (data) were a feature.

Our project also featured as part of the E-day on the Isles of Scilly and was part of some educational messages to the children on E-day.

A video from the day can be found here: https://www.youtube.com/watch?v=A86RC_TqJLM

In addition the event was reported here: http://news.bbc.co.uk/1/hi/uk/8294250.stm

A Closedown Report was initially published and this has since been recently refreshed to reflect up to date thinking. The report can be found via the link in Section 1.

Follow On Projects

- NEXUS- Power Line Carrier NIA project
- LV Sensor Evaluation
- Smart Energy Islands, ERDF project

Policy changes

- LV Monitoring is now part of policy through this and follow on projects and trials.

Investments

- Additional investment on this project amounted to £461k, the detailed rationale for this investment is provided within Section 5.1.

1.3 HV Voltage Control Phase 1 (WPDT1003)

EXCEPTIONAL BENEFITS

- This project provided us with some fascinating learning about the use of STATCOM devices which was then reused on the Low Carbon Hub project. The reuse of this knowledge was invaluable and we continue to gain benefit from appropriate use of these devices. The key benefit being the learning being applied to develop the Active Network Management tool that forms the basis of our Alternative Connections.

1.3.1 Background and the challenge

The challenge that this project sought to address was that as more distributed generation is connected to the 11kV rural network, the adverse impact it has on the network is becoming more apparent. Across large areas of this network, distributed generation is triggering high costs of reinforcement often driven by voltage issues. Predominantly this reinforcement is required for voltage rise but voltage step change is also becoming a concern in some of our areas. This can also be difficult to precisely pinpoint which we believe is a common issue across the UK. A solution to this is desirable as the intention is that more and more people may wish to have their own generation and as a DNO we need to find ways to support that aspiration.

Intermittent generation installed towards the end of the feeder on rural networks in particular is often the worst affected by these issues. There are several ways that we thought that they could be addressed and using reactive power from a Distribution Static VAr Compensator (D-SVC) is one of the more innovative ways.

Therefore this project aimed to understand and address the issue of fluctuations seen on long distribution lines in a rural area. The objective being to determine the effectiveness of D-SVCs (Static VAr Compensator for Distribution Networks) as a means to control voltage on 11kV rural networks.

This project demonstrates WPD's approach to portfolio management that focuses on delivering value for money. As this was a new technology for WPD, it needed to be trialled in a measured way. Therefore a considered approach was agreed before registering the project, one that would minimise risk as well as thoroughly test the device. This project was halted after Phase 1, which in itself provide useful learning.

1.3.2 Approach taken

It was decided to split it into two distinct phases as follows:

- Phase 1 - Trial a single installation of Hitachi's D-SVC on the 11kV network for 18 months.
- Phase 2 - Optimisation of multiple D-SVCs across two primary substation for a further 24 months.

Each was going to be a separate project so that if the first could not be proven then the second one would not be required. We believe that this was the right approach as the technology was so innovative and therefore had a higher level of uncertainty. We structured the project in a way such that it could be readily halted if required.

The project needed the support of local landowners and so some initial work was done as part of Phase One that would ensure that should we move into Phase Two this could be a smooth transition. Our approach also needed to include the support of the business as the equipment needed to be installed, commissioned and then integrated into WPD's control system, PowerOn.

We set out to select an appropriate site which involved an extensive search including a number of site visits. This proved to be challenging as most DG developers tend to avoid feeder ends due to the potential high reinforcement cost associated with voltage rise. A location in Cornwall connected to Falmouth

Bickland Hill primary substation was identified and selected for the project. The generator was a large 1.8MW windfarm near Penryn. It was 4.3km from the primary substation on a mixed underground/overhead feeder but predominantly constructed of overhead lines.

We then undertook the various site works and commissioning. For this project the project partner, Hitachi, supplied the D-SVC and it was connected at 11kV through a transformer. More information on the precise nature of the device can be found in the Closedown Report.

The D-SVC helps to regulate the voltage by managing the power factor so that the device is either importing or exporting reactive power. Hitachi originally envisaged the D-SVC to be a standalone system without needing any integration to other operational WPD control systems. However, it was important for such a trial that WPD maintained some basic control functions to reduce any risk to WPD customers (albeit the risk was not considered to be significant).

Following site selection, the impedance data of the network was provided to Hitachi who modelled the performance of the D-SVC. Meanwhile monitoring was installed along the feeder and relevant wayleaves were agreed for the site. The D-SVC was purposely located on land adjacent to a windfarm so the landowner was likely to be more responsive to our need for land agreements. This approach worked well.

Within the D-SVC was a communications card and from this the status of the D-SVC could be established and control signals could be sent. The system is similar to many remote/local systems on the network with a selector switch to denote if the device is in remote or local mode. This functionally was extended to the substation remote telemetry unit (RTU) via a hard wire connection, which enabled remote control by the WPD Control Centre using PowerOn. The diagrams within PowerOn were updated to provide a simple user interface through a number of on screen buttons and indicators.

Finally, we then undertook a series of tests. During the intensive tests we recorded 1ms resolution data on the D-SVC performance. This allowed the valuable capture of knowledge pertaining to the D-SVC's characteristics.

1.3.3 Results

There were a number of criteria that we used to assess the project. As we had decided to use this project as a trial to inform Phase 2 the criteria clearly had to be mindful of the next phase.

The results of the project were conclusive. The technology is not suitable for roll out as only parts of the solution work in a way that would be useful to a DNO. In addition the Power System models were wrong and so therefore we were able to cancel the second phase.

It is thought that this is more likely to work at 33kV and above and this was tested on the Low Carbon Hub Tier 2 project. This was trialled at Thrusthorpe as a 33kV FACTS device, taking on board the learning from this project and adopting a new transformer design.

Measure	Status
Success Criteria 1: Identify optimum settings for the D-SVCs for a given load and to achieve optimum voltage.	✓
Success Criteria 2: Use changes in set points & low pass filter to expand understanding of D-SVC performance for a given set of parameters and a given network load.	✓
Success Criteria 3: Utilise learning gained from the above items to ensure that a D-VQC can be developed to optimise multiple networked D-SVCs over a wide distribution network.	✓
Objective 1: to determine the effectiveness of D-SVCs (Static VAr Compensator for Distribution Networks) as a system to control voltage on 11kV rural networks.	✓

This project provided WPD and stakeholders with the expected outcomes in line with its objectives but it also provided some useful learning around this new type of technology and its potential for adoption in the UK. Moreover were then able to inform Phase Two with the following learning:

- The level of voltage control realised was below expected levels. This was partially due to the power difference between the D-SVC and the wind turbine. The performance would have benefited from an impedance tuned transformer.
- The transformer that is selected needs to have a HV VT metering unit to ensure that appropriate protection can be fitted and ensure visibility for the HV voltages and power from the D-SVC.
- The D-SVC does need to integrate with the Control System as control engineers do not want a separate system. The system needs to be automated but have enough feedback to the control engineer so that they know the status and have a way to disable the system if required.
- There are limitations in the current options available for WPD for high bandwidth, low latency communication to relatively remotes areas of network.

These learning points were taken forward to Phase 2 but the project was halted early on as it became apparent that the D-SVC was not appropriate for the 11kV network on the scale we were seeking to test. The learning though was taken forward into the Low Carbon Hub and Network Equilibrium.

1.3.4 Outcomes

The project did prove that these devices can indeed reduce voltage fluctuations on long lines. The D-SVC was shown to reduce the peak voltage by 50V and help smooth the voltage profile which was a good outcome.

Whilst the project was not able to move beyond the initial scoping of the second phase it was still a positive outcome as we were able to demonstrate that the STATCOM devices do work at HV to a point. We do continue to monitor the market for solutions to this particular problem.

Knowledge Dissemination

Below we detail the main knowledge sharing activities undertaken as part of the HVC SVC phase 1 project:

Event	Knowledge shared
LCNI 2011	General update on progress.
LCNI 2012	We shared the background to the project, our aims and objectives. Progress to date and some early data. We also shared our thoughts for Phase 2.
LCNI 2013	Results of the HVC Phase 1 trials shared and progress towards Phase 2.
LCNI 2014	General update on the project, results and thinking.
ENA R&D Managers Group	We have shared our findings with this group for further dissemination of the results.

A Closedown Report was initially published and this has since been recently refreshed to reflect up to date thinking. The report can be found via the link in Section 1.

Follow On Projects

- There was an intention to carry out a Phase 2 NIA project following on from this but this was terminated. It was terminated because it was concluded that the device would not be effective on HV networks and there was we believed at the time little benefit to be gained from progressing as intended.
- We did though take the learning from this and use it to good effect on the Low Carbon Hub project and Network Equilibrium

Policy changes

- No policy changes have been made as a result of this project but the results from the project have fed into our conclusions around the Low Carbon Hub project and we continue to investigate internally the use of the STATCOM devices at higher voltages under business as usual.

1.4 Early Learning of LV Network Impacts from estate PV cluster (WPDT1004)

EXCEPTIONAL BENEFITS

- 20% headroom capacity released through findings from this project informing the analysis undertaken within LV Network Templates.
- This project and PV Suburbia have therefore enabling the uptake of additional PV across our four areas. This is particularly significant given the extensive pipeline of applications that we have in the South West and this can be seen via this report:

  https://www.westernpower.co.uk/docs/About-us/Our-business/Our-network/Strategic-network-investment/WPD-Regen-DG-Growth-Scenario-Report-RevisionA.aspx

1.4.1 Background and the challenge

With the increasing publicity around Solar Panels, and the level of uncertainty about their widespread take-up including the impact on the local networks across the UK, the project sought to investigate whether voltage limits would be exceeded on a new housing estate where all the homes had PV installed. As we had no previous installation of any scale the challenge was how this uncertainty could be evaluated. An opportunity arose whereby we would have access to a whole new housing estate with solar panels on each house. This was a perfect scenario and one that afforded us the opportunity to do some assessments and analysis within the confines of a discrete project set up to do the required analysis.

Having access to data about the impact of a dense installation of PV within one area was of potential benefit to WPD(and all DNO's) because our design assumptions may need to be refined where the density of this particular type of LCT reaches a certain particular level. This could prove to be invaluable to us and ultimately customers.

The key objective of the project was to establish what effect this high density of PV had on the low voltage (LV) network, in particular looking at the voltages for different sizes of LV cable. Monitoring was installed mid-feeder and the feeder end for each phase which was also complemented with additional data on PV output, tap change and solar irradiance.

The results would be collected and analysed throughout the lifecycle of the project and it was anticipated that a series of conclusions would be drawn from the results.

1.4.2 Approach taken

The project sought to test the accuracy of our present modelling through real life voltage and load measurements on one feeder of an LV system. We also sought to further ascertain early learning via data on the behaviour of multiple densely populated PV units on a single estate and to test the validity of our traditional modelling. Our modelling at the time indicated that no more than 12 units could be accommodated.

We were approached by Melin Homes who had built a housing estate with PV on each home in Crickhowel. The LV designer calculated, using the standard tools, that the voltage rise would be above statutory limits and therefore a 300mm2 cable would need to be installed to replace the existing 95mm2 cable. We decided to explore what effect replacing the cable would have, and compare this with a scenario where reinforcement was not applied.

We did this by installing two pillars for the LV main which allowed us to select either 95mm2, 185mm2 or 300mm2 cable. The cabinets were standard pavement mounted 3 phase, three feeder cabinets. The cables were selected by inserting or removing links into the cabinets. We installed PM3000 units as it was widely used by the staff in the local office for data collection purposes. The PM3000 is a ruggedized 3 phase power quality meter which can measure voltage, current, real and reactive power, harmonics and

flicker. The units were readily available from the local depots and local staff had the relevant software on their laptops.

The data was collected from February 2012 with the main body of data being collected from May 2012 onwards at the pillar and feeder ends. This meant we had data through the summer months at the four main locations.

1.4.3 Results

This trial allowed us to explore what impact cable impedance has on voltage rise due to domestic PV. We collected a large amount of high resolution data which allowed us to conclude that in this case the impedance of the cable has negligible effect on the voltage.

The additional data collected has given us clearer understanding of how voltage at the feeder ends relates to the LV main during different times of day and the scenarios included properties net exporting from PV. We also were able to obtain a greater insight into how installed capacity can be affected by orientation of the PV panel and its efficiency meaning that the tangible effect on the distribution network is less than initially expected.

All data from the project was collated and analysed by E.ON New Build & Technology on our behalf.

The key learning for us and the industry was that voltage was not significantly affected by the LV main impedance or the PV Panels. Following on from this we revisited our LV planning assumptions around the impact of PV and this has resulted in some changes to our policies including removing the assumption to install oversized cables on embedded domestic generation.

