Low Carbon Networks Fund
Full Submission Pro-forma

Section 1: Project Summary

1.1 Project title

Flexible Plug and Play Low Carbon Networks (FPP)

1.2 The Lead DNO

Eastern Power Networks (EPN), UK Power Networks

1.3 Project Summary

The Flexible Plug and Play Low Carbon Networks (FPP) project will bring together a rich consortium of partners to address one of the key challenges faced by Distribution Network Operators (DNOs) in enabling the development of a low carbon energy sector. The FPP project will demonstrate how, through the innovative integration of technological and commercial solutions, the cost-effective connection of renewable generation to a distribution network can be achieved.

The FPP technical innovation focuses on the development of a vendor agnostic open standards platform to enable end-to-end communication between distributed smart network technologies and generation. FPP will implement active network management for decentralised monitoring, control and overall operational management of both network and generation. Commercial innovation will be delivered in the form of new contracts to provide flexibility and choice to generation customers. FPP will address the need for a more responsible, cost efficient and flexible approach to generation customer connections.

The knowledge and learning generated from trialling the different FPP project methods will be used to develop a Strategic Investment Model, which will allow DNOs to quantify, for different demand and generation scenarios, the integrated value and benefits of different smart technologies, smart commercial arrangements and smart applications. This model will also determine from both an economic and carbon perspective whether it is better to reinforce the network or use smart alternatives.

1.4 Funding

Second Tier Funding request (£k)	6,780

DNO extra contribution (k)	1,002	**External Funding (£k)**	989

1.5 List of Project Partners, External Funders and Project Supporters

The following partners have been chosen for their breath of experience, expertise and innovation culture:

Cable & Wireless Worldwide, Silver Spring Networks, Smarter Grid Solutions, Alstom Grid, Converteam, Fundamentals,S&C Electric, GL Garrad Hassan, Imperial College London, University of Cambridge and the IET.

Additional details on the above project partners can be found in Appendix F.

1.6 Timescale

Project Start Date	01/01/2012	**Project End Date**	31/12/2014

1.7 Project Manager contact details

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Section 2: Project Description

2.1 Aims and objectives

Context - Renewable energy is at the heart of the UK Low Carbon Transition Plan (LCTP). In the Renewable Energy Strategy, DECC sets an ambitious target for 30% of the UK's electricity to be generated from renewable energy sources by 2020 and up to 40% by 2030. However, in their Renewable Energy Review of May 2011 (considering both 2020 and 2030 scenarios) the Committee on Climate Change (CCC) recommended (inter alia) that '*ambition for offshore wind to 2020 should not be increased unless there is clear evidence of cost reduction*' and '*if renewable energy targets for 2020 can be made in other ways, a moderation of offshore wind ambition for 2020 would reduce the costs of decarbonisation*'. Recognising the need for an affordable low carbon transition, these statements from CCC suggest that a higher contribution from onshore wind generation and other renewable forms of generation to both the 2020 and 2030 targets may be necessary. Given the typical scale of developments, most renewable onshore generation (in England and Wales) will connect to distribution networks. However, with a passive approach to network management, the ability of distribution networks to accept further renewable generation without substantial investment is often limited. For example, without reinforcement, the connection and operation of new sources of generation might give rise to breaches of thermal or fault level ratings, or statutory voltage limits. On the other hand, should it prove feasible to actively manage generation export and network configuration on a real-time basis, this should enable closer matching of generation export and network capacity and therefore enable additional renewable generation connections.

The Problems - Although Long-Term Development Statements (LTDS) provide developers with some visibility of available network capacity, where multiple developments are under consideration, an LTDS cannot provide a reliable indication of the many potential permutations of generation which may eventually be connected, or in what order, or therefore at what point in time substantial reinforcement would be required. This leaves developers in the unsatisfactory position of being unable to reliably predict network connection costs or, therefore, the commercial viability of their project. Moreover, a piecemeal approach whereby individual, or even selective groups of generators with similar proposed target connection dates, are considered in isolation will invariably lead to a suboptimal solution giving rise to higher overall network reinforcement and connection costs. These higher costs and/or the uncertainty of future connection costs can make the financial risk of development of generation unattractive to new developers. This poses a significant risk to the success of the Renewable Energy Strategy and ultimately the LCTP.

UK Power Networks' EPN distribution network serves an area of approx. 30km diameter (700 km^2) between Peterborough and Cambridge which is particularly well suited to renewable generation. Over recent years UK Power Networks has experienced increased activity in renewable generation development activity in this area, and a rapid rise in connection applications, with 90 MW of wind generation already connected and around 188 MW at the planning stage (57 MW consented, 35 MW submitted as connection applications, and 96 MW at the scoping stage). The connection of these anticipated levels of wind generation is expected to require significant network reinforcement to mitigate network thermal and voltage constraints and reverse power flow issues. However, traditional network reinforcement based on a passive `fit and forget' approach inherently lacks the flexibility to consider the active management of generation export and network constraints, which could provide a cheaper, faster, and more efficient connection solution for renewable generation, such as wind.

The Method - The Flexible Plug and Play Low Carbon Networks (FPP) project will trial innovative technical and commercial solutions that allow Distribution Network Operators (DNOs) to move from a passive 'fit and forget' to a more active 'fit and flex' approach. This will enable the most flexible and cost effective means of connecting renewable generators to be identified and provided, ultimately increasing the capability of distribution networks to accommodate higher levels of renewable generation.

The latest developments in open standards and internet protocol (IP) communications is enabling higher speed peer-to-peer communications, simplified system design and commissioning, reduced wiring and bespoke configuration of interfaces, and easier integration and interoperation of equipment from different vendors. The IEC 61850 standard for substation automation promises to enable this integration and interoperability. This will facilitate the widespread adoption of smart devices and applications as required to maximise the contribution from renewable generation. Building a technical platform based on IEC 61850 and IP communications will enable DNOs to more easily and flexibly deploy new technologies and therefore explore a variety of alternative connection solutions for new renewable generators. The FPP project will provide the first opportunity for UK Power Networks to deploy IEC 61850, which will be implemented in addition to the existing suite of open standards protocols utilised in operational telecoms.

2: Project Description cont.

Recognising the need to reduce uncertainty regarding connection costs, the FFP project will explore the innovative commercial arrangements that will enable an Active Network Management (ANM) approach. This will involve establishing contractual arrangements that define access to the network capacity available in real-time for more than one renewable generator. These commercial arrangements will form the basis for considering new technical connection solutions and also the grouping of generators at the planning stage.

The Trials - The area between Peterborough and Cambridge is the ideal test bed to trial the methods proposed within the FPP project. The methods to be adopted include the development of an open standards IP communications platform (which will make use of the latest developments in smart grid standards such as IEC 61850) to support the flexible management of network constraints by smart applications, including Active Network Management, through the management and coordination of smart devices. The technologies that the FPP project will trial (described in detail under 2.3) include a quadrature-booster, dynamic line ratings, modern protection relays, intelligent tap changer relays, frequent use switches and smart generator controllers. While these are proven 'smart' technologies, integrating them into the operation of the distribution network and demonstrating interoperability is largely unproven. The FPP project will test and prove the scope for integration and interoperability of these technologies at scale.

The knowledge and learning generated from trialling the different FPP project methods will be used to develop a Strategic Investment Model, which will allow DNOs to quantify for different demand and generation scenarios, the integrated value and benefits of different smart technologies, smart commercial arrangements and smart applications. This model will also determine when it makes best economic and carbon sense to reinforce the network or use smart alternatives.

Underlying the FPP project trials is a proactive and robust stakeholder engagement approach, which will ensure that at every stage of the project key stakeholders such as local authorities and renewable generation developers will be able to contribute to and learn from the FPP project.

2.2 Technical description of project

The FPP project will use an innovative approach to integrating technology in order to address the problems that were outlined in section 2.1, which include:

Thermal constraints - the two 33 kV circuits between Peterborough Central and March Grid (please refer to the diagram in Appendix B) are the main arteries that transfer power from the wind farms in the central part of the FPP project area. The two circuits are at full capacity, leaving limited headroom to connect additional generation. New renewable generators connecting to this network will be constrained due to the presence of thermal constraints during times of low demand and high generation output. **Dynamic line rating** has the potential to allow relaxations of existing constraints and obviate the need for prescribed seasonal limits to export to the distribution network.

Reverse power flows - wind generation capacity is further limited by the directional over current protection deployed at March Grid, which results in a reverse power flow limit of 34 MVA. The reverse power flows through Peterborough Central are also limited to 42 MVA for the same reason. The protection settings are a legacy of traditional distribution network operation where power was expected to flow from higher to lower voltages; previously, if current was detected flowing in the reverse direction it was taken to be an indication of a fault. A further constraint is that transformer tap changing relays in the FPP trial area may not support reverse power flow. **Modern adaptive protection** should alleviate problems due to reverse power flows.

Voltage constraints - It is uncommon for the proposed levels of renewable generation to be connected to an area the size of the FPP trial project area. The operation of the renewable generation is expected to raise voltage levels on the 33 kV network. **Modification to the operation of transformer tap changers** during times of high generation output and/or the **management of generator real and/or reactive power** will enable the connection of higher levels of generation while maintaining network voltages within acceptable limits.

Flexible network configurations - Interconnected 33 kV networks give rise to power flows towards the lowest source impedance, which can result in thermal overloads and the other problems listed above at certain pinch points, whilst other circuits with spare capacity remain underutilised. This is particularly evident during network outages. The standard switches currently deployed in the trial area are not designed for frequent operation; replacing these with **new 'frequent use' switches** not currently deployed in the UK, will enable more flexible network configurations to reduce or remove network constraints. Similarly, on interconnected circuits, active management of power flows using a **quadrature-booster** will maximise overall network capacity.

2: Project Description cont.

Generator control mechanisms - Connection of renewable generation is further limited by lack of generator control mechanisms, essentially the management of generator real and reactive power. UK Power Networks currently adopts a limited form of active control over generators whereby electro-mechanical relays provide control signals to constrain generator output during unplanned outages. As this system is relay driven, it is a binary action (on or off, or to a number of preset seasonal power export levels) and does not allow the generation export to track to the real-time export capacity available on the network. A more **sophisticated electronic based form of ANM** will provide greater refinement in the control of generator export and enable a closer match to available network capacity.

Interoperability of new controllable devices - The industry is moving toward the widespread use of open standards to facilitate interoperability, both within substations and between substations. IP communications are also becoming more prevalent in the power industry. In order to fully coordinate and leverage the benefits of smart devices and applications, challenges associated with interoperability must be addressed. The implementation of an **IEC 61850 based communications system over an IP platform** will enable a wide range of vendor products to be trialled and tailored to resolve specific network constraints and demonstrate interoperability.

Commercial arrangements - If generators are to connect to the distribution network and be actively managed (i.e. have their output regulated to meet distribution network constraints) then new commercial arrangements and connection agreements are required. The order in which generators will be allowed to access network capacity available in real-time must be defined. Estimates of anticipated energy volumes exported will require to be provided to prospective developers to allow an assessment of the economics of a smart connection option. In the FPP trial area, there are a number of interactive generator applications; existing practice fails to recognise the potential benefits of considering groups of generators. Considering each generator individually can result in piecemeal and sub-optimal network investment. A **commercial framework which supports a holistic development strategy** while providing a mechanism that fairly apportionments costs between developers would be a significant advancement on existing connection charge assessment procedures.

As to why the **proposed method is technically innovative**: while each of the solutions briefly outlined above would be innovative in their own right, the goal of FPP is to apply a holistic, rather than a piecemeal approach to resolving network constraints to distributed generation and, at the same time, create a commercial framework which will benefit existing and future consumers through more efficient network investment while reducing uncertainty for financial stakeholders in distributed generation development. It is this holistic integration of technologies under an equally holistic commercial framework, using a large-scale test bed of existing and pending generation, which characterises and differentiates FPP as a uniquely innovative project. FPP will enable quicker, more economical and larger numbers of renewable generation connections to distribution networks. The **key stages** and elements of the project are as follows:

(1) Design and **deployment of an Information and Communications Technology (ICT) platform** to facilitate the necessary information exchange and control capability to implement solutions to address the network problems described above. Activities will include:

- (1.1) Development and deployment of an open standards IP communications platform across the FPP trial area;
- (1.2) Upgrading of existing Remote Terminal Units (RTUs) to support open standards data communications protocols such as IEC 61850, in addition to the existing protocol set;
- (1.3) Establishment of a Local Area Network (LAN) in FPP trial substations;
- (1.4) Deployment of a range of smart devices from various vendors;
- (1.5) Interoperability testing of smart devices and ANM applications using open standards communications protocols over IP;
- (1.6) Development of common data models across all smart devices and applications.

(2) Integration of **smart devices** from various vendors to facilitate the management of distribution network constraints to accommodate higher levels of renewable generation;

(3) Integration of **smart applications** such as ANM to coordinate smart devices and generator real and reactive power to manage network constraints and therefore accommodate higher levels of renewable generation;

(4) Development and implementation of **smart commercial arrangements** that are informed by key stakeholder requirements, and identified through a robust and transparent stakeholder engagement process.

2: Project Description cont.

(5) Technical and commercial learning will be captured and disseminated throughout the project. This will be fed into the development of a **Strategic Investment Model** that will identify the triggers for network reinforcement based on what can be technically and commercially achieved using the latest advances in smart grid technology. This project will incorporate and build upon (but not duplicate) learning from LCNF projects being undertaken by other DNOs that are currently underway, representing a significant learning opportunity for all UK DNOs.

In order to deliver the above, the FPP project activities have been arranged into the following eight work streams:

WS1. Communications Platform
WS2. Smart Devices
WS3. Smart Commercial Arrangements
WS4. Smart Applications
WS5. Stakeholder Engagement
WS6. Strategic Investment Model
WS7. Learning and Dissemination
WS8. Systems Integration

A detailed description of these workstreams is included in the FFP Use Cases document (Appendix 1).

2.3 Description of design of trials

The following trials will be undertaken to prove the solution delivered by the FPP project:

(1) Implement IP connectivity between trial substations and LAN infrastructure within substations;

(2) Develop data models for all smart devices and applications using standard IEC 61850 models where possible or identify the approach to be adopted if utilising other open standards such as DNP3;

(3) Simulate open standards based communications traffic on the IP communications network under various operating conditions to understand performance levels;

(4) Establish devices in the trial environment and perform all configuration tasks;

(5) Demonstrate open standards based data exchange between RTUs and a variety of smart devices over IP;

(6) Integrate the following **smart devices** to the FPP infrastructure to prove data exchange, interoperability and functionality using open standards and IP communications:

(6.1) Four Dynamic Line Ratings (DLR) devices and weather stations at known and future thermal constraint locations:
- Explore whether DLR devices provide an increase in ratings at times of peak loading of the network and if this increase in rating coincides with high output from wind farms and other generators;
- Determine if additional wind farms can be connected to the existing grid using DLR devices.

(6.2) Two sets of modern protection relays at March and Peterborough:
- Determine the scope for overcoming limitations of existing directional overcurrent protection and review existing protection settings to attempt to permit increased connection of renewable generators;

(6.3) Two sets of Transformer tap changer control relays at grid substations and some primary substations:
- Examine the scope for introducing greater intelligence into automatic voltage control system to take generator output into account and to prevent voltages from breaching limits;

(6.4) Two Frequent use switches at normally open points between March and Peterborough:
- Determine the benefits of switches that are designed to operate frequently to reconfigure the network and provide greater flexibility than is possible with fixed 'normally open points' (NOP);

(6.5) Generator controllers at new and existing generators:
- Interface to native generator control systems to explore the potential for monitoring and/or controlling real and reactive power and coordinating this control capability with other smart devices using smart applications;

2: Project Description cont.

(6.6) Energy storage system:

- Control charging and discharging of the Hemsby storage device, installed as an IFI project, and ascertain the scope for coordinating it with the operation of Smart Devices and the control of generator real and reactive power using Smart Applications;

(6.7) One Quadrature-booster:

- Install a quadrature-booster within the FPP trial area to overcome an existing constraint due to sub-optimal load sharing

(7) Deploy **smart applications** to the FPP trial area to test and prove the use of open standards and IP communications for smart applications to reliably exchange data and control instructions;

(7.1) ANM will monitor real-time network parameters and coordinate and control the operation of multiple smart devices and real and reactive power of multiple generators in order to:

- Maintain power flows within thermal constraint at multiple locations;
- Ensure voltage profiles remain within limits;
- Trial different commercial arrangements using the ANM infrastructure, to provide insight into the impact of contractual arrangements on actual network operation;

(7.2) ANM controllers will be distributed to at least two locations in the FPP trial area, proving redundancy and decentralised control with automatic and geographically diverse fail-over;

(7.3) Adaptive protection will be implemented to provide greater flexibility in network protection and explore all possible means of removing barriers to connecting increased renewable;

(7.4) The application of real-time ratings will involve determining the dynamic ratings of all circuit sections on the network based on weather measurements and a thermal model of the power system. Estimates will be validated by DLR devices, proving the accuracy and validity of estimates and potentially therefore reducing the instrumentation required to achieve DLR;

(8) The project will further demonstrate the inherent flexible plug and play approach by integrating additional smart devices and evolving the smart applications as more renewable generators emerge in the FPP trial area. The above developments will be delivered according to the needs of the developers and the goals of proving and demonstrating the communications and open standards platform.

Each of the proposed **FPP trials will be conducted in three stages**, according to established practice and best standards approaches to new technology deployment. These are as follows:

Planning Stage - Infrastructure planning and project partners will perform power systems analysis and device or application modelling to determine the operating regimes of smart devices and smart applications that are to be deployed to the network area. New planning tools will be used to assess the deployment and interaction of the smart devices and applications, based on the commercial arrangements that have been identified in workstream 3. For example, the addition of several generators that contribute to an identified set of constraints on the network will be subject to time-series modelling to estimate the reduced energy curtailment from each site if power flow management is introduced, or if network normally open point (NOP) positions can be moved automatically at times of peak network loading to improved superior load sharing.

Pre-Production Stage - A pre-production environment that will be representative of the FPP trial real world environment will be established at a UK Power Networks facility. The IP communications network, RTUs and interfaces to all smart devices and applications will be subject to integration testing prior to deployment to the substations and network in the trial area. For example, the ability of a standard RTU deployed by UK Power Networks in the trial area to integrate and exchange data using IEC 61850 with a smart device such as a protection relay will be tested in the pre-production environment.

Production Stage - The smart devices and applications will be deployed to the FPP trial area and commissioned into operation. The smart devices will exchange data across the IP communications network both with each other and with controllers hosting smart applications. For example, measurements of current at particular nodes and the dynamic line ratings at critical locations will be fed to an ANM application that will autonomously manage generator outputs within the real-time constraints on the network.

2: Project Description cont.

Under workstream 6, a Strategic Investment Model will be created which will incorporate, as elements of the Model, the smart applications and commercial arrangements being deployed throughout the trials. The Model will be used initially to evaluate the expected costs and carbon benefits of the trials. The subsequent deployment of each smart device or application will then provide an opportunity to revisit assumptions regarding the performance, costs and capabilities of the various elements of the Model. It follows that the Strategic Investment Model will be revised and validated over the course of the trials and will therefore gradually evolve over the course of the project. The Strategic Investment Model will then be used to retrospectively assess the success of the project in meeting its objectives of providing quick, low cost and economically viable connections for renewable generation.

A detailed description of the envisaged trials can be found in the FPP Use Cases document (Appendix 1)

UKPN has approached key stakeholders of the FPP project (renewable generation developers, local authorities and renewable energy associations) to discuss its proposed scope. All were very keen to learn of our plans and were highly supportive of the project.

The renewable generation developers (EDF Energy Renewables, West Coast Energy, EcoGen and RES) believe that our proposed trial of new smart grid technology and flexible commercial arrangements would be of significant benefit in enabling the cost-efficient connection of renewable generation. Cambridgeshire County Council, mindful of the necessary high levels of new generation development planned for the area, expressed its support for the fact that FPP aims to facilitate such connections in future. Furthermore, Scottish Renewables, which represents the renewable energy industry in Scotland, believes that the FPP project could provide long term benefits to its members and push forward the transition to a low carbon economy.

Six formal letters of support to the FPP project are enclosed in Appendix 3.

2.4 Changes since Initial Screening Process (ISP)

The project scope has not changed since our Screening Submission but:

Total project costs have increased to £9.89 million but the total funding request has decreased to £6.78 million.

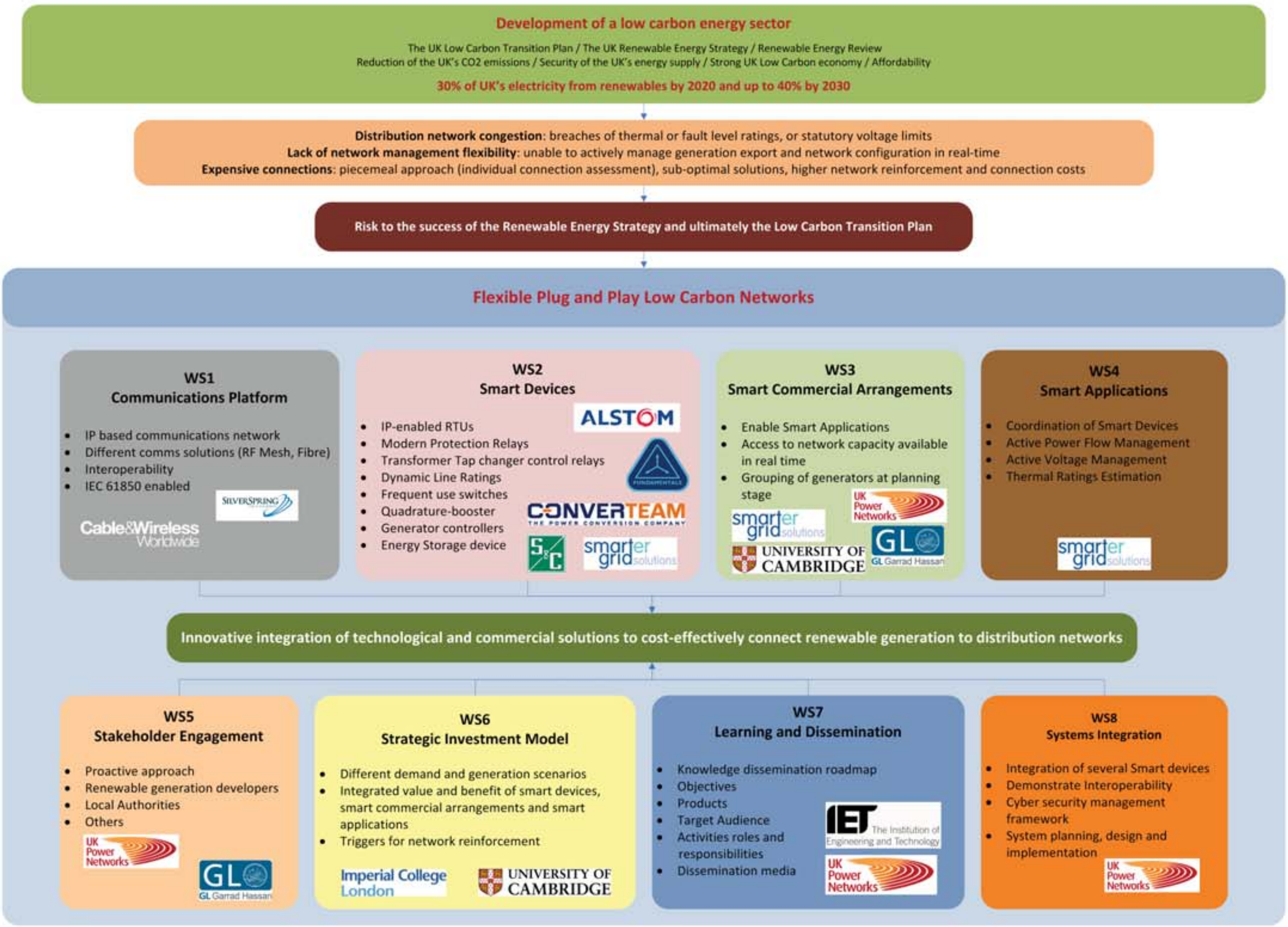
UK Power Networks have also reviewed the initial derogation requirements set out in the ISP and no longer believe that a derogation will be required for the DG incentive scheme.

2: Project Description cont.

