Low Carbon Network Fund

First Tier Portfolio Reward Report

prepared by the Expert Panel

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1 Introduction

1.1 This report sets out the conclusions and recommendations of the Expert Panel that was established to assess the Low Carbon Network Fund's First Tier Portfolio Reward submissions.

The Panel comprised:

- Dr Robin Bidwell (Chair)
- Sharon Darcy
- Professor Nicholas Jenkins

The Panel was assisted by Leigh Fisher, Consultants appointed by Ofgem.

The Panel received the Submissions in April 2017 and met to consider these Submissions and the report prepared by Leigh Fisher at the beginning of May 2017. Questions were raised with the DNOs by Leigh Fisher, Ofgem and the Panel. The DNOs presented their portfolios to the Panel on 8 and 9 May 2017 and the Panel requested that all information should be available within five further working days. The report was prepared following further Panel assessment and discussion and further work by the Consultants.

1.2 Tier 1 Reward Governance

The rules governing the format of the submissions and the approach to be used in assessing these submissions is set out in LCNF Governance Document V.7 and the Guidance Note on the First Tier Portfolio Reward (05-10/2016).

The Governance Document sets out the overall framework and objectives of the Reward. The Low Carbon Network Fund itself was intended to enable the DNOs to explore and implement innovative and cost effective methods of

facilitating the networks' low carbon transition. The Governance Document states '… (the) objective in designing the LCN Fund was to replicate the incentives on unregulated companies to innovate … (the Fund seeks) to use the discretionary award to imitate the commercial benefits of innovation by rewarding DNOs for successful innovation ….'

Section 2 of the Governance Document sets out the assessment process that the Panel has followed. It requires the Panel to evaluate the reports against a list of Discretionary Reward Criteria. The Document makes clear the DNOs are required to demonstrate 'exceptional performance against the criteria in relation to actual or planned use of the solutions developed during the Tier 1 funding'.

The 2016 Guidance Note requires the DNOs to demonstrate exceptional performance of the portfolio against one or both of the following criteria:

(i) Accelerating the development of a Low Carbon energy sector and have delivered net financial benefits to future and/or existing customers, and/or
(ii) Sharing knowledge amongst all DNOs.

In addition, there are criteria relating to the amount of the DNOs' money (over and above any compulsory funding) that enabled the portfolio projects to be successfully delivered; and a criterion on exceptional effort to ensure the portfolio delivered exceptional learning.

The Panel is also required to determine the quantum of the reward. The Guidance Note states that the total amount of money available for the First-Tier Portfolio Reward is £15 million. There are six DNOs and it was therefore proposed that the maximum reward that might be gained by any one individual DNO should not exceed £2.5m.

1.3 The Approach adopted by the Panel

In determining whether or not a reward could be considered exceptional and, if so, the quantum of the reward, the Panel with assistance from the Consultants evaluated the submissions against each of the criteria. Based on this evaluation they drew conclusions as to the significance of the Portfolios taking particular account of the following:

- Whether the projects in the portfolio had significantly accelerated the development of the low carbon energy sector and/or significantly increased the capacity of the network.
- Whether the portfolio had the potential to deliver significant financial benefits to customers.
- Whether the DNO had made a significant effort to widely disseminate the results of the work to other DNOs/other parts of the industry and to help them understand the project outcomes.

The Panel in drawing their conclusions also were aware of the following:

- The initial LCNF work was planned and undertaken from 2010. There have been considerable advances subsequently but it was important to assess the contribution in the context of the period when the trials were conceived and executed.
- There is necessarily a strong overlap between the problems that the individual DNOs have chosen to address: in particular, how to increase the capacity of the network to allow more Low Carbon Technologies (LCTs) to connect at lower cost. The DNOs have built on each other's learning to an extent where it is not always possible to determine the role that an individual DNO played in some of the advances that have been made. The Panel has not attempted to trace whose learning has had the greatest influence but have judged each portfolio on its own merits.

- There are real difficulties in quantifying the likely capacity, carbon and financial benefits with any degree of robustness and indeed the role that particular interventions might play given further and competing interventions – particularly where these are based on assumptions around the speed and nature of the roll out of LCTs and the potential constraints on each network where they will need to connect. Different approaches involving differing levels of optimism have resulted in widely differing benefits claimed for similar interventions. The Panel has found the calculations helpful in so far as they provide guidance on the importance of particular types of development but have not relied on the figures themselves when coming to a conclusion.

1.4 Terminology

The DNOs' submissions contain a number of terms referring to types of connections and the commercial agreements that cover them. Some of these terms (ANM) are generic, some are more widely used (Flexible Connections and to a lesser extent Alternative Connections) and some are DNO specific (CMZ). This report uses the following terminology.

- ANM (Active Network Management) is control by a DNO of a network with complex constraints through continuous monitoring to allow allocation of capacity on the network, making the maximum free capacity available to customers. ANM may refer to management of the network but also to the technical management of the output of generators.
- Flexible Connections and Alternative Connections are bi-lateral agreements between the DNO and a distributed generator or load that allows connection of the generator or load at reduced cost of network reinforcement (or enabling quicker connection) but with

certain conditions imposed on the operation of the generator/load. A simple example might be to allow higher generation in the winter when local loads are greater. Another example might be to allow a higher power rating of the generation or load depending on the number of (often redundant) circuits supplying the area of network at the time. A Flexible Connection Agreement often relies on Active Network Management for its technical operation.

