Low Carbon Network Fund

Report and Recommendations 2014

Prepared for

The Gas & Electricity Markets Authority

By

The Low Carbon Networks Fund Expert Panel

October 2014

1 Introduction

1.1 This report has been prepared by the Low Carbon Networks (LCN) Fund Expert Panel (the Panel). It sets out the Panel's recommendations to the Gas and Electricity Markets Authority on the portfolio of projects to be funded in the 2014 Second Tier funding round. Members of the Expert Panel are as follows:

- Dr Robin Bidwell (Chair)
- Sharon Darcy
- Prof Nicholas Jenkins
- Prof David Newbery
- Sean Sutcliffe

1.2 We received four submissions – the total funding requested from the Low Carbon Network (LCN) Fund was £21.9m. Full details of each submission will be available on the Ofgem website. The names of the companies, titles of the submissions and the total cost and the amount requested from the LCN Fund are as follows (the values in brackets indicate the total cost of the projects).

- **Fault Level Active Response (FLARE) – Electricity North West (ENW) - £4.425m requested (£5.539m in total)**
- **Low Energy Automated Networks (LEAN) – Southern Electric Power Distribution (SEPD) - £2.67m requested (£3.068m in total)**
- **Kent Active System Management (KASM) – South Eastern Power Networks (SEPN) - £3.345m requested (£3.898m in total)**
- **Balancing Generation and Demand (Equilibrium) – Western Power Distribution (WPD) - £11.48m requested (£13.09m in total)**

1.3 The Expert Panel followed the evaluation process set out in the LCN Fund Governance Document v 6 (April 2013). Initial submissions were received by Ofgem and were screened by Ofgem staff for compliance with the requirements set out for the Initial Screening Process. Consultants were appointed by Ofgem to review the submissions. The Panel met the DNOs together with the Consultants early in the evaluation process. The project teams presented their submissions followed by a question and answer session. During the period up to the completion of the Consultants' reports and prior to the second DNO meeting, the Consultants and the Panel sent each of the DNOs a number of questions with the purpose of clarifying the submissions and highlighting areas of concern. A further bilateral meeting was then held with the DNOs.

Following these meetings, the Panel met to review each of the submissions in the context of the criteria set out in the Governance Document. In evaluating the submissions, the Panel took into account all of the documents that had been made available: the submissions, their appendices, the material made available at the presentations, the Consultants' reports as well as any additional information that had been submitted via Ofgem or the consultants from the DNOs. Based on this evaluation, the Panel reviewed the projects against the criteria.

This report should be read together with the Consultants' reports (these are published in full), the DNO's submissions and any other information published concurrently with it on the Ofgem website. This report sets out the results of the Panel's deliberations and its recommendations for the Authority. As such it is primarily concerned with the assessments, conclusions and recommendations of the Panel; all the details of the projects and the technical evaluations undertaken by the Consultants are contained in the other published documents.

2 Evaluation Criteria

2.1 The criteria that the Panel are required to take into account in the evaluation process are set out in the LCN Fund Governance Document under the Tier 2 evaluation process. In this section, we list the evaluation criteria and briefly discuss a number of points that arose during the evaluation process. A full description of the criteria is set out in the Governance Document.

2.2 (a) Accelerates the development of a low carbon energy sector and has the potential to deliver net financial benefits to future and / or existing customers.

Carbon benefits. The Governance Document states that the DNO must demonstrate how the solution makes a contribution to the Carbon Plan (DECC December 2011 updated April 2013). The Governance Document specifically states that a solution may facilitate the use of low carbon electricity. Three of the submissions addressed the problem of how to manage the network when there is an increasing amount of renewable generation connecting to the system. One looked at how better to cope with the network voltage variations associated with distribution generation; one focused on fault levels – a problem exacerbated by a local need to connect CHP in urban areas; and one sought to improve network planning and control through more accurate estimation and forecasting of what was happening on the network. Each of these could be seen as steps on the road to the DNO acting as a Distribution System Operator.

All of the schemes challenge industry practice and orthodoxies; and one would require changes in statutory limits at the UK and possibly EU level if the full potential of the method were to be released.

The fourth project addressed the issue of losses in the Distribution Networks. Distribution losses cost GB well over £1 billion each year and contribute significantly to greenhouse emissions. Although this project

only addressed one of a number of the causes of losses, any method that reduces losses is worthy of exploration.

Overall, the Panel felt that all the projects had the potential to make a real contribution to the Low Carbon Transition.

Financial benefits. It is extremely difficult to calculate the benefits arising from these schemes. They depend on forecasting a large number of variables up to 2050 and some of the solutions may be superseded long before then. But each step towards more active management of the distribution network (and in one case integrating data from the Transmission System Operator) should allow for a smarter way of connecting and managing distributed generation – and avoid the costly alternative of more strengthening of circuits, transformers, etc.

This year the Panel felt that some of the benefit calculations understated the total benefit to the distribution system – primarily because they did not include potential benefits to the wider stakeholder group – for example, bringing in more DG capacity could provide considerable benefit. In one case (losses), it is clear that there is little direct benefit to the DNO; but there is a broader societal gain from making progress on this problem that may be understated by the (modest) financial savings to consumers.