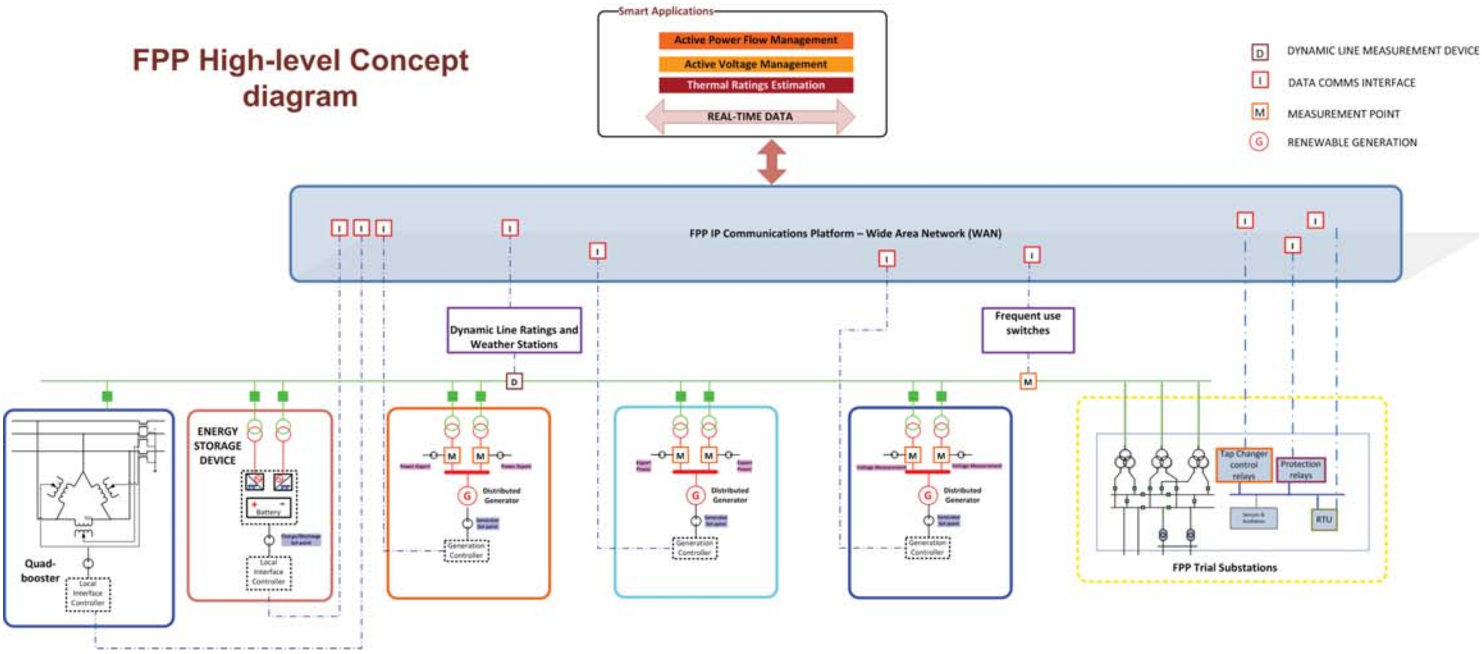
2: Project Description cont.

2: Project Description Images, Charts and tables.

FPP Context diagram



FPP High-level Concept diagram



Section 3: Project Business Case

Business Case Context

UK Power Networks has recognised a clear need across the UK DNO community for a change in the level of engagement and methods of interaction with renewable generation (RG) customers. UK Power Networks recognises that the existing approach to network investment and delivery of generation connections, especially in generation dominated areas, is limited due to existing technical standards, inflexible connection charge assessment methodologies and the need to maintain commercial confidentiality (for example, in considering multiple RG customers together). By exploring new solutions to these issues through a coordinated series of trials, UK Power Networks will deliver benefits for all UK DNOs by demonstrating how engagement with RG customers can be improved, and cost effective and timely solutions to localised network problems derived.

To allow smart solutions to be deployed as an alternative to network reinforcement UK Power Networks has recognised that the existing IT systems and communications will need to be upgraded by using a scalable and open standards platform to facilitate the implementation of smart devices from any vendor supplying equipment compliant with standards such as IEC 61850 to resolve local network constraints. This will increase competiveness between vendors and realise direct network benefits through avoided or deferred network reinforcement. The FPP project has targeted the use of smart devices and applications to resolve network constraints associated with renewable RG customers but equally this same platform would be applicable to network constraints driven by other factors, including demand growth (perhaps through Electric Vehicles). It follows that the learning from FPP will be expected to extend to applications other than distributed generation.

For the FPP project, UK Power Networks has identified a 700 km^2 zone within its EPN licence area with the following characteristics:

- Rural area with attractive wind characteristics complementary to wind power generation;
- High current penetration of wind energy in the distribution network (mostly connected at 33 kV)
- Presence of other distributed generation;
- Substantial pipeline of wind projects in the area;
- Existing network assets reaching their limits in terms of capacity and operational integrity.

The area has an existing need for local and wider network reinforcement to accommodate additional generator connections which cannot be justified on a project by project basis. The existing planning and industry charging framework do not support the cost-effective treatment of multiple connection applications and this is becoming a potential barrier to renewable energy development and the achievement of UK carbon reduction targets.

Initial analysis has shown that the proposed infrastructure and smart devices to be deployed by the FPP project will enable connection of up to an additional 188 MW of new wind generation with significantly reduced need for network reinforcement. The project will also address constraints already experienced by an existing biomass CCGT power station which will enable 41 MW of additional capacity to be deployed. Furthermore, the project will allow continued grid access to two other wind farms of 28 MW capacity currently disconnected under single circuit 132 kV outage conditions.

In order to address the network constraints identified in Section 2, UK Power Networks has considered three options:

(A) Business as usual (rely on existing approaches and traditional network reinforcement);

(B) Undertake a series of standalone innovative technology or commercial concept trials;

(C) Undertake an integrated and coordinated series of trials to develop a 'fix and flex' DG-enabled network.

3: Project Business Case contd.

(A) The current '**Business as usual**' approach generally requires each generation connection application to be considered individually, often with little certainty as to the sequence in which generators may connect and/or the overall take-up of connection offers. To prepare this business case UK Power Networks has applied engineering judgement and made use of informed estimates to determine the reinforcements that would be required to provide an unconstrained connection to each of the pending RG customers in the area (i.e. to derive the counter-factual). The network cost of accommodating all of the new renewable generation, as currently identified, would be approximately £15.13 million (Appendix G). Therefore, it has been assumed that the **total cost of the 'Business as usual' approach would be circa £15.13 million.**

(B) The '**series of standalone trials**' approach and piecemeal deployment would result in an inefficient and uncoordinated solution. For example, without considering how the commercial arrangements associated with Active Network Management (ANM) will impact both RG customers connecting now, and future RG customers connecting at a later date, not all of the cost synergies and benefits of using this technology would be realised. A series of independent trials would most likely focus on individual smart devices deployed as point solutions (essentially the traditional approach of treating each RG connection as a standalone project but incorporating smart technology). **This would fail to deliver the benefits** of stakeholder engagement and of deploying a flexible plug-and-play ICT architecture which would ensure future deployments of ANM in a timely manner with the ICT architecture in place to support them.

(C) The '**integrated series of trials**' requires the implementation of an open-standards based ICT infrastructure to permit the rapid and cost effective deployment of smart technologies in the development timescales required for RG connections. The coordinated approach allows the interaction and interoperation of various smart grid technologies to be tested as a solution across a wide area of the electricity network and for a number of potential customers. The opportunity to consider a number of individual RG connections collectively offers opportunities for new commercial arrangements, strategic long term investment decisions and deeper customer engagement to address local issues.

This project business case is built on the basis of delivering a fully integrated trial applied to the connection of RG while avoiding or reducing network reinforcement. This same solution, or parts thereof, will be suitable for managing generation and demand related constraints elsewhere on the UK Power Networks distribution network. The business case and extrapolation of the benefits has been applied only to the connection of RG.

The total **cost** of the FPP project (the 'integrated series of trials' approach) is **£9.89 million** (Appendix A) which represents an **estimated saving over the 'Business as usual' approach of approximately £5.25 million.**

Direct Benefits

In the UK Power Networks DPCR5 Full Business Plan Questionnaire there was no allowance for distributed generation 'shared costs' capital expenditure as it was assumed that any costs would be recovered through connection charges. These savings will therefore provide real benefits to RG customers. **UK Power Networks will not receive any Direct Benefit** in DPCR5 as a result of undertaking the FPP project.

Tangible Benefits

The business case for the FPP project has been built based on a number of benefits which are quantified below. The project will also deliver a number of indirect or intangible benefits to various stakeholders including RG Customers, UK Power Networks, other UK DNOs, Ofgem and other UK Government Departments.

The net benefits of the FPP project method have been calculated using the following methodology:

1. Calculation of the 'net' cost of the FPP project method being trialled;
2. Extrapolation of the FPP project methods to the UK for the periods to 2020 and 2030;
3. Quantification of the net benefit of the FPP project method.

3: Project Business Case contd.

The cost of the FPP project method being trialled is £9.89 million. **The cost of replicating this method ('net' cost) has been assumed to be £5.5 million**, which assumes savings on the Strategic Investment Model development costs, learning and dissemination costs, stakeholder engagement costs and project management costs.

Extrapolation methodology

The ENA report *"Evaluating the case for introducing locational DUoS charges for CDCM generators"* [1] has recently been published. This presents three different scenarios for DG growth rate. Low growth assumes an additional 2.9 GW of DG connecting to the distribution network by 2021, Medium scenario assumes 5.8 GW and High growth rate scenario assumes 11.6 GW. For the purpose of our analysis we have considered the medium scenario, i.e. assumed that an additional 5.8 GW of distributed generation to be connected to the distribution network by 2021.

In order to validate the above assumption we have compared it against the findings of the following reports:

- 'ENSG: Our Electricity Transmission Network: A Vision for 2020', Department of Energy and Climate Change, March 2009 [2]
- '2050 Pathways Analysis', DECC, July 2010 [3]

The ENSG report anticipates that 11 GW of onshore wind will be connected in Scotland alone by 2020 with a further 4 to 6 GW in England and Wales. The report does not differentiate between transmission and distribution connected projects. The 2050 Pathways Analysis report presents four potential levels of growth for onshore wind generation. Using the mid point level of growth the Pathways reports suggests a total value of onshore generation of 17 GW by 2020. While the report does not differentiate between transmission and distribution connected onshore wind, a reasonable assumption is that for England and Wales, the great majority of this onshore wind will be distribution network connected.

The above indicates that the 5.8 GW figure from the ENA report represents approximately 34% of the total onshore wind capacity estimated by both the ENSG and Pathways reports. The latter reports focus on onshore wind rather than all forms of distributed generation making the extrapolation calculation presented below conservative in nature. It is therefore reasonable to assume that 5.8 GW of distribution generation could be connected to areas of Great Britian's distribution networks in situations where the FPP project methods could be applied.

The FPP project trial area includes 14 primary substations and the analysis in the *"Evaluating the case for introducing locational DUoS charges for CDCM generators"* report indicates that 5.8 GW of distributed generation would be supplied by 157 primary substations. This means that a further 11 (≈157/14) projects similar to FPP would be required by 2021. Assuming that a similar amount of wind capacity would be enabled (188 MW) by each of the 11 projects then the FPP methods being trialled could be used to connect up to 2.1 GW (≈11x188) of onshore wind generation. This is the figure that has been assumed as the wind generation capacity enabled by the FPP project across the UK by 2021.

Therefore, the net benefits of rolling out the FPP project method to the UK would be **£ 108 million** = [2.1 GW/ 0.188 GW x (£15.13 million - £5.5 million)] by 2021.

The ENSG document also includes an addendum extrapolating analysis to 2030. This document presents estimates for the growth in distribution connected generation in the period up to 2030. It estimates a combined growth in distribution connected generation of 11 GW up to that period. The analysis above assumed a growth in distribution connected generation in the period 2010 to 2020 of 5.8 GW. Growth of 11 GW would require approximately 21 additional projects of similar geographic scale to the FPP project to connect approximately 4 GW (≈ 21 x 188MW) of distributed generation with a total net benefits of **£205 million** by 2030 (at 2011 costs).

[1] http://2010.energynetworks.org/storage/DOC%20-%20ENA%20final%20report%20-%2001-04-11%20-%20STC.pdf
[2] http://www.ensg.gov.uk/assets/ensg_transmission_pwg_full_report_final_issue_1.pdf
[3] http://www.decc.gov.uk/assets/decc/what%20we%20do/a%20low%20carbon%20uk/2050/216-2050-pathways-analysis-report.pdf

3: Project Business Case contd.

Carbon Benefits

The FPP project could deliver 242 thousand tonnes of CO_2 emission savings by 2020. Based on projections of renewable generation enabled by rolling out the FPP solution across GB, these emissions savings would increase to 4.8 million tonnes of CO_2 by 2030. The carbon emission savings calculation and its underlying assumptions are presented in Appendix 2 and are based on zero carbon wind generation replacing a much higher carbon intensive grid mix taken from the Analytical Annex to the UK Low Carbon Transition Plan [4].

Other Benefits

A wide variety of stakeholders will also experience benefits from the project which are difficult to quantify. Instead, a description and a qualitative assessment of these benefits is presented.

RG Customers

As noted by Ofgem's 16th May 2011 consultation, "Distributed Generation: an Open Letter requesting views on the process of getting connected" [5], criticisms have been made by distributed generation customers relating to the connection process and the level of communication with DNOs. In some cases DNOs have been unresponsive and inconsistent in their approach to RG customers yet these customers find it difficult to complain as they must continue to work with the DNO as the local network operator licence holder. Through this consultation it was also identified that there was room for improvement in more frequent and open stakeholder engagement to discuss and resolve local issues through development of appropriate solutions.

It is exactly this issue that the FPP project aims to address in order to bring direct benefits to RG customers. By working with RG customers and offering potential solutions (e.g. new commercial arrangements, smart technology, considering multiple applications together, etc.) to the local problem through a dedicated Stakeholder Engagement workstream, the project will address local issues, provide a blueprint for engaging with RG customers in other areas of the UK and demonstrate a range of smart solutions that can also be adopted elsewhere as a flexible alternative to conventional reinforcement.

By using this project to update the DG Connections Guide, producing technical reports on each smart solution, and issuing reports to the DNO community on the perspective of the RG customer, similar benefits will be available to other RG customers across the UK.

The renewable generation developers (EDF Energy Renewables, West Coast Energy, EcoGen and RES) believe that our proposed trial of new smart grid technology and flexible commercial arrangements would be of significant benefit in enabling the cost-efficient connection of renewable generation. Cambridgeshire County Council, mindful of the necessary high levels of new generation development planned for the area, expressed its support for the fact that FPP aims to facilitate such connections in future. Furthermore, Scottish Renewables, which represents the renewable energy industry in Scotland, believes that the FPP project could provide long term benefits to its members and push forward the transition to a low carbon economy. Six formal letters of support to the FPP project are enclosed in Appendix 3.

UK Power Networks

The Strategic Investment Model developed by this project will inform the future network and business plans for UK Power Networks. It is the tool that will be used to realise the benefits described in this proposal.
It will evaluate and justify decision making in the areas of network reinforcement and utilisation and, linking with existing UK Power Networks modelling tools, it will provide input to the business plans for future RIIO submissions. UK Power Networks will develop new skills and capabilities in areas such as advanced ICT, interoperability and standardisation, and project and operations management as part of managing the FPP project life-cycle. These are expected to:

- reduce reliance on a discrete number of technology vendors so fostering competition;
- reduce the design and commissioning time for DG connections, hence improving customer service;
- reduce the risk of stranded assets and/or suboptimal network utilisation.

The new commercial arrangements proposed will lead to more efficient approaches that will speed up connection of connections and improve service to DG developers.

[4]http://www.decc.gov.uk/assets/decc/white%20papers/uk%20low%20carbon%20transition%20plan%20wp09/1_20090727143501_e_@@_uklctpanalysis.pdf
[5] http://www.ofgem.gov.uk/Networks/ElecDist/Policy/DistGen/Documents1/DG%20Forum%20Open%20Letter_May.pdf

3: Project Business Case contd.

Other GB DNOs and the Wider Energy Industry

UK Power Networks will lead learning dissemination for the project, as detailed in section 5, ensuring that the benefits and knowledge accrued can be transferred and applied to the rest of the UK's DNOs and the wider energy industry. However and in more specific terms, this section highlights benefits associated with principles of access and the Supplier hub model.

The project will benefit other UK DNOs by trialling different types of constraining off arrangements with RG customers and will analyse the impact of these arrangements. Lower upfront costs (achieved through lower priced connections) could result in reduced revenues for the generator due to constraining off arrangements (albeit for variable wind generation such constraining off requirements will be relatively infrequent). The acceptability and impact of different `principles of access' will be trialled as part of the project. The project will trial arrangements that give greater access to customers already connected such as `last on, first constrained off' as well as a range of shared constraint arrangements such as percentage constraint for all generators at certain connection points. These trials will generate significant learning regarding the implications of different principles of access on the development of distributed generation and on the barriers to entry for small renewable generators. The FPP Strategic Investment Model will quantify the impact of different commercial arrangements enabling DNOs to evaluate the efficiency and impact of each approach in real situations. The project will examine the commercial effect of this approach both from the DNO perspective and from the perspective of the generator, and share this knowledge with other UK DNOs.

National Grid's requirements for responsive demand ancillary services for residual system balancing has resulted in demand aggregators forming contractual relationships with customers - potentially modifying the electricity demand or generation expected by Suppliers. This in turn poses difficulties in Suppliers accurately predicting their positions before gate closure leading to to potential imbalances which could ultimately cause them to raise retail energy prices. Active Network Management, through being able to constrain demand or distributed generation, acts in a similar way to dispatched demand response but for the purpose of distribution network constraint management rather than system balancing per se. Going forward, responsive demand is expected to play a much more significant role in the market by reducing the requirement for additional conventional generation and/or distribution network capacity to support electrification of heat and transport, and to compensate for a much larger contribution from variable generation (see Poyry - Demand Side Response: Conflict Between Supply and Network Driven Optimsation - A Report to DECC - November 2010). It follows that extensive use of ANM on distribution networks will create even greater uncertainty for Suppliers. The FPP project will examine the impact of ANM and the predictability of Supplier imbalances and therefore significantly add to understanding in this emerging area of concern.

UK Power Network's 'Low Carbon London' LCNF Tier 2 programme is investigating the scope for active management of DG to mitigate network congestion (thermal, voltage or fault level) through constraining-off arrangements and/or to provide network support by constraining-on arrangements. The FPP project builds on learning from the Low Carbon London (LCL) project and seeks to enhance and extend this learning. The LCL project has already gained valuable learning about customer acceptability of ANM and incentives to accept certain levels of generator constraint. The LCL project has so far focussed on existing customers who have already been connected but could benefit from commercial arrangements from changing contractual arrangements resulting in incentive payments. The FPP project goes much further in attempting to proactively connect greater levels of renewable generation without incurring extensive network reinforcement costs.

In summary: the FPP technical innovation focuses on the development of an open standards platform to enable end-to-end communication between distributed smart network technologies and generation. FPP allows for decentralised monitoring, control and overall operational management of both network and generation by active network management applications. This concept and technical architecture has not been tested in a production environment in the UK before and will be a leap forward in the evolution of the DG-enabled network. Commercial innovation will be delivered in the form of investment modelling and new commercial contracts to provide flexibility and customer choice to generation customers. FPP will address the need for a more responsible, cost efficient and flexible approach to generation customer connections.

The table at the end if this section provides a summary of the benefits of open standards ICT platforms such as will be deployed by the FPP project.

3: Project Business Case contd.

3: Project Business Case images, charts and tables.

Benefits of open standards ICT platforms	
Features of open standards ICT platform	**Benefits**
Open standard data communications protocols	Less technical specification effort for UK Power Networks - refer to international standards instead
	No bespoke development for smart device vendors - devices can be offered without additional cost for bespoke development
	Multiple smart device vendors can provide solutions - greater competition between vendors
	Less testing effort for UK Power Networks - certified compliant devices can be provided by vendors
	Reduced risk of operational issues because no bespoke development of data communications protocols
	Reduced lifecycle risks as smart devices are more likely to be replaceable with alternatives
Wide area communications infrastructure	Economies of scale - no communications costs for adding communications for new smart devices at existing locations within the trial area
	Economies of scale - minimal communications costs for adding communications for new smart devices at new locations within trial area, or extending trial area
	Economies of scope - no communications costs for additional active network management services at existing locations within trial area
	Economies of scope - minimal communications costs for additional active network management services at new locations within trial area, or extending trial area
Active network management platform using open standards data communications protocols	Economies of scale - no costs for adding existing active network management services to existing platform for new locations within trial area
	Economies of scope - minimal costs for adding new active network management services to existing platform
	Multiple active network management solution providers can offer solutions - greater competition between providers

Project Business Case images

Section 4: Evaluation Criteria

(a) Accelerates the development of a low carbon energy sector

Enables economically viable connection of renewable generation

The FPP project will demonstrate how to build an open standards platform that will enable the progressive and flexible addition of new smart devices and applications. These applications will directly address existing or anticipated constraints and operational limitations of the network in order to facilitate and accelerate the connection and operation of renewable generation in a constrained or DG dominated network. Replication of this approach based on the learning derived from this project will allow DNOs to move from a passive 'fit and forget' to a more active 'fit and flex' approach.

The FPP project will develop a Strategic Investment Model to identify the most flexible and cost effective solutions for renewable generation connections. The FPP Strategic Investment Model will present a method of coordinating the planning and operation of distribution networks, providing a means of considering multiple generators together at the planning stage, and comparing various smart alternatives to network reinforcement. The Strategic Investment Model will be used to assess the cost and carbon benefit of the FPP project trials and the success of the overall project in meeting its objectives to provide quick, low cost and economically viable connections for renewable generation. The fact that similar challenges exist in other areas of GB makes the learning from this project particularly valuable.

Facilitates the deployment of renewable generation

Learning from the FPP project trials will inform how the deployment of smart devices and applications, and the accompanying ICT, can reduce or defer the need for new distribution network capacity to facilitate the deployment of renewable generation. This aligns with the goals of the Renewable Energy Strategy, which requires significantly more renewable generation to connect to UK distribution networks in short timescales. The FPP project will demonstrate technical and commercial solutions that can be implemented by DNOs to ensure the networks are not a barrier to the deployment of renewable generation, in the short, medium and longer term.

The Low Carbon Transition Plan discusses the increased use of electricity as an energy carrier, essentially adding greater demand to the electricity system and reducing the consumption of fossil fuels for heating and transport. Decentralised sources of low carbon electricity production are encouraged by the Feed-in Tariff arrangements, by local government carbon reduction strategies, the Committee on Climate Change Renewable Energy Review of May 2011, and will in future be incentivised through the Zero Carbon Home initiative (from 2016). It follows that greater volumes of low carbon generation will need to be accommodated by distribution networks. The FPP project will provide the means to maximise the flexibility and utilisation of existing distribution networks - increasing their ability to facilitate both increased demand and increased generation.

The technical and commercial solutions trialled within the FPP project will be applicable to other parts of GB, meaning other areas could overcome network barriers to low carbon objectives by considering the cost and carbon benefit of developing the network and accompanying ICT infrastructure in parallel. This directly aligns with one of the goals of the Low Carbon Transition plan: to plan and enable timely investment in network infrastructure.

CO_2 Emissions reduction

The FPP project will contribute further to the Low Carbon Transition Plan by enabling greater amounts of renewable generation to connect to distribution networks, more quickly than under a business as usual scenario, and in a cost effective manner. The FPP project will result in emissions savings of 242 thousand tonnes of CO_2. Using DECC non-traded shadow carbon prices this equates to an equivalent financial benefit of £10.5 million NPV. If the methods trialled in the FPP project are subsequently rolled out across the UK, this will result in emissions savings of 4.8 million tonnes of CO_2. This converts to a financial saving of £192 million NPV. The Carbon Calculation methodology can be found in Appendix 2.

4: Evaluation Criteria contd.

Potential for replication

The FPP project will explore the coordination and interoperation of smart devices by a number of smart applications, through IP communications using open standards. There is no evidence of this challenge having been previously been addressed elsewhere in GB through trials at this scale. The IP communications platform and open standards approach plays a crucial role in ensuring that the proposed FPP approach can be replicated, and targeted at the many real and common challenges associated with the connection of increased levels of distributed renewable generation across GB. This approach is essential to facilitating the deployment of truly interoperable smart grids and providing the quickest possible means of enabling economically viable renewable generator connections. The FPP method will be generic and hence applicable to all GB distribution networks, irrespective of the fact that the smart devices and applications required in different areas may vary. This is the greatest benefit of establishing an approach that facilitates the flexible plug and play of new technology and a means of identifying the most cost and carbon effective connection solutions to implement in any given area.

