Electricity Network Innovation Competition

Report and Recommendations 2016

Prepared for

The Gas & Electricity Markets Authority

By

The Electricity Network Innovation Competition Expert Panel

October 2016

1 INTRODUCTION

1.1 This report prepared by the Electricity Network Innovation Competition (ENIC) Expert Panel (the Panel) sets out the Panel's recommendations to the Gas and Electricity Markets Authority on the portfolio of projects to be funded in the 2016 NIC funding round. Members of the Expert Panel are as follows:

— Dr Robin Bidwell (Chair)

— Jo Armstrong

— Alan Bryce

— Sharon Darcy

— Prof Nicholas Jenkins

1.2 We received six final submissions. The total funding requested from the ENIC was £46.8m and the fund available this year is £81m. Full details of each submission will be available on the Ofgem website. The names of the Funding Licensee, titles of the submissions and the amount requested from the NIC Fund are as follows (the values in brackets indicate the total cost of the projects).

- **OpenLV: Opening up the Smart Grid**
  Western Power Distribution (WPD) – led by EA Technology Limited (EATL)
  £4.9m requested (£5.9m in total)

- **Proteus: Agile Technology for Future Networks**
  WPD - led by Ricardo
  £7.8m requested (£9.4m in total)

- **PowerFuL-CB: Power Electronic Fault Limiting Circuit Breaker**
  UK Power Networks (UKPN)
  £4.6m requested (£6.2m in total)

- **Transmission and Distribution Interface (TDI) 2.0**
  National Grid Electricity Transmission (NGET) & UKPN
  £8.0m requested (£9.6m in total)

- **INSPIRE*:* Whole-systems thinking for a more complex world of data**
  SP Distribution (SPD)
  £6.0m requested (£8.5m in total)

- **Phoenix: System Security and Synchronous Compensators**
  SP Transmission (SPT)
  £15.6m requested (£19.9m in total)

1.3 The Expert Panel followed the evaluation process set out in the Electricity Network Innovation Competition Governance Document (v2.1 2015). 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 assist in the review process. The Panel and the Consultants met the Funding Licensees early in the evaluation process to allow the project teams to present their submissions. The Panel and the consultants met the Funding Licensees a second time to allow them to clarify points and address matters of concern to the Panel. Throughout the process, Ofgem, the Consultants and the Panel sent each of the Funding Licensees a number of questions with the purpose of clarifying the submissions and highlighting areas of concern.

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 Consultants' advice as well as any additional information that had been submitted via Ofgem or the Consultants from the Funding Licensees; they also took account of information from meetings that were held with the Funding Licensees and any material provided during those meetings.

Based on this evaluation, the Panel reviewed the projects against the criteria. This report sets out the Panel's recommendations to the Authority.

1.4 The Panel evaluated each submission using the criteria set out in the governance document under the following headings (see the full governance document for details).

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

(b) Provides value for money to electricity customers.

(c) Generates knowledge that can be shared amongst all relevant Network Licensees.

(d) Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development and/or Demonstration project to demonstrate its effectiveness.

(e) Involvement of other Project Partners and External Funding.

(f) Relevance and timing.

(g) Demonstration of a robust methodology and that the Project is ready to implement.

1.5 This report should be read together with the Funding Licensees' submissions and the other information that is published concurrently with these 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 views of the Panel; all the details of the projects are contained in the other published documents.

2 EVALUATION OF SUBMISSIONS

2.1 Open LV - Opening up the Smart Grid
Western Power Distribution (WPD) - led by EA Technology Limited (EATL)
£4.9m requested (£5.9m in total)

2.1.1 The Proposed Project

At present low voltage (LV) networks are operated by the distribution network operators (DNOs) on a fit-and-forget basis. There is very limited visibility or control. As increasing capacities of embedded generation and low carbon load are connected, more active management of the LV network will be required so that the available capacity is used most effectively and costs of reinforcement are minimized.

The project will enable the release of capacity of LV networks by installing a secure, low cost intelligent data collection and control unit at 11kV/415V substations that will provide a platform for effective monitoring and operation. The platform will include intelligence, secure communications and monitoring of the power flowing through the transformer and its temperature as well as the current in selected LV feeders. The information will be provided to interested parties including the DNO, those seeking a connection and community energy groups. The improved visibility of the state of the network will allow the DNO to improve its operation of the circuits and other parties to investigate ways to make better use of the network, e.g. by developing software applications to enable them to purchase energy collectively and to connect new loads and generators.

The project will have three outcomes.

- The capacity of the network to accept low carbon loads and generators will be increased through applying new software applications to make use of the real-time dynamic thermal rating of transformers and meshing of LV networks.

- Community energy groups and other third party organisations (e.g. councils, housing associations, schools, universities, etc) will gain access to network data and

information, via the Cloud (a remotely-accessed data storage system), to assist them in developing software applications (Apps) to make better use of the network.

- Finally, interested third parties, such as energy retailers or network equipment manufacturers, will be encouraged to develop and apply innovative services and solutions through software applications mounted on the platform.

Through a customer engagement plan, an important part of the learning in this project is to understand how communities and customers can make use of information about the LV electricity network that serves them. WPD cited existing interest from customers to receive data on time-of-day network capacity, for renewable generation and storage, the possibility of local time-of-use tariffs, and real-time carbon foot-printing. In the future this data could, for example, be used to make better use of solar PV for low-income households in social housing.

Key features of the platform, called LV-CAP, are that it will be a low cost system that meets modern standards of cyber-security and at the same time enables third parties to develop software applications that can safely run on it. Taking this approach, it will allow better use of the assets by the DNO, and provide information and data to community energy groups and others, wishing to connect to and use the network.

During the project the hardware platform will be developed and installed at 60 substations. It will be used to demonstrate how network capacity can be increased through real time rating of transformers and meshing, or connecting together adjacent LV circuits. Actuators will be installed on five circuits to demonstrate how the LV network can be controlled.

The project will also include demonstration of at least five and up to ten software applications running on LV-CAP. Community and other third party groups who wish to take an interest in their energy supply and use will be provided with access to network data and supporting information, and WPD and EATL are undertaking to work with community groups to help them develop applications. Examples of customer benefits include the application of local network data to help organized communities manage their electricity supply usage and costs. The platform will also

provide a facility for interested third parties to develop and install new applications that will allow more effective use of the LV system by the DNO and by its customers. A number of organizations have already expressed interest in developing software applications.

2 .1.2 Carbon, Environmental and Financial Benefits

Through the application of the LV-CAP, it is anticipated that DNOs will be able to increase the capacity of the LV network through real time rating of transformers and meshing LV circuits, thus delaying or lowering reinforcement expenditure that would otherwise be anticipated (described as Method 1).

The IT platform will also make usage data more accessible for community groups and third parties. They will be encouraged to develop software applications and so derive direct benefits for the DNO's customers, such as potential tariff reductions derived from reducing peak loads and negotiating lower network charges in cases where the DNO would otherwise need to strengthen the network (Method 2).

Finally, the new IT system will also offer the opportunity for third party application developers to develop Apps that would ultimately provide savings for both DNOs and DNO customers (Method 3).

The application of the OPEN LV platform is projected to derive the following financial, environmental and capacity benefits at the GB level, following full rollout:

	Financial Benefits £M (net present value (NPV))		**Carbon Benefits**	**Capacity Benefits**
	2030	**2050**	**2050**	**2050**
Method 1	0	120	117.6ktCO2	0.54GW
Method 2	4	177	31.4ktCO2	0
Method 3	164	298	2.9MtCO2	5.3GW

These estimates are based on the following assumptions.

- That at the GB level, between 5,000 and 73,000 feeders will have benefitted through this lower cost application (out of a total of between 133,000 and 686,000 LV feeders that could need some form of reinforcement by 2050);

- The community benefits are based on around 20,000 communities benefitting from a 10% reduction in their electricity bills by 2050;

- Finally, the use of third party Apps will lower the reinforcement costs on 400,000 LV feeders by 2050.

If successfully rolled out at the GB level, the estimated financial, environmental and capacity benefits that are projected in the Submission are considerable; £595M NPV by 2050; 3MtCO2 and 5.8GW respectively. The expected breakeven point for the project is 2023, i.e. 6 years from project commencement.

The benefits shown above are calculated based on the Transform Model and assume the current average aggregate of benefits will be achieved more widely. There is obviously considerable uncertainty in determining what type of benefit might arise from offering more visibility on the LV networks – both to the DNO operator and to community groups and third parties. It is also not clear as to the extent to which community groups and other interested third parties would engage, and to the extent they do, what would be the potential financial benefit to the distribution network. However, the Panel considered that while the nature of the potential benefits might be difficult to predict, there was a real potential to assist the Carbon Plan (by allowing local community groups to engage) and by providing another tool to help DNOs avoid the considerable cost of local network strengthening. The Panel was satisfied that the eventual roll out costs should be low and that the benefits should far outweigh the costs.