2.3 (b) Provides value for money to distribution customers.

This criterion requires the Panel to take account of the size of the benefits and resulting learning in relation to the costs of the project to the LCNF. It is important to note that it is the DNO system and distribution customers that must benefit in order that the criterion is satisfied. The criterion recognises that there may be wider benefits to third parties and these may be taken into account in the evaluation. This criterion also explicitly requires the Panel to consider cost in relation to the learning that will be achieved. The Panel lays particular stress on whether, given the goals, the cost of delivering the project was

reasonable and whether the learning to be achieved will provide real benefits for DNO customers.

The Panel was pleased to see that all the submission teams were proposing to employ a robust process for ensuring that services and equipment were procured competitively.

2.4 (c) Generates knowledge that can be shared amongst all DNOs.

This criterion specifies that new learning must be generated; and this learning should be relevant to the planning, development and operation of an efficient distribution system and of value to other DNOs.

All of the projects this year would require a change in practices if they were to be made Business As Usual. The Panel was aware that distribution company managers could have some reservations about introducing some of these innovative approaches. The Panel did receive assurances from senior members of submission teams that if successful the methods would be made Business as Usual. However, it is important that where possible DNOs consult widely (with other DNOs) and in a timely fashion at each stage of the project and disseminate results as quickly as possible in order to help build confidence in the innovative approaches being applied.

2.5 (d) Involvement of other partners and external funding.

The Panel noted that there were fewer partners in most of the bids than in previous years. Where the primary goal is to look at new ways of operating the network, the Panel recognises that competitive tendering, particularly for equipment, may result in a lower cost option than developing the project jointly with a supplier. However, with the more complex projects, there could be value in engaging with additional expertise at an early stage. Similarly where industry practices are being challenged, there might be a case for perhaps partnering with another DNO that has a similar issue to help build confidence in the industry.

The Panel also noted there was less engagement with universities than in previous years – though in one case the team planned to select a university at a later stage. If used appropriately, universities can play a valuable role in providing specific expertise as well as assisting in disseminating results.

2.6 (e) Relevance and timing.

All of the submissions addressed problems that are relevant to the immediate future – in particular the more active management of the networks.

2.7 (f) Methodology.

The project must be ready to implement. This was the case for all of the projects and the Panel was pleased to see that in most cases a great deal of preparatory work had been done.

The Panel was also pleased to see that in a number of cases there was explicit reference to results of other LCNF projects and that efforts were being made to build on other work and address gaps in learning. The Panel were keen to see that projects built on the learning from Tier 1 / NIA projects.

Overall, the methodologies were well constructed. However, in one case the Panel struggled to understand precisely what an important phase of a project was trying to achieve. A clear statement of individual tasks, their role in the project and their associated costs and benefits is essential.

There is still a tendency for SDRCs to refer to project stages rather than project outcomes and results. The SDRCs are intended to reward delivery and not effort.

2.8 Presentations.

The presentations are an important part of the process. They provide the Panel with assurances over the level of senior commitment in the DNO; an understanding of how the project will be delivered and whether there are implementation concerns; they also provide (during the second bilateral meeting) an opportunity for the discussion to focus down on the specific questions that the Panel requires to be clarified. The Panel found the bilateral discussions productive – the process had been changed so that the DNOs met the Panel and Consultants at the same time; all the teams focused on the questions during the second discussion. In most cases, there was a senior Director present to help convince the Panel that this work would be fully delivered and, if successful, integrated into the company's activities. It is also helpful when the relevant technical experts are able to attend one or other of the meetings.

3.0 Evaluation against the criteria

3.1 Fault Level Active Response (FLARE) - Electricity North West (ENW) - £4.425m requested (£5.539m in total)

Description of Project. Short circuit fault levels are a significant constraint on the connection of Low Carbon generation (particularly CHP units but increasingly other Low Carbon Technologies) in urban areas. This project will trial specific fault level limiting interventions to address the constraints caused by short circuit fault levels.

ENW will develop a fault level assessment tool; this software will calculate in real time short circuit fault levels on their network. Should the potential fault current exceed the equipment rating, an instruction will be sent to activate the preferred mitigation technique.

The technical mitigation techniques that will be examined in this project are Adaptive Protection leading to the Sequential Tripping of circuit breakers – and the use of Is Limiters – a technology that has not previously been employed on the UK networks because of health and safety concerns. With Adaptive Protection, the settings of protection relays are changed in real time depending on the state of the network to result in sequential tripping. Sequential Tripping is a technique in which circuit breakers are tripped sequentially so that their individual fault rating is not exceeded. Both Adaptive Protection and Sequential Tripping are techniques that are occasionally used on transmission networks, but not on the distribution system.