- A Constraint Managed Zone (CMZ) is created when a section of the distribution network does not or will not comply with Network Standards of voltage or security. In order to avoid costly reinforcement of primary plant, a contract is made between the DNO and CMZ operator for the provision of services to bring the network back into compliance with the Standards. A simple example might be a battery to reduce the peak load of a network that is leading to a requirement for an additional redundant transformer to be installed to feed the network.

2 UK POWER NETWORKS (UKPN)

Tier 1 Funding	£2,392,000
Licensee compulsory contribution	£266,000

Project Name	Project Summary
Demonstrating the Benefits of Short-term Discharge Energy Storage on an 11kV Distribution Network	UK Power Networks installed a 200kWh Li-Ion battery at an electricity substation site in Hemsby, near Great Yarmouth. The purpose was to demonstrate that an intelligent energy storage system (ESS) can support the existing distribution network and allow more renewable generation to connect by smoothing their intermittent output, reducing voltage fluctuations and shifting load.
Validation of Photovoltaic (PV) Connection Assessment Tool	The project monitored networks with solar PV clusters, site data was collected and analysed to establish a draft connections assessment policy. In addition a connections assessment tool for solar PV was created and made available internally, as well as to other DNOs.
Distribution Network Visibility	The project aimed to demonstrate the benefits that come from the smart collection, utilisation and visualisation of distribution network data. It has successfully shown that visualisation of network data combined with other data sources can help tackle current and future challenges, such as facilitating new load and generation (including low carbon), increasing asset life and maintaining a secure and reliable supply.
LV current sensor technology evaluation	This was a collaborative project between UK Power Networks and Western Power Distribution to compare off-the shelf LV monitoring technologies that can be retrofitted to existing distribution substation equipment. Comparisons were conducted in both laboratory and operational field environments.

Source: Based on Table 1 of the UKPN submission

2.1 In the submission, the projects were presented as assisting with the integration of renewables onto the network (the Hemsby Storage and PV Connection Assessment Tool); the other two projects were concerned with providing visibility of conditions on the Low Voltage network, allowing rapid assessment

of available capacity and identifying where LCTs can be connected without first having to reinforce the network or operate without constraints.

2.2 Contribution to Carbon Plan/Network Capacity

UKPN undertook early trials on the application and control of battery storage on the 11kV distribution network. The stated goal was to demonstrate that an intelligent storage system could support the existing distribution network. UKPN told the Panel that this work provided important learning for subsequent battery storage projects (including the Smarter Network Solution project); they also noted that in the eight years since these original trials, grid-side storage has demonstrated, through Enhanced Frequency Response (EFR), that it has the potential to play a major role in the operation of the power system with 200 MW contracted for EFR (2017). Storage can also provide an additional solution for allowing more LCTs onto the system.

UKPN also undertook early work on monitoring at LV substations and followed this up with the development of a network visualisation tool (Distribution Network Visibility). They informed us that by combining measurements from LV busbars with data from other sources and by presenting this partly as a visual tool, they had provided a very valuable and time-saving aid to planners and operators and, amongst other outcomes, this had facilitated the integration of LCTs and other loads. They noted that this tool (or at least the underlying methodology) had been provided to more than one other DNO. The Panel accepted that while combining the LV monitoring data with other data had created a valuable decision aid; it was less clear that this had brought about a step change in network planning or operation.

Two other projects were submitted. A study of the impact of solar PV on the network where, by gaining greater knowledge of the actual loads imposed,

they were able to change their connections procedure and allow more solar onto the network. UKPN told the Panel that this had changed their approach to connections and that it had strongly influenced both the industry and wider government strategy.

The fourth project was undertaken jointly with WPD, reviewing all the commercially available Low Voltage monitoring solutions. It was stated that this joint project provided a large number of spin off benefits, including a better understanding of how to use these technologies in practice, joint work with the manufacturers to improve the solutions and it was stated the work also underpinned a number of LCNF projects and other projects undertaken by the industry.

2.3 Financial Benefits

There were particular difficulties in assessing the financial benefits arising from this portfolio. The Distribution Network Visibility tool, the PV Connection tool and the evaluation of available LV sensor technology were all projects that facilitate efficient management of the network – and in the case of the PV tool, this created a greater understanding of PV's impact on the network and through that allowed more connections than might otherwise have been made. The primary financial benefit arose from avoided network strengthening costs, should it have proved necessary for the DNO to pay for network strengthening arising from PV. Understanding how battery storage could be managed on the network has proved important and, as the DNOs with battery projects involved in the First Tier Portfolio Reward noted, this early work has been further developed such that storage is expected to play a role in balancing the network.

2.4 Dissemination

The Panel were told that UKPN played a major role in establishing the Energy Storage Operators' Forum (ESOF) in May 2012, to facilitate the sharing of their experiences from the Hemsby Battery Storage project. UKPN believe that they played an important role by sharing this early knowledge. They stated that Hemsby was the first battery of its kind to deliver grid-scale storage in the UK and that they were the first DNO to test integration requirements and to assess multiple revenue streams through stacking of use cases. UKPN considered that their sharing this knowledge through an ESOF White Paper and Good Practice guide helped to de-risk storage for other DNOs. They noted they also carried out dissemination work with Newcastle University and that the work had directly helped other DNOs and informed Ofgem and BEIS smart energy work.