Measure	Status
Success Criteria 1: The estate had all of its PV units installed.	✓
Success Criteria 2: WPD installed the cabling, pillars and monitoring.	✓
Success Criteria 3: Data was captured and analysed.	✓
Success Criteria 4: WPD writing report and sharing with other DNOs.	✓

The project's results were such that we now know that the high resolution data can be used to inform specific instances of high propagation of domestic solar and moreover we fed this information into the Tier 2 LV Network Templates project.

Also the project found that the monitoring equipment, which is capable of high accuracy voltage, current, power and power quality measurements is portable and can be utilised on other projects for example we are using this on our Losses project.

1.4.4 Outcomes

This project has provided us with some significant learning and in conjunction with the findings of PV Suburbia has allowed us to increase the amount of PV generation connections by 20%.

Knowledge Dissemination

The following knowledge dissemination occurred during this project:

Event	Knowledge shared
LV Monitoring Knowledge Sharing Event, 11th July 2013	Learning from 7 LCNF projects shared with a particular emphasis on LV Sensors. 80 people attended from a wide range of interested parties (10 companies exhibited their sensors, including Outram Research whose device was also tested on AFLMS).
Balancing Act 2014	General overview of the project.
LCNI 2011	General update on progress.

A Closedown Report was initially published and this has since been recently refreshed to reflect up to date thinking and information.

The report can be found via the link in Section 1.

Follow On Projects

- The learning from this project then fed into the Tier 2 LV Network Templates project, thereby creating a platform from which to maximise learning.
- Losses NIA project – learning used on devices to ensure high accuracy data and cable sizing information.

Policy changes

- LV Planning assumptions have been revisited as a direct result of this project meaning that we are able to allow 20% more PV to connect than previously. We explain more about what this means later in this report.

1.5 Seasonal Generation Deployment (WPDT1005)

EXCEPTIONAL BENEFITS

- Project proved the technical viability of utilising seasonal diesel generation to defer reinforcement.
- Provided insights and data needed to develop our DSO strategy.
- Learning then leveraged to develop further ideas in FALCON, SYNC and ENTIRE all of these projects crucial to the development and understanding of Flexibility Services.

1.5.1 Background and the challenge

The premise of this project was to test the theory that third party generators could provide a service to DNOs at periods of high demand to provide a peak reduction service. This was by way of providing additional generation in the form of diesel generators that could be installed at a substation and provide an "on demand service" through an innovative commercial arrangement. This concept was based on future energy scenarios which show that demand will increase and therefore managing peaks could well involve utilising a third party solution, should it be proven to be commercially viable.

In developing a technically feasible solution, it was also necessary to find a commercial solution to cater for generation availability and operation as well. The commercial solution was envisaged as being a contractual framework that would be appealing to third parties as well as DNOs with a price point that was attractive when compared to conventional reinforcement.

This project if proven to be successful could also provide additional insights into how the industry could make changes to industry arrangements to facilitate the inclusion of third party generation.

The main driver behind the trialling of this concept, if it could be proven to work, was that it could provide an additional mechanism to DNOs as part of a range of tools to assist with the management of the network. It was important to be able to test this theory in the confines of a small initiative as the risks, should it not work operationally, and could be significant to local customers. The project therefore had to be a relative short and focussed one with clear direction at the outset.

1.5.2 Approach taken

The project plan had two distinct phases, the first phase being the installation of the single point of generation at an 11kV substation site. The key objectives for this phase being the initiation, development and deployment of an engineering solution, creation of the relevant commercial arrangements and the first stage generation control methodology. This phase would require extensive input from the WPD Network Services Team in order to be able to find a suitable location and one where we could test the hypothesis with minimum risk to customers.

The second phase objective being to utilise network connected generation along with strategically placed generation connected on a contiguous section of the 11kV network. We partnered with Flexitricity to provide aggregated generation at times of network overstressing. As recognised Industry experts they had the relevant experience in this area and would provide input and guidance on how best to achieve the project objectives.

It was proposed to operate the generators under the Short Term Operating Reserve (STOR) agreement with National Grid in order to supplement any payments by WPD for the provision of a demand response service. In approaching it this way we also believed that there would be minimal commercial issues associated with the integration of a third party's generator units on WPD's land. We intended to install and operate a new specifically developed control mechanism for the operation of the generator. This would monitor the load demand on the selected primary substation and would be automated and negate the need for manual operation.

The project was terminated before the technical aspects could be developed and deployed as it became clear that the commercial aspects of the trial could not be made to work for the generators and WPD. Nevertheless, there are learning points detailed below that we think will be useful for the development of the DSO/DNO roles and responsibilities and provide significant value to the industry about the value of generation of this type. More detail is provided within the Closedown Report.

Further work on market models and the SO/DSO coordination is needed in order to be able to determine the viability of this in the future.

1.5.3 Results

A number of the criteria and objectives for this project could not be met and the project was terminated. Thishas given the industry some fascinating and important insights into the commercialisation of generation deployment for the temporary resolution of network constraints.

Clearly in order to determine the commercial viability of something you have to try something first and by undertaking this trial we have been able to cast some light on this in a way that would not have otherwise been possible.

Measure	Status
Success Criteria 1: Install and commission seasonal generation set.	×
Success Criteria 2: Ability to accommodate additional load without the need for large-scale network reinforcement through peak lopping techniques.	×
Success Criteria 3: New commercial arrangements reflecting the needs of the local grid.	✓
Success Criteria 4: Development of an engineering interface and control methodology.	✓
Success Criteria 5: Assessment of the business case for deferring capital expenditure on the network.	✓
Objective 1: Develop and deploy an automated network generation control system. To provide network support through the integration of an automated demand triggered generation system.	✓
Objective 2: Develop and deploy an Availability and Commercial Operating arrangement - “DNO to DSO”.	×
Objective 3: Provide a commercial arrangement similar to the "STOR “ Short Term Operating Reserve” arrangements between aggregators and National Grid (NG), but specifically tailored to reflect the needs of the local grid rather than GB system balancing.	×
Objective 4: To increase network flexibility and security through the use of robust generation.	×
Objective 5: To ensure that the engineering model and commercial framework are aligned in order to provide maximum benefit for existing assets and end user customers.	×
Objective 6 : Assess the benefit from capital deferment, by complimenting existing network assets with strategic generation thus maximising asset life.	×

1.5.4 Outcomes

The main outcome of this project was just how uncompetitive “diesel generation” was, at the time of the project, when compared to conventional reinforcement. Whilst it is disappointing for the project team when something cannot be made to work, this is invaluable information and offers some clear indicators of how

much work is needed in order to derive a set of tools for the industry to be able to work effectively in an uncertain future.

We also found that the connection of the seasonal generation to the existing network was proven to require the same design principles to that of a normal generator connection to the system despite only needing connection for the winter 3 month period. More information can be found on this within the Closedown Report.

We have been able to make some changes to our alternative connections policies that may make these types of generation more attractive, which to us is a good outcome given that we could not make this work at the time.

Another significant element of commercial learning was the value that a generator owner/operator attributes to the certainty of revenue in terms of the length of the contract to secure their assets' connection to the electricity network. STOR contracts are typically in the region of 10 to 15 years, however WPD were looking to contract for a period of between one and three years. The lack of security in financial return meant that a larger return was sought for the time the generation was installed. This is a useful learning point and one that we hope can be taken forward into future discussions.

It is clear though that there is work to do in this area from a market perspective but it does also help inform the debate and give insight on DSO/DNO.

Knowledge Dissemination

Given the results of the project it was not deemed appropriate to hold specific events and so we provided the following updates only:

Event	Knowledge shared
LCNI 2011	General update on progress.
LCNI 2013	Results of the project shared with Stakeholders alongside thoughts on related initiatives within innovation funded projects.
Balancing Act 2014	General overview of the project.

A Closedown Report was initially published and this has since been refreshed to reflect up to date thinking and information.

The report can be found via the link in Section 1.

Follow On Projects

- We were able to take this forward into FALCON, SYNC and ENTIRE.

Policy changes

- No policy changes were made as a result of this project.
- Alternative connections changes have been made to allow more diesel generation to connect to the network should market conditions change.

1.6 LV Sensor Evaluation (WPDT1006)

EXCEPTIONAL BENEFITS

- Exceptional collaborative learning which has then be further utilised on Project FALCON, the Losses Project, LV Connect and Manage, Car Connect and the current NIC project for 2017, OpenLV.
- LV Sensors are now part of policy and have the potential to release benefit to customers on an enduring basis.

1.6.1 Background and the challenge

This project started on the back of some of the issues faced on LV Network Templates, PV Suburbia and the Isles of Scilly projects. We approached both projects which had a requirement for some form of monitoring capability with the same solution, namely split core CTs and whilst this was functional it did not offer the most effective way forward. Moreover as the industry transitions to a smarter grid it is increasingly apparent that a far deeper understanding of the LV Network will be required. There was at the time only limited monitoring on the UK LV network and this would have to change. In particular we believe that there will be an increasing need to be able to monitor LV Substations, a much greater level of granularity of data will be required in order for the business to be as effective as possible in a much more connected world. Customers will be more sophisticated and so will we.

However there were a number of devices on the market that were new to the market and unproven in terms of performance and safety that could have been used at the time. Moreover information coming from projects across the sector meant that an optimal solution needed to be found without having to undertake vast trials. WPD issued a consultation to that effect and whilst we got a lot of useful information and feedback it was not sufficient with which to move forward with. So WPD decided to explore in a project what would be the most effective and appropriate proposition. At the same time we became aware that UK Power Networks(UKPN) were exploring similar solutions so it was agreed that we would undertake a joint initiative with them to assess the various types of LV Sensor available to see which would be best for a wider roll out within the DNO sector.

The benefits of an effective LV Monitoring solution are clear, with the increasing desire to connect generation and the uncertainties around customer behaviour and the impact on demand, more information on the network is vital. LV monitoring, in our view, has a series of uses ranging from providing information to assist our investment decisions to more “real time” decision making around the operation of the network. The purpose of this project being to give us the insight into the most appropriate solution to our medium term and long term needs.

1.6.2 Approach taken

In order to fully understand what was available and what was possible we issued a consultation document to gain some initial insights and data. The responses we received were somewhat inconclusive and could not provide us with a more compelling answer than using traditional methods via the use of fixed ring CTs used on the Tier 2 LV Network Templates project that was about to commence at that time.

We decided that we needed to do a thorough assessment of what was available on the market with a trial in laboratory and field conditions. We would then provide the data back to the industry. We became aware though that UKPN were also undertaking some related work and it was decided that we should collaborate in order to deliver an optimal result as quickly as we could. The units were to be tested under laboratory conditions at the National Physical Laboratory and in the field on their low voltage networks, equipping 28 substations with sensors from seven different manufacturers.

1.6.3 Results

Most of the measurement criteria for this project were met. The trial could not be run in all instances for the desired 12 months due to operational limitations to carry out the installation training. This though did not affect the overall statistical integrity of the results.

The trial proved that there are a number of solutions that do meet the requirements of a DNO and moreover that manufacturers are responding to the changing market and including more and more functionality that will be required in the future.

We also proved that it is feasible to retrofit monitoring equipment of this type and the project, via UKPN, produced a safe installation procedure that is available to all.

Communications via GRPS did highlight some challenges and we are taking this learning forward with learning from other projects that have required communications through our NEXUS NIA project.

Finally, this project showed that it is possible to monitor LV networks in a substation without interrupting customers. This paved the way for a more widespread roll out after some additional trials. These trials included FALCON and the Losses Project in the shorter term, and are planned for both our Car Connect NIA Project and NIC project, OpenLV in the immediate term.

In the background LV Monitoring is now a Standard Technique and is used under Business as Usual and more importantly is part of our investment plans under ED1. Where we have identified hotspots for new transformers but are uncertain of what the scale of work is we utilise these monitoring devices in order to be able to properly assess the scale of work required. This is therefore contributing to the effective operation of the business and in cases will be affecting the level of investments required for customers: again this is a real benefit to the customer as investments may be lower because we have more information available to us.

Measure	Status
Objective 1: the project aims to evaluate innovative current sensor technologies in a controlled laboratory environment and field situations.	✓
Objective 2: the project will evaluate sensors from 7 manufacturers and the field trials will last for 12 months.	×
Objective 3: the objective is to generate knowledge of LV monitoring techniques enabling wider roll outs to facilitate a low carbon future and minimising disruption to customers.	✓
Objective 4: a full report detailing the results of individual tests and a comparative assessment will be produced.	✓
Success Criteria 1: DNO's approve safe installation procedures.	✓
Success Criteria 2: Testing and report of lab evaluation is completed by NPL.	✓
Success Criteria 3: a 12 month field trial is completed.	×
Success Criteria 4: A full project report has been written- evaluating and comparing sensor results from laboratory and field trials.	✓
Success Criteria 5: The results of the project will determine LV monitoring policies.	×

1.6.4 Outcomes

This was a very successful project for the transition towards the "Smart Grid". These technologies will become standard in a relatively short time and will provide the visibility of the network and the financial benefits of using them will become apparent in due course. Without this project it we would not be in the position to have used these devices on FALCON, the Losses Project, LV Connect and Manage, Car Connect and the current NIC project for 2017, OpenLV.