2.1.3 Value for Money

The outputs for this project are expected to include a low cost box (Method 1) that can be easily installed in the low voltage substation; data feeds that can be accessed both to

assist WPD with the control system and by community groups and third party developers.

Overall, the Panel considered that this project offered good value for money, but there were some concerns that EATL's costs were high and although they were contributing £463k in kind, nevertheless they were a potential long term beneficiary. Following discussions, WPD were able to agree with EATL they should further reduce their costs.

WPD selected EATL through a process whereby they put a 'problem case' to the wider sector; they received 35 responses and eventually 11 submissions. In a procurement process of this type, it is potentially difficult to drive down costs. However, WPD assured the Panel they had reviewed all the costs and had achieved good value for money.

2.1.4 New Learning

The Panel considered the most important new learning associated with this project was to determine the appetite and ability of communities and App developers to engage with DNOs; and to develop applications that help manage the network. The project should test willingness and ability to engage and possibly the price points that will be necessary to secure engagement, as well as the data flows that will be necessary to make the system work. Early involvement of community engagement expertise will be important.

There were some concerns about how well the learning would be captured and disseminated. Given that the community element of this project is a relatively novel approach, it will be important that the learning from this project is disseminated beyond EATL into WPD's business-as-usual activities and the wider sector in order that engineers should have confidence to consider this as an approach for planning and managing the LV network. The Panel was reassured that, in the final submission, the inclusion of dedicated resource to carry out an economic assessment and extrapolation of the community learning should help to address this concern and –

through the provision of case studies and other tools – support the wider adoption of the approach by other community groups.

2.1.5 Innovation

The Panel recognized the importance of building a low cost box for monitoring the LV system, while at the same time being fully secure for use in active network control. However, it considered the principal innovation was the provision of data about the operation of the LV network to community groups and other third party users in a form that could be accessed for third party applications.

The Panel considered this project to be innovative and appropriate for NIC funding.

2.1.6 Involvement of other Partners

EATL is the only contributing partner; however, Nortech and Lucy Gridkey have also been selected as suppliers. The project has support from Bristol City Council and the universities of Bristol, Reading and Oxford, and apparently a major energy supplier has expressed interest in developing an App. The Panel was pleased to see the involvement of community engagement specialists in the later stages of the development of the bid. EATL is making a contribution in kind; WPD will also be using equipment from Nortech or Lucy Gridkey. The Panel discussed whether they might have been expected to make a contribution but decided there would be no specific long term benefit arising to these companies as the communications container can be deployed by others.

2.1.7 Relevance and Timing

The Panel considered the project to be relevant and timely: the roll out of the Carbon Plan will inevitably put stress on the LV networks. The project should also support the development of local solutions and smart cities.

2.1.8 Robustness of Methodology

The Panel considered that overall the methodology was sound but, given the importance of the trials and learnings associated with the third party access to date, the Panel was concerned that insufficient attention had been paid to early community engagement and capturing this learning. In the submission, the community engagement element of the project had yet to be fully developed and the Panel felt that there was not sufficient funding to deliver the projected benefits. Expertise will be needed to liaise externally pre and post-trial with communities and other interested groups and the wider sector, including App developers (to persuade them of the benefits of the approach), as well as internally within WPD (to ensure that the requirements of all sides are fully understood). Following discussions with WPD a revised plan for this aspect of the work was submitted and its share of the budget increased.

In addition, the Panel was concerned that the communities would be expected to fund the Apps that would be required by the trials. It appreciated WPD's intent that it was important that the communities should feel that they owned the problem and solution, but nevertheless failure to find the resources to fund the Apps would affect the proposed project and the learning. WPD agreed to help ensure that sufficient resources were made available and if necessary would themselves fund one of the Apps from their corporate social responsibility budget. However, they were keen as part of the trial to demonstrate the interested parties would consider it sufficiently worthwhile to raise the funds themselves.

2.1.9 Conclusion

The Panel was strongly supportive of many aspects of this project. The Panel was satisfied that WPD had responded to many of the concerns raised during the evaluation process and recommends that this project receives NIC funding subject to the following condition:

- that the community engagement plan should be revised to ensure that sufficient pre-planning, trial structuring and early consultation work is carried out and some hypotheses around potential engagement are properly tested (e.g. Who engages? Under what conditions? What are the barriers? How do all participants see the benefits? etc). An additional successful delivery reward criterion (SDRC) should be

put in place to cover this and delivered in the first twelve months of the project. Some of the key learning will be around third party access and this should be properly researched; this project should be viewed and so treated as more than an engineering and control project.

2.2 Proteus: Agile Technology for Future Networks
Western Power Distribution (WPD) (Project led by Ricardo)
£7.8m requested (£9.4m in total)

2.2.1 The Proposed Project

The project will develop and trial a mobile, trailer mounted toolkit that will temporarily resolve the effects of overloads on the LV network and gather data for the later design of a permanent solution.

The connection of increasing numbers of small, embedded generators (e.g. solar PV systems) and low carbon loads (e.g. electric vehicles) has the potential to overload LV networks and lead to voltage and thermal excursions outside operating limits and to possible power quality problems. Based on the Transform model, the proposal estimates that 50,000 11kV/415V substations in GB will be overloaded by 2030.

A range of equipment will be integrated and mounted in a trailer that can be towed behind a vehicle. This mobile equipment has the potential to be deployed rapidly to allow a DNO to bring the power flows, voltages, harmonics and phase imbalance on an overloaded LV system back into limits temporarily. It may also be used to monitor the network and to identify the optimal permanent solution to be implemented.

The mobile equipment is intended to be deployed rapidly (within a day or so) and will provide a temporary solution to a specific LV problem (typically for around three months). During this time it will be gathering diagnostic data that will provide the basis for the design of a permanent solution. It is intended that the operation of the equipment will be automated, enabling a field technician to connect it quickly and

relatively easily either at the substation or at a network open point, such as a street pillar or underground link box. A permanent solution will then be proposed based on applying smart grid techniques, which offers the potential for it to be at a lower cost than were the conventional approach to be taken to upgrading the network capacity.

The package will consist of the following key elements:

- A Flexible Capacity Unit will be located temporarily at an 11kV/415V substation to reduce excessive load on the transformer or cables and maintain acceptable voltages.

- In some situations, an additional auxiliary Dispersed Capacity Unit will also be installed temporarily on the LV network, typically at a link pillar, to transfer load to an adjacent substation that has spare capacity, thereby maintaining network voltages. It is suggested that an average of 200kVA of network capacity will be released by each installation of the mobile package.

- Network monitoring capability that will be installed at strategic locations on the network.

The main equipment will consist of reconfigurable power electronic converters and associated coupling transformers to redirect power flows and maintain network voltages and will include:

- A convenient means of rapidly connecting energy storage batteries or a generator.

- A means of providing additional ventilation and cooling of the substation transformer.

- A local network diagnostic and autonomous control system, comprising sensors, computing hardware and algorithms.

- A remote monitoring and management system which will connect to a number

of mobile units by a suitable communications link.

WPD estimate that the equipment would be suitable for use on around one quarter of overloaded networks, and that a maximum of around 550 units could be deployed across GB.

The system will have a local autonomous logic and control capability. It will take in network information monitoring data to set functions, operation modes and set points. Remote data management and the control system will enable users to track real time performance and to implement certain control actions (such as changing modes and set points). However, the system does not allow real time operational control – this will be done locally by a member of WPD's operational staff. It is intended the management system will also collect and log historical data so that users can understand historical performance.

Following detailed design work, a 'demonstration solution' will be subjected to pre-deployment testing at an appropriate UK test facility in order to ensure that the system is safe to install on the live network and the system functions as expected. The equipment will be trialled at a number of different sites. In the final part of the trial phase, the system will be deployed at a site with real or simulated network capacity issues, and with simulated time pressures, in order to determine whether the technology can solve the issue and characterise it so that a permanent solution can be found. In each case, the trial sites will be selected to maximise the learning associated with the aim of the trials.

2.2.2 Carbon, Environmental and Financial Benefits

The availability of the Proteus flexible and dispersed capacity units is projected to save time in applying temporary solutions to LV network problems and provide time to determine the most cost effective permanent solution.

It also has the potential to help manage the anticipated increase in domestic and other low carbon technologies (LCTs) and renewables connecting to the LV network – and potentially assist in avoiding the need for strengthening by providing an interim fix

followed by a more efficient solution (e.g. LV feeder meshing).