UKPN produced a 'how to' guide for planners based on the Data Network Visibility project and this fed into an IT White Paper that was shared with the ENA and other DNOs. With the LV sensor equipment project, the collaboration and dissemination with the manufacturers was considered to be one of the most important parts of the work; a knowledge-sharing event was held with around 80 people.

Finally, as already noted, the implications for the network of solar PV installations was widely shared and, the Panel were told, had a direct impact on practice by the industry.

2.5 Other Benefits

The LV current sensor evaluation project provided valuable learning on the capability of these devices and the safety of installing and using them; as such, their role as enabling technology for other LV projects was important.

The Hemsby work provided other spin-off benefits: learning on the control of voltage issues arising from variable renewable generation through using the STATCOM function of the battery; and knowledge about the installation footprint for battery storage and its ancillary equipment suggested that the battery itself was always likely to be a small part of the required footprint area – suggesting that higher battery capacities would not necessarily increase the space required significantly.

2.6 Panel conclusions on the Portfolio

Compared with the other DNOs, the Panel noted that this was a relatively limited portfolio with four projects addressing (primarily) the integration of renewables and network visibility. Compared with other submissions the Panel considered that this was a less coherent portfolio: there was less evidence of the projects building on each other to create learning designed to address a particular issue.

The Panel recognized the importance of the early work on storage and the learning that supported future battery projects; and the potential for the carbon savings arising from the Hemsby Project and the PV connection tool. They also recognized the potential carbon benefit from the increased understanding of the network arising from the visualization tool and from the work on LV sensor solutions.

UKPN claimed relatively modest financial benefits – focusing mainly on the OPEX savings arising through greater efficiencies, although they did note the considerable financial savings that had been estimated from future use of storage on the system.

It was noted that additional funds have been used to complete some of the work (in particular the Hemsby Storage project).

The Panel addressed the issue of whether this portfolio of work could be described as exceptional using the criteria set out in the Guidance Note. They concluded as follows:

- The early work on the Hemsby Storage scheme provided a strong basis for learning for subsequent storage projects and the results were well disseminated.
- The other three projects all provided useful learning that assisted the integration of LCTs and informed later LCNF and related work.
- The Panel considered the dissemination and engagement of stakeholders to have been well constructed and delivered.

Based on the information contained in the submission, subsequent discussions and answers to questions, as well as work undertaken by the consultants, the Panel concluded that while taken overall the portfolio had provided valuable learning to the industry, it did not consider it had demonstrated exceptional performance against the agreed criteria.

3 ELECTRICITY NORTH WEST (ENW)

Tier 1 Funding	£3,836,015
Licensee compulsory contribution	£426,225

Project Name	Project Summary
The 'Bidoyng' Smart Fuse	This project deployed Smart Fuses (previously developed under the IFI Fuse Restorer project) to mitigate the impact of LV transient faults on customers by reducing restoration times to less than three minutes.
Fault Current Active Management (FCAM)	This project investigated innovative techniques to manage the breaking capacity and through fault withstand capability of existing protection assets, as an alternative to traditional operating methods. It included an independent risk assessment of the use of existing and new assets for fault current management.
Voltage Management (on Low Voltage Busbars)	This project explored the potential to use alternative technical solutions for controlling voltage on LV networks, to help manage increased load and generation by installing: power quality filters, Power Perfectors, distribution transformers with on-load tap changers (OLTCs) and LV capacitors. The University of Manchester used the findings to identify and assess the benefits of deploying the various technologies on the network.
Low Voltage Integrated Automation (LoVIA)	This project developed and trialled an integrated solution and novel application of automated voltage control on LV networks by combining existing and new equipment including: LV monitoring at the mid and end-points of feeders, distribution transformers with OLTCs and substation controllers. The control solution delivered regulation of network voltages based on local and remote real time measurements.
LV Protection and Communications (LVPaC)	This project developed and tested enhanced protection and communication functionality to be applied to the Kelvatek load management devices, WEEZAP and LYNX. This enhanced functionality will allow greater control on the LV network, facilitate the low cost adoption of LCTs and further permit a more appropriate response for a range of faults as network loads change.
Low Voltage Network Solutions (LVNS)	This project installed monitoring equipment on the LV network; the data from this was analysed and combined with network modelling by the University of Manchester to provide a better understanding of the available capacity on LV networks to accommodate LCTs. Project findings have helped to: develop policies on what and when to monitor on LV networks; improve processes for LV monitoring and data collection; better understand how LV monitoring and network models can support other innovation trials; and assess future implications for LV planning, operations and connections policy.

Source: Based on Table 1 of the ENW Submission

3.1 The Portfolio

Out of the six projects in the Electricity North West (ENW) portfolio, five focused on the Low Voltage (LV) system. The sixth addressed the issue of Fault Current Management on HV networks. In their presentation, ENW noted that the five LV projects all addressed the issue of capacity on the network and cost reduction through improvements in efficiency.

3.2 Contribution to Carbon Plan/Network Capacity

Four out of six of the projects (85% of the portfolio by value) directly support the carbon plan – primarily through increasing network capacity by controlling the voltage on the LV network. In addition, the increased understanding of the network (through monitoring and modelling) led to faster connection of Low Carbon Technology (connect and manage) without requiring detailed study. The work - in particular the LVNS project - enabled ENW to be confident that there was sufficient excess LV network capacity to allow connection of a certain number of PV systems (20 on an 11/0.4 kV substation). Only if more generators (ie the total capacity of PV exceeding 20 typical domestic generators) wish to connect, does the policy move onto monitoring the specific feeder/substation and finally to voltage control interventions.