In due course as more LV Monitoring is in place capacity will be able to be made available for the connection of more Distributed Generation and with this in mind WPD is currently undertaking a review of a more formalised roll out. We expect to be able to make this a policy during 2017.

In addition new RMUs have monitoring included now as standard as part of our procurement policy and our framework agreements for retrofitting includes new projects and ED1 LCT Hotspots. This means that LV monitoring will increasingly because a feature across our network.

Knowledge Dissemination

The following knowledge dissemination activities were undertaken during this project:

Event	Knowledge shared
LCNI 2013	Jointly presented with UKPN on the findings of the project.
LV Monitoring Knowledge Sharing Event, 11th July 2013	Learning from 7 LCNF projects shared with a particular emphasis on LV Sensors. 80 people attended from a wide range of interested parties (10 companies exhibited their sensors, including all 7 under trial).
Dissemination events with Sensor manufacturers	A number of meetings were held to share the findings from the various trials with the manufacturers and in some instances manufacturers were able to show how they had improved their devices.

A Closedown Report was initially published and this has since been recently refreshed to reflect up to date thinking and information. The report can be found via the link in Section 1.

Follow On Projects

- The learning from this project has led directly into FALCON, Losses Project, Car Connect and may well be implemented as part of OpenLV.

Policy changes

- Our policy has been amended to reflect the use of LV Monitoring devices as part of business as usual. In addition though we are utilising these devices across a number of other innovation projects as is mentioned in this application.

1.7 Active Fault Level Management Scheme (WPDT1007)

EXCEPTIONAL BENEFITS

- Innovative solution tested and proven and then taken forward to a more industrial scale under FlexDGrid.
- The management of Faults is a challenging issue and this technology has the potential to positively impact customers, the results were significant proving real-time fault level monitoring capability on an existing 11kV distribution network is possible.

1.7.1 Background and the challenge

Fault level issues on the electricity network can be a barrier to the connection of new Distributed Generation (DG). In order to explore this in more depth we developed a project to test a Fault Level Monitoring (FLM) system in laboratory conditions and at a primary substation including site testing, commissioning and analysis of the fault level management scheme within a 11kV substation to see if this would aid the deferment and / or avoid costly reinforcement, increase network resilience as well as allow the connection of new DG.

The hypothesis being that FLM devices can facilitate the installation of DG close to larger demand centres, through more granular fault level knowledge, which in turn could reduce electrical losses and increase the overall efficiency of the distribution system. The intention was to trial the device within the confines of a small project to see if it could work before scaling it up to a more robust test within a larger demand centre. If proven successful we envisaged a Tier 2 project with a much broader remit.

This was the first time that one of these devices had been used in the UK and followed on from learning within an Innovation Funding Incentive (IFI) project undertaken by Scottish Power Energy Networks. The main project aim being that if proven to work within this project and reduce fault level issues then it could be trialled on a larger scale ahead of implementation in to business as usual.

The industry is increasingly conscious of the issues that this project sought to address. As these issues increase it was felt that addressing it then as an innovation proposition it would have particular value to all DNO's.

1.7.2 Approach taken

This project was a proof of concept ahead of a much larger demonstration project if the concept could be proven.

The project had two contiguous phases in a traditional waterfall style to ensure that each phase was completed before progressing to the next; the first phase involved the design, integration and factory acceptance testing of the fault level monitoring device. The second phase involved the implementation of the device in a field trial to manage the connection of a distributed generator, firstly through open loop control and then through closed loop control.

The first task we had to complete was the confirmation of what would be installed and this was solved by integrating two existing products, S&C Electric's Pad Mounted Style IntelliRupter® PulseCloser and the Outram Research Limited's PM7000-FLM(as demonstrated within the Early Learning project). We had carried out some preparatory work prior to project registration to more fully understand the requirements and feasibility of the creation of the Active Fault Level Monitor (AFLM). That initial research proved invaluable in ensuring feasibility and set up of the project ahead of project registration.

Following project registration the device needed to be designed and developed and then tested under laboratory conditions before connection to the network. This test was undertaken at S&C's facility in Chicago, with the project team creating a test procedure to prove the device. These tests were

successfully carried out and preparations made to select an appropriate location on which to install it on the WPD network.

A number of decisions had to be made in order to facilitate the installation of the device and following this, the device was installed at Ladywood Substation in Birmingham- this was done deliberately as Birmingham would be the chosen area for the larger demonstration project (FlexDGrid) should this first stage be proven successful.

After installation a number of predesigned tests were undertaken to thoroughly determine the effectiveness of the device. These tests were rigorous in order to increase confidence levels ahead of the larger demonstration.

1.7.3 Results

The project had a prescribed lifecycle from design, test, install and demonstration and whilst there were challenges along the way, we were able to prove that it is possible to have a device that, when instructed, can provide real-time fault level monitoring capability on an existing 11kV distribution network. This is a tremendous result for customers and WPD.

The next step was, and remains, to trial the device over a prolonged period and this is being undertaken under FlexDGrid with the final results due in Spring 2017. Initial conclusions were that this will form part of WPD's policy in due course, it will make capacity available on urban networks in the future, provide additional security of supply and reduce CI/CMLs. These are of course for the future, but the signs from AFLMS and FlexDGrid are extremely promising and we think validate the approach; this is leading edge technology and before major implementation, it needs to be thoroughly tested.

Throughout the project a detailed methodology for the integration of the AFLM device on to the 11kV network and the active control of the device was completed. In addition through the various Tier 1 projects we have undertaken and specifically the learnings from them, we have implemented the Alternative Connections Offers and Agreements. These enable, through various techniques (and will include Fault Level Monitoring in the future), customers to connect to the network without the need for extensive reinforcement. This we believe to be a positive outcome for all parties. More information will be published in this as part of SDRC 11 on FlexDGrid.

In terms of the overall project objectives we achieved all that we set to achieve:

Measure	Status
Objective 1 : Integration of technologies to provide real-time fault level values.	✓
Objective 2: Installation of Active Fault Monitoring device at Primary Substation.	✓
Success Criteria 1: Conduct Factory Acceptance test of fault level monitoring devices.	✓
Success Criteria 2: Install and commission the active fault management scheme.	✓
Success Criteria 3: Ability to monitor fault levels in real-time to accommodate additional distrusted generation without the needs for large scale network reinforcement.	✓
Success Criteria 4: Integrate distributed generation into the network more quickly.	✓
Success Criteria 5: Development of an engineering interface and control methodology.	✓
Success Criteria 6: New contractual arrangements to maximise generation connectivity.	✓

1.7.4 Outcomes

This was a WPD project which delivered outstanding results and one that proves that innovation works. We were able to prove that it is possible to deliver a new solution in the confines of a small initiative.

Knowledge Dissemination

No formal dissemination activity was undertaken on this project due to the relatively short project lifecycle. A Closedown Report was initially published and this has recently been refreshed to reflect up to date thinking and information. The report can be found via the link in Section 1.

In addition a dissemination presentation was undertaken at LCNI 2012 around the project set up and results. At the same event we also shared our thoughts on what might be the next steps in developing Fault Level Management. A more detailed update has been provided at our own Balancing Act event on ALFMS and FlexDGrid and we anticipate undertaking a technical event in Q2 2017 and a general closedown event specifically for Fault Management in Q3 2017 including LCNI.

Follow On Projects

- FlexDGrid- Tier 2 project.

Policy changes

- During this project a WPD policy was created for the Application and Connection of 11kV AFLM Devices. This is ahead of the full demonstration project, FlexDGrid..

1.8 Community Energy Action (WPDT1008)

EXCEPTIONAL BENEFITS

- Significant amount of knowledge about community engagement generated and published via WPD and CSE.
- Detailed understanding of DDSR in the context of communities which we are using in conjunction with the more operational aspects of the learning to implement best practice in the sector.

1.8.1 Background and the challenge

This project sought to investigate the methodology and practicalities of engaging with domestic communities to deliver domestic demand side response (DDSR). It attempted to achieve this by trialling community load reductions .This project was about customers actively reducing consumption in a targeted manner through community engagement centred around specific substations. The scale of Community Energy Action was significantly different to our ECHO LCNF project which also aimed to peak load shift but through online householder engagement.

This type of trial was important for two reasons, firstly there is a need to understand customer appetite for demand response of this type and secondly there is a need to delve into and trial ways in which to see what the optimal solution is. There was little or no reference projects and material to determine what the right mechanism would be for the UK.

In trialling DDSR in this way the intention was that customers would “own” their substation and would undertake various “tests” at agreed times to see if we could measure directly the impact of their actions on the network. Of course this was quite a challenge and in particular for a DNO and so having the Centre for Sustainable Energy (CSE) on board to coordinate the various customer engagements through their network was a key ingredient.

The challenge with Community Energy Action was having sufficient density of customer interest and engagement around a substation as well as a coordination of the various trials. In order to achieve this, the whole project was coordinated from a practical perspective by CSE who had originally proposed the concept to us.

1.8.2 Approach taken

The scope of this project was to work with 10 communities to firstly gather “normal” demand data over a period. We then implemented some targeted incentive based tariffs to reduce demand and then see the impact on the local network. The project was a relatively simple concept at the highest level but a significant undertaking nonetheless.

The project had a series of lifecycles with CSE running the engagement and analytical workstreams, WPD’s role was largely around the infrastructure and technological aspects. We believe that this division of the workload did make the overall project management aspects of the delivery clear and well structured.

A community energy monitor would also be developed for one community to allow customers to see at a glance what their individual demand and the entire community demand was. This would be the link between the customer and the project and act as the test of success – if the project could get the engagement right the monitor would provide the information to the customers to keep their engagement and interest going.

This whole project was a considerable undertaking with 10 different communities, managed by 5 energy charities trialling these techniques, but of course if the UK is to make the most of smart meters and then smart grids then customer education and engagement is vital.

The intended benefit of this project was to be able to see if using demand side response could reduce the peak demand (a peak lopping service in effect) thus allowing WPD to defer or even negate conventional reinforcement which could reduce the cost of demand driven reinforcement significantly. Additionally, the communities selected had expressed a preference towards low carbon technologies and this allowed WPD to obtain indicative demand data for communities of the future.

This information would, we hoped, prove useful in gauging the extent to which the industry has to engage with consumers in order to get the sort of responses that we may need in the future.

1.8.3 Results

We achieved all of our stated objectives, but this project was not easy. All of the issues that we faced are documented within the Closedown Report, a link to which can be found in Section 1. The facts though do not make for a positive business case for these types of service in the current market conditions. The amount of effort required to adjust customer behaviours is enormous and outweighs the cost of conventional reinforcement.

We did receive good ideas from some of the customers, who did engage with the project, but we also struggled to get significant engagement with the more affluent areas under trial who also happened to be those with LCTs already. This in itself is a powerful lesson for the industry. Detailed information and analysis on this aspect of the project is provided within the Closedown Report and more importantly helps shape our approach to customer engagement and our wish to push forward a best practice approach for this across the industry. We are committed to ensuring that we remain customer focussed and to do this we have to remain at the very top of our game.

The positives from the project though are compelling in some key areas; some of the incentives we used were extremely well received and prove that part of the issue we face is education (for example, the use of slow cookers, see Closedown Report) and there was some success from getting communities to work together which some of them appreciated. There was also some confusion about who the “Sponsor” of the project was and we believe this is not uncommon, customers know their supplier, and they appear to be less aware of their DNO. All of these lessons are something that we have a lead role in addressing.

Measure	Status
Objective 1: An understanding of the effectiveness of demand side response at a community level.	✓
Objective 2: An understanding of what effect do incentives provide.	✓
Objective 3: That the communities were successfully engaged and that we receive positive feedback.	✓
Objective 4: A developed community energy monitoring device.	✓
Objective 5: An understanding of the potential effects of low carbon technology on the LV network.	✓
Objective 6: Delivery of the project to budget and on time.	✓

1.8.4 Outcomes

DDSR within the context of this project was found to be less than successful for a number of reasons. Some of the reasons pertain to the somewhat ambitious scale of the project, but clearly without scale it is extremely difficult to evaluate the impact of customer trials. It was a lot harder to get the technology to work in the way that was envisaged and this is something that we have shared with those suppliers responsible for the smart metering rollout. This is not something for which there is a silver bullet in our

opinion and as such we continue to push for best practice in community engagement projects. We also published recently a paper on DDSR and this is available on the WPD Innovation website (here is the link: https://www.westernpowerinnovation.co.uk/News/Demand-Side-Response.aspx).