The project team has estimated the following financial, environmental and capacity benefits at the GB level, following full roll-out:

Financial Benefits £M (NPV)		**Carbon Benefits**	**Capacity Benefits**
2030	**2050**	**2050**	**2050**
91	407	7.1ktCO2	58MVA

The project team has, as an assumption, stated that Proteus will ensure temporary power quality restoration within two days compared to the current business as usual experience of anything between 3 to 12 months. Using the Proteus solution, only one to two customer interruptions are expected, compared with up to 360 individual customer interruptions, many of whom could potentially be interrupted multiple times until the permanent solution is found under BAU. Proteus may also help with short-term voltage problems.

It has been estimated that the cost of investigating and planning the permanent solution is £10k under Proteus compared to £5k under BAU. The cost of the permanent solution varies depending on the solution chosen. However, the Proteus offering is assumed to deliver additional financial savings as the information gathered with its temporary solution allows a more sophisticated final selection (including doing nothing as the data gathering may suggest the fault that triggered the original intervention could prove to have been temporary).

The submission suggests with full roll out there would be 25 units being deployed in the first year and then doubling annually up to a total of 550 units for use across GB.

Whilst under these projections the benefits of the full deployment of Proteus could be viewed as considerable, the Panel had concerns about the underlying assumptions.

- A sizeable proportion of the Proteus benefits arise from the expectation that the project will lead to more cost-effective, non-traditional permanent solution being

deployed. It is not clear the extent to which this will be a truly incremental benefit, because temporary BAU solutions already exist that could offer the planning time and the data needed to determine the best solution; and lower cost smart techniques previously funded by LCNF/NIC can already be included in the options considered for the longer term solutions on LV networks.

- The benefits are dependent on all DNOs (including WPD) deciding to invest in purchasing relatively large numbers of these solutions. Given the options that DNOs have and will have for managing overloaded LV circuits this may prove not to be the case. In addition, the Proteus vehicle and associated connections may be viewed negatively by local authorities and customers should it be parked and fully-installed in local neighbourhoods, for upwards of 3 months at a time, especially if it creates a major inconvenience to normal road or pedestrian use or noise disturbance.
- The Panel also considered that its use would be far more limited than proposed. For example, it is probable that for many of the potential problems, a lower cost diagnostic approach would be suitable; once the level of problems that are anticipated on the LV network start to occur, it should also be possible to predict sufficiently early where faults would occur and to take pre-emptive action.
- In particular, the Panel was not convinced that other DNOs would see Proteus as a strategic solution for responding to the anticipated overloading of tens of thousands of LV networks, calling into question the assumptions about the scale of its roll-out and the total resulting benefits.

The breakeven analysis suggests that if only 15 units were deployed, the NIC grant would not be repaid until 2035, i.e., over 15 years from project commencement. The Panel was conscious of the likely future changes in the technology over this period as well as the availability of other solutions to manage overloaded LV networks.

2.2.3 Value for Money

The proposed Proteus system would be an additional tool for managing constraints on the LV network. In particular, it would allow the DNO to deal more rapidly with faults arising from overloading the network and will potentially provide information that will lead to more cost effective solutions. The particular benefit for customers will

be the ability to quickly resolve the immediate issue, identify the source of the problem and put in place the appropriate solution in a faster time frame than would otherwise be the case. The Panel recognized the importance of the rapid deployment of equipment to restore power when a fault (arising from an overloaded circuit) arose; and clearly there is also a need to find ways to improve the availability of information to the extent that this allows for lower cost solutions for overcoming the problem in the long term.

However, it was not convinced that packaging the equipment into one mobile device would create sufficient additional benefits to make this relatively expensive project value for money for customers. It further considered that, for data collection and the design of long term solutions, better, lower cost options were potentially available or under development. In many situations, solutions for dealing with an overloaded circuit (e.g. provision of a generator) would still be required and Proteus might offer limited additional value in the immediate aftermath of a fault.

The Panel was concerned that the integrated system within the trailer could become obsolete over time – and, being integrated rather than fully modular, it would be more difficult to keep up to date. The expectation is that the LV network will become stressed in 2025 and beyond, so in the Panel's view there was a real risk that this particular integrated solution could become outdated.

At the same time, the Panel could accept that a small number of these vehicles might prove valuable to a DNO: but given the cost of the project (over £9 million in total), and concerns that better ways of dealing with this future problem are likely to be found, meant that the Panel did not consider this project value for money.

There were also concerns about the high cost of certain aspects of the project: in particular, the Ricardo charge out rate was considered high given the significant amount of time they were contributing to the overall project. Ricardo subsequently proposed to reimburse to customers (via Ofgem) 5% of the revenue on each of the units sold, up to 120% of the customer funding.

2.2.4 New Learning

New learning will be created in this project as Proteus uses some solutions currently untested on the LV networks such as static synchronous compensators (STATCOMs) and unified power flow controllers. New learning will also arise from the integration of techniques previously deployed in other Low Carbon Networks Fund (LCNF)/ENIC projects: FUN-LV (UKPN), FALCON (WPD) and Celsius (ENWL).

There is a well thought through dissemination plan and UKPN will peer review the project as it progresses. However, this dissemination is largely externally facing: there is less detail on how Ricardo will work with internal WPD stakeholders to ensure that the Proteus solution is fully adopted by the DNO's own business. However, we are assured that WPD would purchase such vehicles, should they be produced.

Ricardo will have foreground and background intellectual property for the integration of the systems within the mobile units and the unit design. WPD has said that the top level approach is not patentable and that other suppliers will be able to produce similar equipment.

2.2.5 Innovation

The proposal is innovative in concept: a mobile set of electronic equipment will be used to redirect power flows and maintain voltages as well as assist with configuration and automatic operation. Such power electronic equipment is only now being installed permanently and demonstrated in a previous ENIC project, FUN-LV. The anticipated automatic configuration and operation of the temporary equipment and the automatic operation of the instrumentation that will collect data and help define the permanent solution will be innovative.

The integration of this equipment and the 'size reduction' required in order to fit the component parts into one vehicle (shown to the Panel as a single 'horsebox' trailer) while maintaining the ease of connection and flexibility required will be innovative and demanding.

2.2.6 Involvement of other Partners

WPD put out a call for projects designed to address the issue of how to temporarily increase LV capacity. Ricardo was selected as the lead project partner from 33 responses. Ricardo has good expertise in running a project of this type and brings additional integration expertise. They will be supported by Turbo Power Systems (FUN-LV project), Imperial College London (experience of logic and control algorithms) and ASH Wireless Electronics (experience from Celsius).

The Panel was satisfied by the appropriateness of the partners and the robustness of the contractual arrangements. Concerns about external funding are addressed above.

2.2.7 Relevance and Timing

There are currently instances of the LV systems being overloaded. However, the Transform model forecast suggests that this problem will become considerably more serious in the late 2020s and 2030s as the use of electric vehicles, LCTs and domestic renewables becomes increasingly common. The Panel did not foresee a large demand for these mobile units until after 2025 when alternative and potentially more cost-effective solutions might be available.

2.2.8 Robustness of Methodology

In principle, the proposed approach is straightforward involving the design and development of the equipment followed by a number of trials. However, the Panel had a number of concerns.

- They considered it would be difficult to shrink the footprint of the proposed transformers so they would fit into a vehicle of the size proposed while maintaining flexibility. Discussions with the project team suggested that this would be a challenge.

- The Panel was also concerned about the effectiveness of some of the mitigation techniques discussed in the proposal and their automatic operation. Some evidence to confirm and illustrate the techniques proposed, perhaps from the

initial results of simple simulation studies, would have strengthened the proposal.

- Finally, the Panel was not wholly satisfied that all of the neighbourhood safety issues had been thought through.

2.2.9 Conclusion

The Panel could see the attraction of the mobile one stop shop that could be 'rushed' to a problem site to provide immediate relief and to assist in the design of a long-term solution – preferably without the need for strengthening the circuits.

The Panel was not, however, convinced that Proteus would provide sufficient real benefits over alternative ways of dealing with these issues. The development of small scale diagnostic equipment could be a better solution in many cases; and it was recognised that in any case the temporary solution would often require a generator or battery to be used. The Panel did not consider that there was enough certainty of take-up of these mobile units by other DNOs to justify sufficiently the initial costs of development. Furthermore, they were concerned that emerging techniques for resolving problems on the LV networks could make the integrated equipment available on the vehicle (and whose development would have been paid for by this project) potentially obsolete.

The Panel was unable to recommend that this project should be funded.

2.3 PowerFuL-CB: Power Electronic Fault Limiting Circuit Breaker
UK Power Networks (UKPN)
£4.6m requested (£6.2m in total)

2.3.1 The Proposed Project

The project uses novel power electronic devices to address the well-known problem of managing short-circuit fault currents – a particular issue in city centre 11kV networks.

Short circuit faults are inevitable in an electrical network and are typically caused by equipment failure due to manufacturing defects, ageing or third party damage. A level of prospective short circuit fault current that is in excess of equipment ratings cannot be tolerated, as the network faults will then lead to unacceptably high currents, further equipment failure and danger to personnel. Rotating generators increase the short-circuit currents that flow in a network when a fault occurs.