The projects that addressed the LV network and increase in its capacity included: Voltage Management on LV Busbars, Low Voltage Integrated Automation, LV Protection and Communication – and work on monitoring and modelling in LV Network Solutions. These projects addressed a wide range of LV issues (including improved communications from standalone monitors and measurement devices associated with other equipment).

The 'Bidoyng' Smart Fuse allowed the impact of LV transient faults to be significantly reduced, with power being restored in less than three minutes. Telemetry provides the real-time status of the installed unit, allowing ENW to manage the LV network faults in a more effective manner. In their submission, they suggest that apart from a reduction in operating carbon, the monitoring element of the project has given DNOs added confidence when connecting PV.

Overall, ENW estimates that their 'connect and manage' practice arising from the work has released 26MW of capacity in the ENW network and their voltage management work has resulted in an 88% increase in capacity of LV networks.

3.3 Financial Benefits

The principal financial savings from this portfolio arise from the increased LV network capacity and reliability and the reduced need for LV network strengthening. In the submission, ENW presented a range of assumptions underpinning potential financial savings. They suggest that the benefits from voltage management using the learning from Voltage Management, Low Voltage Integrated Automation (LoVIA) and LV Protection and Communications (LVPaC) amounts to around £60k per substation intervention (estimating the overall benefit at around £2 million). The Smart Fuse is estimated as saving around £1.8 million in 2016. In the submission, ENW also notes that the Smart Fuse project underpinned the development of a fault support centre that is estimated to save in excess of £2 million a year.

3.4 Dissemination

The Panel considered that ENW had made a significant effort to disseminate the results of the portfolio projects. In the case of the Low Voltage Network Solutions work, dissemination included: an ENA LCT group 'Connect and Manage' policy workshop; information provided through four journal papers and 18 conference papers; and data available on the data share website used by the Universities of Manchester, Loughborough, Newcastle and Dublin. There was information-sharing with other DNOs.

The Smart Fuse (Bidoyng) project was a close collaboration with Kelvatek. Information was shared through the ENA R&D Managers' group; ENW took part in Kelvatek's video. The Fuse has now been deployed widely across the DNOs (there are apparently nearly 10,000 Bidoyngs currently in operation).

The Panel noted that ENW's work led to serious engagement with their supply chain and two new products (Bidoyng Smart Fuse and those from LVPaC) were delivered as business-as-usual directly resulting from these Tier 1 projects. Both products have enhanced the DNOs' ability to identify and restore faults more rapidly and effectively and have been rolled out by other DNOs.

3.5 Other Benefits

Smart Fuse and associated developments have provided benefits in terms of safety, with HSE showing interest in their ability to pre-locate faults and prevent exploding joints, and service (the Fault Support Centre).

The Fault Level response work underpins ongoing projects such as Respond. If the techniques proposed by this work can be proven to be safe, there will be substantial financial benefits arising.

A number of the projects address the issue of avoiding unnecessary customer interruptions – either through faults or when connecting LCTs.

3.6 Panel conclusions on the Portfolio

The Panel considered the portfolio was well constructed. Within the goals of the LCNF, the portfolio was arranged under five innovation themes: safety and the environment; network resilience; capacity; efficiency; customer service. Potential projects that did not fit into these themes were rejected. The portfolio primarily focused on the operation and management of the LV networks; strategic problem identification to help construct the portfolio was carried out with the University of Manchester. With the exception of the Bidoyng Smart Fuse, all of the projects led onto subsequent second tier work helping to de-risk these larger projects: in particular, Smart Street, Class, Celsius and Respond.

The Panel noted that the projects and the portfolio had made a significant contribution to the operation, management and reliability of the Low Voltage networks, as well as increasing their capacity. This increased capacity enabled low carbon technologies to be connected more rapidly and potentially without the cost of reinforcement. In the Panel's view, the major benefits that arose from the work were, however, more associated with managing the network reliably and efficiently, rather than solely on achieving carbon benefits.

In summary, the Panel concluded:

- It was a well-constructed and well managed portfolio largely focused on some real network problems that were a potential barrier to LCT roll out
- There were significant outcomes both in terms of products (resulting from exceptional supplier collaboration) and changed practices
- The dissemination to other DNOs, academics and the wider industry was well carried through
- The results of the work had the potential to offer cost savings to customers.

Based on the information contained in the submission, subsequent discussions and answers to questions, as well as work undertaken by the consultants, the Panel concluded that the portfolio included innovative work, provided valuable outcomes to the industry, and the results were extensively disseminated. This portfolio was considered to have provided a significant contribution and, as such, the Panel is able to recommend a First-Tier portfolio reward.

4 WESTERN POWER DISTRIBUTION (WPD)

Tier 1 Funding	£4,719,200
Licensee compulsory contribution	£595,800

Project Name	Project Summary
Interconnection of WPD and NGC SCADA	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.
Isles of Scilly (IoS)	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.
HV Voltage Control (SVC Phase 1)	The project sought to address the impact of DG on long distribution lines and the resultant voltage fluctuations that occur. This was tested via the use of innovative Static VAr Compensators (SVCs) which control voltage.
Early Learning of LV Network Impacts from estate PV cluster	The project sought to look at the impact of high density solar PV on the LV network, in particular, looking at the effect of using different sizes of LV cable and considering the maximum number of PVs that can be connected to typical sizes of cable.
Seasonal generation Deployment (SGD)	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 the commercial arrangements required.
LV Sensor Evaluation	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.
Active Fault Level Management Scheme (AFLMS)	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.