Is Limiters are used widely in continental Europe and have also been used in this country on a small number of industrial power systems, but the devices have not been used on the distribution networks because they do not fail to safe, although the Panel were told that their safety record to date is extremely good, with 120,000 Is years' experience with no failure since 1961. In this project ENW are planning to limit their use: they will only be employed to prevent buried cables from bursting under high through-flowing fault current. Should they fail, the consequences of that failure are then contained by the earth and so are less catastrophic than, for example, at urban substations. ENW believes it can develop a safety case for the use of this technology that will gain the acceptance of the industry and the Health and Safety Executive.

In addition to trialling Adaptive Protection and Is Limiters, ENW will examine the potential for industrial, commercial and generation customers to offer a 'Fault Current Limiting (FCL) Service'; this service will involve customers' sites that contain a large item of rotating equipment that contributes fault current being tripped off rapidly in the event of a fault elsewhere on the network. This will prevent these sites from contributing fault current and so help lower the potential overall fault current. The customer will be asked to accept the risk of a slightly increased frequency of interruption in return for a payment. The assessment of the FCL Service will be largely based on a customer

survey, with the intention of determining the willingness and price associated with providing the response when required. ENW will carry out trials with one generating customer and one load customer (a pumping station).

Carbon and Financial Benefits. In their submission, ENW quantifies the considerable additional capacity that will be released at each substation if the trials are successful. They also note that by 2050, without action, fault levels will be exceeded on circuits fed from the majority of their primary substations and Bulk Supply Points (BSPs). ENW is experiencing particular problems in the Greater Manchester area where expensive reinforcement is likely to be the only way to allow CHP and other Low Carbon Technologies onto the system. In their submission, they have calculated that at the nine trial networks, they will release 341 MVA of network capacity (the same as traditional techniques). Intervention to the nine trial sites would cost around £6.1m if traditional reinforcement techniques are used; Adaptive Protection and the Fault Current Limiting Service are each calculated at £[redacted] and £[redacted] respectively – a considerable saving. The Is Limiter is projected to cost £[redacted], offering a smaller saving. However, the Panel recognize the considerable disruption associated with digging up underground cables in urban areas; and the Is Limiter will be used specifically to protect these cables. It is suggested that FLARE will release capacity up to 18 times faster and up to 80% cheaper than traditional reinforcement techniques and will release overall around 9,500 MVA of low carbon generation/demand for ENW and 127,000 MVA with a GB wide roll out. Overall, it is argued that FLARE will offer considerably lower cost solutions to new customers and that all customers will benefit through reduced Distribution Use of System charges.

The Panel considered that these Methods, if successful, would have the potential to deliver considerable financial benefits to distribution customers.

In their submission, ENW note that the Greater Manchester Combined Authority (a supporter of the project) is strongly interested in bringing more local, Low Carbon generation onto the system (in particular, CHP). The Panel were told that fault levels were a key barrier to bringing on new generation in the urban areas; and ENW suggested that these methods would facilitate the faster connection of Low Carbon generation. To the extent that a key constraint on LCTs particularly in urban areas is the effect on fault levels, it is clear that this project would play an important role in accelerating the development of a Low Carbon energy sector.

Value for money for distribution customers. The Panel considered the size of benefits and the potential for learning from this project represented good value for money.

A competitive process was employed to identify the consultants and software supplier. [redacted]. The Panel was informed that Schneider was subsequently selected.

Generates knowledge for DNOs. This project has potential to provide a considerable body of new knowledge that will be of benefit to other DNOs. Taken together with FlexDGrid (a WPD project funded by the LCNF in 2012) and the IFI and Tier 1 projects undertaken as preparation for these projects, this should help build the toolbox of fault level management options available to the DNOs.

The Panel considered that the calculation of real time short circuit fault levels (the fault level assessment tool) to be both innovative and with the potential to create learning for other DNOs.

Partners and external funding. The Panel considered PB Power a strong partner for the project; it did however note that as PB Power is also the consultant on FlexDGrid, a considerable body of knowledge will be developed within PB Power and it is important that this knowledge is

widely disseminated throughout the industry. The Is Limiter is only supplied by ABB. The Panel noted that ABB is providing one of the two Is Limiters free of charge.

The customer survey is being undertaken by Impact Research, supported by project partners Ener-g, the Combined Heat and Power Association and United Utilities. The submission notes the involvement of such partners will assist with the survey work**.**

Relevance and timing. The Panel considered this project to be relevant and timely – fault level issues have the potential to result in either preventing LCTs from connecting to the network or requiring expensive network strengthening.

Robust methodology ready to implement. The Panel considered this to be a well-constructed project with a clear and coherent methodology. However, the Panel was concerned that there were potential risks that would limit the acceptability of this approach to fault level mitigation. Specifically, there was a risk that the safety cases – in particular those associated with the software and the Is Limiter – would not be robust enough to satisfy the management of the Distribution Companies and the Health and Safety Executive. Indeed, safety concerns about the impact of Is Limiters on customer apparatus have in the past deterred DNOs in the UK from using these devices. Should the trials prove successful, it is important that every effort is made to ensure that the Distribution Companies share in the learning in a way that makes them comfortable with these methods. The Panel is aware that 'safety first' is an important consideration with fault levels.

In addition the Panel recognised that it might be difficult to construct a Fault Current Limiting Service that was sufficiently attractive to customers for them to enter into such contracts, but that it was important to test such willingness to participate.