The design of the short circuit level of networks was chosen many years ago before the widespread connection of distributed generation. The fault level was chosen to be close to equipment ratings to minimize cost while maximizing power quality. Thus the operating short-circuit level of dense (11kV) distribution networks in urban centres (e.g. London and Birmingham) are close to their upper limits. In these situations, the connection of the generators of new Combined Heat and Power (CHP) schemes to the network is not permitted without changes to substantial parts of the associated distribution network, particularly circuit breakers and cables. This often leads to high costs e.g. for equipment replacement or additional protection. These costs and/or the unacceptable levels of disruption result in such CHP schemes, which are an important way to de-carbonize heat, effectively being denied a network connection.

Several novel fault current limiters to address this problem have been investigated and trialled in previous network innovation projects but so far no satisfactory equipment has emerged. It has been particularly difficult to reduce the footprint area of the equipment to fit into the space available in city-centre substations and to establish a robust safety case. An existing solution, which does address physical size and is known as a fault current limiter, is a "single-shot" device which means that, if it operates, it subsequently takes a number of hours or days to re-connect the circuit for normal operation. Existing inter-trip systems also require distributed generators to be isolated from the system, often until the network is fully repaired and reinstated. These impact directly on the availability of the customer's generation and on wider network security of supply.

This project aims to support the development and testing of two fault current limiting circuit breakers based on power electronics. Semi-conductor based fault current circuit

breakers are expected to have a smaller footprint than the magnetic fault current limiters investigated previously and they have not so far been trialled in GB. One is to be tested at an 11kV substation and one in the premises of a customer with CHP. After testing in a short circuit laboratory, trials will demonstrate the operation of the 11kV fault current limiting circuit breakers on the live network.

A key part of the project will be to develop safety cases that will support the operation of these devices on UK networks. This work will be undertaken early in the project, once the initial design of the circuit breakers is finalized. A robust safety case is essential before these safety critical devices can be installed on the network and during the bi-lateral meetings the Panel was reassured that sufficient time and resource had been allocated for this aspect of the project.

There are four work streams.

- In the first work stream, prototypes will be developed for the substation (by ABB) and for the customers' sites (Applied Materials (AMAT)). These prototypes will be fully tested in the manufacturers' own laboratories (AMAT has already carried out tests at an independent laboratory) and will expect to laboratory-test any changes to the design.

- During work stream 2, the two technologies will be demonstrated: at the substation and at the customer premises. A key component of this phase will be the development and approval of the safety case. We understand that work on this has already been started.

- Work streams 3 and 4 are designed to match these potential solutions with customer requirements and expectations. The results of the learning are to be captured in an assessment of the suitability of the different trial solutions. In the final work stream, stakeholders will be targeted and information on the suitability of the technologies and the lessons learnt will be made widely available.

2.3.2 Carbon, Environmental and Financial Benefits

The deployment of the ABB Fault Limiting Circuit Breaker (FLCB) at a substation or the AMAT FLCB at a customer generator site offers cost effective solutions to securing more distributed generation (DG) on fault-level constrained networks.

The following financial, environmental and capacity benefits at the GB level, following full roll-out were declared:

	Financial Benefits £M (NPV)		**Carbon Benefits**	**Capacity Benefits**
	2030	**2050**	**2050**	**2050**
TOTAL			3,814ktCO2	462MW
Method 1: ABB	113	403		
Method 2: AMAT	124	370		

The major beneficiary from the headroom released will be CHP connection customers, which is particularly beneficial to urban constrained networks. It is estimated that between 694 and 770 sub-stations could become constrained due to fault level violations from 2020, representing approximately 20% of GB primary distribution substations. Additional head room will become increasingly necessary if planning rules to incorporate CHP schemes in new build proposals are to be deliverable e.g., as a means of meeting Government emissions and energy efficiency targets and delivering more cost effective heating solutions for low cost housing. For example, the Greater London Authority expects that 25% of London's heat and power will come from local sources by 2025. Already UKPN has seen connections requests not being realised because of the high cost of addressing fault level constraints.

The Panel noted that the potential costs savings for the PowerFuL-CB solutions are considerable; the submission put forward an average cost of BAU upgrading of sub-stations at around £2.48 million per sub-station whereas the ABB solution costs between £0.5m and £1.25 million and the AMAT solution is £0.3 million per generation connection.

The breakeven analysis shows that only three ABB units or one AMAT unit would need to be deployed to ensure customers' ENIC contribution is recouped.

The Panel considered that this project offered considerable benefits: it has the potential to assist with the roll-out of more CHP in urban areas, should be less disruptive than alternatives and the potential benefits far outweigh the cost.

2.3.3 Value for Money

The primary long-term beneficiaries from this project will be the developers of CHP and local residents – to the extent that this reduces their heating costs. In addition, it is an important element in decarbonising the provision of heat. The DNO is less of a direct beneficiary – except in so far as it more widely assists the management of fault levels on the urban circuits.

The Panel considered this project to be important in so far as it would add to the DNO's toolbox when addressing urban centre fault levels. A key issue for this and other potential technologies relates to the safety case and in particular to developing an approach that 'fails safe'.

Overall, the Panel considered that this project should provide good value for money.

The Panel was conscious that two manufacturers (ABB and AMAT) would be trialling their technology which, if successful, would provide considerable commercial benefit to the two companies. The Panel was satisfied with the contribution made by AMAT and, following discussions with UKPN, ABB increased its contribution. The Panel noted that this was the highest contribution (as a proportion of total project cost) that ABB has provided for any LCNF/NIC project.

2.3.4 New Learning

Safety was considered by the Panel to be a key issue for this project. UKPN have agreed to establish a safety case process tailored to the GB distribution industry. This will provide valuable future learning.

The project also has to focus on understanding the requirements of potential customers and linking that to creating advice on possible solutions in different contexts. This again should provide valuable learning for, in particular, CHP developers and local authorities for those sites where space is at a premium.

Furthermore, the project will demonstrate whether or not these technologies can be deployed on the GB network.

2.3.5 Innovation

Fault current limiting circuit breakers based on power electronics are only now becoming possible through the development and wide availability of high power solid state switches. Two innovative devices using different technologies will be trialled and compared in slightly different applications.

2.3.6 Involvement of other Partners

From discussions with UKPN, the Panel was satisfied that UKPN had selected appropriate partners for this project. Supporters include the Greater London Authority, Imperial College (who will provide advice on power electronics), ENWL and WPD. The latter two distribution companies face similar issues in their regions.

2.3.7 Relevance and Timing

There is considerable attention being paid to the installation of CHP: for example, the GLA expects a considerable increase in the demand for new CHP connections – their Coordinated Action scenario projects a six-fold increase from the year 2020 to the year 2031, rising to nearly 1.7 GW of CHP being connected in London (compared with the current 300 MW).

It is clear that this is a relevant project and will contribute to the Low Carbon Transition.

It is also timely. One solution is close to demonstration (AMAT's) and one requires significant work (ABB's).

2.3.8 Robustness of Methodology

The Panel was satisfied that UKPN had a robust methodology. First, they had addressed the need to engage with DG customers in the target area. They had had dialogue with the Association of Decentralized Energy to help them engage with the DG/CHP community; and they had learnt lessons from the Flexible Plug and Play project.

As noted above, a critical part of this project is the safety around the equipment to be trialled. Frazer-Nash had already prepared a safety case feasibility study for the bid involving UKPN's chief electrical engineer. The full safety case will cover the safety of the technology itself and the network and operational implications. UKPN assured us that they were committed to engage with the HSE and their own management; and that there would be no risk to the network during the trial itself.

The Panel had two concerns.

- The Panel was told that the new equipment would be run in series with conventional (larger) equipment as a fail-safe precaution should the trialled equipment not operate as expected. The Panel was assured that this need for back up equipment would not lead to space limits being exceeded and thereby reduce the applicability of the solution and that there would be circumstances in the longer term where such back-up would not be required. The Panel would like to see an SDRC at the end of the first year that covered the delivery of a study plotting a longer term path, including the technological and operational safety case, to the time when the trial equipment could be deployed as BAU without the FLCBs being installed in series with a back-up.

- The Panel had some concerns about the net cost to the project of ABB's work. However it was recognized that ABB's equipment was only at technology readiness level (TRL) 4 and that there was possibly insufficient a global market

to justify ABB bringing the technology to TRL 7 in the timescale dictated by the project. In the context of the urgency of finding a solution to the city centre fault level issue, the Panel considered the increase of ABB's contribution to be adequate on the basis that ABB would take the risk of ensuring the FLCB would be fully tested and would be at a stage when it was ready to connect for the trials. ABB also committed to subsequently ensure the technology was further developed so as to be offered as a commercial product.