Perhaps even more importantly it may be that Demand Side Response could feature as a responsibility under a DSO role or another role within the industry and so therefore we do need to try and get to the heart of what DDSR actually means when coupled with a community energy saving theme. This though needs to be done in the context of the business case for smart metering.

The closedown report for Community Energy Action is rich in learning about what works and does not when it comes to Community Engagement. We believe that it is imperative if we as an industry are to ensure that the business case for this transition remains positive that we learn and agree the best model for customer engagement at all levels.

We have undertaken a number of projects in this space and feel that whilst there are lots of positives there are also some lessons that we do want to share with the industry.

Knowledge Dissemination

Due to the nature of this project extensive engagement with our stakeholders was the foundation of the project so we have not detailed all the individual events.

As is stated elsewhere in this report, we have undertaken a series of Tier 1 projects where customer engagement has been a dominant theme. The industry has some powerful insights into the way to manage that relationship and we are currently undertaking some work to bring this together into a best practice guide with the industry. We feel passionately that there is more to be done as an industry to fully leverage some of the benefits that are anticipated as part of the roll out of smart meters, the adoption of smart grids and the systems that will need to be in place.

Below we detail the main knowledge sharing activities undertaken as part of the Community Energy Action project:

Event	Knowledge shared
LCNI 2013	Summary results and conclusions presented as part of a Community Engagement presentation.
LCNI 2014	Further updated presentation with CSE on the findings of the project.
LV Monitoring Knowledge Sharing Event, 11th July 2013	Learning from 6 LCNF projects shared with a particular emphasis on LV Sensors. 80 people attended from a wide range of interested parties (10 companies exhibited their sensors, including all 7 under trial).
Balancing Act 2014	General overview of the project.
Ofgem Event on Community Energy	Future Networks Manager presented on the outcomes and reflections on Community Energy and specifically insights from CEA.

More recently we have been sharing out experiences and thoughts on community engagement with the industry and stakeholders with a view to developing best practice.

A Closedown Report was initially published and this has since been refreshed to reflect up to date thinking and information. The report can be found via the link in Section 1.

Follow On Projects

- ECHO - Tier 1 project, this took the learnings from the engagement aspects of CEA and sought to test Demand Side Response (that is, turn down) as opposed a targeted peak lopping service.

- FREEDOM - NIA project centred in Bridgend and engaging with local Housing Associations.
- Connect and Manage- NIA project in Milton Keynes and Nottingham.

Policy changes

- No policy changes were implemented as part of this project, but the findings are being used to develop WPD's strategy for Demand Response and this is then forming part of our positioning around DSO. This project and others within our portfolio we see as key contributions to the debate.
- CEA did reuse Gridkey devices from LV Sensors & FALCON and these devices are now part of policy.

1.9 Electric Boulevards (WPDT1009)

EXCEPTIONAL BENEFITS

- Significant CO_2 savings throughout the project and beyond of 110,044 kgCO2e.
- Milton Keynes is now adopting Electric Buses across its area.
- Policy changes to support Electric Bus introduction shared with all DNO's.
- Potential to save customers £43.9m through reduced reinforcement costs.

1.9.1 Background and the challenge

The wider roll out of a GB electric bus fleet has the potential to impact on DNO's and customers due to the potential need for extensive reinforcement of the network and the possible impacts on power quality through the installation of inductive charging. As electric buses are not widely adopted it was impossible though to find evidence of what the impacts would be. With the help of a consortium, the Electric Boulevards project sought to investigate fully what would happen in the event of a more widespread adoption of these vehicles.

DNOs do not have familiarity with the requirements for connecting the various devices required to run a fleet of electric buses and also there may be diversity, peak current, flicker properties and harmonic contribution to take into account as well. Electric Boulevards was designed to be the catalyst for obtaining what we thought would prove to be essential insight.

The aim of the overall project was to understand the impact of installing inductive charging of electric buses on the distribution network. This would be done through the monitoring and recording of data from electric buses operating on a route in Milton Keynes in partnership with Milton Keynes Council and Wrightbus. The data providing WPD and other DNO's with the insights needed to make better investment decisions based on the real life operation of an electric bus fleet.

This project sought to facilitate the decarbonisation of the public transport system by determining the infrastructure requirements for inductive power transfer (IPT) chargers and trial new techniques of connecting these devices to the distribution system. Stored battery energy on the buses was supplemented by opportunistic wireless charging around the route and the application of charge deferral to alleviate network constraints. This we believe to be an outstanding success with ongoing CO2 savings through the extended use of the buses in the trial area. More information on this is provided in the Closedown Report.

1.9.2 Approach taken

The approach taken for Electric Boulevards was a traditional waterfall delivery with a series of project partners and suppliers helping with the overall delivery of each phase. The three phases were Design and End to End testing in lab conditions, Build and Commissioning, Testing and finally the Trials, Data Collection and Analysis Phase. It was anticipated that the project would run from January 2014 to December 2015.

As part of the overall delivery package the Transport Research Laboratory were asked to complete a series of reports throughout the project lifecycle to provide timely analysis of the data. We believed that this would ensure that not only would we have signposts throughout on the progress and impacts but it would also provide early warnings that we could then use to manage the project.

As a type of community project it was important to ensure that there was a level of information available to stakeholders throughout the project rather than just a "big bang" at the end. This proved useful as well for dissemination throughout as we were able to share analysis at various stages in the project.

The project would facilitate connections of inductive power transfer devices by connecting a number on the distribution network using innovative ways and monitoring their effect on the adjacent electrical system. This would then be shared with stakeholders as part of a template that could be used across the UK to facilitate the uptake of Electric Buses and hence contribute to the achievement of the Carbon Plan through decarbonised public transport.

1.9.3 Results

Electric Boulevard was a tremendous success on a number of levels. We proved that electric buses do not necessarily mean significant increases in the amount of reinforcement needed to the electricity network. We also proved that they can work on a "charging en-route" basis as well as proving that whilst there is some disruption whilst the charging devices are installed, that they can be made to work. This is a fantastic result for WPD, our stakeholders and the wider energy system.

We have been able to save a considerable amount of CO_2 towards the Carbon Plan which is an ongoing saving for Milton Keynes and we also now have a template for all DNO's to use in respect of a wider take up of electric buses. This demonstrates the value of innovation and more importantly it demonstrates how coming together with the local community can produce great outcomes for all parties.

We set out to establish a number of key objectives and success criteria and these are detailed below:-

Measure	Status
Objective 1: Infrastructure will be installed to provide connection to three IPT chargers in the Milton Keynes area using a number of different arrangements.	✓
Objective 2: HV and LV monitoring will be installed before and after IPT charger commissioning in order to retrieve background harmonic levels.	✓
Success Criteria 1: Install HV and LV monitoring devices on the adjacent network.	✓
Success Criteria 2: Conduct preliminary lab testing of the IPT charger.	✓
Success Criteria 3: Connect IPT chargers to the network using innovative techniques.	✓
Success Criteria 4: Demonstrate charge deferral based upon network constraints.	✓
Success Criteria 5: Develop an IPT charger connection policy.	✓

1.9.4 Outcomes

There were a number of key outcomes anticipated as part of the delivery of the project, the results of which we are particularly proud. This was a very successful project, providing powerful insight into the impact of Electric Buses for all DNOs. In summary the findings were:

- HV reinforcement is not always needed and our templates provide DNOs with a tool to help with planning for this, these will be shared via ENACT in Q1 2017.
- Inductive Power Transfer chargers can be connected to the LV network in certain circumstances (e.g where the network impedance permits connection).
- By connecting to the LV, the cost of full IPT adoption of electric buses would be reduced by in excess of £43.9m. This is a significant cost reduction and more information on how this was calculated in provided within Section 4.3.
- The impact on end customers whilst the electrification of the bus network is undertaken could be substantial as the works required are not insignificant.

- The PM7000 units used for power quality analysis recorded detailed information for analysis to be carried out.
- We already have the correct processes to assess disturbance.

By enabling the buses to operate within Milton Keynes the current statistics show that as of September 2016 the bus fleet had done 671,000 miles which translates into a real CO_2 reduction of 110,044 kgCO2e[1] of carbon. Moreover, the buses proved very popular in Milton Keynes, and it is the Council's intention to expand the use of them further:

https://www.milton-keynes.gov.uk/pressreleases/2016/jul/more-electric-buses-destined-for-mk

Due to the nature of the project a number of dissemination events occurred to further share the insights of the project. We have not detailed all events as some were not specifically related to the dissemination of learning from the project. We do though continue to explore ways in which to support the decarbonisation of the transport system and more recently have announced Car Connect to support domestic electric vehicle adoption.

Knowledge Dissemination

Disseminating knowledge is a key part of these projects and we have spent a considerable amount of time going to events to share our findings. We detail below the main ones for reference purposes. Other events though have included a number of events with academia to share our conclusions.

Event	Knowledge shared
Presentation at MK Energy Group – 08.05.2013.	Shared information on approach with consortium member.
Presentation at EVE Meeting, Geneva – June 2013.	Dissemination of proposed approach to wider international audience consortium members.
Presentation at LCNF 2013 – 14.11.2013.	Dissemination of proposed approach to other DNO and industry members.
Article in Thinking Cities– November 2013.	Outlined project.
Article in Thinking Highways – April 2014.	Outlined project.
Presentation at IET Transport Sector: Electric Vehicles and their Appetite for Power – 19.06.2014.	Explained initial findings and potential impacts to technical audience.
Presentation at LCNI 2014 – 21.10.2014.	Dissemination of initial findings to DNO and industry.
Article in IET Magazine – Wireless Power Transfer for Electric Vehicles – May 2015.	Discussion of IPT technology and DNO impacts.
Presentation at MASP Project Consortium – 14.05.2015.	Update on potential benefits on future installations occurring due to project outputs.
Presentation at Thinking Cities – 03.06.2015.	Update on project findings to national audience.
Article in Energy Engineering – September 2015.	Discussion on project outputs.
Presentation at LCNI 2015 – 27.11.2015.	Total project findings to DNOs and industry.

[1] http://www.carbon-calculator.org.uk/

A Closedown Report was initially published and this has since been refreshed to reflect up to date thinking and information. The report can be found via the link in Section 1.

Follow On Projects

- CarConnect- ”Electric Nation”.
- More Bus routes are being added as detailed above .

Policy changes

- Significant business change has been made and other changes are anticipated to be made as a result of Electric Boulevards and Car Connect. Changes to design assumptions have already been made and we have a template for other DNO’s to use for planning Electric Buses. From Car Connect we anticipate that similar quality outputs will be found around the take up of these vehicles.

1.10 Energy Control for Household Optimisation (WPDT1010)

EXCEPTIONAL BENEFITS

- Significant learning around the barriers to Domestic Demand Side Response.
- Learning on customer engagement fed into additional learning from other community projects and our work towards best practice.

1.10.1 Background and the challenge

This project followed on from Community Energy Action and the work undertaken by the Smart Grid Forums Work Stream 3 (WS3) in investigating the next step in Domestic Demand Side Response (DDSR) and specifically the potential to control domestic demand through direct control, price signals and planned load shifting. This technique could provide additional network control at times of peak loading, allowing high loads to be actively managed and potentially deferring system reinforcement. With the advent of low carbon technologies, such as electric vehicles and heat pumps, this capability could become increasingly important as heating and transportation become more reliant on electricity.

This has been actively discussed within the industry as a potential solution to the issue of security of supply. However, we believed at the time that these theories needed to be put into practice.

DDSR is a potentially complex solution relying heavily on customer engagement. Previous customer/community projects have delivered significant learning and we took these lessons into ECHO to try to ensure that the project could actually test the premise of DDSR in real life.

In trying to test DDSR it was important to have engaged customers with access to information to hand about the trials, the technology in customer homes to control load and the measures in place to determine how successful the trials were.

Finally we wanted to ensure that the results of this trial could then be used to feed into the work of WS3. Constructing a project that would test the theory of DDSR and also provide valuable insight into the work of the industry as a whole had to be an important aspect of validating DDSR.

1.10.2 Approach taken

The project was designed and delivered by the Energy Savings Trust who clearly had the skills and contacts to make the customer engagement aspects of the project as successful as possible. We looked to leverage ESTs database of customers with an interest in participating in energy trials of this kind, it also has links to Housing Associations which we felt could be an important contributor to the trial.

We planned to recruit 200 customers in order to have a statistically reliable group. A solution was selected for the domestic control system, sitting between the socket and the plug. The device would create a link between itself and a communications device connected to the home broadband.

A web portal would be made available to the customers for them to monitor their energy usage and help manage their appliances remotely. In addition to the customer interface there were a series of incentives developed to engage customers in the trial of DDSR. Data would be collected through the device and a series of prescribed tests undertaken to see their impact on demand.

The project also required the development of the device to the carry out the control and data exchange. This aspect of the project was challenging and we believe requires more work within industry and appliance manufacturers to make it work in a more integrated way for customers.