Panel conclusions. The Panel consider this to be a robust project that will deliver considerable learning on an issue that has the potential to create a considerable barrier to the rollout of LCTs. The Panel recognised the importance of the problem and considered the work on the fault level assessment tool and related interventions to be of particular importance. There was some concern that the Fault Current Limiting Service would have trials limited to two customers.

3.2 Low Energy Automated Networks (LEAN) – Southern Electric Power Distribution (SEPD) - £2.67m requested (£3.068m in total)

Description of project. This project addresses a way of reducing fixed losses of 132/33 kV and 33/11 kV distribution transformers. The submission notes that DNOs have an obligation to design and operate networks in such a way as to reduce losses – as well as maintaining a safe and secure energy supply and providing value for money for electricity customers. SEPD note that the highest proportion of distribution losses comes from transformers and low voltage circuits.

In order to meet security standards at primary substations, DNOs keep two transformers energised – these transformers share the substation load – providing redundancy and security in the event of a fault or scheduled maintenance. The submission notes that new transformers are often specified at a higher capacity than is needed in the short term to allow for future increases in load; also that on existing networks, the introduction of Low Carbon generation is reducing the mean load falling on the transformer. Initial studies suggest it would be possible to switch out one of the two transformers – possibly for considerable periods (i.e. in some cases several months) – and thereby reduce fixed losses.

The project will employ a Transformer Auto Stop Start (TASS) method that will be applied to selected primary substations that have two transformers. When the substation load falls below a predetermined level, one of the two transformers will be switched off. Care will be

taken to control the frequency of switching. The trials will examine simple, remote switching – i.e. from the control room or from existing remote control mechanisms. Specific control equipment and the use of advanced switchgear will also be trialled to see whether this lowers the risk of damage to the transformer.

The key issue is whether this method (increased switching off and on of a transformer) will affect the life of this expensive asset as compared to the relatively modest cost savings. Point-on-wave switching and the use of fast circuit breakers will be trialled to see whether this lowers the risk of damage to the transformer.

The project has an important initial phase (Phase 1) in which SEPD will engage with transformer suppliers to investigate how transformers may react to this new operating regime. Phase 1 will also include an in depth study of load profiles across the network – this will enable the sites to be selected for the trials. The selected transformers will be monitored throughout the two years of operation.

In addition to TASS, the trial will examine the potential for interconnecting the substations via the 11 kV network. This method is called Alternative Network Topology (ANT). The aim of ANT is to configure the network so that if one transformer is switched out under TASS and the second transformer experiences a fault, there will be no loss of supply due to the interconnection with another substation.

Carbon and financial benefits. Reported electrical losses amount to 6% of the power transmitted over the distribution networks (Ofgem, 2010),[1] costing GB around £1 billion per year and accounting for 1.5% of all greenhouse gas emissions in the UK. The transition to the Low Carbon economy is expected to increase the amount of electricity carried by these networks (and the associated losses); in addition, the connection of

[1] https://www.ofgem.gov.uk/ofgem-publications/43516/distribution-units-and-loss-percentages-summary.pdf

Low Carbon generators onto the network can reduce the load on existing transformers – which, given the fixed losses, increases their relative losses per MWh transformed.

The submission suggests that the methods proposed could save over 31,000 MWh of electricity over 45 years, worth over £40m to GB customers. This equates to savings of 6,421 tonnes of CO_2.

The Panel noted that in the context of the GB system the savings would be modest – the energy saved each year from an individual substation is expected to be around 90 MWh with an annual value of £4,500 (around £126,000 over 45 years). These losses are ultimately borne by customers – based on the figures presented by SEPD, the benefit of this project to a domestic household would be around 10p per year.

In spite of these modest benefits, the Panel considered that this method (if it proves successful and if it could be shown not to reduce transformer asset life) would be an additional low cost tool to tackle the issue of losses, with the benefits flowing entirely to consumers.

Value for money for distribution customers. The Panel considered while the benefits are not large in absolute terms – and there are risks to asset life – that nevertheless this trial would provide potential benefits in terms of learning that was commensurate with the funding required. The team is committed to including competitive procurement processes for acquiring the equipment; the aim is also to test the market to ensure there is a robust supply chain to support a widespread rollout.

Generates knowledge for DNOs. Identifying effective approaches to tackling losses has been a significant challenge for DNOs. Under ED1 and Licence Condition CRC14 DNOs are required to focus on loss reduction.

The work on monitoring the asset life of transformers will prove valuable; this will continue after the trials are complete. The Panel

considered it important that the results should be promptly disseminated – particularly if there were signs of deterioration.

The learning will be widely applicable; and there is a well worked through dissemination programme.

Partners and external funding. There are no partners identified and the project will acquire the equipment through competitive procurement. The Panel did have some concerns that no transformer manufacturers were included as partners – but following discussions were satisfied that full consultation would be carried out with them and other stakeholders.