The FPP project is expected to be able to facilitate an additional 188 MW of renewable generation in the trial area. If the FPP method is replicated across the UK an additional 2.1 GW could be facilitated by 2020 and 5 GW by 2030.

Generates new knowledge and skills

The FPP project will be one of the first in GB to embrace open standards, in particular the extensive use of IEC 61850 and the establishment of IP connectivity both within and between substations. Such standards promise to ease the cost and complexity associated with the proliferation of new smart technologies. Trials of this approach will generate knowledge and skills in UK Power Networks and their partners. Further development of this skills base is essential to ensuring low carbon networks are a practical reality across GB; indeed, the Low Carbon Transition plan identifies the building of the skills base as a key enabler of the low carbon energy sector. It is important therefore that learning, skills and the means of managing new knowledge to enable the FPP method is shared with all DNOs and industry participants. This is a fundamental objective of FPP which is supported by a comprehensive dissemination strategy building on UK Power Networks' experience with Low Carbon London.

Fosters competition and innovation

The FPP method promises to reduce dependence on a limited portfolio of technology vendors and, in so doing, foster competition and innovation. The flexibility afforded by the FPP methodology means that if such an approach was widely adopted, vendors would have to ensure interoperability to enable the real benefits of coordinated network planning and operation to be realised. The FPP method means that new approaches to network management, including novel distributed network control arrangements using smart applications, can be more easily deployed, making use of existing open standards interfaces to coordinate and control smart devices and interact with smart applications.

4: Evaluation Criteria contd.

(b) Has the potential to deliver net financial benefit to existing and/or future customers

As described in Section 3 the net financial benefits of rolling out the FFP method nationwide would be £108 million by and 2021 and £205 million by 2030 (at 2011 price levels). These costs represent direct benefits to existing and/or future customers.

Base Costs Assumptions

In order to identify the reinforcement work required to connect the planned renewable generation in the FPP area, a notional order of connections has been assumed. The minimum conventional network reinforcement required to upgrade all identified constrained sections of the network is estimated to cost £15,130k, broken down as follows:

- Upgrade approximately 75.2km overhead lines and 3.2km of underground cable of 33 kV circuits at total estimated cost of £6,530k.
- Replace 2 x 60 MVA and 2 x 45 MVA 132/33 kV grid transformers at Peterborough Central and March Grid respectively with new 2 x 90 MVA units at each site at a total estimated cost of £8,600k.

The estimated base cost is conservative. It excludes provisions of likely reinforcements at 132 kV and/or 11 kV systems.

A detailed description of the base costs assumptions can be found in Appendix G.

Method Costs Assumptions

The method costs represent the costs for replicating the FPP Method once the trial is successful as part of a nationwide roll out. In order to derive the method costs, the following assumptions have been made

- The duration of a roll out project would be between 12-18 months in comparison to the FPP trial project duration of 36 months. Reduction in project duration would reduce PM and resource costs.
- Knowledge captured during the FPP trial will be available to DNO staff. DNOs will be better placed to deliver such projects without the need for specialist contractors. On this basis, it is assumed that no contractor costs will be incurred by a roll out project.
- No further R&D costs will be incurred for the quadrature-booster.
- The FPP trial will lead to an increase in expertise, experience and standardisation of ANM scheme development. It will reduce engineering time for ANM configuration and pre-production testing which will result in cost reduction.
- The Strategic Investment Model will be available at the end of the FPP project and therefore no costs are incurred for such activity in a roll out.
- No costs for learning dissemination and stakeholder engagement are required for the roll out. It is expected that these are embedded in business as usual operations for DNOs and will not be born by the roll out project.

Therefore the method costs applicable to the roll out of such a project have been calculated at £5.5 million as shown in Appendix A.

4: Evaluation Criteria contd.

(c) Level of impact on the operation of the distribution system

The traditional approach to planning and operating distribution networks follows a 'fit and forget' philosophy that results in a largely passive infrastructure. Constraints due to new renewable generator connections are traditionally addressed by DNOs at the planning stage with network reinforcement solutions identified and implemented prior to the connection of generators. The method proposed by the FFP project will allow DNOs to move towards a 'fit and flex' approach, which in turn will enable the most flexible and cost effective means of connecting renewable generation.

The FPP project will demonstrate and deploy more flexibility in the operation of the network. Smart devices will be deployed to provide specific functionality that currently does not exist or is not widely deployed in the UK. Smart applications will then coordinate these devices, including controlling generator real and reactive power, in accordance with network constraints - as defined by static, seasonal or real-time capacity limits - according to the contractual arrangements in place with renewable generators. This represents a new active mode of operation for the distribution network, with smart applications performing autonomous management of power flows and/or network thermal and voltage constraints in accordance with commercial arrangements.

The FPP project will demonstrate an entirely new way of sharing data between devices in the field and creating flexibility in substations and beyond to ensure interoperability can be achieved. Substations will be equipped with IP connectivity that is currently not deployed by UK Power Networks, to support the use of the latest developments in open standards. The FPP project will represent the first time that all of these new technologies, smart devices and applications have been deployed and controlled in a coordinated and interoperable way.

The learning and outcomes from the FPP project trials will inform how the planning and operation of distribution networks will be impacted. The following are envisaged changes to the 'traditional' operation of distribution networks:

(1) The use of real-time ratings of the distribution networks assets, rather than static or seasonal ratings, where this will release useful additional capacity;
(2) Automatic and frequent relocation of normally open points to reduce or minimise constraints;
(3) Control of generator real and reactive power;
(4) Active management of power flows using Quadrature-boosters
(5) Coordination of transformer tap changer control relays providing holistic automated voltage control;
(6) Adaptive protection that takes account of the operation of other smart devices and network conditions;
(7) Autonomous coordination of the above smart devices and generators by applications to remove power flow and voltage constraints:
    - in response to real-time system conditions;
    - according to the commercial arrangements in place; and
    - distributed to multiple locations in the trial area.
(8) Peer to peer exchange of data and control instructions to support a distributed control philosophy, as opposed to the traditional centralised control philosophy of data being provided from RTUs located in the substation to the UK Power Networks centralised SCADA system (using open standards to ease integration and facilitate interoperability).

The main beneficiaries of the FPP project are the generators that will connect to the distribution network. These generators could receive faster, cheaper, and/or less constrained grid connections, based on the approach being adopted across the planning and operation of the network in the FPP trials. Once the trials are complete, the FPP methodology will be applicable to other network areas.

4: Evaluation Criteria contd.

(d) Generates knowledge that can be shared amongst all DNOs

The FPP project will tackle the practical challenges associated with the adoption of IP based communications both within and between substations. This will include the management of this new infrastructure, establishing and maintaining security, and the creation and administration of data models and schemes to permit the integration of smart devices and applications. These issues, which it is believed have not been tackled previously in GB, will provide significant learning for all DNOs.

One of the benefits of the FPP methodology is the testing of interoperability of equipment from multiple vendors. This is necessary to prove that developments in open standards are proceeding as intended and that the vendors are in step with the requirements placed on them to provide this functionality.

In deploying and coordinating smart devices and applications for the first time using these standards it is possible that gaps will be identified in the existing data models and schemes. This will be addressed in the project by the creation of templates and models that incorporate the data and controls required for the smart devices and applications to interoperate. This learning, surrounding the capability and potential limitations of existing open standards, will be of great interest to DNOs trying to overcome the challenges of renewable generation integration with smart technologies.

The FPP project will be deploying new equipment that will be making use of a new means of communication and data exchange. The flexible nature of the platform means that new processes will be developed to commission new devices onto the platform and to decommission those that are no longer required or have achieved the purpose of the trial. These processes will be tested, and the ability of the FPP methodology to streamline and simplify the commissioning/decommissioning process will then provide learning to other DNOs. This learning will be gradually updated throughout the project.

The FPP project will demonstrate fully distributed control, with smart applications deployed to multiple locations on the IP network. These smart applications will perform all constraint management tasks and will automatically 'failover' (i.e. switch over automatically on failure to an alternative application when required) providing redundancy across the geographical area of the FPP trial. This will provide learning to other DNOs regarding the capabilities of the IP communications and open standards platform and the challenges and benefits of distributing smart applications that autonomously operate smart devices and maintain the network within defined limits.

In addition to the above technical learning points, the FPP project will answer some key questions that are of relevance to every DNO faced with significant numbers of connection applications from renewable generation, including:

- When is the right time to reinforce the network?
- How can various smart alternatives to network reinforcement be considered and what criteria should be used to assess the options?
- What knowledge of customers and technologies is required in order to perform this assessment?
- Can the latest developments in open standards and IP communications provide the platform to ease the integration and interoperability of smart devices and applications to leverage maximum benefit for renewable generation?

The above will be captured and disseminated throughout the project, which will then be fed into the development of the FPP Strategic Investment Model. This model will be available to, and easily replicated by all DNOs. It will identify the triggers for network reinforcement based on that which can be technically and commercially achieved using the latest advances in smart grid technology. The FPP Strategic Investment Model will incorporate and build upon (but not duplicate) learning from LCNF projects being undertaken by other DNOs that are currently under way, representing a significant learning opportunity for all GB DNOs.

4: Evaluation Criteria contd.

(e) Involvement of other partners and external funding

For the purpose of the FPP project, UK Power Networks has approached a number of commercial organisations and academic institutions to provide services, products and ideas to develop the project.

The Partners have been chosen for their breadth of experience, expertise and innovation culture. All Partners will support the project throughout its life-cycle (solution design, installation of operational systems, trials and reporting).

Detailed information on each Partner, their role in the project and letter of support is included in Appendix. A summary is included below:

Cable & Wireless Worldwide (CWW) is a leading global telecoms company with in-depth experience of deploying and managing infrastructure for highly critical energy systems. CWW will work closely with Silver Spring Networks to provide the backbone of the IP Open Standards Platform for communications networking (hardware, software and services).

Silver Spring Networks (SSN) has extensive experience in designing and implementing smart grids communication platforms for utilities in the United States. Silver Spring Networks will provide communications connectivity within the trial area utilising its innovative RF Radio mesh solution.

Smarter Grid Solutions (SGS) delivers applications and services to electricity network operators to allow them to manage network constraints and avoid or defer network reinforcement costs through active network management (ANM). SGS will deploy their power flow and voltage coordination management applications in the ANM scheme to be implemented in the FPP project.

GL Garrad Hassan has more than 25 years experience in the renewables industry and has provided services to all the major developers and operators of windfarms in the UK. Garad Hassan brings an expert understanding of the technical and economic aspects of wind energy development. Garrad Hassan will lead the stakeholder engagement process (WS5) while providing technical and commercial support to the other FPP project workstreams.

Alstom Grid is a global leader in power distribution and transmission. Alstom will provide the dynamic line rating and protection equipment for the trials as well as the quadrature-booster.

Fundamentals bring their expertise in design, manufacturing, supply of Automatic Voltage Control (AVC) schemes. Fundamentals will manage the AVC installations that have been included in this project and ensure their integration in the Open Standards platform.

Converteam have wide-ranging expertise in the area of power systems conversion and are the providers of Remote Terminal Units currently utilised by UK Power Networks. Converteam will provide technical and systems integration support at substation level and throughout the trials.

Cambridge University's Electricity Policy Research Group (EPRG) will provide economic, regulatory and competition analysis of the FPP Strategic Investment Model. The EPRG is Europe's leading academic research group on electricity policy. The EPRG have long-standing interests in network access pricing, economic regulation of networks and in decarbonisation and renewable policy. The EPRG also has an outstanding record of interdisciplinary research collaboration and excellent dissemination channels.

Imperial College London (ICL) is a science-based institution, consistently rated amongst the world's best universities and it has one of the largest engineering faculties in the UK. ICL will develop the FPP Strategic Investment Model that will identify the most cost-efficient and low carbon solution to connect renewable generation to the distribution networks.

S&C Electric Company (S&C) is a leading innovator in the area of switching and protection products for electric power transmission and distribution. S&C will provide SF6-based 33kV frequent-use switch with relevant communications and applications support throughout the FPP project.

The Institution of Engineering and Technology (IET) is a world leading professional organisation for the engineering and technology community. The IET will support the FPP project as a learning and dissemination partner. The FPP project will utilise the IET's communities model in order to disseminate learning to IET members while exploring other opportunities and working closely with the Institution.

4: Evaluation Criteria contd.

Further details about the about the above Partners can be found in Appendix F (Additional Details on Project partners). Details about Partners contribution are included in Appendix A (Full Submission Spreadsheet).

The total partners' contribution is £0.99 million.
DNO compulsory contribution is £0.99 million.
UK Power Networks is also making an additional contribution to the project of £1.00 million.

(f) Relevance and timing

The FPP project will address a wide range of technical and economic issues associated with the connection of renewable generation to the existing distribution networks. 188 MW of wind generation capacity is at various stages of the planning process and looking to connect to the FPP trial area. Existing LCNF and IFI projects in GB, including the Central Networks 'Low Carbon Hub' project, are focusing on the testing and deployment of devices to solve particular technical issues on the distribution network. The FPP project will build upon the learning from these projects to enable the wider geographical interoperability of smart devices and trials using a distributed control architecture. **The FPP project therefore fulfils the logical next step for these technology trials, paving the way for the use of new strategic investment models and operational systems that streamline the adoption of smart devices and applications.** The FPP project will fully embrace, and test, the use of open standards, which will be crucial to facilitating the integration of large numbers of low carbon technologies and ensuring that the benefits of interoperability can be securely achieved.

The FPP project will explore the full range of benefits that can be gleaned from the interoperability of smart devices and applications, and on a platform which supports the 'plug and play' integration of various technologies. FPP could be the location for trials of additional smart devices and applications in the future.

The FPP project is dealing with issues that exist today in the trial network area and elsewhere in GB. UK Power Networks has already studied the feasibility of ANM in the FPP area for an existing constrained generator and a future wind farm connection. These studies proved the viability of the deployment of smart applications to enable increased output from an existing generator and the maximisation of energy export from a future wind farm. In both cases, the barriers facing progress with the deployment of ANM are of a commercial nature. It is not currently clear how best to ensure that decisions made regarding ANM can maximise the potential of the network to accommodate more generators. The FPP Strategic Investment Model will directly address this question, and in so doing will resolve what is recognised as one of the main barriers today to the adoption of smart devices and applications to enable more holistic and efficient renewable generation connection strategies. Such an investment model has not been considered in other projects that are concerned with the trial of specific smart devices. This demonstrates both the relevance and timeliness of the FPP project to the hurdles facing renewable generation today and the value of the learning that will be provided to DNOs in GB and beyond.

4: Evaluation Criteria contd.

4: Evaluation Criteria contd.

4: Evaluation Criteria contd.

4: Evaluation Criteria images, charts and tables.

Evaluation Criteria Images

Section 5: Knowledge dissemination

☐ Put a cross in the box if the DNO does not intend to conform to the default IPR requirements

5.1 Learning dissemination

The FPP project will generate extensive learning opportunities for UK Power Networks, the wider DNO community, renewable generation developers, national and international standards bodies, academia, local authorities and other key stakeholders such as the ENA, DECC and Ofgem. In order to ensure that learning is effectively disseminated, a work stream will be established for this purpose. **Work stream 7: "Learning and Dissemination"** will focus on both internal and external learning and knowledge dissemination activities. This work stream will build on the knowledge dissemination synergies with other relevant LCNF projects such as Low Carbon London and the Low Carbon Hub.

A **knowledge dissemination roadmap** will be developed at the start of the FPP project in order to produce a clear and effective dissemination plan. The goal of this dissemination plan is to ensure accessibility to, and dissemination of, the FPP project results and methods. The knowledge dissemination plan will adopt a well-structured methodology in order to define:

(1) Dissemination Objectives:

- Ensure the provision of appropriate and reliable information to stakeholders regarding the FPP project.

(2) Dissemination Products. This will include but not be limited to the following items:

- Report on introduction to open standards Information and Communication Technology platforms for distribution networks;
- Report on Active Network Management of distribution networks to facilitate increased renewable generation;
- Report on innovative technical and commercial aspects of actively managed renewable distributed generator connections;
- Tutorial for on the FPP communications platform and open standards implementation (open to all DNOs);
- Workshops for Infrastructure Planners on the Strategic Investment Model and new processes and procedures for providing smart connection solutions for renewable generation;
- Workshops on the operation of the deployed smart devices and applications (including the interaction of the deployed FPP solutions with Control Room and Operations staff).

(3) Target Audience. The target audience for dissemination activities is anticipated to include but not be limited to:

- UK Power Networks staff;
- All GB DNOs;
- The Energy Networks Association (ENA);
- Industry and Government led working groups such as those overseen by the Smart Grid Forum and Smart Grids GB;
- Ofgem;
- DECC;
- Academic Institutions;
- The IET;
- Local Government Authorities;
- Local Communities;
- Trade Associations (including the Renewable Energy Association and Renewable UK);
- Renewable generation developers.

5: Knowledge dissemination contd.

(4) Dissemination Activities Roles and Responsibilities. The dissemination of learning and knowledge gained by the FPP project will receive support from across the UK Power Networks business and Project Partners:

- Learning will be coordinated through the Future Networks division within UK Power Networks which will ensure that all learning generated by the FPP and other UK Power Networks LCNF projects is disseminated effectively and that successful trials are translated to business-as-usual solutions. Central to this function is the process of seconding staff from the business to work on the FPP project. These staff will subsequently return to functional, operational roles and act as champions of change within the business;

- The Future Networks division will be responsible for dissemination activities involving: other DNOs; industry and Government led working groups; Ofgem; DECC; and the ENA.

- The Future Networks division will also coordinate dissemination activities with Universities, The IET, Government Authorities and Local Communities, Trade Associations and renewable generation developers. This activity will be supported by Garrad Hassan who will be responsible for stakeholder engagement activities across the FPP project;

- Dissemination activities will receive the full support of FPP Project Partners throughout the duration of the project.

(5) Dissemination Media. The learning obtained through the project will be disseminated using a variety of methods and communications media, including:

(5.1) Internal Communication:

- Future Networks Quarterly Newsletter;
- Intranet site dedicated to all LCNF project activities;
- Internal workshops;
- Internal reports;
- Development of internal business champions;
- The learning from the FPP project will inform the UK Power Networks business plan to be submitted to Ofgem as part of the new RIIO regulatory framework.

(5.2) External Communication:

- Development and production of a project website;
- Use of internet platforms such as LinkedIn and Webinars;
- Conferences and workshops, in addition to the LCNF annual conference;
- The FPP Strategic Investment Model will be made available to all UK DNOs, including instructions on the use and application of the model;
- The FPP project may identify areas of existing technical and regulatory standards (e.g. Distribution Code, Engineering Technical Reports and the DG Connections Guide) which are impacted by the trials or where the implications of a UK wide roll-out will have such an impact. These areas will be documented in reports and presented to other DNOs through the Energy Networks Association;
- International Standards Committees, expected to include the IEC;
- Contributions to and communication with relevant Industry Working Groups such as the IET, ENA, Smart Grid GB and Smart Grid Forum;
- Workshops with renewable generator developers;
- Scientific papers;
- Magazine articles.

5.2 IPR

UK Power Networks intends that the FPP project will conform to the default IPR arrangements.

5: Knowledge dissemination contd.

5: Knowledge dissemination images, charts and tables.

Knowledge dissemination images

Section 6: Project readiness

Requested level of protection require against cost over-runs (%).	5%
Requested level of protection against Direct Benefits that they wish to apply for (%).	0

Account of why the Project can start in a timely manner

UK Power Networks will be able to begin the project in a timely manner directly after confirmation of the funding award by Ofgem. In order to ensure this, UK Power Networks has the following key components of implementation in place:

- A detailed analysis of project objectives and requirements, with well defined work stream scopes together with in-depth use cases (Appendix 1). These use cases detail the proposed solutions, trials to be performed and their learning objectives. The use cases will be used in the detailed design stage as key input to detailed planning and technical design of the project.

- An established Future Networks team comprising a dedicated Low Carbon Networks Technical team, a Commercial Strategy team and Innovation and Standards team. These teams can ensure the timely implementation of the project while the project specific resource is allocated and mobilised.

- Identification of risks that could potentially delay the start of work at work stream level and where appropriate will proactively mitigate these issues by initiating activities before award notification at UK Power Networks' risk. The two main activities requiring early initiation are resourcing and drafting of the delivery contracts.

- A detailed Project Plan outlining the activities, milestones and dependencies (Appendix C)

- A clear governance structure with defined roles and responsibilities with named resources in place, with the authority, responsibility and knowledge to make decisions in a timely manner (Appendix E)

- An active risk register, mitigation and contingency plans in place (Appendix D)

- A change management procedure as a control mechanism to mitigate against risks, for example, of overrunning costs

- Ongoing engagement with the Low Carbon London project to ensure that further lessons learnt on that project can be applied to the FPP project (similarly with other relevant LCNF projects)

Furthermore UK Power Networks and the Project Partners have significant capability in delivering large complex programmes within this space; with this combined wealth of experience UK Power Networks can deliver the project to time, cost and quality. For example:

- UK Power Networks is delivering the Low Carbon London Project. This project has been successfully underway since December 2010 and while it is driving business change within UK Power Networks. It is also ensuring that a low carbon set of skills and expertise is developing within the business.

- Cable & Wireless Worldwide, the primary communications partner on the project, designed, delivered and managed a dedicated Next Generation Operational Telecommunications Network to support National Grid's Core Network Infrastructure and Operation Systems. They have in-depth expertise and experience of the most critical energy systems in the country, which is highly relevant to the deployment of smart grid.

6: Project readiness contd.

- Smarter Grid Solutions (SGS), the active network management systems partner on the project, has a unique understanding of the technical and commercial issues involved in the deployment of ANM solutions to manage grid constraints through their deployment of the world's first multiple constraint and generator ANM scheme on Orkney. SGS has also worked with UK Power Networks on a number of complete and ongoing projects of relevance to this Project, including Low Carbon London.

- For further details on the experience the Project Partners will bring to this Project please refer to Project Partner details in Appendix F

UK Power Networks has a Memorandum of Understanding (MoU) and agreed principles of collaboration in place with Project Partners and is therefore confident that the Project can start in a timely manner with full Partner support from Project initiation. A copy of the FPP MoUs can be provided upon request.

UK Power Networks has also accumulated considerable insight and knowledge through the Low Carbon London project which will be utilised and built upon during this project. The FPP project will leverage the learning (and where possible existing work) from Low Carbon London in areas such as project governance and management.

Account of how the costs and benefits have been estimated

UK Power Networks' cost estimates are based on:

- Receiving quotes from the Partners and benchmarking them where possible
- Previous experience on such projects
- Cost comparison of certain items with Low Carbon London

UK Power Networks financial and carbon benefit estimates are based on generation and renewable energy forecasts presented in published reports.

Account of the measures a DNO will employ to minimise the possibility of cost overruns or shortfalls in Direct Benefits

Project delivery and risk management will be based on industry leading and proven UK Power Networks delivery methodologies (based on Prince 2) and governance.

Project Governance arrangements will incorporate a number of controls to minimise the possibility of cost overruns and/or shortfalls in direct benefits, including:

- The appointment of a Project Steering Group, which will meet monthly. The Project Steering Group will define the acceptable risk profile and risk thresholds for the project. It will ensure that the project delivers within its agreed parameters;

- A Design Authority that will design the various trials and continuously review scope, ensure alignment with project objectives, and sign-off products and change requests. The Design Authority will have both a technological and commercial oversight to ensure that the two components of the overall solution remain mutually compatible and capable of delivering the optimal outcome;

- Mandatory monthly reporting to the UK Power Networks Executive Board by the Project Sponsor/ Manager

- Regular risk reviews led by the Project Office Manager with results reported to the Project Director/Project Steering Group

- Weekly work stream progress reporting to the Project Manager and robust financial control through mandatory monthly reporting from the Project Manager into the Steering Group/Project Board - including Project Sponsor oversight to prevent potential overspends before they occur and use of specified tolerances in projected spend

6: Project readiness contd.

- A well-structured and detailed Project Initiation Document and Project Plan and an appropriately defined and controlled suite of products to be delivered by each work stream, to ensure clarity of scope, objectives, approach and deliverables;
- A robust change management procedure that ensures all requests for change are analysed for cost impact among other elements.