The next ingredient revolved around the integration of all aspects of the project. This part required the management of the end to end process to ensure that the monitoring was in place, the technology in the homes working and that the customers were engaged and had the necessary information to carry out the

tests. Most of this work was undertaken via the Energy Savings Trust and the outcomes provided a fascinating insight into the role of DDSR.

1.10.3 Results

The results of ECHO were encouraging and challenging in equal measure. As we have seen in a number of customer facing projects the amount of work required to keep customers engaged throughout the project lifecycle is significant. We made some major steps forward in evaluating DDSR as a concept but the results were such that we feel that it still requires some work. This work is imperative for informing the debate on household flexibility.

To put the findings into perspective we found that customer utilisation payments for DDSR would cost £6,660 /MWH, factor in the cost of the software and control centre and this would make the figure c. £6m per MW of available domestic load. To put these costs into some context the average STOR utilisation price in January 2015 was £131.94 MWh and high end lithium batteries cost approximately £1.4m per MW installed. Reinforcement costs are considerably less. As can be seen it is very difficult to make a case for DDSR when compared to the alternatives.

We do feel that more success could be gained from it with further advances in the technology and also if an energy supplier or appliance manufacturer (or EV manufacturer) were to act as the sponsor or focal point of the DDSR. This would provide a more dynamic link between the energy savings (through the bill) or with the device and its connected appliance (it would be even better if the appliance came with this functionality built in). These are of course developments for the market to consider.

There were though some fascinating insights into the use of appliances and what customers would be prepared to sacrifice and commit to. Moreover the project has provided some useful information about the duration of events for which customers would be willing to commit to and we are of the view that this will be extremely powerful in the furthering of the debate of this service.

It is our view that there is still a substantial learning exercise that needs to be undertaken in order for the full breadth and depth of the potential of DDSR to be understood so that the market can make use of this service.

Broadly the project met most of its objectives, but there is still work to be done in this area. We intend to keep a watching brief on market developments across the board and may revisit this at some point in the future should the right opportunity arise, including the rollout of smart metering which may be a catalyst. We continue to discuss this project further with other interested stakeholders who may be able to provide alternative and more effective outcomes.

Measure	Status
Success Criteria 1: Recruitment and installation of devices at 200 properties.	✓
Success Criteria 2: Quantification of the amount of peak load reduction possible through such techniques.	✓
Success Criteria 3: Update WS3 Transform Model parameters.	✓
Success Criteria 4: Deliver the project to time, cost and quality.	✓
Success Criteria 5: Deliver a technology solution that works out of the box.	✓
Objective 1: To achieve high levels of customer satisfaction.	✓
Objective 2: To understand the scale and structure of payments required to ensure behavioural change.	✓

Objective 3: To quantify the potential changes in peak load through domestic demand response.	✓
Objective 4: To identify the scope for long term enduring demand response services and ascertain customer appetite in relation to deferment of load.	✓
Objective 5: To evaluate which domestic devices offer the greatest potential load reduction / deferment.	✓

1.10.4 Outcomes

As is stated elsewhere in this report, we have undertaken a series of Tier 1 projects where customer engagement has been a central theme. Each project has afforded the industry some powerful insights into the way to manage that relationship and we are currently undertaking some work to bring this together into a best practice guide for the industry.

The costs of DDSR when compared to the alternatives are clearly uncompetitive. Therefore we continue to keep a watching brief on the market to see if developments afford us the opportunity to revisit this area further. We are firmly committed to sharing our thoughts and reflections on our portfolio of projects to move forward the debates that are underway around roles and responsibilities.

Knowledge Dissemination

We presented the background and findings of ECHO at these key events:

Event	Knowledge shared
LCNI 2013	Shared the idea behind the project(it was at initiation stage and had just been registered). Also presented a Community Engagement session where we shared some reflections on CEA and Smart Hooky as well as ECHO.
Balancing Act 2014	General overview of the project and progress to date.
LCNI 2014	Progress update and reflections on customer engagements & customer profiling.
LCNI 2015	Final Conclusions and reflections about the project in line with results of Community Energy Action.

A Closedown Report was initially published and this has since been refreshed to reflect up to date thinking and information. The report can be found via the link in Section 1.

We have tested flexibility services at both generation and demand in our Innovation Projects. Flexibility has and continues to be at the heart of our programme of work and we are committed to sharing with Stakeholders our findings.

Follow On Projects

- Currently no follow on projects are planned in this space but we are keeping a watching brief on developments.

Policy changes

- No policy changes have been implemented as a result of ECHO, but WPD is keen to be involved in the debate about domestic flexibility where we feel projects like ECHO have an important part to play in developing the various roles and responsibilities of industry participants.

1.11 PV Suburbia (CNT1001)

EXCEPTIONAL BENEFITS

- 20% headroom capacity released through findings from this project informing the analysis undertaken within LV Network Templates.
- This project and Early Learning have therefore enabling the uptake of additional PV across our four areas. This is particularly significant given the extensive pipeline of applications that we have in the South West and this can be seen via this report: https://www.westernpower.co.uk/docs/About-us/Our-business/Our-network/Strategic-network-investment/WPD-Regen-DG-Growth-Scenario-Report-RevisionA.aspx

1.11.1 Background and the challenge

The challenge of accommodating extensive micro generation on the network is potentially significant. This project sought to investigate what would happen to the network where significant numbers of PV were installed in discrete locations within a much wider conurbation and to determine the wider impact of two-way power flows on a network that would not have been designed with this in mind.

Clearly this investigation was important for two reasons, firstly Government policy has been supportive of micro generation through Feed In Tariff's and secondly, because of that incentive the potential ramp up in demand for PV in particular had seen a rise across the WPD four areas and as such more information was thought to be of benefit for us and our stakeholders.

The key challenge for DNO's is that if a high penetration of micro generation is installed in a compact suburban environment, the cumulative effect could have a substantial impact on the existing distribution network.

Nottingham is one location where several hundred PV panels had already been installed in dense locations; further dense areas were also wanting to install more PV.

This project sought to comprehensively monitor sections of suburban network identified as having a dense PV penetration. The project aimed to better understand how multiple Solar PV installations impacts all aspects of the LV network operation, improving the future planning assumptions.

1.11.2 Approach taken

This project sought to comprehensively monitor sections of suburban network identified as having a dense PV penetration. The project aimed to better understand how multiple Solar PV installations impacts all aspects of the LV network operation, improving the future planning assumptions. It was designed to follow three distinct phases, each of which delivering their required outputs and objectives before moving to the next phase.

Phase 1 – Project Design. This included the selection of substation monitoring technology, transducers and the trial locations. At the project inception, no suitable, cost effective off the shelf, semi-permanent distribution substation monitoring solution with appropriate transducers was available. A monitor capable of analysing all the network characteristics was sourced from a smart metering company, EDMI. The meter was configurable and designed for Transmission, Distribution and Industrial customers. A range of suitable transducers had to be combined together to provide a safe, easy way of monitoring distribution substations.

The trial locations were selected across the Meadows, Aspley and Broxtowe networks to monitor the feeders with the greatest modelled impact from the embedded generation.

Phase 2 – Installation in distribution substations. The project required installation of the most suitable monitoring equipment, transducers and remote communications in selected substations on either the substation or individual feeders.

Phase 3 – Recovery and Analysis of data. The data generated from the eight substation feeders required analysing to better understand the impact of Solar PV as observed at the distribution substation. The learning from this project has been used in conjunction with the WPD Projects, LV Network Templates and Early Learning, to update WPD's policies concerning the connection of LV connected solar PV generation.

The learning from these projects is complementary to other projects which have been monitoring PV under different circumstances.

- PV impact on suburban networks – Installation of PV on existing homes in large suburban estates with an existing electricity distribution network.
- LV Network Templates – Identifying the distribution network headroom for Low Carbon Technologies (LCTs) across a whole region.
- Early Learning – Installation of PV on a small estate of new properties, clustering of LCTs on every property, installed with a switchable distribution network configuration.

1.11.3 Results

This was an extremely successful project for the industry. A series of key measures were determined at the outset and the project met all of its objectives. Moreover, it has also led to changes to design assumptions within the business and allowed increase connection of PV units by customers. This is a great outcome for customers and DNO's alike and means that customers wishing to connect PV to our network have a heightened chance to making full use of PV into the future.

Measure	Status
Success Criteria 1: Select a range of sensors to be developed and tested by April 2011.	✓
Success Criteria 2: Install the substation monitoring equipment by May 2011.	✓
Success Criteria 3: Determine the frequency of monitoring each characteristic by July 2011.	✓
Success Criteria 4: Analysis 12 months data, highlighting the measured impact of PV on the distribution network by September 2012.	✓
Success Criteria 5: Write a close out report around the key objectives and the lessons learnt by November 2012.	✓
Objective 1: To measure and capture voltage, current, harmonic, real and reactive power data on a range of distribution assets in suburban areas.	✓
Objective 2: Determine how to install equipment safely with minimal or no interruption of supply.	✓
Objective 3: Determine how often the network characteristics need to be monitored (for example 1min, 5min, 15min).	✓
Objective 4: To interrogate the large amounts of data generated to highlight significant network issues created by the installation of PV panels.	✓
Objective 5: Determine the effect of installing large numbers of PV panels on the LV network.	✓

1.11.4 Outcomes

This project in conjunction with the findings of "Early Learning of LV Network Impacts from estate PV cluster" has led to changes to the design assumptions across our network, thereby allowing 20% more PV to be installed as a direct consequence of the findings. This information has been made available to all DNO's to allow them to make adjustments to their design assumptions as appropriate.

This is in addition to the learning we generated around data capture which is a significant result for the industry. The data, which is available upon request, provided the backbone to changes in our design assumptions and also providing some additional insights into the impact of PV on local networks.

Knowledge Dissemination

Learning from this project has been shared with other DNOs at different stages throughout the project and the project was presented at both LCN Fund conferences in 2012 and 2013.

Event	Knowledge shared
LCNI 2011	General update on progress.
LCNI 2012	Shared the project rationale, what was being done and what the early findings were.
LCNI 2013	Combined presentation on our Community projects.
LV Monitoring Knowledge Sharing Event, 11th July 2013	Learning from 7 LCNF projects shared with a particular emphasis on LV Sensors. 80 people attended from a wide range of interested parties (10 companies exhibited their sensors, including all 7 under trial).

A Closedown Report was initially published and this has since been recently refreshed to reflect up to date thinking and information. The report can be found via the link in Section 1.

Follow On Projects

- No follow on projects have been undertaken on this area. PV Suburbia complemented the learning gained on "Early Learning of LV Network impacts".
- Our Losses NIA project is currently using the EDMI meters used in this trial.

Policy changes

- An additional 20% headroom capacity release for PV installations is now available from the assessment of the diversity and the modifications to WPDs planning tools. We explain more about what this means in Section 2.2.
- The project concluded that better kit for LV network monitoring is now available and this is validated through our LV Sensors project.

1.12 Hook Norton (CNT1002)

EXCEPTIONAL BENEFITS

- LV Monitoring- Learning from this project fed into our LV Monitoring assessment project and LV is now policy within WPD.
- Telecoms- Additional insights into the use of UHF and purchase of additional spectrum came out of this project and others. This is now being taken forward as part of some additional investigation into telecoms solutions for the future within Project Nexus.

1.12.1 Background and the challenge

Hook Norton is a vibrant rural community in Oxfordshire with around 2,500 residents and 800 properties. In 2009 the village was awarded £400k from DECC's Low Carbon Communities programme to help its residents 'decarbonise'. Hook Norton, like many rural villages represents a unique challenge when it comes to carbon reduction because success can only be achieved via a high level of engagement with the local community. One of the key challenges faced by communities, like Hook Norton, is lack of visibility of energy usage at a personal and community level. Through the Smart Hooky project this has been achieved through a combination of substation and consumer energy monitoring. It is therefore expected that over time the village will see a reduction in energy consumption and a reduction in its carbon impact.

Hook Horton itself has its supply delivered through a mixture of overhead and ground mounted distribution substations. As one of the key objectives was to trial methods for monitoring low voltage networks and obtain a more detailed view of energy consumption we had to trial new monitoring as well as narrowband Power Line Carrier (PLC) communications to provide the data back to the National Energy Foundation (NEF) for analysis.

This was therefore a substantial challenge to ensure that we could create a network that would work as well as a "hub" for the residents to engage with the project. That being said the positivity within the community for the project enabled us to create enough interest to undertake the trial and achieve some positive outcomes.

1.12.2 Approach taken

The project explored customer engagement and incentive programmes alongside community wide energy monitoring. From a technology perspective, the project deployed a PLC communications network at scale within the low voltage (LV) network, illustrating its potential capabilities for enabling smart grid end point measurement and data aggregation. An in-house designed substation monitoring solution was also developed utilising off-the-shelf components with a trial Ultra High Frequency (UHF) radio backhaul system to gather information on the performance of the LV network. Using this method reduced timescales, allowing more time to be directed at the community aspects of the project.