Relevance and timing. The Panel recognised that it is likely that losses on the system will increase and that action was timely and relevant. It was noted that the newer transformers are designed with reduced fixed losses – but the issue of running transformers in pairs will still result in unnecessary losses. In addition, it will be many years (possibly 40-50) before all the existing transformers have been replaced. The Low Carbon Transition has the potential to change the loading of transformers – and this project will provide timely information both on this issue and on a way to reduce some of the associated losses.

Robust methodology ready to implement. The Panel considered this to be a well-constructed project. The submission team had recognised the key risks and the Panel were satisfied that the decision point at the end of Phase 1 and the methods of addressing these were sensible. The work in Phase 1 would be particularly important - in particular discussion with transformer manufacturers and other stakeholders and understanding transformer loads on the networks. The Panel had some concerns that the senior management of networks might be reluctant to implement this method if they felt that the life of their expensive transformers could be reduced. The detailed monitoring work that the project would undertake during and after the project, including of partial discharge and gas and moisture in oil measurements, was seen as important to provide assurance on transformer asset health. As noted

above, it is important that the monitoring should continue into the future and that there should be wide dissemination of any signs of asset deterioration. There is little benefit to the DNOs of implementing this project other than meeting the general need to reduce losses – the benefits accrue to GB customers in general.

Panel conclusions. The Panel were pleased to see a project addressing the difficult topic of losses. There are risks to the transformers in the method proposed – and SEPD are committed to an initial study working with transformer manufacturers to evaluate these risks before proceeding to the trials. The Panel were pleased to see that in the final submission there was an explicit decision point at this stage and they would expect SEPD to discuss the conclusions with Ofgem before proceeding to the trials. Even if successful the Panel had concerns over the extent to which the project would satisfy a wider audience that asset life would not be impaired; and whether such a method could be made Business As Usual across the industry. The Panel considered this relatively low cost project would provide a range of learning that would be valuable to the industry and could be a step in giving the industry confidence in implementing this new technique.

3.3 Kent Active System Management (KASM) – South Eastern Power Networks (SEPN) - £3.345m requested (£3.898m in total)

Description of project. This project addresses the issues that arise when large amounts of intermittent wind and solar generation are connected to the distribution network, particularly at times and places where there is limited local demand. There are then potentially delays before further renewable generators can join the network and significant connection costs, and a need to constrain off the renewables under certain conditions. The submission proposes that in order to ensure the performance of the network (in particular following planned outages) and achieve optimal utilisation, there is a need to develop technical and analytical capabilities to increase the ability of DNOs to understand and operate their networks given the changing requirements.

The 132 kV network in East Kent connects two grid supply points and takes power from 510 MW of low carbon generation, including the 315 MW Thanet Offshore Wind Farm. It is anticipated that two new interconnectors to mainland Europe will be connected in the area. A large portion of this network operates in parallel with National Grid's 400 kV network. The transmission and EHV distribution networks in the area are interdependent.

There are a number of near term issues. National Grid needs to undertake work in around 2018/19 as part of their NEMO Interconnector Project – consequently UKPN expects that this will add to pressure on outage planners. Secondly, it is difficult to connect any more distributed generation onto these networks and there are already problems arising each year during maintenance work that results in renewable generators being constrained off the system.

The purpose of the project is to provide additional information using Contingency Analysis software to develop a more realistic assessment of the capacity of the network to accommodate power flows and to potentially release network capacity – for example allowing more Low Carbon generation to connect or to reduce the number of days that it might be constrained off. This is seen as helping the control room engineers and outage and network planners to manage the network in real time in order to improve performance; to better manage planned and unplanned network outages, and to improve long term planning capabilities. The tool will import data from National Grid that will provide visibility of the anticipated loading on the transmission network and the utilisation of the Super Grid transformers. The Panel were told that currently managing power flows on this interconnected 132 kV network is challenging, with around 34 contingency scenarios needing to be analysed– a task that will be complicated by the growing number of distributed generators with offers to connect to the network. This project should provide software to inform that process.

An existing piece of software will be purchased from the United States (from Bigwood Systems) and the necessary systems and data sets will be developed to be used in conjunction with the contingency analysis tool. Once complete, there will be trials to cover real-time reliability assessment and management; outage management using short-term load and generation forecasting models to study network congestion; and longer term network capacity management.

The prediction of the output of wind and solar generation is an important part of the contingency analysis tool. The Panel encouraged UKPN to investigate the capability of National Grid to predict the output of renewable generation in the environmental conditions of this part of England.

Contingency analysis tools are used by transmission system operators, but are not used on UK distribution networks. A key feature of this project will be the improved operation of the distribution system through a better understanding of generation, loads and capacity and the integration of information from the Transmission Operator.

Carbon and financial benefits. The benefits of this project were focused on the deferral of traditional reinforcement and installation of an additional Super Grid transformer. In addition, an estimate was made of the value of allowing further generation from Low Carbon sources connected to the Distribution Network and improvements in the efficiency of the outage planning work. UKPN argued that subsequent implementations of the contingency analysis tool would be relatively low cost; and they calculated the benefits at GB network scale in the range of £65m (net present value). Within UK Power Networks, there was an expected benefit of £7m by 2030 – assuming implementation at six sites.