2.3.9 Conclusion

Fault level constraints are a particular characteristic of dense urban networks; and UKPN argue that a significant number of DG connection enquiries in their area are not being realized because of the cost of managing these constraints using conventional means. The two pieces of equipment that are being trialled each offer particular benefits to manage the problem; and they both address the issue of the need to overcome space limitations. These technologies would be considerably cheaper than existing solutions.

The Panel recommends that this project receives ENIC funding subject to the additional SDRC discussed in 2.3.8 above.

2.4 Transmission and Distribution Interface (TDI) 2.0
National Grid Electricity Transmission (NGET) and UKPN
£8.0m requested (£9.6m in total)

2.4.1 The Proposed Project

The transmission system in the South East of England has limited capacity to accept either new interconnectors to continental Europe or distributed generation connected to the distribution network. It is particularly constrained under certain network configurations during planned or reactive outages. The technical constraints are:

- Dynamic voltage stability: requiring reactive power delivery at short notice;

- High voltage: managing the voltage on the network during low load periods; and
- Thermal capacity: potentially leading to generation curtailment during the summer maintenance period.

Rather than install new transmission plant, distributed energy resources (DER), such as generation and storage, connected to UKPN's distribution network, will be managed to control flows of real and reactive power in both the transmission and distribution networks, to release capacity on the transmission system. At present, distribution-connected DER is typically controlled to meet the requirements only of the generator and the distribution system. The project will demonstrate how the control can also be changed to support transmission system needs while still operating within acceptable limits on the distribution system.

Thus an innovative solution is proposed in which UKPN and National Grid will collaborate to maximise the use of distribution-connected DERs to resolve transmission voltage constraints. UKPN will control flows of real and reactive power in their network to release capacity on the transmission system. This will be done through a combination of technical and market mechanisms.

Specifically, the project will focus on:

- Providing a technical solution based on information and communication technologies to interact with all market participants so as to facilitate the provision of services by the DER to NGET;
- The development of new commercial arrangements between the DER, the DNO (UKPN) and NGET– with the goal of ensuring they are sustainable over time.
- The engagement of potential market participants to ensure the involvement of a wider number of players.

The TDI 2.0 approach aims to test the potential for tapping into regional power markets through innovative commercial arrangements. In particular it will:

- seek to establish whether transmission network voltage constraints can be relieved cost effectively by using reactive services from DERs co-ordinated through DNOs;
- develop technical control systems to facilitate wider and more extensive use of existing regional assets, so that NG can secure the services it needs more cost effectively whilst not being detrimental to the operation of the distribution network;
- seek to test the potential for the provision of additional distribution network capacity via establishing new, network-wide contracting arrangements – ensuring that the incentive structure developed secures sufficient DERs to make this new market operate on a long-term sustainable basis;
- seek to develop a new commercial framework that will underpin the development of a distribution system operator (DSO) route to market.

In the project, UKPN will offer reactive and active power services to NGET, thus developing a new local balancing mechanism. UKPN will act as the 'aggregator of aggregators' (i.e. a service aggregator). For reactive power, the DNO will run a forward tendering process to secure reactive capabilities, using criteria that will put technical requirements first. For active power, they will be the gate-keeper for modifying the flow of megawatts from real-time bids on to the network.
The project involves:

- the development of an IT system that will permit effective and timely interaction with all market participants,
- the development of new commercial arrangements for the provision of the new services likely to be offered,
- extensive market and customer engagement to understand the potential for impediments to wider roll-out and
- the establishment of a framework for secure grid operations which will deliver efficient coordination across SO and DNO investment planning, operational planning and real-time horizons.

There will be an initial design phase followed by functional testing to ensure that all technical aspects (including the ICT controls) are working. Following the testing phase, trials will be carried out with selected renewable generators. The aim is to

select different groups of generators based on criteria including: the location of the DER, the technical capabilities of each resource to provide the services and their availability at the time of the trial. The trials are aimed at providing information on ways in which to provide the most effective reactive responses.

Overall, the project is aims at create learning outcomes on:

- the technical delivery of services when delivered by DERs through UKPN to NGET;
- the use of automatic voltage control and voltage target changes at grid and grid supply point (GSP) transformer to maximise the response the DER can deliver;
- engaging potential service providers and providing a valuable service to the SO;
- understanding the cost of delivery to the DER and the length of contracts required to secure such services;
- determining if the market is attractive enough for new participants and different technologies; and
- assessing how the coordination and governance works in practice with the different roles, processes and business models that will need to be integrated into the solution.

2.4.2 Carbon, Environmental and Financial Benefits

The project will demonstrate how the constraints on the transmission system (outlined in 2.4.1) can be addressed through services, procured from DERs connected to the DNO's network.

Two cost benefit cases are presented. One (Method1) assumes all the benefits accrue to the distribution system; the other (Method 2) assumes an additional saving through the use of TDI 2.0 to reduce some of the reactive power compensation required to be installed on the Transmission network, through installing a cheaper equivalent on the DNO network.

A key benefit from the TDI 2.0 approach is the delay or avoidance of significant investment in the transmission infrastructure that would otherwise be required to allow access to and faster deployment of DG on the DNO network.

The application of the TDI 2.0 approach throughout the GB network is projected to derive the following financial, environmental and capacity benefits at the GB level:

	Financial Benefits £M (NPV)		**Carbon Benefits**	**Capacity Benefits**
	2030	**2050**	**2050**	**2050**
METHOD 1	152	379	See below	See below
METHOD 2	163	413		

The additional financial benefits projected to accrue from deploying Method 2 means this reaches breakeven marginally faster than Method 1; year 10 as compared to year 11.

There will potentially be 3,720MW of new DER connections in the project area by 2050, which is projected to require an additional £190 million (2016 prices) of capex investment to secure. Utilising the TDI 2.0 approach should reduce these capex costs to £90 million. Overall the estimated saving up to 2050 is around £25-30 million and for a GB rollout around £400 million.

In the submission, NGET states that the time is rapidly coming when it will not be possible to connect any further renewable generators to the distribution system in this area because of transmission constraints. To allow further distributed generation, significant and costly capital expenditure by UKPN would be required. The Panel recognized that this project would provide the considerable carbon benefits of allowing further renewable generation to be delivered in the South East to meet the Government's goal of decarbonizing electricity generation.

2.4.3 Value for Money

There has, in recent years, been considerable discussion about the potential for the transmission operator to collaborate with DNOs to help address issues on the transmission system. In the South East, there is a particularly acute problem that will limit the amount of distributed generation that can be connected in future unless some form of action is taken. This project will examine the practicalities of operating a coordinated system between the SO and the DNO with the potential for creating considerable value for money for customers (and enable more distributed generation to be connected). Customers should also benefit from potential savings in transmission charges, and distribution network customers should also share in the DNO's new revenue stream.

The Panel considered the proposed supplier procurement system to be satisfactory.

2.4.4 New Learning

There is considerable interest in the practicalities of the collaboration between the SO and a DNO in terms of supplying services. Learning that this project is likely to produce will include:

- Are there enough DERs in the system, offering the services that NGET is going to require to ensure an effective and sustainable market pricing system can be developed?
- Will the pricing mechanism that is developed ensure cost effective long-term supply of services?
- Will the entry and transactions costs be too high to prevent small DER participants from being able to access the market?
- How will access to this market affect current commercial arrangements between DNOs and DERs, as well as between NGET and DERs?
- What governance arrangements will be needed between NGET, the DNO and the DER owners to ensure there is a level playing field both in the dispatching regime as well as in managing and monitoring the flow of funds.

TDI 2.0 will also develop governance arrangements around new products/market development. There are proposals for a Market Development Advisory Panel (to involve project partners, Ofgem and electricity generators, etc) and a working group (which also includes Suppliers and Elexon). This is designed to provide learning on the management of conflicts of interest in the development of the market rules and structures.

Overall the Panel considered that the approach being adopted will offer significant learning on what will be needed not only for the establishment of a new market arrangement but also the measures that will need to be considered if a DSO is to develop a collaborative arrangement with the SO.

2.4.5 Innovation

The complexity of developing a new, open market system for the trading of DER services is not trivial both in terms of cost and complexity. . The project is also technically innovative in understanding how the DNO's system and DER can be operated in such a way as to ensure that reactive power sourced at distribution level is delivered up to the transmission system. The control algorithms and systems being demonstrated in the trials are innovative.

2.4.6 Involvement of Other Partners

UKPN are the key partner in close collaboration with NGET. Baringa have been recruited to assist with market understanding and technical expertise in areas such as managing reactive power. In developing the project, the partners have had contact with Elexon and suppliers.

2.4.7 Relevance and Timing

The provision of this learning can be considered as extremely timely, and in relation to the South East, a successful outcome would enable DG to continue to connect to the distribution network. A better understanding of whether this is an appropriate model

for a DSO, and whether the benefits of 'local' services are deliverable in this way, will be important.