A domestic energy measurement system was created by AND Technology and deployed throughout the village. The initial development work for this system was funded through the Innovation Funding Incentive (IFI). It featured a Smart Node installed at the customers meter point, which made current readings. Data from the node was transmitted via PLC communications, back to a Smart Hub data concentrator sited with the monitoring solution in the substation.

Smart Nodes were installed across four substation zones at 46 domestic properties. These nodes allowed total household current to be measured via a clip on Current Transformer (CT) attached around a live conductor. Installation was completed by WPD's Smart Metering team, with appointments scheduled with customers through NEF. A dual pole isolator switch was also installed to allow easy isolation. Installations took approximately 30 minutes at internal meter positions and external meter boxes.

The National Energy Foundation was appointed to work alongside the Hook Norton Low Carbon Club (HNLC) to lead on the consumer engagement aspects of the project.

To support the project, Smart Hooky branding was developed in keeping with the feel of the village, along with leaflets and posters to explain the project objectives and support customer recruitment for the installation of smart nodes.

1.12.3 Results

There was some key learning to come out of Smart Hooky that has culminated in changes to our business and in particular around the use of LV Monitoring. This monitoring has two benefits to WPD and customers, firstly the enablement of additional connections through released capacity and secondly the increased visibility of the network will over time lead to efficiency savings within the business. LV Monitoring is therefore becoming a business as usual tool to enable new ways of working. This is clearly a great outcome from innovation.

As with all of our community engagement projects there were a mixture of results that came out of it and Smart Hooky had a fairly large number of key measures which for completeness are shown here:

Measure	Status
Objective 1: To develop and explore customer engagement and incentive programmes. This aspect would include a small scale domestic demand response trial.	✓ ✗
Objective 2: To develop community data measurement and display capabilities and to provide this and other relevant information back to the local community via a web portal/customer interface.	✓
Objective 3: To deploy Power Line Communications (PLC) technology at scale within the low voltage (LV) network, illustrating its potential capabilities for enabling smart grid end point measurement and data aggregation.	✓
Objective 4: To test an ‘off the shelf’ asset monitoring solution for HV/LV pole-mounted and ground-mounted substations.	✓
Objective 5: To test and demonstrate a miniature smart grid telecommunications network (with multiple technologies) that will enable both local and remote network visibility.	✓
Objective 6: To explore the changes that could be made to a network control system for enabling simple forms of Low Voltage (LV) network monitoring and management.	✓
Success Criteria 1: Accelerates the development of a low carbon energy sector.	✓
Success Criteria 2: Has the potential to deliver net benefits to existing and/or future customers.	✓
Success Criteria 3: Has a Direct Impact on the operation of a DNO’s Distribution System.	✓
Success Criteria 4: Generates new knowledge that can be shared with all stakeholders.	✓
Success Criteria 5: Focuses on network Solutions that are at the trialling stage.	✓
Success Criteria 6: Does not lead to unnecessary duplication.	✓

1.12.4 Outcomes

One of the main reasons for selecting Hook Norton for this trial was because the village was already very active in terms of lowering their carbon footprint. This we believed made the engagement messages somewhat easier to communicate and we hoped would mean that participation would be a little easier to achieve.

Due to HNLC's previous engagement with the community, the project benefited from a 'warm' audience to talk to and engage onto with the Smart Hooky project. By the end of September 2011, we had gathered interest from 70 residents across the village as follows (38 of which were members of HNLC). This was an outstanding result given other projects struggles with customer engagement.

There was a considerable amount of effort required to enable the communications network to work and some of these issues were to do with the networks themselves, which has not been uncommon in those projects we have undertaken with a communications requirement. These issues are being researched as part of our Telecoms Template NIA project.

As is stated elsewhere in this report, we have undertaken a series of Tier 1 projects where customer engagement has been a central theme. Each project has afforded the industry, we believe, some powerful insights into the way to manage that relationship and we are currently undertaking some work to bring this together into a best practice guide for the industry.

As with a number of our projects, the findings from Smart Hooky have informed our policies around LV monitoring and we continue to explore more opportunities for the increasing use of this technology.

Knowledge Dissemination

The following events were undertaken as part of our knowledge dissemination activity on this project:

Event	Knowledge shared
March 2013- Residents workshops	This was the kick off workshop with residents.
LCNI 2011	General update on progress.
LCNI 2012	Shared the rationale and thinking behind the project and the tools that were developed. We also shared our thoughts on the process of customer engagement.
LCNI 2013	Summary results and conclusions presented as part of a Community Engagement presentation.
LV Monitoring Knowledge Sharing Event, 11th July 2013	Learning from 6 LCNF projects shared with a particular emphasis on LV Sensors. 80 people attended from a wide range of interested parties (10 companies exhibited their sensors, including all 7 under trial).
Smart Hooky Closedown Event	At closedown an event was held to close down the project with the community and stakeholders to share findings.

A Closedown Report was initially published and this has since been refreshed to reflect up to date thinking and information. The report can be found via the link in Section 1.

Follow On Projects

- No specific projects were highlighted from the findings of Smart Hooky but the results have fed into our work on Community Engagement.

Policy changes

- The learning from Smart Hooky and other projects is now actively informing our policies on LV monitoring.

2. Description and evidence of portfolio compliance with reward criteria

2.1 Aspects of the Carbon Plan that have been facilitated (A1)

Our Tier 1 portfolio has contributed to the Carbon Plan by exploring new and innovative ways to reduce WPD's impact on the environment, through the three pillars of innovation Customers, Assets and Operations, as well as exploring ways that we could help facilitate more innovative means to help the various communities in which we operate reduce their CO_2 emissions. There are a number of issues that networks need to address in order for the Carbon Plan to be met.

The key ones that our portfolio sought to address were as follows:

- Electrification of Transport- the potential for increased costs to reinforce the network.
- Adoption of Low Carbon Technologies & their impact on the network.
- Connecting new generators to the network & at reduced cost wherever possible.

Our portfolio of projects in conjunction with the rest of the projects sought to tackle these issues head on.

The Carbon Plan[2] sets out the UK Governments targets for carbon reductions through a series of "budgets". Throughout this section we have grouped portfolio benefits into the following categories:

- **Enabling the Carbon Plan**- these benefits are proactively helping stakeholders and WPD meet some of the principles of the Carbon Plan.
- **Communities and Customers**- these benefits will mean better service, better cost management and more quality engagement with our customers.
- **Generators** – these benefits will enable Generators to connect to the network more readily .
- **Market**-these benefits we see as a little more strategic and will inform the market by using our knowledge and experience from all our projects.

As a business we detail our own strategy for this within our Environmental reports which can be found on our website here:

https://www.westernpower.co.uk/About-us/Our-Business/Environment.aspx

The Carbon Plan had three key central aims and our projects have aligned to these aims as follows:

Aim	Project
Moving away from Fossil Fuel Generation to alternative means.	PV Suburbia, Early Learning and Low Carbon Hub.
Heating Homes.	Smart Hooky & Early Learning.
Travel- including public transport.	Electric Boulevards, 2nd Life &CABLED.

An example of this is Electric Boulevards which alone has to date contributed a reduction of 110, 044 $kgCO_2e$[3] of CO_2 emissions through the ongoing use of electric buses. This is made up of currently 671,000[4] miles of bus usage not being undertaken via conventional diesel buses. Moreover this project

[2] https://www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions--2
[3] http://www.carbon-calculator.org.uk/
[4] This comes from the project partners regular report. A copy of the report can be provided on request.

has also provided a template for other DNO's to use in respect of a wider rollout of Electric Buses as well as proving that wide-scale reinforcement is not required. The Carbon Plan states that there needs to be "a step change in our move towards ultra-low carbon vehicles, such as electric vehicles" during the fourth Carbon Budget. We believe that our projects provide crucial information to enable this step change sooner rather than later.

More recently we have taken the outputs from this project and used them to inform our own initiatives around the use of Electric (and Hydrogen) vehicles within our own fleet as trials ahead of a more focussed rollout.

In addition the Carbon Plan highlights that "The Government aims to create the right conditions for homes and businesses to generate their own heat using low carbon technologies". A number of our projects have been focussed on providing those conditions for customers to adopt LCT's (e.g. Isles of Scilly, PV Suburbia and Early Learning of LV Network impacts).

Some of our projects have directly focused on customer solutions as can be seen in the table above, others we see as enabler (e.g. SVC Phase 1). The important consideration is though that there is a plan and that the projects link through to enable learning and solutions to be found to addressing the challenges we face.

2.2 Releasing network capacity (A2)

Generally capacity release requires much larger projects and investments. However, we have seen our Early Learning and PV Suburbia projects release capacity for the installation of more LCT's and this has been embedded as policy into the business. This was achieved through the analysis undertaken on LV Network Templates which was able to prove that the rated output of PV is only ever actually 80% of its total even when optimally placed. This has enabled us to release 20% of available headroom capacity for PV installs.

The benefits from our portfolio, are detailed below. We have explored findings from our Tier 1's in other projects(at both Tier 1 or 2) that have the potential to make capacity available, which further adds to the good news from our portfolio. A good example of this being the AFLMS project which is being further tested via FlexDGrid and should the results of these trials be successful then the Fault Level Monitoring devices will enable the release of capacity through better fault management. Moreover Fault Level Monitoring is expected to feature as an aspect of the role of a DSO, the results of AFLMS and FlexDGrid therefore is of particular relevance.

For the other projects within the portfolio, an unexpected benefit was that by increasing our knowledge in key areas we have been able to release capacity now or will be able to do so in the future. There were some projects where they have enabled us to release capacity to customers in the form of allowing more LCTs to connect. The learning from our projects can also help other DNO's around capacity release and in particular with regard to PV.

In addition, the increasing use of LV Monitoring, which in itself is something to have come from innovation projects, will mean that additional capacity will be made available on the network in the future which is another key benefit to customers. The use of LV monitoring will be another technique that all DNO's will adopt increasingly as they will enable better investment decisions to be made through the provision of more information for reinforcement planning, they will also give more localised information about the performance of the network which in turn will further benefit customers. Data will be a key enabler for Smart Grids and LV Monitoring will be crucial to this.

Below we indicate which project has released capacity:

Category	Project	Capacity released
Enabling the Carbon Plan	Network Management on the Isles of Scilly, LV Sensors Evaluation, Early Learning of LV Network impacts, PV Impact on Suburban Networks	Additional 20% headroom capacity released to allow connection of PV on the Isles of Scilly. On Early Learning and PV Suburbia similar levels were also found in percentage terms. This equates to an increase of capacity of between 6 and 8% on the Isles of Scilly. The increasing use of LV Sensors and Monitoring will release capacity as we increase our understanding of the network at a much lower level than has previously been available to us. By investing in these technologies we believe that capacity benefits and service benefits will accrue over time..
Generators & Communities and Customers	Active Fault Level Monitors	Will release capacity & it's follow on project FlexDGrid will enable capacity to be released if it is proven to be successful in more urban environments

Table 2: Projects within Portfolio that have or will release capacity

In addition we have seen these capacity benefits:

- Released capacity through LV Sensors and LV Network Templates- meaning 20% headroom capacity available at LV substations.
- More sophisticated Voltage Control through the SVC Phase 1 project, then Low Carbon Hub and Network Equlibrium means that on the majority of our substations, there has been an increase on more than 12% in their generation capacity by removing voltage constraints.
- Electric Buses – existing capacity utilisation without the need to carry out conventional reinforcement, this will provide a customer benefit of £43.9m.
- PV Suburbia and FALCON- continued exploration of the use of Dynamic Asset Rating which we continue to believe may have some potential benefit in the future.

2.3 Delivering Financial Benefits (A3)

EXCEPTIONAL BENEFITS

- Since 2013 365MW of new connections have been through Alternative Connections, these connections have come to market as a direct result of our Portfolio. This equates to a customer saving of £73m. This is calculated by taking the more commonly used convention that any alternative connection would normally be a high cost scheme costing c.£200k per MW, thereby meaning that customers have saved £73m.

As on other areas, learning is at the programme and portfolio level. A number of our projects have already delivered financial benefits either to customers or to WPD as operational efficiencies or have the potential to in the future.

We detail below the Portfolio level benefits with the projects provided as examples.