The Panel felt that the benefit calculations had possibly not captured all the gains that might be achieved by smarter operation of the distribution system; and the calculations used a number of assumptions that the

Panel felt were not necessarily robust. In addition the DNO pointed out that real-time contingency analysis – while enormously valuable compared with the current scenario approach – was likely to be only a step on the road to active network control and system balancing at the distribution level. This project will potentially in due course, however, offer considerable benefits in terms of deferring investment and managing increased amounts of generation on the distribution system.

The carbon savings claimed by UKPN again appeared lower than the longer term potential (275,000 tonnes per year if implemented at 30 export constrained grid supply points); there would be additional benefits arising from allowing generation to connect quicker and operate with fewer constraints.

Value for money for distribution customers. The Panel considered that this relatively low cost solution, if it became business as usual, would provide benefits both at the project scale and for the wider GB rollout. UKPN had followed a competitive procurement process in selecting the software to be used. The Panel had some concerns about day rates of the consultants, but following the provision of details of the individuals that would be working on the project and the scope and extent of that work, the Panel were satisfied.

Generates knowledge for DNOs. As noted above, this project should provide valuable knowledge on operating the distribution system; the use of load and generation data would provide better visibility on what was happening on the grid and potentially avoid the need for an unnecessarily conservative management regime. The project will provide knowledge on working with National Grid and on appropriate methods and possible obstacles to receiving and using data from National Grid; it will also provide learning on how to make the move toward real time system operation.

Partners and external funding. National Grid and Navigant Consulting are partners on this project. Navigant is a US based firm and will advise

on the development and integration of the software and the supporting business processes.

Navigant assisted in a competitive procurement process to identify Bigwood Systems. They have been selected as the preferred supplier of the contingency analysis software and will provide continuing support and maintenance. The software will be provided to other DNOs at the same price. The relevant source codes developed during the project will be made available to other DNOs free of charge. There was some concern expressed about Bigwood Systems as the company is relatively small. However, Bigwood has a track record of working with a number of major US and Japanese utility companies and UKPN had satisfied themselves that the company was sufficiently robust.

Relevance and timing. The challenges faced by the South East are immediate and should be partly addressed by the successful outcome of this project. At a wider level, it is important that work is done to understand how to operate the distribution system in a smarter way.

Robust methodology ready to implement. The Panel considered the project to be reasonably robust and well thought through. Preliminary work had already been completed and the most appropriate software for the project had been identified. The Panel did however recognise that this was primarily a software project and therefore carried inherent implementation risks; the outputs would be critical to the improved operation of the network. However, the Panel understood that the software had been successfully implemented elsewhere; and in this project it will be used 'off line' – though the outputs will potentially determine how the network is managed.

The Panel noted the proposed project management approach and considered it important that this should be fully and effectively implemented; the nature of the project requiring the integration of new software and the use of data from different sources will require good management.

Furthermore, it is essential that the tool is actually employed and the control room engineers, as well as the outage and network planners, use the tool to its full capability. It is important that the other DNOs should be engaged and the necessary communication activities should be implemented to ensure that they are comfortable with the software and the outcomes. The Panel asked that the SDRCs were revised to take account of these issues.

Panel conclusions. It is generally recognized that distributed generation – particularly where it is concentrated such as in the South East and the South West – requires that the distribution system is actively managed in a way that was not originally anticipated. Such active management clearly requires information from and engagement with the Transmission System Operator and the Panel saw this project as an important step in the evolution of the smart grid. As such, the Panel considered this to be an important project and while the benefits claimed for the distribution company are relatively modest, there is potentially a wider benefit to customers arising from enabling more Low Carbon generation onto the system. The Panel felt that this project had the potential to provide considerable learning.

3.4 Balancing Generation and Demand (Equilibrium) – Western Power Distribution (WPD) - £11.48m requested (£13.09m in total)

Description of project. This project addresses the issue of managing voltage on the distribution system. This is an increasing challenge, particularly where there is an increased demand for connecting renewable generation and other LCTs to the rural distribution system. The capacity of the distribution networks to accept the output from Low Carbon generators in rural areas is more frequently limited by voltage rather than thermal limits.

WPD stated they currently receive 145 applications from renewable generators in the South West to connect to the HV and EHV systems per

month. WPD gave examples of the delays and high costs (arising from network reinforcement) of recent connection offers that had been accepted.

The projects will trial three methods.

First, Enhanced Voltage Assessment (EVA). Present practice for forecasting network voltages aims to ensure the system remains within limits by assuming conditions of maximum generation and minimum load. This is unduly conservative and results in the need for expensive reinforcement and delays for renewable generation to be able to connect to the grid. The EVA work is designed to provide a much higher granularity of data about voltages across the system under a range of system conditions. This will create more knowledge about voltage profiles and the identification of available voltage headroom, and will allow for more realistic forward planning (which should allow for more connections); the assessment will also underpin new voltage management approaches.