2.4.8 Robustness of Methodology

The Panel was impressed during the bilateral discussions with the considerable grasp that the project partners had of the non-engineering complex issues that will need to be addressed. Issues of the recruitment of DERs, capable of providing 130 MVAr of reactive power, with available active network management (ANM) capability is key to the project: the partners have already identified 12 companies, including 9 aggregators that are interested. There are plans for user group meetings and surveys to ensure sufficient capacity is recruited. Issues such as governance arrangements, interactions between the DNO and NGET, settlement, etc appear to have been well thought through.

2.4.9 Conclusions

This is a complex project: requiring engagement with DERs and the need to convince them to supply a new service; encouraging new generators/storage to participate to assist with their connection; requiring close collaboration between the DNO and NGET to ensure the delivery of the services; and the development of new market and governance arrangements. The Panel was assured that the project team would be able to address these challenges and felt that a successful outcome would both create learning for the wider industry, as well as providing benefits for the South East region.

The Panel recommends that this project is funded.

2.5 INSPIRE*:* Whole-systems thinking for a more complex world of data
SP Distribution (SPD)
£6.0m requested (£8.5m in total)

2.5.1 The Proposed Project

Passive distribution networks are slowly becoming active, requiring increased intelligence and active network management to ensure that the transition to smart grids by 2030 is fully achieved. With the number of smart grid techniques growing and the costs of deployment falling, the challenge and opportunity facing the sector is how to ensure effective integration of legacy systems with these new and more complex control and data management systems in a cost effective and timely fashion.

UK network operators typically operate three distinct software systems. Distribution Management/Supervisory Control and Data Acquisition systems (DMS) are used for the real time control and monitoring of the network. Geographical Information systems (GIS) describe the location of assets while Enterprise Asset Management systems (EAM) record the condition of the assets. The number of interactions between these disparate data systems is expected to increase significantly. The transition to a Smarter Grid with its reliance on the intelligent use of data and more intensive use of assets increasingly requires information from all these systems. At present data from multiple systems has to be managed and coordinated manually and so there are obvious benefits in integrating the distinct software systems more closely.

The Whole-systems Information Synthesis Management Platform (WISP) will integrate and manage the data that is provided by all of the existing software systems. The WISP will be a proprietary data handling platform developed by CGI. A single easily accessible database will be used to record the details of each aspect of the network. The WISP platform will integrate and manage distribution network data to create new business intelligence, whilst also enabling enhanced business processes including advanced network planning, smart system operation, data analytics and stakeholder data exchange. The WISP will also provide an open standard interface to support plug-in applications.

The WISP will be developed as part of this project. It is designed to select and synthesise existing data from a number of disparate data sources (including the DMS, GIS and EAM). The intention is that the WISP will be able to interface with the different data sources, correlate the information into an integrated network data set and make this easily available for all potential applications. It will be open, flexible

and inter-operable and will conform to multiple standards such as the Common Information Model (CIM).

Once the WISP has been built, it will be demonstrated by four Use-cases. These will be limited trials involving (where relevant) a small part of the network. The overall aim is to demonstrate the functionality of the WISP (as an open source data handling system) and show how the integration of data from different sources can improve the effective management of the network. The Use-cases are as follows.

- Firstly, the WISP will be used to allow the DNO to maximise the use of a smart grid techniques by co-ordinating data gathering and analysis which reduces the need for network investment to give the same level of network utilisation (Use-case 1).

- Improved network visibility for third parties will save on the manpower costs associated with coordinating data handling and data management between DNO and SO that is currently undertaken manually (Use-case 2).

- The WISP will facilitate better data analytics which helps predict and pre-empt faults that would otherwise require more extensive field resources to rectify (Use-case 3).

- Finally, the WISP delivers greater accuracy in network planning which reduces network investment through increased utilisation of existing assets (Use-case 4).

It is intended that the WISP will be suitable for adoption by all network operators. The roll out of the WISP across the GB network is expected to facilitate the delivery of smart grid benefits arising from improvement in monitoring and active management.

2.5.2 Carbon, Environmental and Financial Benefits

The effective management of data from proliferating sources is essential if that data is to be used to help the business (and the networks) operate efficiently. In their

presentation, SPD drew attention to a research study that suggested that 'data driven decision making' made organisations more productive. Most businesses are looking for better ways to present data from multiple sources to their managers in order to support more informed decisions.

The benefits have been estimated based on the four trials (Use-cases) that will be undertaken during the project (see 2.5.1).

Based on the benefits arising from these Use-cases the following financial, environmental and capacity benefits at the GB level have been estimated.

	Financial Benefits £M (NPV)		**Carbon Benefits**	**Capacity Benefits**
	2030	**2050**	**2050**	**2050**
Use-Case 1, 2, 3 & 4	1.75	93	2,230ktCO2	1,088 MVA

In developing these numbers, the project team made the following assumptions

- that at the GB level, Use-case 1 will deliver 1% of additional benefits that are currently projected to arise from the smart solutions already being developed (i.e., 1% of the assumed £12 billion savings from the Transform model by 2050);
- Use-case 2 savings are based on eliminating manual data handling equivalent to one FTE per licence area;
- Use-case 3 assumes a saving per avoided fault with the GB fault rate estimated to be 0.092 faults per annum per km of 11 kV overhead lines;
- Use-case 4 delivers 5% more accuracy in investment planning which translates into 2.2% less investment required in reinforcing the network.

If successfully rolled out at the GB level, SPD believe the projected financial benefits that could arise are £1.75 million NPV by 2030 rising to £93 million by 2050.

There are, however, a number of questions around the assumptions underlying SPD's estimates:

- Firstly, the Panel is of the view that better data management and more sophisticated data analytics will increasingly become business as usual (BAU) for all DNOs and indeed most businesses. Consequently, it is difficult to argue that the NIC funding is needed to secure the benefits proposed (at least at the quantum requested);

- SPD projections state the breakeven date could be achieved relatively quickly, i.e., by 2026 or 2028, depending on the nature and rate of roll-out. However, the latter date is only achieved following full roll out of Use cases 1, 2, 3 and 4 plus one additional new application (yet to be specified) every two years across all of SPD and SPMW. The earlier 2026 date is achieved if three DNO companies also fully deploy all four Use cases and one additional application every two years thereafter. With IT developments subject to a fast pace of change, a breakeven date that is more than five years beyond the project inception date makes it hard to justify NIC funding support at the level requested;

- The extent to which the WISP approach will be the route of choice by all 14 licensees is not clear, but this is essential to deliver meaningful levels of benefit; the WISP proprietary platform may well be viewed as a barrier for some DNOs; and

- The data integration costs are not trivial which means the business processes each licensee chooses to include may well be less than the GB rollout assumptions made by SPD. The timescale proposed in the benefits case may seem prudent (i.e., one WISP rolled out per licensee per annum). However, in the Panel's view there is in any case a BAU need to improve data management and analytics and this is likely to mean that all DNOs will be developing their IT systems and undertaking business process re-engineering in parallel with the WISP development, potentially reducing any GB-wide benefits case associated with the WISP.

2.5.3 Value for Money

The Panel had no doubt that the integration of data from multiple sources would provide a basis for improving the efficiency of the business and providing fuller information to support decision making. Clearly, the potential benefits of the Use-cases may only be a very small part of the applications that could be developed; there could be the potential for many more across the business.

However, the Panel was not clear that developing bespoke software for this purpose would necessarily be the most efficient solution; the Panel was aware that other DNOs have been active in this area and may be developing alternative approaches. And not all DNOs would necessarily find the solution developed for SPD as the route they wished to follow. Although the aim is to create an open, inter-operable system, decisions will be taken that potentially favour interactions with SPD's existing data sources.

A second concern of the Panel was that this project could be considered as BAU. DNOs should reap real rewards from improved use of their data and, over the next 5 to 10 years, it is likely that all DNOs will have improved the data analytics associated with their principal activities.

The Panel also noted the high day rates of some of the project partners, particularly given the number of days allocated.

However, the Panel still recognised that this was an important project for the DNO and that there would potentially be new learning. It suggested to SPD that a very much reduced cost of the project could potentially justify ENIC funding on the grounds that many DNOs were grappling with this problem and some of the outcomes would be of interest across the industry.

Following discussions, SPD did reduce the cost, but in the judgement of the Panel, the cost of the project was still too great for them to feel that it provided value for money.

2.5.4 New Learning

The Panel considered that this project has a number of challenges and will provide some learning of interest to other DNOs. Examples include: methods of interfacing with the different types of data feed; the difficulties of handling data from overlapping data sources; the difficulties of cleaning legacy data (and deciding what needed to be brought into the new system); problems associated with changing business processes so as to ensure that in future the data is provided in a suitable format; the ease of interfacing applications with the data management system, etc.