Category	Project	Benefit
Communities & Customers	Network Management on the Isles of Scilly & LV Sensors	There are clear benefits to customers coming from the findings of the Isles of Scilly project. Firstly we have a better understanding of the performance of the network and this will in time lead to operational efficiencies. Secondly, having worked closely with the community we have invested in a Local Action Fund and have delivered energy saving measures to the Islanders. As well as cost savings from early standardisation of LV Sensors for the business the project determined also that in the future they will provide better network management information- benefits of this will accrue in the medium to longer term. LV Sensors do form part of business as usual and so we expect customers to benefit around reduced reinforcement costs where appropriate. This project enabled us to have the confidence to bulk buy devices and use them on other innovation projects, FALCON and Community Energy Action.
Enabling the Carbon Plan	Electric Boulevards	When rolled out across the UK, over 6,500 bus chargers will be required and when connected to the existing LV using this project learning (rather than requiring HV reinforcement), could save customers in excess of £43.9m. More information is provided within the customer benefits on this calculation. Expected financial benefits £43.9m.
Generators	Active Fault Level Monitors	Benefits will accrue to DG operators who suffer large reinforcement schemes for connection due to high network fault levels. Better fault level management should rectify this and reduce losses which will positively impact customers in the future once the technology is proven to work, this is being examined within FlexDGrid with results in Q2 2017. Policies are already in place to support this within the business.

Table 3: Projects within Portfolio that have or will have a financial benefit

There were also a series of additional financial benefits that occurred as a result of the projects:

- Lower Connection Charges for customers through AFLMS.
- Innovative Connections- export limited, Timed Connections, Seasonal DG, these have been enabled by the use of various technologies used on our Tier 1 projects and then adopted across GB and we estimate that these have saved customers £73m to date.
- Less Reinforcement- 20% more headroom capacity through our PV Suburbia, Early Learning and then LV Networks Templates projects. More customers are benefiting from being able to connect PV and this is important given the expected uptake, particularly in the South West. More information is provided on this within the PV Suburbia and Early Learning project descriptions.

2.4 Rollout across the DNO's system and across GB (A4)

Part of the principles and foundations of the innovation funding used by DNO's is the ability to roll out solutions and knowledge across the UK. WPD is proud of its work in this area in particular. We have done this across the whole programme and this is something that we are wholly focussed on embedding into the culture of innovation within our business. This has been apparent in the Alternative Connections work we have rolled out and all DNO's are now offering a range of alternative connections.

In order to support a GB wide roll out we are committed to sharing information and learning and have done so through the following measures;

1. We have a DNO Buddy System within Future Networks with a nominated Engineer being responsible for each DNO.
2. Bilateral Meetings with DNO's on genera and specific matters.
3. Meetings with Aggregators, Suppliers and OEM's.
4. All policies when approved are shared via the ENACT portal.

At this level of project it can be challenging though to find answers for some of the more niche challenges that are explored, but there are a number of areas where our good work can be leveraged across the UK, we detail below what we have done and their application to the GB network:

Category	Project & Solution	Application
Enabling the Carbon Plan	Electric Boulevards - template.	This can be used by all DNO's where electric bus routes are planned. This will enable them to model and plan the appropriate changes required to support the bus network. This would not have been developed without Electric Boulevards and provide a unique insight into the impacts of these vehicles.
	PV Impact on Suburban Networks, Early Learning of LV network impacts – templates/ planning assumption changes.	Templates or changes to planning assumptions are available from WPD for other DNO's to use as required. These projects have proved that additional capacity can be made available to allow the connection of PV. As mentioned previously we have been able to release 20% of headroom capacity through the detailed analysis of the performance of solar panels. This was calculated through the outputs from these two projects and the analysis from LV Network Templates which concluded that the output rating of PV panels is never achieved even when optimally placed and under sun. This has enabled us to release an additional 20% of headroom capacity.
Enabling the Carbon Plan	SVC Phase 1- use of STATCOM devices.	Confirmed that these will not work at 11kV but do offer benefits to DNO's at higher voltages and are being increasingly rolled out across WPD where appropriate. We have no reason to assume that the rest of the UK could not also use and benefit from these devices. The learning from this coupled to that from Network Equilibrium is also providing data and insights about voltage control and the release of capacity. Whilst this is difficult to quantify at this stage we expect during the lifecycle of Network Equilibrium to have further updates to share.
Market	Seasonal Generation Deployment	This project, coupled with the learning from Project FALCON, SYNC and ENTIRE, is enabling alternative connections to be made available to customers, with more new options coming in the future.

Table 4: Projects within Portfolio that have had a GB Roll Out impact

We have also undertaken significant knowledge dissemination where the application of what we have found or delivered we believe to be of clear benefit to the industry and this is shown by the following:

Projects	Knowledge Dissemination
Community Energy Action, Smart Hooky, ECHO	All community engagement projects and their learning have recently shared at two REGEN SW events around best practice in these sorts of project. WPD is committed to ensuring that the industry does learn from the lessons learnt.

Table 5: Projects within Portfolio that have other additional benefits

In addition to this we have recently published an article on Domestic Demand Side Response on our Innovation Website:

https://www.westernpowerinnovation.co.uk/News/Demand-Side-Response.aspx

2.5 Other Benefits (A5)

We have had other internal benefits from our projects as follows:

Category	Project	Knowledge
Market	Interconnection of NGC and WPD SCADA.	The ICC Protocol developed and used as part of this project was and continues to be used on the ANM system that we are rolling out across WPD and also has been used as part of the Flexible Power Link within Network Equilibrium. This learning has saved considerable time and effort. Moreover to date ANM has been offered at over 500 locations resulting in up to 365MW (across all four areas and voltage levels) of additional generation capacity being connected of the 1.7GW offered. This clearly shows how the process of innovation can work and work well for stakeholders and in particular customers.
Market and Generators	Seasonal Generation Deployment.	It is our understanding that diesel is still common place for STOR contracts with National Grid, this shows that it can be made to work from a practical perspective, the market in our view needs to resolve the contractual interaction between STOR and a DNO. This we see as part of the DSO/TSO discussions.

Table 6: Projects within Portfolio that have delivered other benefits

There have also been a number of additional benefits:

- We have focused our efforts around advanced network management through our programme of Innovation projects because we believe that system flexibility will be delivered through the Distribution Network.
- Accelerated learning and change - these projects have brought about changes to our business around how we learn and then implement change. This is shown by a number of initiatives that have occurred within the business such as the Capacity Loan Scheme which did not come out of the Innovation regime but was based on some of the learning through our projects.
- Staff Development - these projects have enabled our staff to develop new skills that will be of use in the future.

- Cross Sector Learning - we have learnt new skills and practices from the military and aerospace.
- UK and Global Leadership – the UK is now at the forefront of smart grid innovation.
- Supply chain - these projects have provided considerable learning about purchasing for us.
- Cultural - our staff embrace the need to innovate.
- Customer Service - service to our customers is improved by the benefits innovation can provide. This has been shown by the increasing number of customers who are accepting Alternative Connections and the level of capacity connecting that may not have via traditional offers.
- Stakeholder breadth - our range of engagements is increasing through the introduction of new trials.
- Local Authority relationships - we have increased our presence within authorities and are regularly engaged with them through new relationships.

2.6 Portfolio management (A6)

Projects within the portfolio have to be able to demonstrate the potential to release benefit. Where an idea cannot be proven we have shown that we are prepared to halt projects when it is in the interests of customers to do so.

The features of our Programme Management procedure are:

- T1 portfolio is integrated within a wider Future Networks Portfolio with Tier 2 and WPD projects.
- All learning is consolidated.
- Programme outcomes are just as important as project outputs.
- There is a Project Sponsor for each project.
- There is a specific reporting regime, that is complemented by all the usual control documentation e.g. RAID log and Change Control.
- Board level oversight.

A good example of these features at work have been Seasonal Generation Deployment which was stopped when it became clear that it was not commercially viable, the change control process was shown in SVC Phase 1 and CEA and issue resolution in the WPD/NGC Interconnection of SCADA project.

Our project management and governance processes are, and continue to be, key to delivering value for money and maximising benefits for customers. These mechanisms support the delivery of the Innovation Strategy which is about Assets, Customers and Operations.

Our projects focus on three key pillars and we show below where we have been able to better manage the bigger picture through proactive portfolio management.

Category	Project	Evidence
Communities and Customers	Active Fault Level Monitors	By using this project as a precursor to FlexDGrid we have been able to de-risk the Tier 2 project by proving it works and this meant that mobilisation was quicker, reducing costs to customers.
Generators & Customers	LVNT and Isles of Scilly.	We trialled variants to LV monitoring and these were found to be wanting. We undertook with UKPN a short trial of all technologies available at that time. The best solutions were trialled on other projects

		and now form part of our normal business processes. In doing so this has also meant that we have been able to reduce costs in some instances through the use of these technologies.

Table 7: Projects within Portfolio that demonstrate portfolio management

We provide more detail in Section 5.1 about how strong portfolio management is applied to our projects and that the overarching vision for the portfolio via our Innovation Strategy ensures that we deliver for customers and stakeholders.

3. Description & evidence of portfolio compliance with reward criteria

3.1 Details & significance of DNOs additional contribution (B1)

Below is our additional contribution for our Tier 1 projects:

Project	Investment	Rationale and Benefits
Network Management on the Isles of Scilly	£461k	It was agreed that this investment, which was wholly additional labour costs associated with the delivery, was justified given the wide ranging impacts of a successful project would be worth it to WPD and the Islanders. We believed that the results of the trials would be of benefit to the industry when analysing the wide scale uptake of LCTs. Creation of the test bed that is now part of the Smart Energy Islands, ERDF project. We have successfully shown that it is possible to work with a community who has an aspiration around energy self-sufficiency. We have also gained valuable insight into the network itself. In addition to this, the specific technologies that were trialled and our findings could well be of further use within the business where there is some commonality with other parts of our network or where consumers are interested in energy self-sufficiency. We have also been able to release capacity headroom. Without our investments we do not believe it would have been possible to see the positive results that we did and the benefits are clear to customers and WPD.

Table 8: Projects within Portfolio that had additional investment

The rest of our projects within the portfolio were all delivered on or under budget and this we believe is a testament to the rigour with which we deliver our projects. If a project needs additional investment we have shown with the Isles of Scilly that we are prepared to invest if there is a business justification for doing so.

3.2 Issues that justified the additional contribution (B2)

We have provided a significant amount of information about the level of investments made by WPD in B1 above. We believe that the rationale of the investment to be sound because the benefit we believed to outweigh the investment.

It quickly became apparent that some of the work on the Islands was going to require more investment than originally anticipated. This investment was largely due to the location and the amount of effort that would be required to achieve what we wanted and had committed to deliver. A change request was raised by the Project Manager which clearly outlined the risks and the benefits of investing an additional £461,000 in the project. The request was reviewed by the Project Sponsor and approved with additional controls applied to ensure that the investment was monitored and scrutinised. In approving any change request the Project Sponsor is charged with ensuring that the Project Manager puts in place the relevant controls within the business to meet the changed scope of work as appropriate.

In investing in the Isles of Scilly, it is our view that in this case the benefit of being able to help the Islanders in their aspiration to be energy self-sufficient, could well have a positive impact on WPD through greater visibility of the network and by allowing more network capacity to be made available for the

connection of LCT's . It has also taught us about what is needed when engaging with communities with similar ambitions and this is informing our best practice approach to community engagements.

We are the top performing DNO consistently and we want to stay there. Investing in the Isles of Scilly was the right decision.

3.3 Demonstrable benefits to customers (B3)

A number of our projects not only gave benefits to customers during the lifecycle of the project but continue to do so today. This is clearly a demonstration of the projects and the aims and objectives of them being aligned to what we set out to achieve and our commitment to the innovation regime and the main aims of the Carbon Plan, namely new forms of generation, heating homes and travel. In addition by enabling cheaper and faster connections of LCTs and more customer choice we believe we are moving GB in the right direction.

It is our view that our projects, coupled with our innovation strategy, mean that customers are benefitting now and we are building further benefits through investing in ideas and transitioning them into business as usual. This is clearly demonstrated by some of the great things that have come out of our portfolio. Allowing customers to connect more LCTs can only be of benefit to the wider achievement of the Carbon Plan. Making better investment decisions through the use of LV Sensors will mean that costs to customers are managed more proactively into the future.

These developments are more and more embedded into our business and as such we consider them to be increasing business as usual as this to us is part and parcel of the evolution that innovation is seeking to bring about.