Community Energy Action (CEA)	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.
Electric Boulevards	DNO's need to better understand the power requirement for connecting various charging devices for running an electric bus fleet. There was an aim to understand the impact of LV connected inductive charging and how the use of them at different points along bus routes can be coordinated with local demand.
Energy Control for Household Optimisation-(ECHO)	The project trialled plug in Domestic Demand Side Response (DDSR) technology with real customers. Direct load control, price signals and planned load shifting were used to test the potential use of DDSR and its impact on customers and DNO's.
PV Suburbia	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.
Hook Norton (Smart Hooky)	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 trialed as part of a test in a rural community around a smarter grid.

Source: Based on Table 1 of the WPD submission

4.1 The Portfolio

There are 12 projects in the WPD portfolio. WPD note that their Future Networks Programme has three areas of focus which underpin their Innovation Strategy:

- Assets: including projects that collect data from the network to enhance modelling, strategies and interventions to avoid or delay strengthening.

- Customers: to provide new solutions to enable customers to connect LCTs; to work with communities to provide local solutions; the testing of new customer tariffs.
- Operations: designed to demonstrate benefits to network operations from the application of technology.

Eight of the twelve Tier 1 projects focus on the LV network.

4.2 Contribution to Carbon Plan/Network Capacity

During their presentation, WPD stated that the Tier 1 work gave them confidence to employ a range of Alternative Connection approaches designed to release network capacity. This and changes in their standards facilitated the connection of LCTs to the networks (where otherwise network reinforcement might be required). Much of the portfolio's work also informed a more simplified approach to design and planning for Low Carbon connections. The work undertaken on a number of projects (including Early Learning, PV Suburbia and LV Networks templates) enabled WPD to release 20% of available headroom capacity with the benefit of being able to connect more solar PV onto the LV system.

Capacity was also released using the learning from their work on voltage management. This demonstrated that a 100V reduction on the 11kV network did not adversely impact power quality – allowed for an increase in the capacity of PV connections by 20%.

WPD undertook work examining whether the LV network could supply power for electric charging of buses. A Milton Keynes trial demonstrated that charging stations, including Inductive Power Transfer chargers (used when

buses are away from the depot), could under certain circumstances be connected to the LV network, providing a significant cost reduction compared with connecting at higher voltages. The coordination with other demand on the network was also considered to develop understanding on how a fleet wide rollout may be accommodated.

WPD were clear during the presentation that not all of the projects had positive outcomes – but in these cases, the learning was able to inform subsequent projects. For example, commercial issues around demand-side response from the Seasonal Generation Deployment project emerged as important and led to the early conclusion of the project.

The Panel noted the work that WPD had undertaken addressing community issues. For example, in Community Energy Action, the goal was to engage with domestic communities to deliver domestic demand-side response; in Hook Norton, the goal was to support a DECC low carbon communities programme to help the residents decarbonise. Both projects explored customer engagement and incentive programmes. In the case of Isles of Scilly, the goal was to assist the residents to be more energy self-sufficient. All cases involved a considerable amount of community engagement and WPD considered the learning from this (not all positive) has been valuable in the construction of other LCNF projects.

4.3 Financial Benefits

The development of novel ways of connecting LCTs to the network, while avoiding unnecessary strengthening, offers a considerable financial benefit to customers. In their submission, WPD have estimated a saving of around £1.7 billion for the whole GB system up to 2050. The Panel recognized that other

DNOs (for example SSE) were also developing innovative and efficient methods of connecting LCTs and managing them on the network and that any estimate of the benefit coming from a specific DNOs contributions is open to considerable doubt. However, it is clear that the Tier 1 work underpinning their Alternative Connections policy has the potential to deliver considerable customer savings. WPD note that since 2013, 365 MW of new connections have been made through Alternative Connections; they argue that normally the cost would be £200k per MW connected and therefore there has potentially been a saving of £73 million.

Connecting the Inductive Power Transfer chargers to the LV network rather than the higher voltages was estimated as offering a saving of around £7k per installation. Estimates of IPT installations are of the order of 6,500, offering again the potential for a considerable financial saving.

4.4 Dissemination

In their submission, WPD note that in order to facilitate dissemination, they have nominated engineers within the team responsible for communicating the progress and results of each project with all the other DNOs; they hold regular bilateral meetings with DNOs and with aggregators, suppliers, etc; and all policies when approved are shared via the ENACT portal.

Since 2014, WPD has held three major thematic dissemination events under the banner 'The balancing act'. These have covered topics including Alternative Connections, Energy Storage and Data, with events attracting 100+ attendees.

WPD described how their projects have been disseminated to the wider industry through ENA Engineering Recommendations and Guidance Notes. In their submission and subsequent presentation, they gave examples of the ways in which their projects have informed ENA Planning Standards and ENA Engineering Recommendations and how their policies have underpinned two of ENA's Engineering Recommendations. On the Electric Boulevard project, apart from communications with other DNOs, they have written articles for a wide range of publications and presented their project findings at conferences. They note in their presentation how their Tier 1 portfolio projects have informed subsequent LCNF and related projects, including CLASS, Equilibrium, FALCON, FlexDGrid, Thames Valley Vision, Respond, Low Carbon London, Freedom, Electric Nation and Echo.