2.5.5 Innovation

The principal innovation in this project would be the development of the WISP itself – tailored to handle information from SPD data sources. It was not clear to the Panel to what extent the work itself could be described as innovative, but overall improved data management would undoubtedly accelerate the development of a number of applications that would improve the efficiency and decision making at SPD and the other DNOs.

2.5.6 Involvement of Partners

CGI are the principal partner. They have a good track record from previous Ofgem projects: they created and project-managed the CIM for previous innovation project FALCON. They will also be able to leverage their learning from the gas and construction sectors. Other partners are NGET, Smarter Grid Solutions, Nortech and the University of Strathclyde. In preparation for the project, SPD held discussions with 20 stakeholders and held a stakeholder event in May (which included representatives from local authorities and suppliers). They have letters of support from a large number of members of the industry.

SPD plan to invite all network licensees, the supplier community and academia to an industry collaborative working group.

CGI already own, or will own, the vast majority of the IP coming out of this project. Licensees will be able to use foreground IP royalty free and background IP required to facilitate the foreground. It was stressed that other DNOs will not have to choose CGI

to carry out their data integration work. CGI is making a contribution (covering proposal and delivery phases of the project). The other partners are also making small contributions in kind.

2.5.7 Relevance and Timing

The Panel recognised the importance of data management to the industry and considered the project timely.

2.5.8 Robustness of Methodology

The Panel considered this to be an important area for the DNOs to tackle – as noted above, making effective use of the data from the more actively monitored networks coupled with other operational and system data should provide real benefits. However, the Panel and their consultants had reservations about the approach being taken. In particular the Panel questioned whether the development of a bespoke data management model was the first step to making the industry-wide change envisaged in the proposal. They would have preferred to see a collaborative development of a specification that had considered all the long term applications and that had received a concrete commitment from at least three DNOs. This could have formed the basis for a strategy; the strategy in turn could have determined the scope of the first stage of work.

The Panel did have some concerns regarding this project's scope – particularly in relation to how complete the demonstration of the applications would in practice be (for example, in areas such as LV Active Network Management). With an IT project of this nature, it was felt that there should perhaps have been a more robust IT road map and a tighter project scope. This would have helped ensure that SPD, rather than a project partner, was in firm control of the project.

Finally, the Panel was also concerned about the very small risk and contingency budgets, given the scale of the project. It was felt there would be considerable challenges – in particular ensuring the data was in a format that could be accessed by the WISP, as well as the other challenges listed above. However, at the second bilateral

meeting, the Head of IT from SPEN said that SPD would be able to address many of these challenges.

2.5.9 Conclusions

The Panel recognised that this project addresses an important and timely issue. Over the next five to ten years, it is likely that all the DNOs will be putting considerable effort into ensuring they make effective use of their data and, where appropriate, building platforms to make it available for third party users and applications developers. But in general the Panel considered that this was work that DNOs should be undertaking as Business As Usual – although there may be a case for some preliminary work as an ENIC or NIA-funded project. However, the Panel would suggest that any such project should be collaborative between a number of committed licensees.

If successful, this project will be of considerable value to SPD, enabling them to make more rapid progress with their use of data. The Panel did not consider that the fund should be paying for this aspect of the project; rather it would have been happy to recommend a more modest contribution from customers on the grounds that by addressing this issue SPD would be increasing the learning available and this should accelerate all the DNOs' work in this area.

The Panel was also not clear that other DNOs would necessarily purchase this particular data integration software (WISP) – it is not unlikely that there will be other solutions being developed.

On these grounds, the Panel suggested to SPD that if they considerably reduced the cost of the project, they would consider recommending its funding on the grounds of the additional learning it could provide (as opposed to the implementation of the system for SPD). While an additional contribution was found, the Panel still considered the cost to be too high in relation to the likely level of additional non-BAU benefits that would be generated across the DNOs and so to their customers at large.

The Panel therefore recommends that this project is not funded through the ENIC.

2.6 Phoenix - System Security and Synchronous Compensators
SP Transmission (SPT)
£15.6m requested (£19.9m in total)

2.6.1 The Proposed Project

The GB System Operator (SO) relies on what are termed "system inertia" and "short-circuit levels" (SCL) to maintain power system stability at 50Hz, and to ensure the correct operation of protective devices in the event of a network fault. These resources have to be distributed geographically across the national network to ensure that no one part of the grid becomes unstable or suffers a failure of protection. Were this to occur, the problem could quickly cascade and in extremis result in a total shutdown of the system.

Much of the inertia and SCL resource comes from large rotating synchronous generators such as those found in coal-fired and nuclear power stations. As the electricity system is decarbonized and the existing fleet of power stations is retired, the number of large rotating synchronous generators connected to the GB network is falling, and in some areas falling very dramatically. In Scotland for example all of the 3.6GW of coal capacity has already closed and 1.2GW of nuclear may close in 2023.

At the same time new sources of power such as wind turbines, solar PV generation and high voltage direct current (HVDC) interconnectors are being introduced rapidly on to the network. These do not provide the same levels of inertia or SCL, and in the case of some HVDC technologies, such as the 2GW HVDC interconnector between Deeside and Scotland, actually rely on the network exhibiting adequate levels of SCL for them to "ride through" a fault. These new technologies therefore increase the vulnerability of the network to faults and to frequency excursions.

With the falling number of large synchronous generators to provide inertia and SCL, the aim of this project is to trial a new combination of compensation equipment that can be connected to the network at strategic locations to provide the necessary

resource. This is called a Hybrid Synchronous Compensator (H-SC), because it combines two existing technologies, namely synchronous compensation, which uses a rotating mass, with a static synchronous compensator (STATCOM), which uses power electronics.

The three problems to be addressed by this proposal are:

- Reduced system inertia (spinning mass)
- Lower short-circuit (fault) currents
- Reduced ability to provide reactive power (and so maintain voltage during and after faults).

The H-SC solution being trialled is to add synchronous compensation and a static electronic compensation to the Grid. The synchronous compensator part of the H-SC is in effect an electrical machine that is operated at no mechanical load, neither as a generator or motor, but rotates on the power system to provide inertia, voltage support and short-circuit current. The STATCOM part provides fast voltage control and has particular advantages dampening unwanted oscillations and harmonics on the grid.

As rotating synchronous compensators are likely to be expensive, the project will investigate how, by combination with a STATCOM, a hybrid solution can deliver a lower cost solution. In addition, while there is confidence that synchronous compensators and STATCOMs can be deployed, NGET is already observing signs of instability and of the potential for compensation systems, when operating independently, to conflict with each other, leading to undesirable effects.

In the project a 140 MVA H-SC will be developed and installed at a 275 kV substation, at Neilston in Scotland. The synchronous compensator and STATCOM will each be rated at 70 MVA and a unified control system used. The project will establish and test a combined control system that oversees both parts of the H-SC in order both to increase the combined effectiveness and to investigate if at least some aspects of the behaviour of the synchronous part can be provided more cost effectively through the STATCOM. The project will also confirm other locations across the transmission

network where the technology can be expected to have applicability. At the end of the project the equipment will enter commercial service and act to support the network.

2.6.2 Carbon, Environmental and Financial Benefits.

The use of SC and H-SC units across the GB network is projected to derive the following financial, environmental and capacity benefits at the GB level:

	Financial Benefits £M (NPV)		**Carbon Benefits**	**Capacity Benefits**
	2030	**2050**	**2050**	**2050**
METHOD 1 & 2	121	857	452ktCO2	2.7GW

The project assumes that the GB-roll out demand for these units is a total of 24 across nine locations.

The GB-wide benefits case has been based on scaling up (by around a factor of three) from the benefits projected to be delivered at the SPT licensee scale. The projected breakeven date is 2023 (i.e., four years after initial installation).

The submission team (in answer to a question from the Panel) laid out the ten system services that this equipment, either stand-alone or in combination or with a battery, could provide. Amongst these services is the role of the equipment in a BlackStart. Under these circumstances, clearly having the resources available to accelerate the restoration of power would offer considerable additional benefits.

2.6.3 Value for Money

This is an expensive project and the Panel questioned whether there might be better and lower cost ways of achieving the same outcomes. Increasing renewable generation (and the reduction in the number of large rotating synchronous generators)

will affect the system and there was discussion on whether installing large rotating compensators on the network would be the best solution.

On balance, the Panel recognized that the potential loss of stability on the network could, in the relatively near future, affect the stability of the network and that a near term solution to this was required. This is an innovative project that will provide both learning around the use of the proposed technologies in various combinations; it will also help to further scope the extent and nature of the problem. The Panel also recognized the importance of these systems as backup for BlackStart situations.