Ongoing assessment of project delivery risk to ensure a successful outcome. Assurance approaches include:

- "Set Up For Success", to ensure that all necessary project disciplines are in place and adhered to;
- Strategic project reviews to ensure the project meets its objectives;
- Peer project reviews where an independent senior project manager reviews the project to provide quality assurance and to ensure accurate project reporting etc;
- Senior Business User will provide quality assurance through regular monitoring of progress against plan and achievement of key deliverables.

Verification of all information included in the proposal

UK Power Networks has endeavoured to ensure that the information contained within this proposal is accurate. UK Power Networks has gone through rigorous processes of information gathering from partners, vendors, and external technical experts. The information has been reviewed with these parties collectively to confirm and refine understanding, as well as reviewing content with internal UK Power Networks resources to evaluate the validity and integrity of information.

Project Partners have also ensured information provided by them has been through a thorough internal review and approval process before being provided to UK Power Networks.

Furthermore UK Power Networks has utilised an independent, external reviewer (PA Consulting) to provide challenge to the overall quality, deliverability, and technical integrity of the proposal.

Processes in place to identify circumstances where the most appropriate course of action will be to suspend the Project, pending permission from Ofgem that it can be halted.

UK Power Networks has a number of processes in place to highlight circumstances that may have a negative impact on the Project to ensure that these are assessed, monitored and managed. These processes will also be effective in substantiating whether the most appropriate course of action would be to suspend the Project:

- The risk management plan details the strategy to be employed to identify, analyse, control, monitor and review risks, and includes the requirement to assess risks in terms of potential impact on costs and on the ability of the project to deliver the requisite direct benefits. The risk management plan also details the roles and responsibilities of those involved in the risk management process including the Project Office Manager who will review and document progress; The Project Manager who will be responsible for ensuring all risks and issues above tolerance are escalated to the Project Steering Group; and the Project Steering Group who will have the overall responsibility to determine whether the most appropriate course of action would be to suspend the Project.
- The internal UK Power Networks business change governance function employs a gateway process for progressing projects through their life-cycle. If the project cannot meet the mandatory entry/exit criteria for any particular gateway (which takes into account risks, issues, benefits realisation and financial position) then the Project Director will provide evidence for suspension and recommend the Project be suspended to the Project Steering Group who will have the overall responsibility to determine whether the most appropriate course of action would be to suspend the Project.

Due to our careful planning of the FPP project, our well developed project management procedures, and the clear need to develop a more effective procedure for managing the connection of renewable generation to distribution networks, UK Power Networks does not foresee any credible circumstance under which suspension would be an appropriate course of action.

6: Project readiness contd.

6: Project readiness contd.

6: Project readiness contd.

6: Project readiness contd.

6: Project readiness images

Project readiness Images

Section 7: Regulatory issues

☒ Put a cross in the box if the Project may require any derogations, consents or changes to the regulatory arrangements.

UK Power Networks has considered the main licence conditions that may be impacted upon by the project and whether there may be a need for a derogation based on the project proposals. UK Power Networks believes that it is only SLC 14 and its associated Common Connection Charging Methodology and Statement (CCCMS) that fall into this category.

The project will engage with existing and new customers if suitable opportunities arise and will explore the potential for offering the technical and commercial solutions developed by the project.

Existing Customers

In the event that an existing customer (generator) who has seasonal thermal rating or post-fault intertrip constraints as part of their connection agreement is approached and wishes to accept an offer to participate in the project, the project will initially fund the installation of relevant smart devices to release network capacity/alleviate the constraint under trial conditions.

Subject to the successful trial of the installation, the generator will be invited to sign up to a new connection agreement which takes into account the additional capacity released and the fact that it might not be guaranteed capacity (i.e. beyond a certain capacity it is not a firm connection). At this point, as the installation would then become a permanent arrangement rather than a trial, relief would be required from charging in accordance with the common connection charging methodology (CCCM) for the installation of the smart devices.

UK Power Networks initially considered whether this relief could take the form of additional paragraphs in the DNO specific section of the CCCM; however our current view is that this could be problematic: precise wording would be required early on in the project when the full requirements may not be known and it could also confuse potential customers who could be unsure as to whether the paragraphs applied to them.

UK Power Networks therefore feels that using the existing ability of the Authority to exempt the licensee from its requirement to charge in accordance with the CCCM (SLC14.2) would be a simpler and cleaner way of proceeding. UK Power Networks plans to work with Ofgem to request consent for a defined geographic area and for customers who sign up to using the new connection agreement such that their connection charge for the additional equipment would be funded by the project and not themselves.

New Customers

A similar consent for new connectees may also be required where this involves a non-firm connection (above a defined capacity) and deviation from the minimum scheme definition - although the precise funding mechanisms will be developed as one of the first deliverables for this project.

7: Regulatory issues contd.

7: Regulatory issues images, charts and tables

Regulatory issues images

Section 8: Customer impacts

The participation of customers in the FPP project will be voluntary. The project will target both existing and future renewable generation customers interested in trialling the technical and commercial solutions proposed by this project.

Existing generation customers - For generation customers within the FPP trial area who already have a connection agreement, the FPP solutions will be proposed to these customers where potentially beneficial but they will have the option of retaining their existing access rights.

Future generation customers (no current offer) - For generation customers within the FPP trial area who have not yet applied for a grid connection to the network area, where applicable, UK Power Networks will provide, within the GSoP license obligation window, both a conventional and an alternative grid connection offer, the latter based on novel technological and commercial solutions derived from the FPP project. The implication of accepting the FPP connection solution will be explained to the customer and the customer will be given a written explanation of the solution in addition to a draft contract to ensure they fully understand the choices they are being offered.

The exact strategy for customer engagement and the commercial contract templates for the FPP offering form some of the first project deliverables.

It is envisaged that the stakeholder engagement team will have initiated contact and provided information to the potential generation customers in the area regarding the project scope, objectives and offering.

UK Power Networks is fully committed to ensuring that customers participating in the FPP project trials are fully informed.

New generators (outstanding offer) - For generation customers within the FPP trial area who have previously received a connection offer (which is valid for 90 days) but have not yet accepted it the following arrangements will apply:

- For customers still within the 90 days timeframe, UK Power Networks, through the stakeholder engagement work stream, will approach these customers to identify whether they will consider receiving an alternative connection offer based on the solutions within the trial;

- Where a grid connection offer has expired this may be a result of simply finalising the contractual terms of the connection offer, in which case the generation customers will be considered an existing customer. However, where a previously issued connection offer has expired and UK Power Networks has not been invited to begin detailed negotiations of contractual terms, the generation customer will be required to re-apply for a connection offer, as per existing practice, and therefore will be treated as if they are a new generation customer (i.e. there is no existing current offer);

- Once new or existing customers have agree to participate in the trials, they may experience some constraint to generation export. At the end of the trials, the extent of the constraint will be evaluated to ensure that it has not exceeded the constraint agreed in the customer's connection agreement or amended agreement. Monitoring equipment installed as part of the FPP project will allow UK Power Networks to fully assess this.

Customer engagement and education

UK Power Networks is fully committed to obtaining informed participation in the FPP project trials. To this end, UK Power Networks will engage directly with customers who are impacted by agreed changes to connections agreements. In addition, Garrad Hassan will conduct stakeholder engagement with both existing and potential generation customers and will provide more information and explanations to customers about the FPP project.

UK Power Networks will ensure that participants understand the implication of accepting the FPP connection solution through:

- A verbal explanation and walk-through of the options and trial implications to the customer;
- A written explanation of the solution and a draft contract to ensure they fully understand the choices they are being offered.

8: Customer impacts contd.

Customer Interruptions

The FFP project is concerned with a generator dominated 132kV and 33kV network group. Planned network outages will be necessary to install certain devices such as:

- Voltage and current transformers (for measurement purposes)
- Modern protection devices
- Upgrades to tap changer relays
- Frequent use switches
- Quadrature-booster

While such network outages will inevitably increase the risk of customer interruptions due to a second fault outage, such risks will be minimised through normal planned outage risk management procedures.

It follows that no customer interruptions are envisaged and UK Power Networks therefore does not need to request protection in respect of the Interruption Incentive Scheme.

8: Customer impacts contd.

8: Customer impacts contd.

8: Customer impacts images, charts and tables

Customer Impacts images

Section 9: Succesful Delivery Reward Criteria

Criterion (9.1)

Successful completion of the first phase of stakeholder engagement activities, resulting in clear identification of key technical and commercial challenges to the FPP project. These outputs will be shared with all the relevant stakeholders, including all GB DNOs, and will form a key input to the Strategic Investment Model and Smart Commercial Arrangements FPP project work streams. This will be completed by the end of Q3 2012.

Evidence (9.1)

Stakeholder Engagement Report I, outlining the findings from the first phase of stakeholder engagement activities.

Criterion (9.2)

Successful development of smart commercial arrangements, which will provide a number of options that can be tested and implemented in new types of connection agreements with generation developers. The development of smart commercial arrangements will be completed by the end of Q4 2012.

Evidence (9.2)

The evidence for meeting criterion 9.2 will be provided by:

- Report on Principles of Access, which will determine the Principles of Access for Smart commercial arrangements

- Connection agreements templates for actively managed generator connections, to be established in conjunction with key stakeholders.

9: Succesful delivery reward criteria contd.

Criterion (9.3)

Successful deployment of an IP communications platform across the FPP trial area to support open standards communication protocols. This will be completed by the end of Q1 2013.

Evidence (9.3)

The evidence for this criterion will be provided by:

- Sign-off of successful installation and commissioning of Cable & Wireless Worldwide Multi-Service Platform (MSP) network and Silver Spring Networks Radio Frequency (RF) Mesh network in the FPP trial area.

- Results of IEC 61850 communication trials using IEC 61850 simulators at various locations in the FPP trial area.

Criterion (9.4)

Successful demonstration of flexible plug and play capabilities of the overall FPP technical solution following completion of the FPP installation phase. This will be completed by the end of Q3 2013.

Evidence (9.4)

The evidence for this criterion will be provided by:

- IEC 61850 certification for all relevant RTUs, IEDs and other IEC 61850 field devices.

- Sign off documentation of installation and commissioning of IEDs and other field devices necessary to support the trials.

- Sign off documentation of installation and commissioning of production of Smart Applications.

- Pre-production interoperability test results for FPP's Smart Devices and Smart Applications

9: Succesful delivery reward criteria contd.

Criterion (9.5)

Successful completion of the FPP Strategic Investment Model including validation and testing of the model utilising data captured within the FPP trials. This will be completed by the end of Q4 2014.

Evidence (9.5)

The evidence for this criterion will be provided by:

- Sign off documentation of completion of the Strategic Investment Model development.

- Validation and test results.

- Provision of the Strategic Network Investment model in a format accessible to third parties.

Criterion (9.6)

Successful implementation of Active Power Flow Management and Active Voltage Management within the FPP trial area. This will be completed by the end of Q4 2014.

Evidence (9.6)

The evidence for this criterion will be provided by:

- Pre-production functional test results for Active Power Flow Management and Active Voltage Management applications

- Sign-off of completion of installation and commissioning of production Active Power Flow Management and Active Voltage Management applications

- Suitable agreements with generators in place (if required)

- Trial results for the Active Power Flow Management and Active Voltage Management trials

9: Succesful delivery reward criteria contd.

Criterion (9.7)
Successful facilitation of faster and cheaper connection of renewable generation to the distribution network, compared to timescales and costs of connection utilising traditional approaches. This will be completed by Q4 2014.

Evidence (9.7)
The evidence for this criterion will be through the provision of one or more connection offer(s) to renewable generators using the FPP methods. The connection offers utilising commercial and technical tools developed under FPP will be compared with connection offers developed for the same connection requests utilising traditional approaches. In order to successfully meet this criterion, the FPP connection offer(s) will have to: - Be cheaper than the offer(s) based on traditional reinforcement - Offer faster project connection timescales than the offer(s) based on traditional reinforcement

Criterion (9.8)
Successful deployment of a Quadrature-booster within the FPP trial area. This will be completed by Q2 2013.

Evidence (9.8)
Sign-off of completion of installation and commissioning of a Quadrature-booster.

Section10: List of Appendices

Compulsory Appendices

Appendix A - Full Submission Spreadsheet

Appendix B - Maps and Network Diagrams

Appendix C - Project Plan

Appendix D - Risk Register

Appendix E - Organogram

Appendix F - Additional Details on Project Partners

Appendix G - Base Case Assumptions

Optional Appendices

Appendix 1 - Use Cases

Appendix 2 - Carbon Calculation Methodology

Appendix 3 - Letters of Support

Flexible Plug and Play Low Carbon Networks

List of Appendices

Compulsory Appendices

Appendix A - Full Submission Spreadsheet (submitted separately)

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Optional Appendices

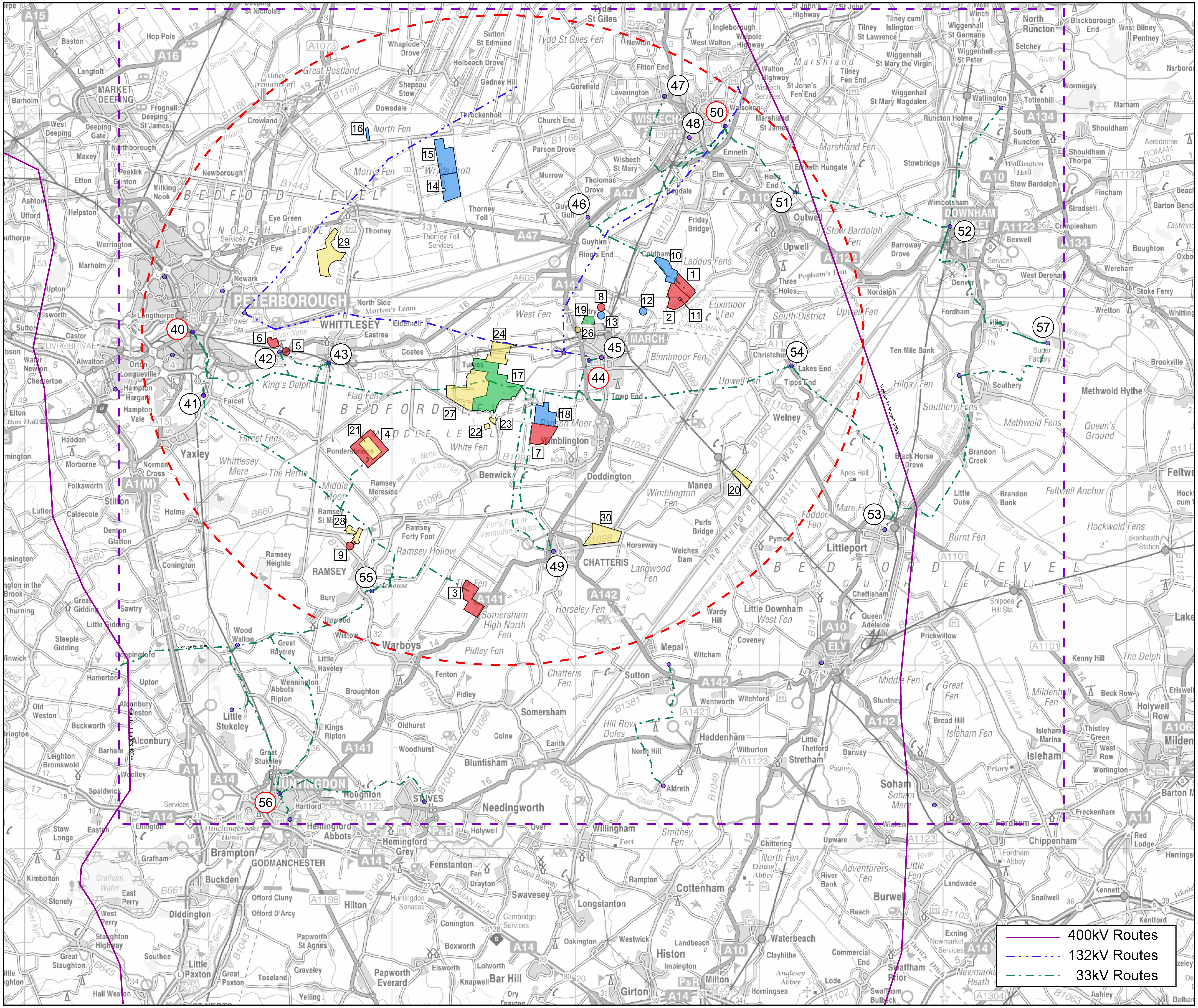
Appendix 1 - Use Cases

Appendix 2 - Carbon Calculation Methodology

Appendix 3 - Letters of Support

Appendix B

Maps and Network Diagrams



Key:

- Wind Farms
- Operational Wind Farms
- Consented Wind Farms
- Submitted Application Wind Farms
- Scoping Sites

- Substations

40 - Peterborough Central
41 - Farcet
42 - Funthams Lane
43 - Whittlesey
44 - March Grid
45 - March Primary
46 - Guyhirn
47 - Leverington
48 - Wisbech Railway
49 - Chatteris
50 - Walsoken
51 - Outwell Moors
52 - Downham Market
53 - Littleport
54 - Upwell Lakes End
55 - Bury
56 - Huntingdon
57 - Wissington BSC

- Core FPP Trial Area
- General FPP Trial Area
- Grid Substations

UK Power Networks

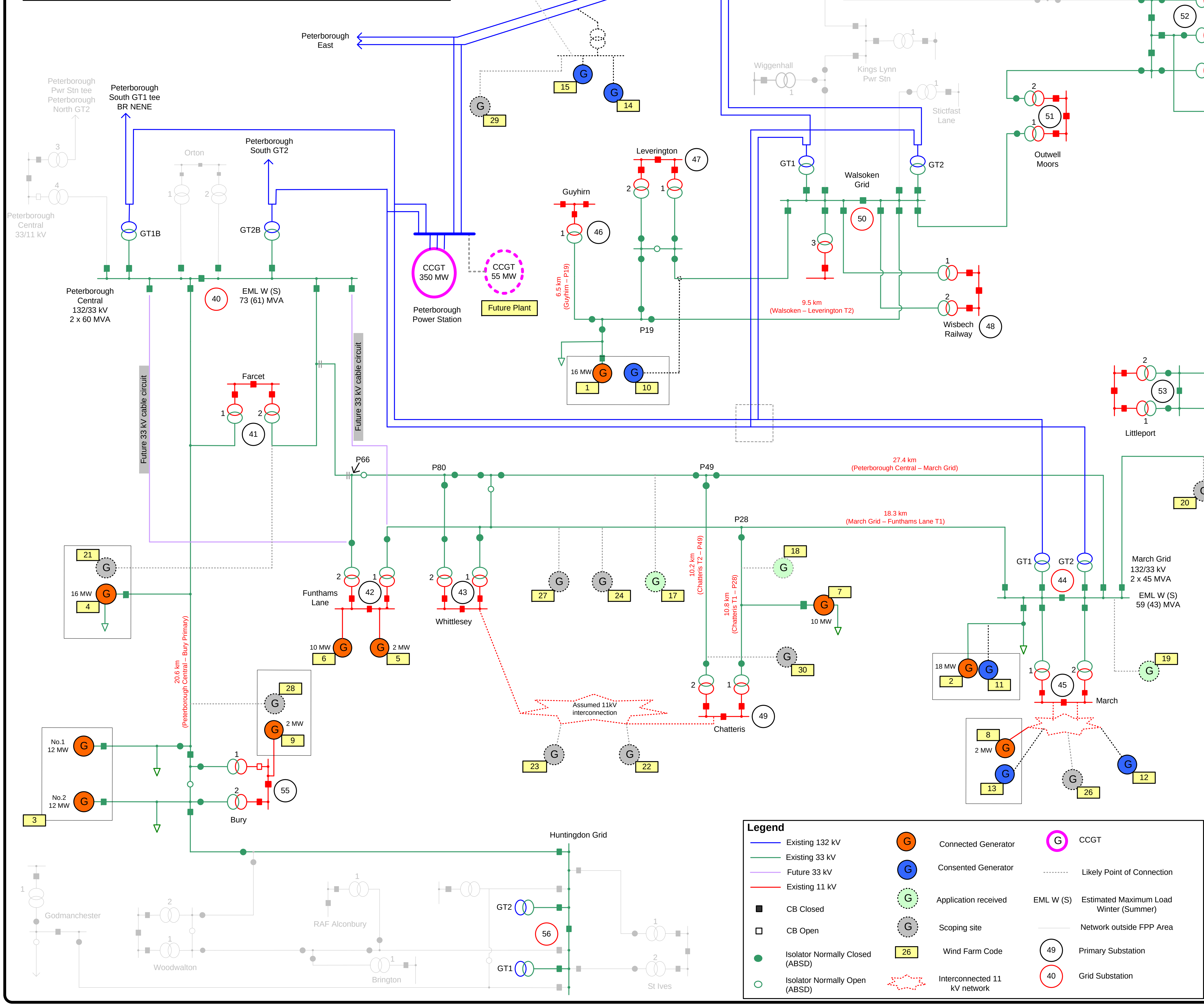
OPERATIONAL WIND FARMS & THOSE CONSENTED, SUBMITTED OR SCOPED FOR THE PETERBOROUGH AREA

SCALE	1:200,000	@ A3	APPROVED	Checked G.M 15-8-11	Approved G.M 15-8-11

DRAWING NO. HQ-4000-1049-2 | Version D

SITE Generation

Simplified Single Line Diagram – Network of Interest only
Flexible Plug & Play



<u>Existing 33kV circuit constraints</u> (Based on summer Rating)

- March Grid to Chatteris T1 tee point (P28) – 200 SCA 23 MVA
- March Grid to Chatteris T2 tee point (P49) – 200 SCA 23 MVA
- Chatteris T1 To tee point (P28) – 150 SCA 19 MVA
- Chatteris T2 To tee point (P49) – 150 SCA 19 MVA
- Chatteris 1 Tee Point (P28) to Whittlesey T1 – 200 SCA 23 MVA
- Chatteris 2 Tee Point (P49) to Whittlesey T2 Tee – 100 SCA 14 MVA
- Whittlesey T1 to Funthams T1 – 200 SCA / 185 Al UG 23 / 20 MVA
- Whittlesey (P80) to Funthams T2 Tee (P 66) – 100 SCA/185 Al UG 23/20 MVA
- Funthams T2 Tee (P 66) To P1 Peterborough – 200 SCA UG 23 MVA
- P1 Peterborough To Peterborough Central 33kV BB – 0.45 OF Al 20 MVA
- Peterborough Central to Farcet T1 – 150 SCA/ 19 MVA
- Farcet T1 To Bury – 200 SCA / 23MVA

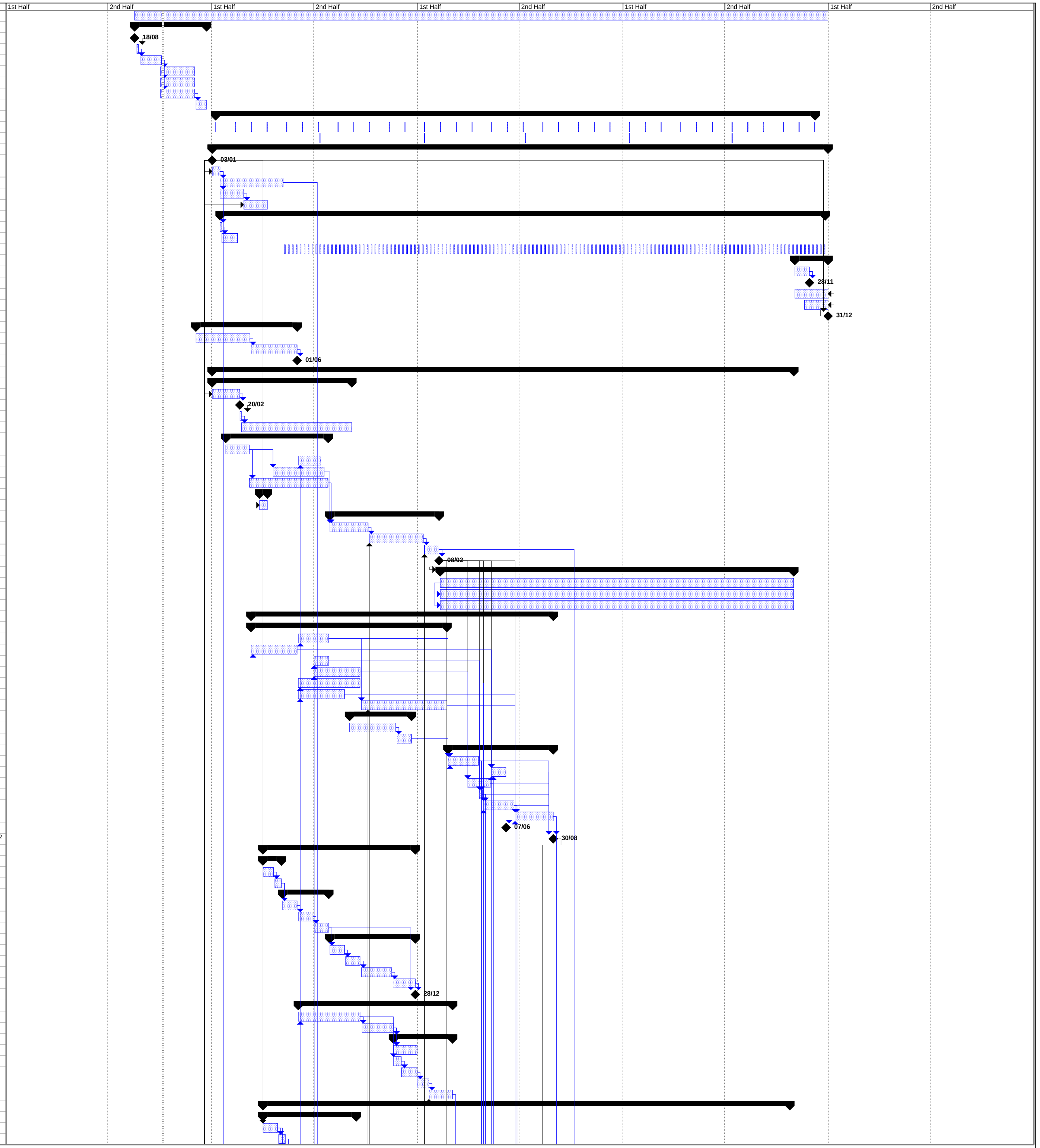
<u>Transformer reverse power flow constraints</u>