The following table details the various projects and their enduring benefits to customers:

Category	Project	Benefits to customers
Communities and Customers	Network Management on the Isles of Scilly, Community Energy Action, LV Sensors.	Customers are able to connect more LCT's with an additional 24MW of available capacity for PV found from the trials. Customers have benefited from a Local Action Fund scheme on the back of the project. We have undertaken 65 home visits and have achieved savings of £53,000 for customers. This is a fantastic result. In the same way that ECHO provided insight into customer behaviour so did CEA. Both projects have shown that the developing technology is there to support these types of service but the issue currently remains the commercial viability. All of this information is immensely powerful in aiding the industry to make good business investment decisions. Customers are benefiting through our use of LV Monitoring on areas of constraint ahead of any reinforcement, the monitoring helps us to determine the most appropriate course of action to remedy the constraint.
Market	ECHO	ECHO provided significant insight into the price point at which customers would be willing to engage in this type of service. Whilst this is not commercially viable at present it is invaluable to the furthering of the debate on how we envisage the whole energy system working in the future. In due course customers will see the benefits of these insights through better investment decision

		making and possibly a DDSR service once the market becomes more viable. We see this as being validated by EA Technology's report where they concluded that "certain economic or external barriers exist and therefore this potential cannot be realised immediately" when considering certain technologies and the potential to deliver benefits.
Enabling the Carbon Plan	Electric Boulevards, PV Impact on Suburban Networks / Early Learning of LV Network impacts.	Benefits to customers are clear. A continued reduction in local CO_2 and a much richer understanding of the impact of Electric Buses is now likely to mean that large reinforcement programmes are now no longer required. Our calculations were that at the low end across 6500 IPT installations nationally reduced reinforcement costs of £6767 per installation would be required to the LV instead of the HV. This equates to a national saving of £43.9m. This with our Early Learning & PV Suburbia projects means that more customers are now able to connect PV to our network across our 4 licensed areas. Our best estimate is that 60kVA per transformer of capacity has been released. The 20% headroom capacity release is validated within the report from our Tier 2 LV Network Templates report which can be found here:https://www.westernpowerinnovation.co.uk/Document-library/2013/StressReport-final-submitted-v1-May-13.aspx
Generators	Active Fault Level Monitors.	Customers will be able to benefit from less fault issues and more connected DG in the future once FlexDGrid is completed. This is further validated within the EA Technology report where "the greatest benefits are observed in improving network performance"- whilst AFLMS was not designed to improve performance within its lifecycle- the results of FlexDGrid we believe will improve performance for customers.

Table 9: Projects within Portfolio that have demonstrable benefits to customers

It is our view that our projects, coupled with our innovation strategy, mean that customers are benefitting now and we are building further benefits through investing in ideas and transitioning them into business as usual. This is clearly demonstrated by some of the great things that have come out of our portfolio.

Customers are benefiting from new offerings to connect and use the network, we have greater intelligence to increase utilisation and capacity and the use of flexibility services to smooth profiles though EV's, Heat and DG all are meaningful outputs from our programme and all align to the three pillars of Customers, Operations and Assets.

Allowing customers to connect more LCTs can only be of benefit to the wider achievement of the Carbon Plan. Making better investment decisions through the use of LV Sensors will mean that costs to customers are managed more proactively into the future.

These developments are more and more embedded into our business and as such we consider them to be increasing business as usual as this to us is part and parcel of the evolution that innovation is seeking to bring about.

4. Description & evidence of portfolio compliance with reward criteria

4.1 Demonstrate where the portfolio has delivered more learning than was expected (C1)

The Tier One Portfolio which is a part of our Future Networks programme of work, includes projects from a variety of funding arrangements. All are driven by the Innovation Strategy.

All of our projects have delivered more learning that we originally anticipated but we have detailed below the significant ones. Each project starts with a series of expected learning points. In most cases we have delivered all of the expected learning In some cases the project could not be proven, but this does not mean that the learning was less valuable. Learning does not always lead to a positive outcome and discovering what does not work is just as useful. We have seen this on projects such as Seasonal Generation Deployment and ECHO where the costs of the alternatives could not be made to work when compared to conventional reinforcement. Whilst this could be perceived as disappointing it does allow us to help shape industry thinking around these particular issues.

Our Knowledge Capture and Dissemination process has a series of categories into which all learning falls into. These are then used when recording expected and new learning throughout the lifecycle of each particular project. This aids the analysis of what we need to do with that learning for the future.

WPD has learnt a considerable amount about not only network operation and the applicability of the various techniques under trial but also the process of learning itself. By its very nature the sector is used to "doing what it has always done" but through our own portfolio of projects we have proven that WPD is not only supporting the need to be innovative, but is embracing it into our business- we continue to try and find creative ways of meeting the challenges faced within the industry and this is proven throughout this application.

In writing this report and in particular this section we have also referenced and compared our reflections with Ofgem's EA Technology report on LCNF projects in order to maintain balance and validate our thinking.[5]

Most important of all the foundation of our First Tier portfolio was to deliver the vision contained within the Innovation Strategy and our supporting processes and procedures ensure that we remain true to that vision.

Below we detail some of the additional learning that we have come across over and above that which we expected.

Category	Project	Learning	Value to Stakeholders
Enabling the Carbon Plan	Network Management on the Isles of Scilly.	Increased understanding of the available capacity headroom, this was learning far in excess of what we envisaged at the outset and is benefitting the residents of the IoS and WPD. Through our active engagement we highlighted to our Social Obligations	Allows the additional connection of LCTs to the network. Providing helpful tips and advice to

[5] https://www.ofgem.gov.uk/publications-and-updates/ea-technology-s-summary-low-carbon-network-fund-learning

		team the findings of the project and this led to a Local Action scheme being launched.	the residents on energy usage meant that we were able to help 65 homes and save £53,000 for them.
	Electric Boulevards	The purpose of the project was to understand more about the effects of electric buses on the network, we did not expect to be able to provide the industry with a template for connecting the IPT devices to the network and all of the related information to allow connection.	In order to be able to meet the Carbon Plan we have to decarbonise transport and this is a key contributor to meeting the targets within the plan. WPD has not only helped reduce CO_2 emissions within MK but also this has enabled an ongoing reduction.
	PV Impact on Suburban Networks / Early Learning of LV Network impacts.	Increased understanding of the available capacity headroom, the project sought to understand the impact on the network but we obtained so much information that we were able to change internal design assumptions.	Allows the additional connection of LCTs to the network
Communities and Customers	Community Energy Action	Significant amounts of learning obtained about engaging with communities about energy. The amount of learning was far in excess of what we envisaged. Whilst the outputs were inconclusive there were some tremendous insights around engagement, the use of free washing equipment to support outdoor drying and the Slo Cooker initiative were all powerful learning and we do believe provide the industry with insights that we did not have before.	The level of detail we were able to provide about what works and what does not is driving our work with the industry to agree some best practice. We have undertaken a number of community engagements, have a fantastic track record in this area and we are keen to share this experience to the benefit of the industry as a whole. By being proactive in this area we think that this only helps socialising the key themes and messages around energy usage.

Market	Smart Hooky	Increased our understanding of the requirements of and demands on a robust telecommunications/data network. We did not intend to learn more about this aspect but through the natural process of trial and error and then subsequent learning on other projects, WPD is absolutely clear about the need to delve into this part of the equation. DNO's will need a series of technologies to support a range of data requirements into the future.	DNO's need a "shopping list" of strategic options around data networks and this project coupled with the learning from FALCON highlighted the need to get to the bottom of this issue. We are currently progressing this with a small NIA and some business as usual initiatives with the aim of providing some answers to the industry during 2017.
	Interconnection of NGC/WPD SCADA	During this project we were able to learn more about ICC protocols and this has been reused on Network Equilibrium on the SVO workstream.	These protocols are potentially significant in terms of secure data exchange. We continue to monitor this development in light of the discussions around DSO/TSO.
	Season Generation Deployment	We learnt what was needed, price points and alternative communications methods.	This has been invaluable in furthering our thinking on Flexibility Services.

Table 10: Projects within Portfolio that delivered more learning than expected

An example of the learning process within WPD is where learning from initial innovation projects (Isles of Scilly and LV Network Templates) has then been formally tested in LV Sensors Evaluation and then the results further trialled at scale in projects like Project FALCON and now forms part of policy. This is a demonstration of how seriously we take the innovation process, learning and moreover how it can be used to maximum effect.

This is not the only example of this process at work and it can also be seen on the Smart Hooky project where we learnt a considerable amount about potential telecommunications requirements for the future and we successfully trialled the use of Power Line Carrier communications between two nodes(with a 70-75% success rate on average). The use of innovative telecommunications was further investigated within FALCON (WiMAX) and now is the subject of the NEXUS project. It is imperative that there is a method applied to taking new innovations through from concept into business as usual and we are committed to doing this by having a proactive portfolio management process in place that delivers results for customers and WPD.

Furthermore the linking between projects can also be seen with LV Networks and the results of PV Suburbia and the Early Learning projects where the results from the two latter projects were analysed within the former.

4.2 Additional Learning as a result of exceptional effort of the DNO (C2)

Additional learning over that expected is detailed per project above. The following elements of learning were delivered as a direct consequence of the additional investments and exceptional effort that WPD put into the projects to ensure delivery.

Project	Learning
Network Management on the Isles of Scilly	Because of the additional investments that we made in this project we have been able to provide the following benefits to the Islanders: 1. Additional monitoring is providing a better service to customers, this can then be reused across the business. 2. Allowing them to connect more LCTs and applying the learning from our community engagements and using this within our stakeholder engagement work. 3. Action Fund scheme has been run on the islands to help customers use their energy more intelligently. 4. Platform developed for future research and development. In addition to this we have also made significant commitments to the Off Islands , regularly going to see them even via boat when necessary. We met also with the Duchy of Cornwall representatives to ensure that any concerns were addressed.
SVC Phase 1	We employed an interpreter to undertake a call with a supplier in Japan in order to go through some of the more technical requirements. This ensured that we were able to complete the design part of the project to time.
Electric Boulevards	We have been instrumental in determining the standards for signage for Council's in respect of Electric Buses.
Early Learning	Customer Engagement experience has been invaluable and in particular we have some key learning around LV pillars that we have shared.
Seasonal Generation Deployment	Learning around theft and Smart Grid security which has then been reused in follow on projects.
AFLMS	Testing took place by WPD in Chicago over a weekend and this then enabled the project to proceed to the next phase.
Community Energy Action	We learnt a considerable amount on community engagements as mentioned previously in this application, WPD even undertook some cooking as part of an event. We see ourselves as part of the communities that we service and we have continued to share best practice in this regard.

All of this work has been delivered by a small team of less than 10 people working collaboratively within the business to get the best possible learning and outcomes for the benefit of customers and stakeholders and it is our belief that the results have been exceptional.

4.3 Exceptional capture & dissemination of learning in a way that maximises value for all customers (C3)

WPD has itself been through a learning curve in respect to learning and we want to ensure that we undertake learning in a way that it efficient, thorough and moreover ensures that all learning is recorded regardless of how small it might seem at the time. To that end we have a defined process that logs all learning and maps that learning dissemination to the most appropriate event to ensure value for money. Where appropriate we have tried to ensure that dissemination occurs at industry events to reduce costs to customers because our target audience is more likely to be at the same events as us. For example, we have presented significant learning at the annual LCNI Conference for example. We have though held a Smart Hooky event at the local brewery of an evening to maximise attendance.

Moreover when appropriate we do maximise the opportunity by disseminating related learning together in one event, for example in July 2013 we shared learning on five Tier 1 projects and two Tier 2 proiects at a dissemination event. This was widely attended and even had an exhibition of the technologies used so that stakeholders could gain maximum benefit from attendance. This ensured value for money by making sure that the learning was all linked to a common theme as well as not burdening the industry with multiple events.

We have also held the following discussions to further add to the shared learning :

- DECC/BEIS- briefing on related topics,
- EU in Brussels,
- Water Industry event where we presented on Innovation,
- MP Engagements- we regularly involve MP's in our stakeholder discussions,
- Annual Balancing Act event on learning,
- CIRED,
- Power balance game,
- IET Power System course,
- TV and Radio interviews, the team is media trained to ensure that we can respond quickly and appropriately,
- Podcasts and a Youtube channel.

We have also utilised telephone conferencing and web conferences to reduce the burden on interested parties and stakeholders who want to engage with us.

We are constantly reviewing how best to maximise value for money wherever we can and continue to explore creative ways of providing updates to the various parties with which we engage. We have recently done an update to all Tier 1 project closedown reports to reflect up to date thinking and provide any additional insights. A notification of this will be emailed out to parties but we do not expect to provide an additional forum to discuss our updates and will instead use conventional methods for providing updates to these projects.

It is also important as a business that we reflect on the wider impacts of innovation and more recently we have launched Capacity Loan Arrangements which allow customers to connect now ahead of other users who may be ahead of them in the queue. This was an innovative idea produced by our business on the back of some of our experiences in innovation projects and the ideas cascaded to our customers. This is clearly a positive demonstration of a mind-set and cultural adjustment within the business and we want

our people to feel that they can put forward creative ideas like this. This can also be seen in WPD's approach to Stakeholder Engagement and we see clear links between the two.

Throughout our projects we have applied a sense of doing the right thing when capturing information and knowledge. Through our extensive experience of learning on our projects we have a template that is used for knowledge capture that is applied across all projects this template ensures that each project manager and the team are consistent in documenting their knowledge across the lifecycle of the project.