SPT have looked at alternative ways of implementing the Phoenix solution: one option was through conversion of a closed down power station and another through the use of independent providers of the services required. Neither offered a clear return on investment for the developers. SPT chose ABB following talks with three global suppliers based on the innovative nature of their solution; the level of their proposed contribution to research and development, and their being prepared to provide a turnkey solution that exposes ABB to any potential downside risks.

The Panel were satisfied that the project could provide value for money.

2.6.4 New Learning

The project will provide learning in relation to the technology itself and the use of the two pieces of equipment in combination; it will also provide knowledge of appropriate sizing for different uses; and knowledge on how to effectively control the equipment to deliver maximum benefits.

In addition, the project will examine whether the services required can be provided by independent developers and will examine possible commercial arrangements. The project will also provide more information on the nature and extent of the problem.

2.6.5 Innovation

The proposal is innovative in trialling a hybrid synchronous compensator/STATCOM

combination located on the same site. The demonstration of the integrated control of this combination of devices, to ensure stable combined operation, and the subsequent evaluation of the most effective ratio of sizes will be innovative. One of the barriers to third parties, such as generators, providing these services is the lack of an existing remuneration mechanism. The project will investigate how commercial arrangements can be designed to secure inertia, fault current and rapid reactive power services from third parties.

2.6.6 Other Partners

The Partners are ABB, NGET, the University of Strathclyde and the Technical University of Denmark. The Panel was impressed by the unified nature of the bid team and, during the second bilateral, the clear grasp of the challenges that needed to be overcome. To help structure the project, SPT have engaged with NGET and SHE Transmission through working groups to provide information and market initiatives and to provide regulatory recommendations. They have also had advice on these issues from Kiwi Power and Smart Grid Consultancy.

ABB is providing almost £2m as contribution to the project (R&D costs and laboratory facilities representing around 10% of the total project costs); there is also a contribution from the universities. The Panel had some concerns that the level of contribution of ABB might not fully reflect the benefits that could accrue to them as a result of the project; but did recognize that ABB was taking some commercial risk.

2.6.7 Relevance and Timing

The submission team provided a clear analysis of the timing of the loss of synchronous generation and the implications for the network. It was clear that this project is timely.

2.6.8 Robustness of Methodology

The Panel considered the project to have a robust methodology with a strong project team.

2.6.9 Conclusions

The loss of synchronous generation on the system undoubtedly poses a major challenge to system stability. The submission team's analysis suggests that there will be an increasing need for action from around 2020 onwards. The solution offered by this project will address the issue and the results of the project will help determine this in an optimal way – and provide the potential basis for independent suppliers to offer the services required. The Panel retains some reservations about the nature of the solution and whether or not more effective options (including changes to system operating practice) might be developed in future. However, overall it was considered to be a strong project and the Panel recommended that it should be funded through the ENIC.

3 RECOMMENDATIONS FOR FUNDING

3.1 Based on the evaluation of the submissions set out in the previous section**, the Panel recommends that the Authority agrees to fund the following projects.**

- **OpenLV: Opening up the Smart Grid**
  Western Power Distribution (WPD) – led by EA Technology Limited (EATL)
  £4.9m requested (£5.9m in total)
  The Panel recommends that this project receives ENIC funding subject to the additional SDRC referred to in 2.1.9 above.

- **PowerFuL-CB: Power Electronic Fault Limiting Circuit Breaker**
  UK Power Networks (UKPN)
  £4.6m requested (£6.2m in total)
  The Panel recommends that this project receives ENIC funding subject to the additional SDRC discussed in 2.3.8 above.

- **Transmission and Distribution Interface (TDI) 2.0**
  National Grid Electricity Transmission (NGET) and UKPN
  £8.0m requested (£9.6m in total)

- **Phoenix: System Security and Synchronous Compensators**
  SP Transmission (SPT)
  £15.6m requested (£19.9m in total)

3.2 The Panel was unable to recommend that the Authority fund the following projects:

- **Proteus: Agile Technology for Future Networks**
  WPD – led by Ricardo
  £7.8m requested (£9.4m in total)

- **INSPIRE*:* Whole-systems thinking for a more complex world of data**
  SP Distribution (SPD)
  £6.0m requested (£8.5m in total)

4 ADVICE FOR FUTURE COMPETITIONS

4.1 The purpose of this section is to provide feedback on particular points arising from this competition and to draw attention to a number of issues that Ofgem may wish to communicate to the companies, or to take account of when revising the Governance Document. The Panel is aware that Ofgem will shortly be consulting on a number of proposed changes to the NIC.

4.2 Economic and Carbon Benefits

The information on benefits was presented in a more consistent and more easily comparable fashion than in previous competitions; this followed the agreed changes on the way that the underlying analyses should be undertaken.

However, the Panel had one concern. It was not clear that the lowest cost alternative was always used when evaluating the benefits that would arise from the proposed project. The teams tended to use as their alternative (or counter-factual) a solution that assumed no new technologies or methods are currently available or are likely to be available based on successful LCNF, NIC and other innovation trials. So, for example, where a Method makes more capacity available, the alternative is often described as physical strengthening of the relevant part of the network. A large number of potentially lower cost alternatives have been trialled using LCNF, NIC and other funds in recent years. The Panel therefore suggests that in the submission, the submission team should make clear that they have reviewed all the alternatives (including ones currently under development) and have used an appropriate cost for the counter-factual.

The Panel does recognise that local geographical and network circumstances may often play an important part in determining the best solution; so while there may be lower cost generic solutions available, they may not be locally appropriate. But in this case the analysis should recognise this more limited application and that it would considerably reduce the extent of the GB roll-out.

The Panel would like to see future submission teams provide the break-down of the costs and benefits of each individual project method, trial or use case, and the associated break-even points, in their bid submission.

4.3 The market for new solutions

Where the request for funding relates to a new technology or piece of software (i.e. a product rather than a system change), the extent to which the product is likely to be taken up by other network companies is important both for determining the benefits and the value for money of the submission. In these cases, the Panel would like to see a more rigorous approach employed to determining potential market size. The Panel would welcome formal confirmation, beyond general letters of support, that other network companies have been consulted in shaping the project, and of how they have committed to taking an active interest in its progress and to applying relevant outcomes in their own companies.

4.4 Engagement of third parties

The Panel were pleased to see the extent to which third party companies (both consultancies and technology suppliers) had been engaged with the process and, in some cases, given a leading role on the projects. In particular, the Panel felt the approach adopted by WPD which had issued a 'call' for ways of dealing with WPD's priority issues, was a well-focused method of trawling for new ideas.

However, where third parties are engaged as partners in this way, two issues need to be explicitly addressed.

- Their costs should be demonstrably competitive. Because it is often not possible to drive down the costs by the normal method of tendering (as the partners 'own' the solution), other methods need to be used to demonstrate to the Panel that the costs are reasonable and as low as would have been achieved in a competitive process. For example, the Panel was concerned by what were considered to be excessively high average day rates for partners that had a major input into a project.

- Secondly, attention must be paid to the extent that the third party partner stands to benefit in the long term from a successful outcome – given that the project is funded by customers' money. This long term financial benefit must be reasonably reflected by the contribution made by the partner. Where future value is potentially above 'normal profit' levels, we would expect to see the inclusion of transparent and suitable profit sharing arrangements.

4.5 Collaboration

In cases where the project addresses an issue that is fundamental to the day to day operation of a network company (an example this year was software to manage data), the Panel would be more comfortable if there was clear evidence that both the project design and the potential long-term 'buy-in' to the solution involved a number of licensees. The ENIC is designed to trial and make available new solutions that will be widely taken up by other network companies; designing a solution that works for the operation of one company may not result in take-up from other companies. In these cases, the Panel would welcome collaborative bids jointly by a number of licensees.

4.6 Assessment of customers' responses and behaviours

Each year, there are a number of projects that involve the engagement of customers. The Panel considers it is important that more attention is paid to these aspects of the projects, particularly where the outcome and success of the trials depends on customer engagement and behaviour change. In these cases, there should be a clear project structure and methodology that will enable the learning to be captured in a systematic way. This does require engagement of the appropriate specialist organisations at an early stage.

4.7 Commercial approaches to network problems

The Panel welcomed the interest this year in how innovative commercial arrangements might be used to address network problems. Such commercial projects, involving the creation of markets and a deeper understanding of the behaviour of

market actors, require a set of skills and experiences different to those of traditional network engineering projects. It was encouraging to note from one project in particular that the need to staff and resource these aspects of the work were taken fully into account in project planning.

5.0 ACKNOWLEDGEMENTS

The Panel fully recognises the amount of work that each of the bids require and the amount of time that is required to address the follow up questions that arise. The Panel would like to thank all of the companies for the submissions, the level of engagement and their responsiveness at the bilaterals and in written answers to questions.

The Panel is also extremely grateful to the Ofgem Team that provided exceptional support and hugely facilitated the work of the Panel and to the consultants for their timely assistance.