- March Grid DOC settings < 34 MVA subject to protection review
- Peterborough Central DOC Settings < 42 MVA subject to protection Review

Appendix C

Project Plan

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Flexible Plug and Play Low Carbon Networks**	880 days	Thu 18/08/11	Wed 31/12/14	
2	**Pre-award activities**	**92 days**	**Thu 18/08/11**	**Fri 23/12/11**	
3	Full-submission to OFGEM	1 day	Thu 18/08/11	Thu 18/08/11	
4	Post submission review and lessons learnt	3 days	Mon 22/08/11	Wed 24/08/11	3FS+1 day
5	Bilateral meeting preparation and answer to OFGEM questions	27 days	Mon 29/08/11	Tue 04/10/11	4FS+2 days
6	Investigate further external funding channels	45 days	Mon 03/10/11	Fri 02/12/11	5FS-2 days
7	Initiate drafting of delivery contracts	45 days	Mon 03/10/11	Fri 02/12/11	5FS-2 days
8	Confirm resource plan and create job descriptions	45 days	Mon 03/10/11	Fri 02/12/11	5FS-2 days
9	Project set up, PID and Investment case approval	15 days	Mon 05/12/11	Fri 23/12/11	8
10	**Project Governance**	**761 days**	**Mon 09/01/12**	**Mon 08/12/14**	
11	**Project Steering Group (monthly**	**761 days**	**Mon 09/01/12**	**Mon 08/12/14**	**55FS+4 days**
48	**Project Review Report (six monthly)**	**523 days**	**Thu 12/07/12**	**Mon 14/07/14**	**55FS+4 days**
54	**Project Management**	**782 days**	**Tue 03/01/12**	**Wed 31/12/14**	
55	Project kick off	0 days	Tue 03/01/12	Tue 03/01/12	
56	Project governance and controls in place	10 days	Tue 03/01/12	Mon 16/01/12	55SS
57	Project team mobilisation & resourcing	80 days	Tue 17/01/12	Mon 07/05/12	56
58	Internal and External communications plan	30 days	Tue 17/01/12	Mon 27/02/12	56
59	Create benefits plan	30 days	Tue 28/02/12	Mon 09/04/12	55SS,58
60	**Project Planning**	**769 days**	**Tue 17/01/12**	**Fri 26/12/14**	
61	Review of bid submission plan	3 days	Tue 17/01/12	Thu 19/01/12	56
62	Create project outline plan and Stage 1 detailed plan	20 days	Fri 20/01/12	Thu 16/02/12	61
63	**Project plan review, update and creation of further Stage plans (weekly)**	**687 days**	**Thu 10/05/12**	**Fri 26/12/14**	**62**
202	**Project closure**	**43 days**	**Mon 03/11/14**	**Wed 31/12/14**	
203	Prepare final benefits report	20 days	Mon 03/11/14	Fri 28/11/14	
204	Final Benefits report	0 days	Fri 28/11/14	Fri 28/11/14	203
205	Decommissioning (as required)	43 days	Mon 03/11/14	Wed 31/12/14	207SF
206	Project Closure	30 days	Thu 20/11/14	Wed 31/12/14	207SF
207	Project completed	0 days	Wed 31/12/14	Wed 31/12/14	55FS+156 wks
208	**FPP Contracts**	**130 days**	**Mon 05/12/11**	**Fri 01/06/12**	
209	Contractual agreement between UKPN and Partners - Phase 1	70 days	Mon 05/12/11	Fri 09/03/12	
210	Contractual agreement between UKPN and Partners - Phase 2	60 days	Mon 12/03/12	Fri 01/06/12	209
211	Contractual agreements complete	0 days	Fri 01/06/12	Fri 01/06/12	210
212	**WS1. Communications Platform**	**739 days**	**Tue 03/01/12**	**Fri 31/10/14**	
213	**Communications platform - site planning**	**178 days**	**Tue 03/01/12**	**Thu 06/09/12**	
214	Site surveys	35 days	Tue 03/01/12	Mon 20/02/12	55SS
215	Sites identified	0 days	Mon 20/02/12	Mon 20/02/12	214
216	Confirm 3rd party site shares and wayleave requirements	3 days	Tue 21/02/12	Thu 23/02/12	215
217	Progress required shared site and wayleave agreements	140 days	Fri 24/02/12	Thu 06/09/12	216
218	**Communications platform - design**	**130 days**	**Fri 27/01/12**	**Thu 26/07/12**	
219	Complete field network design	30 days	Fri 27/01/12	Thu 08/03/12	
220	Complete high level and detailed application design	30 days	Mon 04/06/12	Fri 13/07/12	335
221	Request and deliver circuits	65 days	Fri 20/04/12	Thu 19/07/12	219FS+30 days
222	Order required equipment	100 days	Fri 09/03/12	Thu 26/07/12	219
223	**Training**	**10 days**	**Tue 27/03/12**	**Mon 09/04/12**	
224	Installation and field resource training	10 days	Tue 27/03/12	Mon 09/04/12	55SS+60 days
225	**Communication networks (install, test, commission)**	**140 days**	**Mon 30/07/12**	**Fri 08/02/13**	
226	Deploy and configure equipment	50 days	Mon 30/07/12	Fri 05/10/12	222,221
227	Network and system testing	70 days	Mon 08/10/12	Fri 11/01/13	226,339
228	Testing with simulators	20 days	Mon 14/01/13	Fri 08/02/13	227,339
229	**IP Communications platform go live - SDRC 9.3**	0 days	Fri 08/02/13	Fri 08/02/13	228
230	**Communication platform reporting**	**450 days**	**Mon 11/02/13**	**Fri 31/10/14**	**229**
231	Data capture	450 days	Mon 11/02/13	Fri 31/10/14	
232	Network performance monitoring	450 days	Mon 11/02/13	Fri 31/10/14	231SS
233	Ongoing reporting	450 days	Mon 11/02/13	Fri 31/10/14	231SS
234	**WS2. Smart Devices**	**385 days**	**Mon 12/03/12**	**Fri 30/08/13**	
235	**Detailed design**	**250 days**	**Mon 12/03/12**	**Fri 22/02/13**	
236	Automatic Voltage Control schemes	40 days	Mon 04/06/12	Fri 27/07/12	335
237	Quadrature booster	60 days	Mon 12/03/12	Fri 01/06/12	333
238	Energy Storage Control System	20 days	Mon 02/07/12	Fri 27/07/12	335FS+20 days
239	Frequent Use Switch	60 days	Mon 02/07/12	Fri 21/09/12	335FS+20 days
240	Adaptive Protection scheme	80 days	Mon 04/06/12	Fri 21/09/12	335
241	Dynamic Line rating units inc weather stations	60 days	Mon 04/06/12	Fri 24/08/12	335
242	Procurement of devices and interfaces (inc FAT)	110 days	Mon 24/09/12	Fri 22/02/13	236,339
243	**Install Operational Systems**	**80 days**	**Mon 03/09/12**	**Fri 21/12/12**	
244	Plan site works	60 days	Mon 03/09/12	Fri 23/11/12	
245	Produce method statements & drawings	20 days	Mon 26/11/12	Fri 21/12/12	244
246	**Deployment of Smart devices (install, test, commission)**	**135 days**	**Mon 25/02/13**	**Fri 30/08/13**	
247	Automatic Voltage Control Schemes(up to 2 schemes to be deployed)	40 days	Mon 25/02/13	Fri 19/04/13	236,353,229,245,242
248	Quadrature booster	20 days	Mon 13/05/13	Fri 07/06/13	249,237,353,229
249	Frequent Use Switch (up to 2 switches to be deployed)	30 days	Mon 01/04/13	Fri 10/05/13	239,229,242
250	Energy storage (interface with existing scheme)	5 days	Mon 22/04/13	Fri 26/04/13	247,238,229,242
251	Adaptive Protection scheme (potential for 2 schemes or interface with existing)	40 days	Mon 29/04/13	Fri 21/06/13	250,240,353,229,242
252	Dynamic Line Rating units including weather stations (4 devices)	50 days	Mon 24/06/13	Fri 30/08/13	251,241,353,229,242
253	**Successful deployment of a Quadrature-booster within the FPP trial area - SDRC 9.8**	0 days	Fri 07/06/13	Fri 07/06/13	248
254	All smart devices installed and commissioned	0 days	Fri 30/08/13	Fri 30/08/13	247,248,249,250,251,252
255	**WS3. Smart commercial arrangements (Use case 03)**	**195 days**	**Mon 02/04/12**	**Fri 28/12/12**	
256	**Smart commercial arrangements development**	**25 days**	**Mon 02/04/12**	**Fri 04/05/12**	
257	Assess and map current process	15 days	Mon 02/04/12	Fri 20/04/12	
258	Incorporate learning from Low Carbon London, Low Carbon Hub and other projects	10 days	Mon 23/04/12	Fri 04/05/12	257
259	**Principles of access**	**60 days**	**Mon 07/05/12**	**Fri 27/07/12**	
260	Evaluate principles of access for generators	20 days	Mon 07/05/12	Fri 01/06/12	258
261	Develop a market based approach for generator connection	20 days	Mon 04/06/12	Fri 29/06/12	260
262	Report on principles of access for generators	20 days	Mon 02/07/12	Fri 27/07/12	261
263	**Develop connection offers including smart options**	**110 days**	**Mon 30/07/12**	**Fri 28/12/12**	
264	Commercial arrangements to permit control of RG units by ANM	20 days	Mon 30/07/12	Fri 24/08/12	262
265	Understand technical and commercial options to be offered	20 days	Mon 27/08/12	Fri 21/09/12	264
266	Consequential losses and non-performing implications	40 days	Mon 24/09/12	Fri 16/11/12	265
267	Develop first connection agreement template offering smart options	30 days	Mon 19/11/12	Fri 28/12/12	266
268	**Successful development of smart commercial arrangements - SDRC 9.2**	0 days	Fri 28/12/12	Fri 28/12/12	267,262
269	**WS4. Smart applications**	**196 days**	**Mon 04/06/12**	**Mon 04/03/13**	
270	Detailed design ANM and generation controllers	80 days	Mon 04/06/12	Fri 21/09/12	335
271	LIC development	40 days	Tue 25/09/12	Mon 19/11/12	270
272	**Pre-Production Environment**	**75 days**	**Tue 20/11/12**	**Mon 04/03/13**	**271**
273	Integrate ANM to PI or Data Historian	30 days	Tue 20/11/12	Mon 31/12/12	271
274	Build Pre-Production Environment	10 days	Tue 20/11/12	Mon 03/12/12	270
275	Install & configure Devices and ANM Applications	20 days	Tue 04/12/12	Mon 31/12/12	274
276	Pre-production (FAT, SAT)	15 days	Tue 01/01/13	Mon 21/01/13	275
277	Pre-production testing of devices and applications	30 days	Tue 22/01/13	Mon 04/03/13	276,339
278	**WS5. Stakeholder engagement (Use case 5)**	**670 days**	**Mon 02/04/12**	**Fri 24/10/14**	
279	**Stakeholder engagement - round I**	**120 days**	**Mon 02/04/12**	**Fri 14/09/12**	
280	Information gathering and preparation	20 days	Mon 02/04/12	Fri 27/04/12	55FS+60 days
281	Create stakeholder engagement plan	10 days	Mon 30/04/12	Fri 11/05/12	280



Project: FPP Project Plan v10
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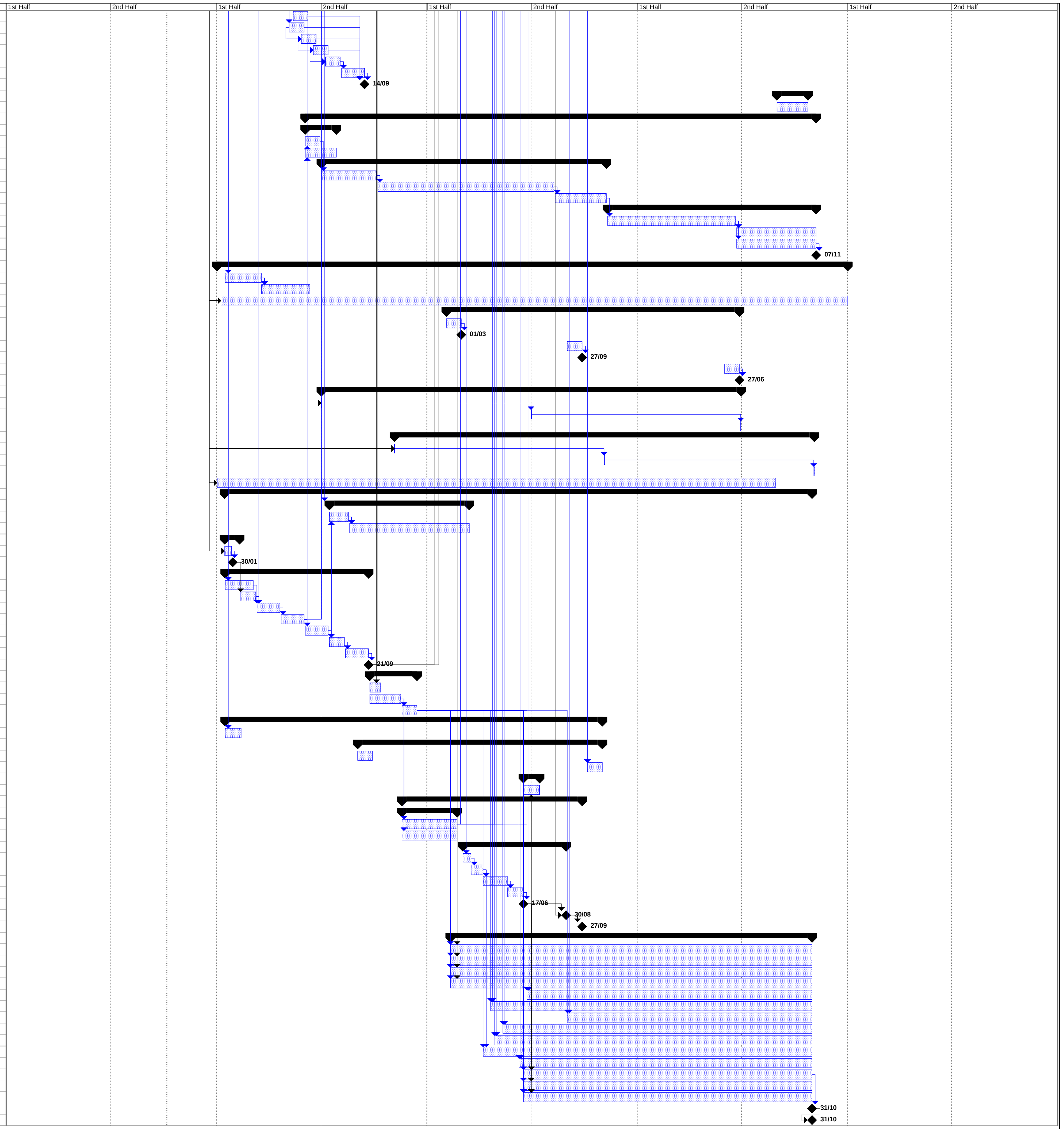
Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

ID	Task Name	Duration	Start	Finish	Predecessors
282	Engage with existing generator customers	20 days	Mon 14/05/12	Fri 08/06/12	281
283	Engage with potential new customers	20 days	Mon 07/05/12	Fri 01/06/12	280FS+5 days
284	Engage with local Government	20 days	Mon 28/05/12	Fri 22/06/12	283SS+15 days
285	Engage with OFGEM/DECC	20 days	Mon 18/06/12	Fri 13/07/12	284SS+15 days
286	Engage with local electricity customers	20 days	Mon 09/07/12	Fri 03/08/12	285SS+15 days
287	Consolidation and report production	30 days	Mon 06/08/12	Fri 14/09/12	286
288	**Stakeholder engagement report I - SDRC 9.1**	0 days	Fri 14/09/12	Fri 14/09/12	282,283,284,285,287
289	**Stakeholder engagement - round II**	**40 days**	**Mon 01/09/14**	**Fri 24/10/14**	
290	Stakeholder engagement round II	40 days	Mon 01/09/14	Fri 24/10/14	
291	**WS6. Strategic investment model (Use case 06)**	**635 days**	**Mon 04/06/12**	**Fri 07/11/14**	
292	**Investment model - requirements**	**40 days**	**Mon 04/06/12**	**Fri 27/07/12**	
293	Detailed specification of inputs/outputs	20 days	Mon 04/06/12	Fri 29/06/12	335
294	Collate information and data required	40 days	Mon 04/06/12	Fri 27/07/12	335
295	**Investment model - design**	**355 days**	**Mon 02/07/12**	**Fri 08/11/13**	
296	Design Model Architecture	70 days	Mon 02/07/12	Fri 05/10/12	293
297	Model development	220 days	Mon 08/10/12	Fri 09/08/13	296
298	Test model	65 days	Mon 12/08/13	Fri 08/11/13	297
299	**Investment model - reporting**	**260 days**	**Mon 11/11/13**	**Fri 07/11/14**	
300	Test model output, validate and re-revisit model	160 days	Mon 11/11/13	Fri 20/06/14	298
301	Documentation and reports	100 days	Mon 23/06/14	Fri 07/11/14	300
302	Publish/disseminate findings	100 days	Mon 23/06/14	Fri 07/11/14	300
303	**Strategic Investment model completed - SDRC 9.5**	0 days	Fri 07/11/14	Fri 07/11/14	302
304	**WS7. Learning and dissemination (Use case 07)**	**783 days**	**Tue 03/01/12**	**Thu 01/01/15**	
305	Learning dissemination map	45 days	Tue 17/01/12	Mon 19/03/12	56
306	Establish website	60 days	Tue 20/03/12	Mon 11/06/12	305
307	UKPN internal engagement and dissemination	778 days	Tue 10/01/12	Thu 01/01/15	55SS+5 days
308	**Produce reports (indicative list)**	**365 days**	**Mon 04/02/13**	**Fri 27/06/14**	
309	Report on introduction to open standards and ICT for platforms for DNOs	20 days	Mon 04/02/13	Fri 01/03/13	
310	Introduction to Open Standards and ICT for platforms published	0 days	Fri 01/03/13	Fri 01/03/13	309
311	Report on innovative commercial arrangements for actively managed distribution networks	20 days	Mon 02/09/13	Fri 27/09/13	
312	Innovative technical and commercial aspects report published	0 days	Fri 27/09/13	Fri 27/09/13	311
313	Report on active network management for DNO applications	20 days	Mon 02/06/14	Fri 27/06/14	
314	Active network management for DNO applications report published	0 days	Fri 27/06/14	Fri 27/06/14	313
315	**LCNF conferences**	**521 days**	**Mon 02/07/12**	**Mon 30/06/14**	
316	UKPN LCNF Conference 2012	1 day	Mon 02/07/12	Mon 02/07/12	55SS+120 days
317	UKPN LCNF Conference 2013	1 day	Mon 01/07/13	Mon 01/07/13	316FS+259 days
318	UKPN LCNF Conference 2014	1 day	Mon 30/06/14	Mon 30/06/14	317FS+259 days
319	**UKPN Annual Workshops**	**521 days**	**Tue 06/11/12**	**Tue 04/11/14**	
320	2012 Workshop	1 day	Tue 06/11/12	Tue 06/11/12	55SS+220 days
321	2013 Workshop	1 day	Tue 05/11/13	Tue 05/11/13	320FS+259 days
322	2014 Workshop	1 day	Tue 04/11/14	Tue 04/11/14	321FS+259 days
323	Publish scientific papers	694 days	Tue 03/01/12	Fri 29/08/14	55SS
324	**WS8. Design and systems integration (Use case 08)**	**730 days**	**Mon 16/01/12**	**Fri 31/10/14**	
325	**RTU replacement programme**	**175 days**	**Mon 16/07/12**	**Fri 15/03/13**	**57**
326	RTU procurement	25 days	Mon 16/07/12	Fri 17/08/12	336
327	RTU installation and commissioning	150 days	Mon 20/08/12	Fri 15/03/13	326
328	**FPP systems conceptual review**	**20 days**	**Mon 16/01/12**	**Fri 10/02/12**	
329	Conceptual review (technology, locations, trials)	10 days	Mon 16/01/12	Fri 27/01/12	55SS
330	Project requirements & use cases reviewed	10 days	Mon 30/01/12	Fri 10/02/12	329
331	**Detailed system design**	**179 days**	**Tue 17/01/12**	**Fri 21/09/12**	
332	Develop user requirements	35 days	Tue 17/01/12	Mon 05/03/12	56
333	Power systems studies & solution modelling	20 days	Mon 13/02/12	Fri 09/03/12	330
334	Develop system functional specification	30 days	Mon 12/03/12	Fri 20/04/12	332,333
335	**Develop overall architecture**	**30 days**	**Mon 23/04/12**	**Fri 01/06/12**	**334**
336	Develop overall data model	30 days	Mon 04/06/12	Fri 13/07/12	335
337	Develop overall test plan	20 days	Mon 16/07/12	Fri 10/08/12	336
338	Develop specification for FAT and SAT	30 days	Mon 13/08/12	Fri 21/09/12	337
339	System overall architecture complete	**0 days**	**Fri 21/09/12**	**Fri 21/09/12**	**338**
340	**Systems Integration - Trial design**	**60 days**	**Mon 24/09/12**	**Fri 14/12/12**	
341	Trial objectives	15 days	Mon 24/09/12	Fri 12/10/12	339
342	Trial design	40 days	Mon 24/09/12	Fri 16/11/12	
343	Trial methodology and KPIs	20 days	Mon 19/11/12	Fri 14/12/12	342
344	**Cybersecurity**	**469 days**	**Tue 17/01/12**	**Fri 01/11/13**	
345	Establishment of a Smart Grid Cyber Security Management System;	20 days	Tue 17/01/12	Mon 13/02/12	56
346	**Security assessments**	**305 days**	**Mon 03/09/12**	**Fri 01/11/13**	
347	Security assessment - design phase	20 days	Mon 03/09/12	Fri 28/09/12	
348	Security assessment - operational phase	20 days	Mon 07/10/13	Fri 01/11/13	228
349	**Training**	**20 days**	**Tue 18/06/13**	**Mon 15/07/13**	
350	UKPN staff training (smart devices, ANM applications)	20 days	Tue 18/06/13	Mon 15/07/13	360
351	**Systems Integration - Production environment**	**225 days**	**Mon 19/11/12**	**Fri 27/09/13**	
352	**Substations**	**70 days**	**Mon 19/11/12**	**Fri 22/02/13**	
353	Install Substation LANs	70 days	Mon 19/11/12	Fri 22/02/13	342
354	Install Substation monitoring equipment where required	70 days	Mon 19/11/12	Fri 22/02/13	342
355	**Configure ANM application in Production**	**129 days**	**Tue 05/03/13**	**Fri 30/08/13**	
356	Build production environment	10 days	Tue 05/03/13	Mon 18/03/13	277
357	Install and commission production	15 days	Tue 19/03/13	Mon 08/04/13	356
358	Configure all interfaces	30 days	Tue 09/04/13	Mon 20/05/13	357
359	Production Testing (End-to-End with selected smart devices)	20 days	Tue 21/05/13	Mon 17/06/13	358
360	System Operational	0 days	Mon 17/06/13	Mon 17/06/13	359
361	All smart devices integrated (End-to-End testing complete)	0 days	Fri 30/08/13	Fri 30/08/13	360,254
362	**Successful demonstration of FPP characteristics of the overall technical FPP solution - SDRC 9.4**	0 days	Fri 27/09/13	Fri 27/09/13	361FS+20 days
363	**Trials and reporting**	**450 days**	**Mon 11/02/13**	**Fri 31/10/14**	
364	Use case 01.1- IP communications across a dedicated network infrastructure	450 days	Mon 11/02/13	Fri 31/10/14	229,343
365	Use case 01.2 - Open Standards based application protocols and interoperability	450 days	Mon 11/02/13	Fri 31/10/14	229,343
366	Use Case 01.3 - IEC 61850 communications across a purpose-built network	450 days	Mon 11/02/13	Fri 31/10/14	229,343
367	Use case 01.4 - Cyber security assessment and monitoring	450 days	Mon 11/02/13	Fri 31/10/14	229,343
368	Use case 02.1 - Modern protection relays	355 days	Mon 24/06/13	Fri 31/10/14	251,343
369	Use case 02.2 - Modern transformer tap changer control relays	400 days	Mon 22/04/13	Fri 31/10/14	247,343
370	Use case 02.3 - Dynamic line ratings	305 days	Mon 02/09/13	Fri 31/10/14	252,343
371	Use case 02.4 - Frequent use switches	385 days	Mon 13/05/13	Fri 31/10/14	249,343
372	Use case 02.5 - Energy storage	395 days	Mon 29/04/13	Fri 31/10/14	250,343
373	Use case 02.6 - Generator controllers	409 days	Tue 09/04/13	Fri 31/10/14	357,343
374	Use case 02.7 - Quadrature boosters	365 days	Mon 10/06/13	Fri 31/10/14	248,343
375	Use case 04.01 - Active power flow management	359 days	Tue 18/06/13	Fri 31/10/14	360,343
376	Use case 04.02 - Active voltage management	359 days	Tue 18/06/13	Fri 31/10/14	360,343
377	Use case 04.03 - Thermal ratings estimation	359 days	Tue 18/06/13	Fri 31/10/14	360,343
378	**Implementation of active power flow and active voltage management within FPP trial area - SRDC 9.6**	0 days	Fri 31/10/14	Fri 31/10/14	375
379	**Successful facilitation of faster and cheaper connections within FPP trial area - SDRC 9.7**	0 days	Fri 31/10/14	Fri 31/10/14	378