This phase of the work will use annual (half hour mean) time series of load and generation data to develop information on expected voltages across the network. As part of this work, WPD will research the DNOs' and customers' equipment to understand whether these would be damaged or fail to operate if the network operated outside the current statutory voltage limits. WPD considers there would be advantages for relaxing these limits, particularly where there was no vulnerable equipment connected to the network. As part of this project, WPD plan to consult widely on the potential for changing industry practices and for widening statutory limits in relation to network voltages.

The second method is System Voltage Optimization (SVO). The SVO method is designed to optimize distribution system voltage profiles over a wide area in the South West. WPD will trial a wide area voltage control system to operate the tap-changers of the 33/11 kV and 132/33 kV transformers. The method will be trialled at eight 132/33 kV

substations and associated 33 kV and 11 kV networks. This system will use the knowledge from EVA to establish optimal voltage targets for the tap-changers. The settings will be updated in real time. The aim is to create extra headroom for distributed generators to connect to the network, while ensuring that customers' voltages remain within existing permissible limits.

The third method is Flexible Power Link (FPL). This will use a Power Electronic device to connect two separate distribution circuits which cannot currently be connected because of circulating currents or fault level constraints. The FPL will allow control of the real and reactive power flow between the two distribution network sections. This will provide a novel way for managing power flows and voltages. The method will trial using one FPL to couple two 33 kV distribution systems. The aim will be to assess the capability of the FPL technology for transferring power and supporting voltages between two distribution systems. This should provide additional capacity where a distribution system with a number of generators can be linked to a distribution system with high demand.

Carbon and Financial Benefits. Considerable carbon and financial benefits are claimed for each of the methods – and it is also anticipated that capacity on the network could be released a great deal more quickly. Overall the financial benefit for the project is estimated at around £45m: the greatest benefits arising from EVA and SVO. The benefits of the Flexible Power Links are relatively small compared with their high initial cost. The Panel recognised that there would be sites where the FPL solution would be valuable; initially WPD proposed trialling an 11kV as well as a 33kV link but following discussion WPD proposed limiting the work to the 33kV as the additional costs of trialling both was difficult to justify in terms of the additional learning.

The increased capacity created by the three methods will allow Low Carbon generation plant onto the networks considerably quicker and at a far lower cost than through traditional circuit reinforcement.

It should be noted that some of the additional capacity assumes that there will be a relaxation of the voltage limits (plus/minus 2% beyond current limits).

Overall, the Panel considered the project would have considerable potential to aid the deployment of Low Carbon technologies and would provide considerable net financial benefits to distribution customers and GB as a whole by considerably reducing the cost of the work that would otherwise be necessary to allow generators to access the system. The Panel recognised the advantages that could be achieved by relaxing the voltage limits on the distribution circuits in certain specific cases; however, they were sceptical about whether this would receive widespread support from the industry and, more importantly, a change in legislation.

Value for money for distribution customers. Both EVA and SVO should potentially provide very good value for money – even if there is no relaxation of voltage limits. EVA in particular, by providing a greater understanding of the voltage characteristics of the networks, should provide a low cost way of using the network more efficiently and allowing additional connections. The Panel was concerned about the cost of the Flexible Power Link. It did recognise that there would be circumstances where this would be an extremely valuable method of linking two circuits with different load and generation characteristics. Nevertheless, the upfront capital cost of the equipment is currently high – although the Panel recognise that if this approach was more widely used, the cost could be expected to reduce over time. The Panel were concerned that the original proposal with provision for two FPL units at the 11kV and 33kV levels would not represent good value for money. WPD made a good case in justifying that of these the 33kV unit, although the more costly of the two units, would deliver greater learning and have broader applicability, and in their final submission limited the testing of the Flexible Power Link to a single link at the 33 kV level. On balance, the Panel considered that with this adjustment the

learning that this would provide and the additional tool that it would place in the DNO toolbox justified the relatively high cost of this part of the project.

WPD has an established process for ensuring competitive tendering for the equipment required in this project.

Generates knowledge for DNOs. All three elements of the project should provide valuable learning for the other DNOs. With EVA the work that would be undertaken on modelling voltage control would be valuable. SVO is a method that has been applied at the transmission level, but implementing it at the distribution level should provide considerable knowledge for other DNOs. Similarly, while Power Electronics is being trialled at the low voltage level (in Fun LV) and at the transmission level, this will be the first project to address the 33 kV level.

Partners and external funding. This project has no identified partners. WPD note that they have developed the proposal in conjunction with PB Power and that the key project collaborators, service providers and equipment suppliers will be selected once the bid is successful. They have identified the equipment and services that will be required and requests for information to suppliers have already been distributed.

Relevance and timing. WPD provided evidence of the increasing number of connection offers that are being made; and the high cost and lengthy delays associated with these offers. Managing the voltage constraints is both relevant and timely. The Panel recognised that Power Electronic solutions are expensive but they are used as Business as Usual for certain applications at transmission voltages and in other sectors. Power Electronics are being trialled at LV and the Panel believes that trialling Power Electronics at higher voltages on the distribution network is important.