4.5 Other Benefits

The learning from the 12 projects has, as already described, fed into a number of other LCNF and related projects. In some cases, this was learning around the 'negative outcomes' – for example, the difficulties encountered in seasonal generation deployment has been used to develop further ideas in FALCON, SYNC and ENTIRE around the use of flexibility services. The unsuccessful use of an 11 kV FACTS device has been addressed in a similar project being implemented at 33 kV as part of the Tier 2 Low Carbon hub, with some of the design issues that plagued the Tier 1 project having been ironed out.

Work on the Isles of Scilly project – for example the LV measurement and COMMS techniques - have found wider application in other projects.

WPD jointly developed with National Grid the inter-control centre communications protocol link between DNO and National Grid control rooms – work that should help with delivering a DSO. The WPD/NG SCADA project was a first for direct communication between the two companies' network management systems. The work has formed the basis of a larger, strategic infrastructure project.

4.6 Panel conclusions on the Portfolio

The Panel considered the portfolio to have been well constructed and managed. As noted above, the projects have been grouped into three areas of Assets, Customers and Operations. WPD also stated they had deliberately chosen a broad portfolio of projects, balancing those on LV, HV urban and rural areas, with many of the projects being developed from ideas from front line engineering teams.

In their presentations, WPD noted that it was the combined learning from across their portfolio that had enabled them to deliver their range of alternative connection approaches and LCT connection standards.

The Panel considered the portfolio included a range of important projects that had helped WPD and the wider DNO community to change practices leading to increased network capacity and increased access for LCTs. The early projects had given WPD a good understanding – particularly of the LV network – and a number of the outcomes offered considerable potential customer savings.

In summary, the Panel concluded:

- The extensive portfolio was well focused and addressed issues that enabled new solutions and changes in practices to be developed.
- WPD had addressed some issues that have been less well examined by DNOs elsewhere: in particular, engaging with communities to find local solutions.
- There was a strong emphasis on effective communication to other DNOs and the wider industry.

Based on the information contained in the submission, subsequent discussions and answers to questions, as well as work undertaken by the consultants, the Panel concluded that the portfolio included innovative work, provided valuable outcomes to the industry, and the results were well disseminated. This portfolio was considered to have provided a significant contribution and, as such, the Panel is able to recommend a First-Tier portfolio reward.

5 SCOTTISH AND SOUTHERN ELECTRICITY NETWORKS (SSEN)

Tier 1 Funding	£4,092,600
Licensee compulsory contribution	£409,300

Project Name	Project Summary
1MW Shetland Battery	Procured the first grid-scale battery for the UK, installed this energy storage device on the SHEPD network in Shetland and integrated this with an active network management system.
Demonstrating the benefits of monitoring Low Voltage network with embedded PV panels and EV charging point	Demonstrated the impact of PV panels and EV charging points on t of an 11kV/LV substation monitoring solution. Gained insight into network of PV and EVs and hence demonstrated the benefits of L operation of the Distribution Network.
TrialEvaluation of Domestic Demand Side Management (DDSM)	Partnered with Glen Dimplex to develop and trial a new range of domestic energy efficient storage heaters and immersion water heaters designed for grid energy storage, demand side management and frequency response.
Demonstrating the Functionality of Automated Demand Response	Implemented and demonstrated basic ADR functionality in commercial buildings. Three building owners were recruited as trial participants, each willing to test the Honeywell ADR system.
Demonstrating the Functionality of Automated Demand Response	Implemented and demonstrated basic ADR functionality in commercial buildings. Three building owners were recruited as trial participants, each willing to test the Honeywell ADR system.
Low Voltage Network Modelling and Analysis Environment	Investigated the creation of a proof of concept 'Low Voltage Network Modelling Environment' that enables a GB DNO to carry out load flow analysis calculations without the need for significant user input.
Orkney Energy Storage Park (Phase 1)	Created a commercial and physical incentive that encouraged third party Energy Storage Providers (ESPs) to locate on a constrained network. The incentives were then tested by running a commercial tender process to identify if suitable ESPs were enticed to apply for the contract.

Low Voltage (LV) Network Connected Energy Storage	Demonstrated the potential benefits, practicalities and costs of installing electrical energy storage (ESS) connected via four quadrant power conversion systems (PCS) on the LV network. Informed and de-risked the larger scale deployment of street batteries as detailed in the NTVV Tier 2 project.
Trial of Orkney Energy Storage Park (Phase 2)	Demonstrated that an Energy Storage System (ESS) could be linked to an ANM system previously installed on Orkney. Facilitated a commercial investigation into the UK energy markets and how ESSs could interact with these markets in order to improve the business case for ESSs.
Impact of Electrolysers on the Distribution Network	Investigated the potential impact that hydrogen electrolysers will have on the electricity distribution network and explored the extent to which this technology can be used to manage network constraints in the future.
Digital Substation Platform – Phase 1	Demonstrated the feasibility of combining ANM and protection systems together to simplify IT architecture and minimise costs by rationalising both hardware and software whilst retaining the benefits and performance of both systems.

Source: Based on Table 1 of the SSEN submission

5.1 The Portfolio

There are 10 projects in the SSEN Tier 1 portfolio. The DNO claims that the outputs from these projects have informed around 17 other Low Carbon Network Fund and related projects.

In their submission, they track how these Tier 1 projects have provided learning for:

- Energy Storage
- Demand Side Management
- Active Network Management
- Constraint Managed Zones
- Low Voltage Strategy

They also demonstrate how these projects have collectively provided learning for the overall goal of managing the network through a Distributed System Operator (DSO).