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Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Flexible Plug and Play Low Carbon Networks

Appendix D

Risk Register

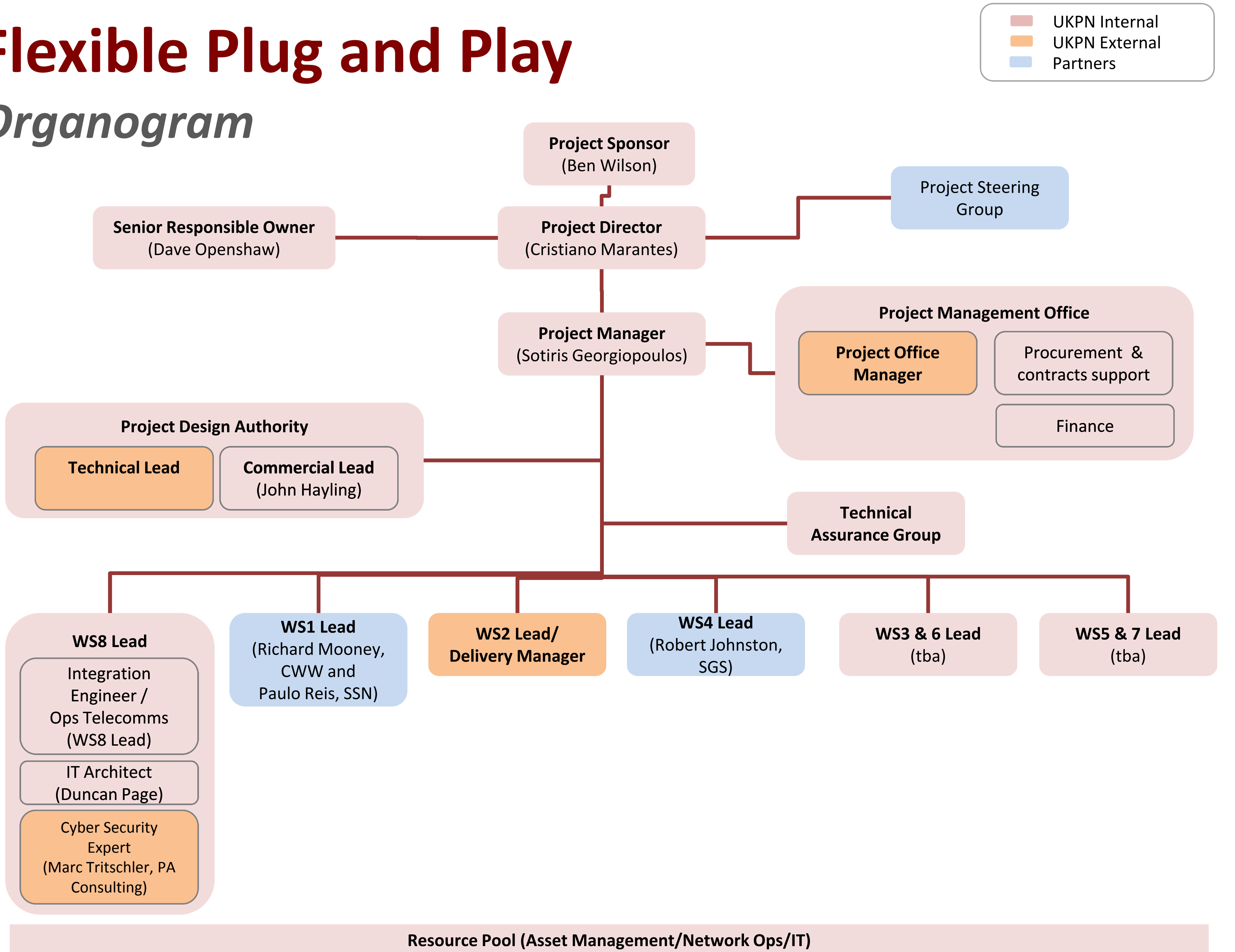
REF NO.	OVERALL RISK STATUS	RISK & IMPACT DESCRIPTION	RISK OWNER	PROBABILITY	SEVERITY	RISK RESPONSE TYPE	MITIGATING ACTIONS	CONTINGENCY	RISK CATEGORY
R0001	On track	The Comms platform may not meet the smart applications' performance requirements leading to system incompatibilities and unsatisfactory trial results	UKPN	10%	4	Treat	The Comms platform should be subject to performance testing using smart devices or simulators under various operating conditions. Comms requirements to be defined at design stage and suitable Comms technology chosen for the purpose of the trials. UKPN to agree SLAs for Comms platform.	Reconfigure the ANM applications to align with the Comms capabilities.	Projects Delivery Risk
R0002	On track	Failure to secure suitable mounting positions/space for the Comms equipment due to limited space in UKPN-owned premises or assets e.g. poles - leading to lengthy negotiations with property owners resulting in programme delays	UKPN	25%	3	Treat	Optimise design and minimise mounting positions/space required. Investigate alternative options for mounting such as a third party provider. Carry out detailed site surveys early in the project.	Consider alternative Comms options such as microwave point to multi-point radio.	Projects Delivery Risk
R0003	On track	Local Opposition to Wind Energy development contributing to negative publicity for UKPN within the project area	UKPN	20%	3	Treat	UKPN will proactively engage local stakeholders and promote the work the project is doing (it is an alternative to reinforcement and new lines/cables)	External communications campaign	Reputational Risk
R0004	On track	If actual MWh or hours of RG operation diverge (adversely) significantly from results within smart grid application feasibility assessment then this may lead to possible complaints from Generators. This is risk is valid for suitable trial with Generator participation.	UKPN	20%	3	Treat	Ensure that RG developers are made aware in advance that the Assessment Results are based on estimates and that the Actual Levels of curtailment are likely to change year on year. Data used in studies should be as accurate as possible and assessment methods agreed by all stakeholders as being suitable. Develop suitable commercial and legal framework for making such connections offers.	Compensate Generators for any unreasonable curtailment of generation or abandon trial and fall back to previous arrangement as agreed with customer.	Financial Risk
R0005	On track	System integration issues occurring due to inadequate testing in Workstreams 1 - 3 leading to delays	UKPN	25%	3	Treat	Ensure that the deliverables from each Workstream are appropriately tested prior to system integration activities and allow sufficient time to develop test specifications	Use time contingency to re-test and troubleshoot on site.	Projects Delivery Risk
R0006	On track	Silver Spring Networks may have to use an unlicensed spectrum if they are unable to get a trial licence on time leading to possible adverse perception from other project stakeholders	Silver Spring Networks	25%	3	Tolerate	Establish whether trial licenses would be available by January 2012.	Consider an alternative technology or supplier as part of the design phase	Legal & Regulatory Risk
R0007	On track	Project Partner(s) withdrawing their participation in the FPP project at a late stage leading to lengthy programme delays to institute their replacement(s) and in the worst case the collapse of the FPP	UKPN	30%	3	Treat	Issue principles of collaboration and request official Letters of Intent from Partners to reduce probability of partners withdrawing from the project - Reduce dependency on specific Partners - this is a vendor agnostic project	Replace Partner with suitable alternative	Financial Risk
R0008	On track	Insufficient levels of RG connecting -Generators may not want to participate (if for example the project interferes with their normal operations) during the FPP project timescales leading to failure to fully trial the FPP in the planned timescales	UKPN	30%	3	Treat	Engage with Generators as early as possible to understand the risks and issues likely to impact their (Generators) normal operations in order to actively manage/mitigate them	Deliver project trials without Generator active participation. Structure trials around other IEDs to prove interoperability. Monitor existing generators and simulate their operation.	Projects Delivery Risk
R0009	On track	Different vendor protocols/ characteristics could potentially compromise the interoperability trials which may cause delays during system integration & trials	UKPN	25%	2	Treat	Ensure that ALL application Comms is based on international standards, and all devices and systems are tested and certified to these standards Ensure that ALL devices are subject to testing in pre-production environment	Allow resources and time to troubleshoot	Projects Delivery Risk
R0010	On track	Delays in resourcing and negotiation/ drafting of delivery contracts could result in delays in project delivery.	UKPN	20%	2	Treat	The resourcing process/production of job descriptions & contract drafting to start pre-contract award. Future Networks to partly resource project. Contracting resource has been allowed for key roles.	Request Partners to resource elements of the project, work on the basis of a Letter of Intent.	Financial Risk

Appendix E

Organogram

Flexible Plug and Play

Organogram



Appendix F

Additional Details on Project Partners

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

Organisation Name	**Cable & Wireless Worldwide**
Relationship to DNO (if any)	Vendor
Type of Organisation	Cable & Wireless Worldwide (CWW) is a leading global telecoms company providing a wide range of high-quality managed voice, data, hosting and IP-based services and applications to large multinational companies, governments, carrier customers and resellers across the UK, Asia Pacific, India, Middle East, Africa, Continental Europe and North America.
Role in Project	Consortium member offering managed communications networking (equipment, connectivity, and services) in the FPP Trial area.
Prior experience brought to Project	CWW has a strong heritage in the UK utility sector through the assimilation of Energis, THUS and Your Comms. It has more than 1,100 operational network sites, many co-located at substations and over 25,000 route kilometres of fibre along UK's electricity transmission networks. We are responsible for the design, delivery and management of a dedicated Next Generation Operational Telecommunications Network (OpTel NGN) to support National Grid's Core Network Infrastructure and Operational Systems, giving us in depth expertise relevant to supporting the deployment of Smart Grid solutions.
Funding *Direct funding being provided to project in resources/time being spent*	Significantly discounted equipment, deployment and professional services in support of this project.
Contractual Relationship *Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?*	Yes
External Collaborator benefits from the Project *How will your organisation benefit from collaborating on this project?*	• Tangible experience of delivering core communications infrastructure and services appropriate for Smart Grid deployments at Distribution Network level. • Integration of CWW and partner technologies (SSN) in a novel configuration, and in a live environment.

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

Organisation Name	**Silver Spring Networks**
Relationship to DNO (if any)	Vendor
Type of Organisation	Silver Spring Networks (SSN) provides hardware, software and services that flexibly connect smart grid devices, creating a unified **Smart Energy Platform**. SSN's Smart Energy Platform is based on open, Internet Protocol (IPv6) standards, allowing continuous, two-way communication between the utility and devices on the grid. Over this unified platform, smart utility networks can deploy any number of advanced applications, such as Demand Response, Distribution Automation and Distributed Generation.
Role in Project	As a consortium partner, SSN will deliver an IP Open Standards Platform for communications networking (hardware, software and services) for the FPP Trial project.
Prior experience brought to Project	SSN is a leading smart grid platform provider that enables utilities to achieve operational efficiencies, reduce carbon emissions and empower their customers with new ways to monitor and manage their energy consumption. SSN has numerous deployments (i.e. over 17 million contracted end-points) with leading utilities around the world, including Baltimore Gas & Electric, CitiPower & Powercor, Florida Power & Light, Jemena Electricity Networks Limited, Pacific Gas & Electric, Pepco Holdings, Inc., and United Energy Distribution, among others. Additional information can be found at **www.silverspringnet.com**.
Funding *Direct funding being provided to project in resources/time being spent*	Significantly discounted hardware/software/services for the project life-cycle.
Contractual Relationship *Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?*	Yes
External Collaborator benefits from the Project *How will your organisation benefit from collaborating on this project?*	The expected primary benefits to SSN include: innovation learning regarding emergent DA applications (UK context).

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

Organisation Name	**Smarter Grid Solutions Ltd**
Relationship to DNO (if any)	Vendor and Project Partner for Low Carbon London
Type of Organisation	Smarter Grid Solutions (SGS) delivers a range of platforms, applications and services to electricity network operators to allow them to manage network constraints and avoid or defer network reinforcement costs through active network management (ANM).
Role in Project	Deliver smart applications and deploy an ANM solution to coordinate and control smart devices. SGS will provide: • Consultancy services on smart devices and ANM solution. • Control platform, SGcore, and communications hub, CommsHUB • Smart grid applications to manage power flow and voltage constraints, and estimate thermal ratings of overhead line 33 kV circuits. • Systems integration and support services.
Prior experience brought to Project	Deployed the world's first multiple constraint and multiple generator ANM scheme on Orkney. Worked with UKPN on a number of projects of relevance to the FPP project, including: • Low Carbon London – Project partner providing ANM solutions to manage Distributed Generation (DG) • ANM Feasibility Studies – for existing generators in EPN within the FPP project area. • Other projects carried out in UK and European DNOs.
Funding *Direct funding being provided to project in resources/time being spent*	Funding contribution by SGS to include Pre-production environment, Software licenses for pre-production, and Programme management
Contractual Relationship *Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?*	Yes
External Collaborator benefits from the Project *How will your organisation benefit from collaborating on this project?*	SGS will benefit from the project in a number of ways, including: • Demonstration of our platforms and applications in a class-leading data and communications architecture • Deployment of our platforms in a configuration not previously trialled • Industry learning in the advancement of new commercial arrangements or 'Principles of Access' to enable actively managed grid access

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

Organisation Name	**Alstom Grid UK Limited**
Relationship to DNO (if any)	Vendor of products systems and services for many years
Type of Organisation	Alstom is a global leader in the world of power generation, power transmission and rail infrastructure and sets the benchmark for innovative and environmentally friendly technologies. It provides turnkey integrated power plant solutions and associated services for a wide variety of energy sources, including wind, and offers a wide range of solutions for power transmission, with a focus on smart grids. In the UK, Alstom Grid is also the Global Competence Centre for HVDC, phase shifting transformers, protection products and is the location of one of two Research and Technology Centres.
Role in Project	Alstom Grid will be a Delivery partner for Work Stream 2 of the project. We will provide innovative technical solutions to accommodate higher levels of RG on the distribution network.
Prior experience brought to Project	Alstom Grid Automation Business has provided utilities and industry with the mission critical software systems and equipment needed to manage the flow of electricity in transmission and distribution grids, ensure grid stability and to protect and control substations for many years. Alstom Grid has been involved in several successful Dynamic Line Rating projects in the UK, including the Dynamic Thermal Rating project, which was awarded the IET Innovation Award in 2010, with SPD and Durham University.
Funding *Direct funding being provided to project in resources/time being spent*	We have proposed a 10% partner contribution towards our component of the project
Contractual Relationship *Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?*	Yes
External Collaborator benefits from the Project *How will your organisation benefit from collaborating on this project?*	Alstom Grid will benefit from the knowledge gained during the development and deployment of protection solutions which will utilise an IP communications interface. The DLR site trial will enhance our experience of the use of this scheme for load management, based on a dynamically-derived line rating.

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

<table>
<tr><td>Organisation Name</td><td>Converteam</td></tr>
<tr><td>Relationship to DNO (if any)</td><td>Vendor</td></tr>
<tr><td>Type of Organisation</td><td>Limited Company</td></tr>
<tr><td>Role in Project</td><td>Converteam will provide hardware for the FPP Trial project:
Primary RTUs
Secondary RTUs
Automatic Reactive Switching Systems
Automatic Tap Changer Controllers Systems
Energy Storage Solutions
STATCOM, Windfarm Power Conditioning equipment
Converteam will also provide support on general system design and specific product support as above.</td></tr>
<tr><td>Prior experience brought to Project</td><td>Converteam has recognised expertise in all of the above areas. Specific expertise drawn from consultancy work done for National Grid on Grid Code Compliance issues, power system stability and harmonic filter optimisation.</td></tr>
<tr><td>Funding
Direct funding being provided to project in resources/time being spent</td><td>Normal ad-hoc non-contract charging rate for project scoping, design and technical support will be substantially discounted, as indicated in separate proposal document.</td></tr>
<tr><td>Contractual Relationship
Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?</td><td>Yes</td></tr>
<tr><td>External Collaborator benefits from the Project
How will your organisation benefit from collaborating on this project?</td><td>Converteam will benefit from involvement in the FPP Trial project through:
Gaining knowledge about the emerging requirements of UKPN in this field
Better able to target Converteam’s own R&D funding that ensures that developments in our product and offer portfolio are aligned with market requirements</td></tr>
</table>

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

Organisation Name	**Fundamentals Ltd**
Relationship to DNO (if any)	Vendor
Type of Organisation	Fundamentals is a SME – Limited Company and supplies Automatic Voltage Control (AVC) expertise to the electricity power industry, mainly through the following: • manufacturer of AVC relays • consulting • installation and commissioning services • panel build (wall mounted, free-standing)
Role in Project	Fundamentals Ltd will supply new modern transformer tap changer control relays that take account of the impact of embedded generation at two identified substation sites within the FPP Trial area. Fundamentals will design, install, commission, and provide applications support technical expertise for the tap changer schemes
Prior experience brought to Project	• Designed the UKPN standard AVC scheme incorporating the Fundamentals SuperTAPP relay • 20 years experience in application of AVC technology to UK and global distribution networks • Existing contract with UKPN for AVC upgrade work (10+ years)
Funding *Direct funding being provided to project in resources/time being spent*	• All consulting activities and commissioning work required for installed equipment at any of the FPP Trial sites will be provided free of charge • 20% discount will be offered on all Fundamentals manufactured AVC solutions • 10% discount will be offered on all installation related activities (site work)
Contractual Relationship *Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?*	Yes • We currently have a signed MoU in place. • We also have a contract (framework agreement) in place for the supply of OLTC and AVC services.
External Collaborator benefits from the Project *How will your organisation benefit from collaborating on this project?*	Opportunity to showcase Fundamentals' developed solutions and obtain 'proof of concept' and performance assessments of operation on the distribution networks to potentially deploy across the UK, Europe and beyond. Further development of existing solutions for real trial sites will allow an accelerated completion of the 'complete AVC vision'. Continued R&D development work for existing staff, which leads to a more skilled and experienced workforce.

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

Organisation Name	**GL Garrad Hassan**
Relationship to DNO (if any)	None
Type of Organisation	GL Garrad Hassan is an independent **Renewables Engineering Consultancy** with recognised expertise at the fore front of offshore wind, wave, tidal and solar sectors.
Role in Project	GL Garrad Hassan will provide (in the FPP Trial project): • Leadership for Stakeholder Engagement Workstream • Technical advisory role to other technical and commercial Workstreams
Prior experience brought to Project	GL Garrad Hassan has more than 25 years experience in the renewables industry and has provided services to all the major developers and operators of wind farms in the UK. This includes supporting developers through achieving grid connection for their project.
Funding *Direct funding being provided to project in resources/time being spent*	GL Garrad Hassan will provide consultancy services to the project and will provide these at a reduced rate compared to its normal commercial business (equivalent to externally funded R&D). All expenses will be passed on at cost.
Contractual Relationship *Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?*	Yes GL Garrad Hassan has also signed a MoU in place with UKPN.
External Collaborator benefits from the Project *How will your organisation benefit from collaborating on this project?*	GL Garrad Hassan will principally benefit by the understanding it will gain of the technology options in the market and awareness of the views by stakeholders that the company has not traditionally interacted with. GL Garrad Hassan will be providing significant background IPR in the course of the work.

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

Organisation Name	**Imperial College London (IC Consultants Limited)**
Relationship to DNO (if any)	Established collaboration with UKPN on Low Carbon London
Type of Organisation	IC Consultants Limited is a Company Limited by Shares (wholly owned by Imperial College London)
Role in Project	Development of Strategic Distribution Network Investment Model that will identify the most cost-efficient and low carbon solution to connect renewable generation to the distribution network based on what can be technically and commercially achieved using the latest advances in smart grid technology being trialled on the FPP project. The model will provide DNOs with a validated toolbox to make informed planning and strategic decisions, delivering a cost efficient network solution that will benefit those parties wishing to connect renewable generation to the distribution network
Prior experience brought to Project	Modelling of operation and planning of active distribution networks with distributed generation. Modelling of system benefits of future real-time demand response facilitated by smart metering infrastructure. Established probabilistic cost-benefit framework for the development of new distribution and transmission network operation and planning standards. Distribution network State Estimation.
Funding *Direct funding being provided to project in resources/time being spent*	30 % of cost is provided as contribution in kind
Contractual Relationship *Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?*	Yes A Memorandum of Understanding is in place between the DNO and IC Consultants Ltd which references the LCN Fund Governance document; it is intended that a Delivery Contract will be agreed between the DNO and IC Consultants Ltd to manage delivery of the Project
External Collaborator benefits from the Project *How will your organisation benefit from collaborating on this project?*	Development and implementation of the Distribution Network Investment Tool is strategically important for maintaining Imperial's leading position in modelling of future distribution network operation and development. This particular project will enable us to convert our established network models into a set of tools that will be used by DNOs to inform their network planning and strategic decisions regarding the value of alternative Smart Grid concepts and technologies.

Project Partner Questionnaire

Please complete the following questionnaire which will be included in the appendices of the pro-forma submission.

Organisation Name	**University of Cambridge**
Relationship to DNO (if any)	Project Partner
Type of Organisation	University
Role in Project	The University's Electricity Policy Research Group (EPRG) will provide economic, regulatory and competition analysis of the Flexible Plug and Play model being developed by Imperial College and UK Power Networks. We will provide a social cost benefit analysis of the model outputs and analyse the regulatory issues arising from the model.
Prior experience brought to Project	The EPRG is Europe's leading academic research group on electricity policy. We have long-standing interests in network access pricing, economic regulation of networks and in decarbonisation and renewable policy. EPRG also has an outstanding record of interdisciplinary research collaboration and excellent dissemination channels.
Funding *Direct funding being provided to project in resources/time being spent*	20% of full economic cost is being borne by the University.
Contractual Relationship *Will the DNO have a contract in place which ensures the External Collaborator (you) complies with the LCN Fund Governance document?*	Yes
External Collaborator benefits from the Project *How will your organisation benefit from collaborating on this project?*	We look forward to developing our links with UK Power Networks, Imperial College and Ofgem. We will acquire detailed understanding of the connection issues facing distribution networks. We will also look forward to working with our local network operator for the East of England.