Robust methodology ready to implement. There are in effect three projects that are being undertaken; with SVO and FPL resting on the work that will be undertaken in the first stage under EVA. It is a technically complex and fairly expensive project. After questioning, the Panel were satisfied that the methodology was sufficiently developed and planned and that work had already been undertaken to allow the project to go forward fairly swiftly. The Panel considered there was some confusion around the principal purpose of EVA. A key component is clearly to model voltage on the distribution network using historic data to improve voltage forecasting and release capacity; however this was not always clear from the proposal or the discussions. Rather, the primary purpose was presented as providing the basis for a piece of advocacy to relax the voltage limits. The Panel recognised the value from modelling the voltage characteristics to assist planners and the operation of the network; they were more sceptical about the possibility of relaxing voltage limits.

We had concerns about the SDRCs, but were pleased to see these were strengthened in the final submission.

While the trial of the 11kV FPL has, following discussion with the Panel, been dropped from the submission, the Panel would hope that the project would investigate the role of FPL devices in distribution circuits widely and so provide learning applicable for other voltage tiers and this learning would be disseminated as an output from this project.

Panel conclusions. Overall, the Panel considered this to be an important issue and the project would provide valuable learning to allow for the more active management of the distribution system. It also addressed particular challenges associated with distributed generation. It will in addition potentially open up discussions about industry practices in relation to voltage limits.

4 Recommendations to the Authority

4.1 We set out below our recommendations to the Authority on the funding of the 2014 projects.

4.2 The Expert Panel recommends that the following are funded:

- **Fault Level Active Response (FLARE) – Electricity North West**
- **Low Energy Automated Networks (LEAN) – Southern Electric Power Distribution**
- **Kent Active System Management (KASM) – South Eastern Power Networks**
- **Balancing Generation and Demand (Equilibrium) – Western Power Distribution**

4.3 The Panel considered that most the submissions presented this year were of high quality – both in terms of content and presentation. The issues that were being addressed should provide valuable learning. In a number of cases, the proposed methods challenged industry orthodoxies. The Panel recognised that such challenges pose risks – the industry (including suppliers and relevant regulators) might be less willing to implement the solutions as Business As Usual. However, providing the trials are well conducted and the results widely disseminated, the Panel was confident that the results would provide the basis for making progress towards a Low Carbon economy.

There remain a number of issues that the Panel would like to draw to the attention of Ofgem and future submission teams.

- Collaboration within the industry. As GB advances towards more active management of the distribution system, the Panel recognises there is some potential for tension between the requirements of the TSO and the DNO as it becomes more of a system operator. Nevertheless the Panel would welcome better and more timely cooperation between the DNOs and TSOs in future bids. The TSO has considerable operational experience – in addition to holding data relevant to managing the overall

network (e.g. on weather, load and generation). While there are fundamental differences in how the networks behave, it is not necessary for the DNOs to entirely reinvent the SO wheel.

Similarly, if some of these more technically innovative techniques that affect the operation of the network are to gain acceptance, the Panel would like to encourage more collaboration between the DNOs – this could even take the form of joint bids in next year's competition.

- In general, project teams delivered well focused presentations. The second bilateral meeting in particular addressed the key issues that the Panel and consultant had highlighted as being critical in terms of understanding the project itself and how well the project met the Fund Criteria. There were also useful exchanges on ways in which the project submissions could be adjusted within the Fund framework to improve them. This level of interaction was welcomed, both in terms of allowing the Panel to make its assessments and of leading to stronger projects.

- In one of the submissions, the objectives and methodology were poorly presented; repeated questioning was required to enable the Panel to fully grasp the purpose of the tasks to be undertaken. Inevitably, such lack of clarity leaves the Panel with some concerns that the methodology has been insufficiently thought through. The submission teams could perhaps employ a more rigorous internal review process – for example it could be helpful to appoint an internal 'devil's advocate' to check the submission and question the team before the document is submitted. This approach would also have the advantage of spreading understanding about the project within the company.

- The new benefits table that presents future financial and carbon benefits was extremely helpful. However, there appears to be some confusion about whether or not the figures presented are

annual, cumulative, or NPVs. The Panel suggests that Ofgem clarifies this aspect of their advice.

- Other reflections from the Panel's deliberations - some of which have also been made in previous years - included:
    - The Panel was pleased to see the use of more preparatory work (eg pre-feasibility studies) and greater use of Tier One funding (NIAs in future competitions) to lay the foundation for larger projects. The Panel does not consider it is acceptable to recommend the release of large sums of money for an ill-defined project that could have been improved with earlier, limited funds spent.
    - The Panel was also pleased to see explicit building on learning from previous innovation projects and drawing on experience from around the world (and from TSOs). Building on existing expertise and experience improves both the deliverability of projects and value for money.
    - More thought needs to be given to engaging universities so that they can play a relevant role in a cost effective manner. Universities can play an important part in terms of the expertise they can offer and their ability to disseminate results.
    - In general, SDRCs are now more clearly focused on specific deliverables, closely linked to the project goals, and on outcomes rather than inputs. However, there still remained occasions when this was not clearly the case.

4.4 The Panel would like to thank the Project Teams for their work. We would also like to thank the external consultants and the Ofgem team for all of the support and assistance that was provided.