5.2 Contribution to Carbon Plan/Network Capacity

SSEN in their submission present information from an analysis carried out for them by EATL. From that they suggest that at least 3 GW of network capacity could be released from the innovation areas described.

- Constraint Managed Zones. They suggest that the learning from Tier 1 projects allowed them to develop the CMZ concept (see Section 1 for definitions). They have claimed cumulative benefits to their network of 74 MW (from 269 schemes), with the potential for a GB wide deployment of a total of 1 GW (4300 schemes) by 2050. The benefit assumes that all are active at the same time (thereby providing a maximum cumulative benefit).
- Active Network Management (including Demand Side Management and Energy Storage). They note that Active Network Management allows for flexible access for generators to the network and that DSM and Energy Storage improves the utilization by shifting demands from peak times. They suggest that around 1000 schemes of 1 MW each (1 GW in total) could be rolled out across GB by 2050.
- Low Voltage Strategy. SSEN note that these projects have reduced uncertainty on the LV system by improving the understanding of the impact of LCTs, the role of storage and the potential for cost efficient monitoring. Their strategy (primarily focused on demand) has allowed an increase of 5% in the original design guidelines. Once this level has been breached, the first intervention may then take the form of monitoring – which might show that even more capacity is available. This intervention could release a total capacity of 75 MW (12,000 interventions) in the SSEN region up to 2050; for the overall

GB system, the estimate is 182,000 interventions releasing over 1 GW of capacity.

It should be noted that SSEN has not yet placed a contract for CMZs, but the approach has been in use for the last 12 months and has been written into their procedures for the last 3 months. They informed the Panel that the portfolio has given them the confidence to move towards a more commercial approach and to be able to go to tender with storage work and to invest their own money outside of the innovation funding incentives.

The Panel considered the work undertaken by EATL to try to estimate the benefits to be extremely helpful. At the same time, there was some concern that the quantum of capacity released potentially depended on a number of favourable assumptions being made – and necessarily took no account of other interventions that are becoming available to help more efficiently manage the network. In their submission, SSEN note how the Tier 1 projects have facilitated the Carbon Plan. They note they are now able to offer a range of flexible connection options to distributed generators; they have addressed through a number of the Tier 1 projects flexible demand management; and they have demonstrated the commercial case for energy storage to support more low carbon generations onto the system.

They have developed tools to enable collection and detailed analysis of LV network data in order to understand the impact of PV and EV charging better and generally to facilitate the uptake of LCTs. In their Shetland projects, they demonstrated flexible demand and energy storage in a project which included managing domestic heat and water tanks and building management systems. One of these projects deployed a new generation of storage heater whereby demand was automatically shifted away from peak demand periods – or towards times when there was higher renewable generation.

The portfolio also examined the implications of increased loading on the network of electric vehicles and the network implications of electrolytic hydrogen production.

5.3 Financial Benefits

The calculation of the benefits necessarily depends on the assumptions underlying the roll out of the interventions. SSEN has claimed benefits for their own networks and separately for GB as a whole. Their analysis recognizes that the majority of the financial benefit associated with ANM schemes accrue primarily to the generator in the form of reduced connection costs. By their estimate, only 20% of the savings would be for the rest of the customers on the network.

There is no breakdown of the financial benefits claimed: the benefit claimed for the SSEN and GB system for 2050 is £48 million and £429 million respectively.

5.4 Dissemination

SSEN was also a founder of the Energy Storage Operators' Forum (ESOF) and through this they facilitated the sharing of their experience with batteries at Orkney and Shetland with other DNOs. Their work helped form the basis of the ESOF Good Practice Guide with the Shetland battery project contributing two safety cases.

SSEN inform us that they were instrumental in establishing the ENA-led ANM Working Group. This group, under their chairmanship, established definitions and technical protocols in a Good Practice Guide for ANM. SSEN

undertook bespoke road shows for network planners to disseminate their work on LV strategy projects.

Overall, the Panel considered that SSEN had had a strong focus on fully disseminating the results of their work.

5.5 Other Benefits

SSEN's portfolio of projects has helped inform their DSO strategy and provided learning that is likely to be helpful for DSO-TSO arrangements.

The Orkney Energy Storage Park concluded that energy storage was likely to be more appropriate in heavily loaded, interconnected networks (due to value stacking) such as those in the south of England. This led SSEN to focus its CMZs in the South. As a result of this project, SSEN has also encouraged stakeholders to develop other approaches to utilize their renewables – these have included projects funded by the Scottish Government's Local Energy Challenge to explore new heating systems to displace existing oil systems and the use of hydrogen to fuel the inter-island ferries. The Shetland Storage Project provided additional learning associated with safety considerations of different battery technologies.

Their DSM project work has led them to understand that demand side barriers are often outside their direct control (e.g. due to the behaviour of landlords and OEMs). SSEN has therefore facilitated a specific session on how to engage stakeholders at the LCNI Conference.

SSEN state that their electrical vehicle projects have influenced government policy and the wider EV supply chain – helping to ensure EVs are capable of

DSM when charging so that the network does not become a barrier to the uptake of electric vehicles.