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TEL: +44 (0)1344 603333

WWW.CW.COM

Cable&Wireless Worldwide

OFGEM,
9 MILLBANK,
LONDON
SW1P 3GE

30 September 2011

FAO: Ofgem Low Carbon Network Fund Expert Panel

Flexible Plug and Play Low Carbon Networks from UK Power Networks

Dear Ofgem Expert Panel,

I write to you as the Managing Director of Enterprise for Cable&Wireless Worldwide,

Cable&Wireless Worldwide have been working closely with UK Power Networks throughout the formulation the Flexible Plug and Play (FPP) project.

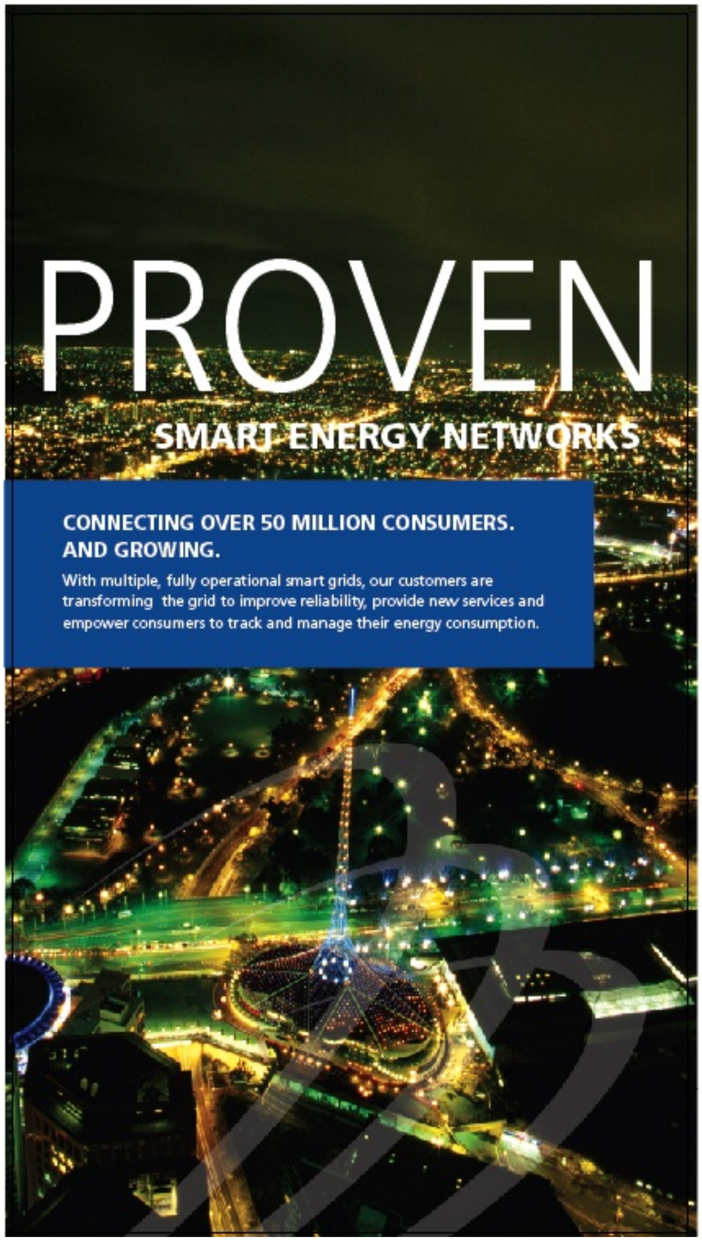
The approach taken between our companies has been one of collaboration throughout allowing our respective strengths and expertise to be brought to bear as the project has been formulated.

We strongly believe that designing communications solutions with the needs of a Smart distribution network in mind, and specifically using communications to enable the cost effective connection of renewable generation to a distribution network, is a critical proof point in the development of the Smart Grid. Flexible network management, interoperability, the adoption of open standards, and the operational benefits for UKPN accruing from faster generation connections are all enabled by a tailored communications solution for the Energy industry. Such approach to repeatable communications solutions will contribute to the future growth in renewable generation.

We believe that the collaborative approach taken to this project best supports benefits realisation, and delivery of value for money in the allocation of Low Carbon Network Funds.

This project has the support of Cable&Wireless Worldwide, and my personal support.

Matt Key, Managing Director, Enterprise



SILVERSPRING NETWORKS®

September 2011

London, September 29th, 2011

FAO: Ofgem Low Carbon Network Fund Expert Panel

Flexible Plug and Play (FPP) Low Carbon Networks from UK Power Networks

Silver Spring is an active partner in the Flexible Plug and Play (FPP) Low Carbon Networks project, and we have for some time been working in close collaboration with UKPN and the other members of the consortium to progress the FPP project.

We believe that the FPP Project affords an excellent opportunity to demonstrate how an IP-based, open standards platform will enable the flexible and cost effective addition of innovative Smart devices and applications, and are excited about the prospect of a continued collaborate in achieving this vision.

Silver Spring is committed to the success of FPP project**.** Silver Spring is dedicated to providing both local resources and global expertise to ensure successful delivery. Furthermore, Silver Spring will deliver a set of innovative technical and commercial solutions that help realize project objectives and maximize value.

Silver Spring delivers proven technology with a leading record of successful deployments. Silver Spring is honored to work with many leading global utilities, each of whom has recognized the most important value of our company – we deliver what we promise. In just the last three years, Silver Spring has helped connect more than 10 million homes and businesses for our utility clients.

Cost effective, reliable communications are the foundational component to the Smart Grid. Deferring or, better, avoiding costly distribution network reinforcements can only be achieved through robust communications connectivity. This is what we do. Silver Spring's active participation in the FPP project will help ensure that the project objectives are achieved, and that the associated unique learnings regarding cost-effective connection of renewable generation to a distribution network are best disseminated to the broad stakeholder community.

Please be assured that you have my personal commitment, and the support of the Silver Spring Networks global team, to ensure that the Flexible Plug and Play Low Carbon networks project is a comprehensive success.

Best Regards,

Scott Lang

Scott Lang
Chairman, President & CEO

Regent House, 113 West Regent Street, Glasgow, G2 2RU
t +44 (0) 141 248 0060
info@smartergridsolutions.com www.smartergridsolutions.com

Dr Cristiano Marantes
Low Carbon Networks Development Manager
Future Networks
UK Power Networks
3rd Floor Newington House
237 Southwark Bridge Road
London
SE1 6NP

Our Ref: 200052-07A
30 September 2011

Dear Dr Marantes,

Smarter Grid Solutions is delighted to be a proposed delivery partner for the Flexible Plug and Play Low Carbon Networks project. SGS believes that the concepts to be trialled and the learning that will be derived from this project will deliver significant benefits to low carbon generation developers, UK Power Networks and other UK Distribution Network Operators. SGS believe that the combination of innovative commercial and technical solutions and proactive engagement with a key customer group, who are in a position to directly influence the UK's ability to meet its carbon emission reduction targets, will set a benchmark for how 'fit and flex' rather than 'fit and forget' approaches to network planning and operation can be adopted across the UK.

SGS fully supports UK Power Networks in their bid to Tier Two of the Low Carbon Network Fund. Projects like this one are vital to ensuring that candidate smart solutions can be identified, assessed and adopted into normal business practise, to improve the service to customers and provide the most cost effective means possible to achieving the transition to a low carbon electricity sector.

Yours sincerely

Alan Gooding
Managing Director

GRID
INTERNATIONAL SALES ORGANISATION

ALSTOM

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www.alstom.com

30 September 2011

UK Power Networks Holding Ltd
Future Networks
3rd Floor Newington House
237 Southwark Bridge Road
London, SE1 6NP

FAO: Cristiano Marantes
Low Carbon Networks Development Manager

Dear Mr Marantes,

FLEXIBLE PLUG AND PLAY LOW CARBON NETWORKS PROJECT

As a global leader in Smart Grid technologies, ALSTOM Grid understands the challenges facing Utilities as they manage the low carbon transition. This will require the development of intelligent infrastructures that enable real-time, two-way management of electricity and information.

The UKPN Flexible Plug and Play Low Carbon Networks (FPP) project will trial innovative technical and commercial solutions to enable the cost-effective connection of renewable generation to a distribution network. We believe this can be achieved using the technologies proposed and that the project will demonstrate significant benefits through the better integration of renewable energies in a more efficient electrical network.

ALSTOM Grid is very proud to be a project partner in providing innovative protection and control solutions and advanced power transformer technologies. These technologies and solutions will be developed in our UK Centres of Excellence and will help to reaffirm the UK as a major source of Smart Grid technologies for the future.

ALSTOM Grid is committed to supporting this important initiative in the transition towards low carbon networks.

Yours faithfully
for ALSTOM Grid UK Limited,

K J Marriott
Commercial Vice President
North West Europe

CONVERTEAM
THE POWER CONVERSION COMPANY

Statement of support for the Flexible "Plug and Play" (FPP) project.

"Converteam's major focus and enduring business objective is that of optimising the customer's overall system design and performance while protecting the environment. Responsiveness, flexibility and sustainability are key features of Converteam's approach to engineering and project management of integrated system solutions – from project inception through to final handover and beyond. In this context, I believe that the FPP project is a key stepping stone towards a low carbon energy sector in the UK.

Research & development is crucial to ensure that Converteam's range of products for the renewables industry sector is constantly improved to match increasingly demanding market trends and quickly evolving customer expectations. In our R&D plans, we therefore focus on developing and implementing technologies to improve reliability, power density and efficiency as well as to optimize the interfaces between each component of a solution. This approach is entirely compatible with the stated aims of the FPP and I am therefore delighted that Converteam have been asked to participate in this project and am also keen to emphasise Converteam's support for the project and the delivery of a successful outcome."

Steve J Raynor

Steve Raynor

Senior Vice President and Managing Director,

Converteam Northern Europe

FUNDAMENTALS LTD
www.fundamentalsltd.co.uk

FUNDAMENTALS

POWER SYSTEMS TECHNOLOGY

Fundamentals Ltd
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Oxfordshire
OX9 3BX

Tel: (01844) 213336
Fax: (05600) 758035

Sotiris Georgiopoulos
Senior Project Manager
Future Networks
3rd Floor Newington House
237 Southwark Bridge Road
London
SE1 6NP

1st July 2011

Dear Sotiris,

Following recent correspondence relating to the UKPN LCNF Tier 2 project 'Flexible Plug and Play Low Carbon Networks', we would like to formally express our interest in becoming a project partner. We especially support the development of a system which can facilitate the connection of renewable generation in the network.

Project Objectives

We can identify several advantages related to the proposed project and how it could address existing industry issues:

- This builds on previous work performed under an IFI project relating to the application of the SuperTAPP n+ voltage control relay. This project showed that significantly more operational flexibility can be achieved by use of local and remote measurement information for network voltage control. The additional local measurements were proven but the next step is to incorporate remote measurements, such as at the point of generator common coupling, into the system, as would be accommodated by the proposed UKPN system.

- Distribution Network Operators must look at a more 'active' approach to network control in order to maximise the amount of renewable energy which can be added to a distribution network without compromising statutory limits but without the need for network reinforcement. The 'deployment of modern RTU's' aspect of the project proposal certainly seems to address this.

- The result of the project should be the ability to add more embedded generation to a network and a better quality of supply for customers. There should also be some scope to make the assessment process for generator connection applications more efficient according to the developed economic model.

- The Eastern Power Networks area of UKPN is a particularly appropriate part of the network to trial new technologies since there is such a diverse mix of load and generation throughout the year, with domestic, commercial, industrial and seasonal loads and also large scale embedded generation. This will allow the extremes of network conditions to be experienced and an observation of how 'flexible management of network constraints', as enabled by the developed technical platform, can cope.

- As part of a LCNF project there should be a willingness, which otherwise may not exist, to attempt a range of different approaches across the network with a view to identifying the optimum solution. Much can be learned from R&D and trial installations which will lead to better solutions. The deployment and integration of several technical solutions will maximise the potential for achieving the ultimate project objective of enabling the connection of more renewable generation without the need for reinforcement.

Project Personnel

Fundamentals Ltd are committed to the development of voltage control systems for the low carbon network and would very much like to be involved with the proposed UKPN project. Personnel who would be involved in the project, with corresponding role, qualifications and experience are as follows:

Dr. Maciej Fila

Job Title:	Application Engineer
Project Role:	Design, engineering, technical support, network analysis, reports, installation, commissioning
Qualifications:	See enclosed CV
Experience:	See enclosed CV

Dr. Jonathan Hiscock

Job Title:	Managing Director	
Project Role:	Project Management	
Qualifications:	1995 – 1998:	*Kings College London* PhD in department of Solid State Physics
	1991– 1995:	*University of Sussex* BSc in Physics with French
Experience:	2008 - present:	Managing Director, Fundamentals Ltd
	2004 – 2008:	R&D Engineer, Fundamentals Ltd
	2000 – 2004:	Software Developer, Lehman Brothers
	1998 – 2000:	Technical Analyst, Logica plc

Mr. Roger Lynn

Job Title:	R&D Engineer	
Project Role:	Software / hardware development	
Qualifications:	1994-1998:	*Manchester University* BSc (hons) MEng Electronic and Electrical Engineering (Industrial Link)

Experience: 2006 - present: R&D Engineer, Fundamentals Ltd
1999-2006: R&D Engineer, Reyrolle Protection

Commercial Framework

Fundamentals will support UKPN in the bid for the proposed project and acknowledge that we do so at our own expense during the bid stages and that we are required to sign a corresponding Memorandum of Understanding.

During the bid stage of the project we would like to develop an appropriate contract to cover our obligations as project partner and how we will quote for related development, installation, analysis and commissioning works. Prices for existing products are available and will be supplied as and when necessary.

If you would like to discuss any of the above any further please do not hesitate in contacting me. I look forward to progressing this interesting development and hope to hear from you soon.

Yours sincerely,

FUNDAMENTALS LTD
FUNDAMENTALS
UK

Dr. Jonathan Hiscock
Managing Director

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tel: 01844 213336
mobile: 07876 596719

GL Garrad Hassan

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UK

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www.gl-garradhassan.com

Our Ref: 110808/B/001

29 September 2011

To whom it may concern

GL Garrad Hassan has extensive experience with network connection of renewable generation, extending over 20 years and over many countries. We have seen traditional 'fit and forget' network design approaches result in network reinforcement that may be unjustified for low-capacity-factor renewable generation, with consequences of long delays, uncertainty for project developers and high costs. We believe that demonstration of design tools and hardware on a real distribution network with a high penetration of distributed generation is an essential step and, if successful, will lead to earlier connections, more options for project developers, and lower costs of integration of renewable generation.

Yours faithfully

Andrew Garrad
President

Imperial College
London

Department of Electrical and Electronic Engineering
Imperial College London

Room 1103
South Kensington campus
London SW7 2AZ, UK
Tel: +44 (0)20 7594 6169 Fax: +44 (0)20 7594 6282

g.strbac@imperial.ac.uk
www.imperial.ac.uk/controlandpower

Prof Goran Strbac
Professor of Electrical Energy Systems
Director of Centre for Sustainable Electricity and Distributed Generation

Dr Cristiano Marantes
UK Power Networks
237 Southwark Bridge Road
London SE1 6NP

2 October 2011

Dear Cristiano

Flexible Plug and Play

I strongly believe that the Flexible Plug and Play Low Carbon Networks project (FPP) is of strategic importance for a cost effective evolution to a low carbon future. It will demonstrate radically new approaches to connecting increased amounts of renewable generation to weak distribution networks by making use of advanced smart grid concepts and technologies and radically new commercial arrangements. Imperial team will develop a novel Strategic Investment Model that will identify the most cost and carbon efficient solutions to connect renewable generation, which will represent a major opportunity for Imperial to provide leadership in the development of new methodologies for distribution network operation and design that will be relevant for future low carbon electricity systems.

Yours sincerely

Goran Strbac

Goran Strbac

S&C ELECTRIC EUROPE LTD.
Excellence Through Innovation

Ref: GD/Mydcs/FPP

30th September 2011

To whom it may concern

Re: FPP Project

S&C Electric Europe Ltd is delighted to be a proposed delivery partner for the Flexible Plug and Play Low Carbon Networks project. S&C believes that the concepts to be trialed and the learning that will be derived from this project will deliver significant benefits to low carbon generation developers, UK Power Networks and other UK Distribution Network Operators.

Kind regards

pp Andrew Jones
Managing Director

Tel: 07970 663285

Appendix G

Base Case Assumptions

Assumptions on Assessment of Base Case costs

1. Generator Connections

1.1 A notional order of connection for the known wind farm sites in the area was assumed. The assumed order was used to identify the reinforcement works that would be required to connect this generation and the conventional network reinforcement required to upgrade constrained sections of the network.

2. 33 kV Network

2.1 The planned project (IDP 3698) installing new 33 kV cable circuits rated 38 MVA each from Peterborough Central to Funtham's Lane will be completed in 2012, and the network split at Chatteris Tee points – to transfer Funtham's Lane and Whittlesey substations from March Grid to Peterborough Central.

2.2 All identified constrained circuits will be upgraded to eliminate onerous load conditions e.g. the Farcet T1 – Bury circuit (**rated 23 MVA**) has both Glassmoor and Red Tile 1 wind farms with combined installed capacity of **28 MW** connected.

2.3 All 200 SCA conductors overloaded will be replaced with 300 ACAR which has not been practical in the past. It is assumed that permission from Landowners for greater 'land intake' for supports required for this construction will be obtained.

2.4 Circuits were installed around 1950's and 1960's and all wood poles and accessories will be replaced like for like because of poor asset condition.

2.5 The network circuit lengths data used is accurate. The IDP unit cost models used are the most up to date. The derived indicative base costs are accurate within 25% tolerance.

2.6 There is no known requirement for reinforcing the existing 11 kV network to connect generators at 11 kV. In the event of a requirement to reinforce the 11 kV system the cost, which is excluded in the base case estimate, will be substantial.

2.7 The estimated Base Case costs exclude project risk.

2.8 Summer rating (constraint) @ 50^{o}C for OHL conductors:

Aluminium Conductor size, mm2	100	150	200	300
Summer Max Rating (MVA) @ 33 kV	14	19	23	31

3. 132kV Network

3.1 Previous studies done for a proposed Waste Plant to be situated adjacent to Peterborough Power Station identified that with a single 132 kV circuit out of commission at summer minimum load and the power station generating, the remaining three circuits could only just accommodate the export towards Walpole Grid Supply Point. It is therefore likely that the 188 MW additional generation would create issues under this situation. When any of these circuits are taken out of service for maintenance or construction work, then generation would have to be constrained further to allow for the possibility of a further circuit fault occurring during the planned outage.

3.2 Further network studies would be carried out at detailed design stage to confirm whether an additional new 132 kV circuit from Peterborough to Walpole GSP is likely to be required.

4. Grid Substation Limitations

4.1 The main limitation on Grid Substations is expected to be reverse power capacity, which is limited by the maximum settings that can be applied to the Directional Overcurrent Protection.

March Grid :

2 x 45MVA transformers, max setting 75% : 34 MVA limit (under N – 1)
Projected worst case reverse power flow with existing generation : 23 MVA
'Spare' capacity : 11 MVA

Peterborough Central :

2 x 60MVA transformers, max setting 75% : 45 MVA limit (under N – 1)
Projected worst case reverse power flow with existing generation : 13 MVA
'Spare' capacity : 32 MVA

4.2 The only way to increase these capacities with existing protection systems would be to replace the transformers with 90 MVA units. This would increase the combined reverse power capacity to 135 MVA.

4.3 It is known that there are other protection methodologies that can meet the function of the directional overcurrent without imposing limits on reverse power on grid transformers at both March Grid and Peterborough Central, but the UKPN standard is for directional overcurrent with maximum reverse power flow settings limited to 75% of the transformer nameplate rating.

Table of Required Network Reinforcement to remove all known constraints

Item	Constrained Network	Traditional Solution Uprate	Estimated Cost (£k)	Justification
1	March Grid to Chatteris T1 tee point (P28) (Circuit No.1)	3.1km x 200SCA to 300ACAR	210	Circuit constrained to 23 MVA limit. If NOP remains at P66, or 33 kV circuit fault generators; should be allowed to continue to export to either Peterborough Central or March Grid. Loads on March Grid – Chatteris 1 & 2 circuits would be 43 MW and 36 MW respectively – reason for upgrading to match 38 MVA rating of new cables from Peterborough Central.
2	March Grid to Chatteris T2 tee point (P49) (Circuit No.2)	5.0km x 200SCA to 300ACAR + 0.2km UG	430	Same as item No.1 above
3	Chatteris T1 to tee point (P28)	10.8km x 150SCA to 200SCA	730	Existing 10 MW connected, and an additional 10 MW Wind Farm is proposed to connect – thereby exceeding the 19 MVA rating of the circuit.
4	Chatteris T2 to tee point (P49)	10.2km x 150SCA to 200SCA	690	Proposed 17.5 MW planned to connect – leaving headroom of 1.5 MVA. In the unforeseen event of Chatteris Load nearly zero, the 2 x 2 MW wind farms connected at 11kV would export to 33 kV network – resulting on overload on this circuit.
5	Chatteris T1 tee point (P28) – Whittlesey T1	11.7km x 200SCA to 300ACAR + 0.1km UG	830	Same as item No.1 – this section is part of the artery circuits linking March Grid to Peterborough Central.
6	Chatteris T2 tee point (P49) to Whittlesey T2 tee (P80)	11.6km x 100SCA to 300ACAR	780	Same as item No.1 – this section is part of the artery circuits linking March Grid to Peterborough Central.
7	Whittlesey T1 to Funthams Lane T1	2.7km OHL 0.8km x 185AL to 630AL	560	Same as item No.1 – this section is part of the artery circuits linking March Grid to Peterborough Central.
8	Whittlesey T2 tee point (P80) to Funthams Lane T2 tee point (P66)	1.5km x 100SCA to 300ACAR	100	Same as item No.1 – this section is part of the artery circuits linking March Grid to Peterborough Central.
9	Peterborough Central to Farcet T1	2.4km x 200SCA to 300ACAR + 2.1km UG	1,100	Connected RG 28 MW + planned RG 7.5 MW on an already overloaded circuit (rated 23 MVA). It is assumed 11 MVA will be absorbed by Farcet 11 kV load leaving a 1.5 MVA overload on the circuit.
10	Farcet T1 to Bury	16.2km x 200SCA to 300ACAR	1,100	Connected RG 28 MW + planned RG 7.5 MW on an already overloaded circuit (rated 23 MVA). Theoretically it would be necessary to remove this constraint by uprating to 300ACAR – assuming Land permissions will be granted (inverse to item 2.3)
11	March Grid Transformers	Replace Txfs with new 2 x 90 MVA	3,200	Increase reverse power flow limit to 68 MVA – to remove the existing 34 MVA limit constraint
12	Peterborough Central Transformers	Replace Txfs with 2 x 90 MVA units, CBs, busbar works	5,400	Increase reverse power flow limit to 68 MVA – to remove the existing 34 MVA limit constraint
		TOTAL	**15,130**	

Appendix 1

Use Cases

Flexible Plug and Play Low Carbon Networks

High-level Use Cases

Introduction

This document presents the use cases that are proposed to be explored in the Flexible Plug and Play Low Carbon Networks (FPP) project. The document begins by setting the context for the use cases presented, before introducing the rationale behind the structure of the use cases and providing a summary of each individual use case. Of utmost importance to the specification of the use cases is the learning expected from the trials undertaken – this is presented in this document. Finally, a high-level overview of the FPP solution is presented, demonstrating the main functional elements of the technical solutions required to undertake the trials.

The use cases presented here are concerned with identifying the high-level activities and outcomes of the various trials to be undertaken in the FPP project. This document will be used as a foundation for the FPP trials and forms the basis for the detailed engineering design work to be performed for each trial.

This document will be updated on a continuous basis throughout the preparatory stages of the FPP project to improve the level of detail it contains.