5.6 Panel conclusions on the Portfolio

SSEN focused their work on the need to move towards a DSO. The portfolio was logically constructed, moving from pure technological solutions such as batteries to a greater understanding of Demand Side Management and the development of commercial solutions such as CMZ. The portfolio incrementally built on the foundations of previous projects and the learning informed a large number of other LCNF work. In particular, it assisted in de-risking new Thames Valley Vision and Northern Isles New Energy Solutions (NINES).

The company has created two internal teams: the Active Solutions team (to bring in new skills) and the Internal Deployment team (to fast track projects into BAU). SSEN's Investment Board now considers whether the CMZ approach can be applied in all cases, seeking to understand the technical, safety and commercial risks involved.

The Panel concluded as follows:

- SSEN presented a comprehensive and well-constructed portfolio that addressed a number of fundamental barriers to the Carbon Plan. As a result, it should become easier and less costly for generators to connect; similarly, it should be possible for a considerable increase in other LCTs (domestic and commercial) to connect onto the network without the need for strengthening.

- Their work on Demand Side Management (including their work on electric vehicles) has also provided valuable learning on how domestic equipment and vehicles can be used to avoid capacity constraints from peak loading.
- The work undertaken by SSEN (along with similar work by other DNOs) will provide considerable benefits to customers.
- SSEN have made a strong effort to fully disseminate the results of their work.

The Panel therefore considered that the Tier 1 projects had made a significant contribution to the Carbon Plan and would create considerable financial benefits to customers; and on that basis, recommend that SSEN should receive a Tier 1 reward.

6 RECOMMENDATIONS FOR THE TIER 1 REWARD

6.1 As noted in Section 1, the purpose of the Tier 1 Reward was to assist DNOs 'capture the full benefits of successful innovation' as concern had been expressed by the companies around the risks of embarking on innovation projects. The original guidance makes it clear that it was only expected that a limited number of DNOs would receive a Tier 1 Portfolio Reward and the amount of the award might reflect overall performance. The subsequent Guidance Note made it clear that the 'reward is about the demonstration of exceptional benefits for customers.' It states that DNOs need 'to demonstrate that what has been, or may be, delivered is beyond what could have been reasonably expected. The FTPR is not to reward companies for successfully delivering their first Tier 1 projects in line with the governance requirements'.

90% of the costs of the Portfolio were funded using the usual mechanisms; the balance was funded by the companies. Of the portfolios presented, the value of the companies' contributions ranged from £266k to £595k.

In consultation with Ofgem, the Panel agreed that the maximum for any award should be £2.5 million – and this would represent exceptional performance against all the criteria.

It is inevitable that there should be a degree of subjective judgement in determining the quantum of the reward. 'Exceptional performance' is itself open to a range of interpretations.

In determining the value of the awards the Panel followed the assessment process as set out in the Governance Documents and the Guidance note. As described in Section 1, the Panel based the award on their assessment of the individual portfolios as set out in Sections 2 to 5 of this report.

6.2 The Panel's recommendations are as follows:

- **ENW**. The Panel considered that ENW had made an exceptional contribution, first by the delivery of the Smart Fuse in collaboration with suppliers delivering a technology that has now been adopted by all DNOs; and secondly, through their set of LV network capacity projects that delivered significant network improvements and financial savings. Overall the Panel noted that the portfolio was well constructed, the work was innovative and addressed some key network capacity and reliability issues, and the dissemination activity was extensive.

  A Tier 1 reward of £1.75m is recommended.

- **WPD**. The Portfolio was well constructed and created significant learning and, in the Panel's view, represented significant performance improvements. This learning enabled WPD to establish their Alternative Connection Approach and make changes to their LCT connection standards providing significant savings for customers and allowed connections to be made at lower cost. Their work on bus charging created learning that should help reduce costs on some future electric vehicle schemes. The Panel also strongly commended the learning from their community engagement and the way they had disseminated the results of their portfolio.

  A Tier 1 reward of £1.75 m is recommended.

- **SSEN**. The Panel considered the work supporting the development of Constrained Managed Zones (and future DSO developments) is delivering considerable learning and has the potential to deliver significant carbon and financial benefits. In addition, their work on domestic Demand Side Management (heaters and vehicles) was innovative and created valuable

learning. Overall, the Panel felt this was an exceptional and coherent portfolio of strong, well-focused projects able to provide significant carbon and financial benefits.

A Tier 1 reward of £2.0 m is recommended.

- **UKPN**. The Panel noted the innovative work that UKPN undertook on integrating battery storage onto the Network and the way the results were disseminated – providing learning for subsequent storage projects; their LV monitoring work and visualisation helped inform their planning and connections with LCTs and their work to understand better the behaviour of solar PV enabled more connections to be made and provided learning for the industry.

  Overall the Panel considered that the work that UKPN had undertaken within the portfolio had provided valuable learning. However, in the Panel's view, the portfolio construction, the outcomes and the potential benefits could not be described as exceptional. Therefore, the Panel does not recommend that UKPN receives a Tier 1 reward.

6.4 The Panel would like to thank very sincerely all the participants in the process: the DNOs, the Ofgem team and the consultants. The Panel considers the work undertaken in the Tier 1 projects (and LCNF in general) has significantly advanced the DNOs' understanding of how the distribution system can be managed to allow connection of LCTs, as well as offering a wide range of possible interventions to reduce the costs that customers would otherwise incur. The Panel (all of whom have been member of the LCNF Panel throughout its existence) would like to congratulate the DNOs for the focus and dedication that they have applied to trialling and developing new approaches to meet the challenge of the Low Carbon Plan and of the need for the networks to be managed in a fundamentally different way.