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Flexible Plug and Play Low Carbon Networks – Context diagram

Development of a low carbon energy sector

The UK Low Carbon Transition Plan / The UK Renewable Energy Strategy / Renewable Energy Review
Reduction of the UK's CO2 emissions / Security of the UK's energy supply / Strong UK Low Carbon economy / Affordability

30% of UK's electricity from renewables by 2020 and up to 40% by 2030

Distribution network congestion: breaches of thermal or fault level ratings, or statutory voltage limits
Lack of network management flexibility: unable to actively manage generation export and network configuration in real-time
Expensive connections: piecemeal approach (individual connection assessment), sub-optimal solutions, higher network reinforcement and connection costs

Risk to the success of the Renewable Energy Strategy and ultimately the Low Carbon Transition Plan

Flexible Plug and Play Low Carbon Networks

WS1/U01
Communications Platform

- IP based communications network
- Different comms solutions (RF mesh, Fibre)
- Interoperability
- IEC 61850 enabled

WS2/U02
Smart Devices

- IP-enabled RTUs
- Modern Protection Relays
- Transformer Tap changer control relays
- Dynamic Line Ratings
- Frequent use switches
- Quadrature-booster
- Generator controllers
- Energy Storage device

WS3/U03
Smart Commercial Arrangements

- Enable Smart Applications
- Access to network capacity available in real time
- Grouping of generators at planning stage

WS4/U04
Smart Applications

- Coordination of Smart Devices
- Active Power Flow Management
- Active Voltage Management
- Thermal Ratings Estimation

Innovative integration of technological and commercial solutions to cost-effectively connect renewable generation to distribution networks

WS5/U05
Stakeholder Engagement

- Proactive approach
- Renewable generation developers
- Local Authorities
- Others

WS6/U06
Strategic Investment Model

- Different demand and generation scenarios
- Integrated value and benefit of smart devices, smart commercial arrangements and smart applications
- Triggers for network reinforcement

WS7/U07
Learning and Dissemination

- Knowledge dissemination roadmap
- Objectives
- Products
- Target Audience
- Activities roles and responsibilities
- Dissemination media

WS8/U08
Systems Integration

- Integration of several Smart devices
- Demonstrate Interoperability
- Cyber security management framework
- System planning, design and implementation

Glossary of Terms

ANM	Active Network Management
AES	Advanced Encryption Standard
CCGT	Combined Cycle Gas Turbine
CNI	Critical National Infrastructure
CWW	Cable & Wireless Worldwide
DECC	Department of Energy and Climate Change
DH	Diffie-Hellman (DH) Key Agreement
DHCP	Dynamic Host Control Protocol
DLR	Dynamic Line Ratings
DNP3	Distributed Network Protocol
DNS	Domain Name System
DNO	Distribution Network Operators
DOC	Directional Over-Current
ECDSA	Elliptical Curve Digital Signal Algorithm
ECDH	Elliptic Curve Diffie-Hellman
ENA	Energy Networks Association
ESS	Energy Storage System
FPP	Flexible Plug and Play
GB	Great Britain
GOOSE	Generic Object Oriented Substation Event
HMAC	Hash Based Message Authentication Code
HMG	Her Majesty's Government
HTTP	Hyper Text Transfer Protocol
HTTPS	Hyper Text Transfer Protocol secure
ICMP	Internet Control Message Protocol
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical & Electronic Engineers
IET	Institution of Engineering and Technology
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IPSec	Internet Protocol Security
LAN	Local Area Network
LCNF	Low Carbon Network Fund
LRIM	Load Related Investment Model
LTDS	Long Term Development Statement
MSP	Multi-Service Platform
NIST	National Institute of Standards and Technology
NOP	Normally Open Point
NTP	Network Time Protocol
OSI	Open Systems Interconnection
PKCS	Public Key Cryptography Standard
PPP	Point to Point Protocol
PRNG	Pseudo-Random Number Generator
PST	Phase Shifting Transformer
RF	Radio Frequency
RG	Renewable Generation
RIIO	Revenue = Incentives + Innovation + Outputs
RNG	Random Number Generator
ROI	Return on Investment
RSA	Rivest-Shamir-Adelman
RTR	Real Time Ratings
RTU	Remote Terminal Unit

SGCore	Smart Application Host
SGi	Active Power Flow Management Application
SGv	Active Voltage Management Application
SGrtr	Thermal Ratings Application
SGS	Smarter Grid Solutions
SCADA	Supervisory Control and Data Acquisition
SHA	Secured Hash Algorithm
SNMP	Simple Network Management Protocol
SNMPv2	Simple Network Management Protocol version 2
SNMPv3	Simple Network Management Protocol version 3
SSN	Silver Spring Network
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UKPN	UK Power Networks
WAN	Wide area Network
WS	Workstream
UC	Use Case

Use Case 01 (U01): COMMUNICATIONS PLATFORM

Use Case 1 is concerned with the basic proving of a newly deployed, open standard based IP communications infrastructure that will form the basis for the Flexible Plug and Play (FPP) platform. The communications infrastructure will form a Wide Area Network (WAN) connecting the FPP trial Primary and Grid Substations, Smart Devices and Smart Applications. This WAN will enable the integration, interoperability testing and trialling of Smart Devices and Smart Applications, which are described in Use Cases 2 and 4.

U01.1 – IP based communications across a dedicated network infrastructure within the FPP trial area using a multi-bearer network

This use case demonstrates the basic capability of the communications infrastructure comprising a Cable & Wireless Worldwide (CWW) Multi-Service Platform (MSP) network and Silver Spring Networks (SSN) Radio Frequency (RF) mesh devices to operate as an IP network under various operating conditions.

Locations

- Grid and Primary Substations within the FPP trial area
- Locations for smart devices within the FPP trail area
- UK Power Networks Control Room

Key Components

The CWW MSP is to provide backhaul network in conjunction with SSN RF Mesh radio across the FPP trial area. The baseline design of the RF Mesh incorporates the following network elements: 2 Master eBridges, 48 eBridges, 6 Access Points, 40 Relay Points. Backhaul from the RF Mesh Radio elements is provided by fibre Ethernet access circuits from Huntingdon and Peterborough into the UK Power Networks Control Room. CWW will deploy 6 Cisco (IEC 61850) Routers for backhaul access to their MSP network.

Within the FPP trial substations a Local Area Network (LAN) will be established for the purpose of integrating devices at the substation level and presenting data to the WAN.

The following additional elements form key components of this use case and others in U01:

IP Addressing
- Simultaneous support for large address space, multi-homing, stateless auto-addressing, prioritization, legacy systems and WAN connectivity, IPv6, IPv4

Networking Protocols
- IP protocols: UDP, TCP, HTTP, HTTPS, PPP, DHCP, DNS, NTP, IPSec, SNMPv2/3, ICMP, and more, Layer 1/2 RF: IEEE 802.15.4-2006 and 802.15.4g

Distribution Automation
- DNP3 (IEEE 1815), Modbus (via transparent serial mode), IEC 61850

Interfaces
- Serial (RS-232), Ethernet (RJ45)

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Prove basic functionality of IP communications infrastructure, under various operating conditions.	Connect IP enabled equipment at FPP trial substations and at UK Power Networks Control Room, and check basic capabilities to communicate e.g., ping and file transfer. Check typical performance (latency etc.) under benign operating conditions e.g., fair weather, all RF mesh relays, ebridges and master ebridges operational.	The use of the communications infrastructure as a general IP network is proven. Performance limits of the communications infrastructure are better understood.
	Repeat tests under various operating conditions e.g., different weather conditions, not all RF mesh relays, ebridges and master ebridges operational, high traffic levels, RF interference, etc. Add new RF mesh ebridges and relays, and remove existing ebridges and relays.	Performance differences between bearer networks are better understood (i.e., for substations at primary or secondary interconnect with MSP network, compared to substations connected via the RF mesh network). Minimum RF mesh configuration for trial area is better understood. The impact of weather, data traffic and other conditions on the RF mesh network are better understood. Commissioning and decommissioning procedures can be developed for RF mesh ebridges and relays. Commissioning and decommissioning risks and challenges are better understood.

High-level Roles and Responsibilities

CWW's deployment of secure, IP based open standards WAN solutions.

SSN's RF Mesh network uses end-to-end IPv6 communication and, if required, IPv6 to IPv4 conversion is supported by CWW from the Access Point to the back-office. IPv6 provides the common ground that enables disparate technologies to work together, resulting in the highest ROI, the least financial risk, and the shortest time to solution. SSN support for IEC 61850, DNP3 and other DA protocols currently is through 'transparent tunnelling' peer-to-peer operation.

UK Power Networks will design and undertake the trials and be responsible for the design and installation of substations LAN.

Dependencies

Depends on all preliminary systems integration activities in WS8

U01.2 – Smart grid specific open standards based application protocols communications and interoperability across a dedicated network infrastructure within the FPP trial area

This use case demonstrates the basic capability of the communications infrastructure comprising CWW's MSP network and SSN's RF mesh devices to support smart grid specific open standards protocols and interoperability requirements.

Locations

- Grid and Primary Substations within the FPP trial area
- UK Power Networks Control Room

Key Components

Same key components as described for U01.1
Protocol simulators

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Use of application protocols for electricity industry data communications.	Configure and connect IEC 61850 client simulator at UKPN Control Room and IEC 61850 server simulator at a substation location, and trial simulator operation over communications infrastructure. Repeat for different combinations of client and server locations, and multiple concurrent client and server locations. Experiment with IEC 61850 communication types other than client-server to the extent possible over the communications infrastructure (i.e., GOOSE and Sampled Values). Repeat for different utility industry data communications protocols e.g., DNP3 over IP.	The use of the communications infrastructure for electricity industry data communications is proven. Skills and experience with IEC 61850 protocol are developed. Skills and experience with IEC 61850 simulation and analysis tools are developed. The limits of the communications infrastructure with respect to handling IEC 61850 communications are understood. Procedures for commissioning and decommissioning IEC 61850 devices can be developed. Skills and experience with other industry data communications protocols are developed. Understanding of the advantages and disadvantages of different industry data communications protocols is developed.

High-level Roles and Responsibilities

CWW and SSN will perform the following roles and responsibilities:
- Implementation services including pre and post sales solution architecture, installation, project management
- Operational and service management of backhaul network, access connections, and RF mesh

- Operational and service management of connectivity to UKPN's network management centre
- Associated network management tools of both core network and radio networks
- Provision of technical support and tools to simulate different operating conditions

Dependencies

Depends on the successful completion of U01.1

U01.3 – IEC 61850 communications across a purpose-built network infrastructure within the FPP trial area using upgraded existing RTUs

This use case will trial new IEC 61850 enabled RTUs within selected substations and across the communications infrastructure comprising of CWW's MSP network and SSN's RF mesh devices.

Locations

- Test Lab environment
- Grid and Primary Substations within the FPP trial area
- UK Power Networks Control Room

Key Components

Same key components as described for U01.1
Converteam T5500 RTUs

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Check that IEC 61850 communications does not impact on existing communications capabilities of RTU.	In the lab environment, configure IEC 61850 server simulator, RTU, plus simulation of existing SCADA communications master. Trial both communications links concurrently with the RTU under various data traffic levels. Re-test with simulated malformed data packets on IEC 61850 link to the RTU, and verify if there is any impact on RTU operation or on its capability to communicate with the simulated SCADA communications master.	The new RTUs' communications functionality is proven. Skills and experience configuring the IEC 61850 capabilities of the new RTUs are developed. Skills and experience in robustness testing of communications interfaces are developed.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Trials of IEC 61850 capabilities of new RTUs.	Trial new RTU in production environment in substation (in parallel with existing RTU). The new RTU should be running both communications links (IEC 61850 client and existing communications link, although the existing communications link may be connected to a simulated SCADA master rather than the control centre). Trial the new IEC 61850 link over the communications infrastructure with an IEC 61850 server simulator located at the substation, and also with an IEC 61850 server simulator located at another substation.	Skills and experience configuring the IEC 61850 capabilities of the new RTUs are developed. Experience is gained commissioning the new RTUs in a production environment and proving the communication links within the substation and with other substations.

High-level roles and responsibilities

CWW and SSN will perform the following roles and responsibilities:

- Implementation services including pre and post sales solution architecture, installation, project management
- Operational and service management of backhaul network, access connections, and RF mesh
- Operational and service management of connectivity to UKPN's network management centre
- Associated network management tools of both core network and radio networks
- Provision of technical support and tools to simulate different operating conditions

Converteam will provide tools and technical support for the new RTUs

UK Power Networks will design and undertake the trials.

Dependencies

Depends on all preliminary systems integration activities in WS8

Depends on establishment of the communications platform in WS1

U01.4 – Communications Platform Cyber Security Assessment and Monitoring

This use case assesses and monitors the cyber security posture of the communications infrastructure comprising CWW's MSP network and SSN's RF mesh devices.

Locations

- CWW network management centre
- SSN management centre
- Grid and Primary Substations within the FPP trial area
- UK Power Networks Control Room

Key Components

Same key components as described for U01.1.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Assess security management	Desktop review and walkthrough assessments of security management policies and procedures in place for the communications infrastructure, and compliance with them, for both provision of MSP network management services and RF mesh network management services.	Understanding of security management policies and procedures relevant to communications infrastructure service provision for smart grid implementations, and potential risks and vulnerabilities.
Assess technical security	Desktop assessment of technical security features of both MSP network and RF mesh network. Desktop assessment of technical security features of both provision of MSP network management services and RF mesh network management services.	Understanding of technical security features relevant to communications infrastructures for smart grid implementations, and potential risks and vulnerabilities. Understanding of technical security features relevant to communications infrastructure service provision for smart grid implementations, and potential risks and vulnerabilities.
Cyber security attack exercises	Plan and simulate execution of potential cyber attacks on the communications infrastructure and service provision thereof.	Understanding and exploration of potential weak points in the communications infrastructure and service provision thereof for smart grid implementations.

High-level Roles and Responsibilities

Same as described for U01.2.

Dependencies

Depends on all preliminary systems integration activities in WS8

Use Case 02 (U02): SMART DEVICES

Use Case 2 is concerned with investigating and trialling smart devices. All smart devices within the FPP project must be interoperable with each other and with the smart applications delivered in workstream 4 using open standards and communicate via the IP-based communications infrastructure established in workstream 1. Each use case in this section is concerned with trialling a different type of smart device.

U02.1 – Modern Protection Relays

Various forms of network protection rely on communications between remote locations. Methods such as current differential unit protection, inter-tripping and carrier-aided distance protection may provide an alternative to the directional over-current protection currently used on the UK Power Networks 33 kV network, which is presenting a barrier to the connection of additional renewable generation. New protection relays will be installed to test the use of the IP-enabled platform in supporting communications-based protection.

Locations

March Grid and Peterborough Central grid substations to overcome the limitations of the existing Directional Over Current (DOC) protection.

Other locations may be considered following a detailed review of protection arrangements in the FPP trial area.

Key Components

Modern Protection Relays
Substation LANs
Open-standards IP Communications platform

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Allow more renewable generation to connect by overcoming the limits of reverse power flow at grid substations imposed by the use of Directional Over Current (DOC) protection. Identify and design alternatives to DOC in the FPP area based on the use of modern protection relays and the open standards IP communications platform. Revise UKPN protection policy to allow alternatives to DOC to be deployed.	Design and trial alternatives to DOC protection including: ▪ Current differential unit protection ▪ Inter-tripping (using Generic Object Oriented Substation Event (GOOSE) or proprietary methods) ▪ Carrier aided distance protection	Suitability of the open standards IP communications platform for different types of protection. Specifications for alternative methods that may be applied when DOC limits the connection of new generation. Design, installation, configuration and management processes associated with modern protection relays.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Make use of the open standards IP communications platform to improve operation and flexibility of protection and thereby remove barriers to RG. Design adaptive protection settings to support network reconfiguration. Revise UKPN protection policy to allow adaptive protection to be deployed.	Integrate the modern protection relays with the communications platform and prove interoperability with other devices and systems. Test the collection of data from modern protection relays to support network operation, smart applications and data archiving. Test settings adaptation based on the provision of information from multiple sources including other relays, the ANM scheme and SCADA.	The capabilities and limits of the communications platform in supporting different types of protection. The potential to use different systems and sources to support adaptive protection.

High-level Roles and Responsibilities

Alstom will design, supply, install, commission the protection scheme and provide applications support.

CWW and SSN will provide design guidance and support on the use of the open standards IP communications platform (WAN).

UK Power Networks will design and undertake the trials, and will install and commission the substation LAN.

Dependencies

Depends on all preliminary systems integration activities in WS8

Depends on establishment of the communications platform in WS1

Supports Use Case 2.4 (Frequent Use Switches)

U02.2 – Modern Transformer Tap Changer Control Relays

Increasing amounts of renewable generation has the potential to alter the voltage profile on the network and impact on the operation and effectiveness of existing voltage control schemes, such as transformer tap changer control relays. This use case involves the application of new transformer tap changer control relays that take account of the impact of distributed generation. The modern transformer tap changer control relays will also be linked to the open standards IP communications platform to facilitate data exchange and interoperability.

Locations

Selected Grid and Primary Substations within the FPP trial area

Key Components

Modern Transformer Tap Changer Control Relays at two substations
Open-standards IP communications platform
Substation LANs
Active Voltage Management Application (U04.2)

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Allow more renewable generation to connect to the distribution network by overcoming the limits of voltage control on 11 kV networks. Demonstrate the use of new transformer tap changer control relays at primary substations with renewable generation (or distributed generation in general).	Deployment of new transformer tap changer control in primary substations with renewable generation connected to the 11 kV network.	The capabilities, limits and requirements of voltage control using only transformer tap changers in 11 kV networks with renewable generation. Design, installation, configuration and management processes associated with modern transformer tap changer relays.
Allow more renewable generation to connect to the distribution network by overcoming the limits of voltage control on 33 kV networks. Demonstrate the use of new transformer tap changer control relays at grid substations with distributed generation.	Deployment of new transformer tap changer control in grid substations with renewable generation connected to the 33 kV.	The capabilities, limits and requirements of voltage control using only transformer tap changers in 33 kV networks with renewable generation. Design, installation, configuration and management processes associated with modern transformer tap changer relays.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Make use of the open standards IP communications platform to improve operation and flexibility of transformer tap changer control and thereby remove barriers to renewable generation. Provide relays with real-time or near-real-time data on generation output.	Integrate the relays with the communications platform and prove interoperability with other devices and systems. Test the collection of data from the relays to support network operation, smart applications and data archiving. Test voltage control performance based on the provision of generation output data of varying quality.	The capabilities and limits of the communications platform in supporting different types of voltage control. The generation output data requirements to achieve different levels of voltage control performance.
Integrate transformer tap changer control at primary substations with co-ordinated voltage management at 33 kV. Interoperability between transformer tap change control relays and voltage management applications running on remote systems.	Modify transformer tap changer voltage control by adjusting settings from a remote location using the communications platform. Test different levels of data provision from the transformer tap changer relays to remote systems.	The capabilities and limits of the communications platform in supporting different types of voltage control.

High-level Roles and Responsibilities

Fundamentals:

- Design, supply, install, commission the tap changer control schemes and provide applications support.

CWW and SSN

- Provide design guidance and support on the use of the open standards IP communications platform (WAN).

UK Power Networks

- Design and undertake the trials, and will install and commission the substation LAN.

Smarter Grid Solutions:

- Provide applications support for the active voltage management application.

Dependencies

Depends on all preliminary systems integration activities in WS8

Depends on establishment of the communications platform in WS1 and the provision of the active voltage management application in WS4

Supports Use Case 4.2 (Active Voltage Management)

U02.3 – Dynamic Line Ratings

Dynamic line rating (DLR) devices, including accompanying weather stations and conductor temperature sensors, have been implemented in various forms in different parts of GB but have yet to become an established tool in GB distribution networks. This project provides an opportunity to prove DLR devices on an open standards IP communication platform and thereby demonstrate how this technology, which is constantly improving, can be integrated most quickly and easily into other systems, such as demand or generation management. The overhead lines and significant penetration of wind farms means the FPP project area is an ideal candidate for DLR solutions focused on overhead lines.

Locations

Selected 33 kV overhead lines in the FPP area

Key Components

Four relays with DLR functionality
Four weather stations including temperature and wind speed sensors
Open-standards IP communications platform
Active power flow management application (U04.1)
Thermal ratings estimation application (U04.3)

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Allow more renewable generation to connect by implementing dynamic line ratings (DLR) on constrained 33 kV lines.	Deployment of DLR relays on 33 kV lines with potential thermal overloads.	The capabilities, limits and requirements of DLR on 33 kV overhead lines in the FPP area. Design, installation, configuration and management processes associated with DLR relays.
Make use of the communications platform to provide the DLR relays with required data, including data from weather stations.	Integrate the relays with the open-standards IP communications platform and prove interoperability with other devices and systems. Test DLR performance with disrupted communications. Test the collection of data from the relays to support network operation, smart applications and data archiving.	The capabilities and limits of the communications platform in supporting different types of relay-based calculation. The weather station data requirements to achieve acceptable DLR performance.
Interoperability between DLR relays and applications running on remote systems. Integrate DLR with active power flow management. Integrate DLR with real time thermal ratings estimation.	Modify DLR relays from a remote location using the communications platform. Test different levels of data provision from the DLR relays to remote systems.	The capabilities and limits of the communications platform in supporting different types of data exchange with the DLR relays.

High-level Roles and Responsibilities

Alstom to design, supply, install, commission the DLR schemes including the weather stations (temperature and wind speed sensors) and provide applications support.

CWW and SSN will provide design guidance and support on the use of the open standards IP communications platform.

UK Power Networks will design and undertake the trials.

Smarter Grid Solutions will provide applications support for the active power flow management and the thermal ratings estimation applications.

Dependencies

Depends on all preliminary systems integration activities in WS8

Depends on establishment of the communications platform in WS1 and the provision of the active power flow management application and thermal ratings estimation in WS4

Supports Use Case 4.1 (Active Power Flow Management) and Use Case 4.3 (Thermal Ratings Estimation)

U02.4 – Frequent Use Switches

The existing isolator switches used at Normally Open Points (NOPs) are not designed for frequent use, but these devices could be replaced with frequent use switches that are remotely controllable. This would allow different network configurations to be identified and implemented manually or automatically to enhance network performance or enable the connection of more renewable generation.

Active network configuration, relying on switches that can be used frequently, offers a potential solution to problems where the optimal network configuration is different according to the circumstances.

Locations

Potential locations:

- Existing 33 kV NOP isolators at the Funthams Lane tee and Whittlesey tee
- Install new 33 kV isolators to create a new NOP at the Chatteris tee
- Existing 33 kV isolator at Bury

Key Components

Two new frequent-use isolators with remote control functionality
Open-standards IP communications platform
Active power flow management application
Active voltage management application

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Make use of the open-standards IP communications platform to operate frequent use switches and thereby remove barriers to renewable generation.	Integrate the frequent use switches with the communications platform and prove interoperability with other devices and systems. Test the collection of data from the frequent use switches to support network operation, smart applications and data archiving.	The capabilities and limits of the communications platform in supporting network reconfiguration.
Interoperability between frequent use switches and devices and applications running on remote systems. Integrate frequent use switches with adaptive protection. Integrate frequent use switches with active power flow management. Integrate frequent use switches with active voltage management.	Modify frequent use switches from a remote location using the communications platform. Test different levels of data provision from the frequent use switches to remote systems.	The capabilities, limits and requirements of other devices and applications in supporting network reconfiguration.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Network reconfiguration to enhance network performance or remove barriers to renewable generation.	Switching to relieve thermal constraints on renewable generation. Switching to relieve voltage constraints on renewable generation or improve voltage performance. Switching to enhance security as patterns of demand and generation vary through time. Switching to reduce total network losses.	The scope for frequent network reconfiguration to enhance network performance or remove barriers to renewable generation.

High-level Roles and Responsibilities

S&C Electric to supply, install, commission the frequent use switches and provide design applications support.

CWW and SSN will provide design guidance and support on the use of the open standards IP communications platform.

UK Power Networks will design and undertake the trials.

Smarter Grid Solutions will provide applications support for the Active Voltage Management application and the Active Power Flow Management application.

Dependencies

Systems integration activities in WS8

Establishment of the communications platform in WS1

Provision of the active voltage management application and the active power flow management application in WS4

Depends on adaptive protection settings in modern protection relays in Use Case 2.1

Supports Use Case 4.1 (Active Power Flow Management) and Use Case 4.2 (Active Voltage Management) where reconfiguration affects the operation of these applications

U02.5 – Energy Storage

Energy storage offers one means to manage intermittent demand and intermittent generation on a distribution network within existing network constraints. UK Power Networks has previously explored with Durham University and ABB the benefits that storage can offer in managing intermittent generation. As a result UK Power Networks has installed a Li-ion storage device, which was commissioned in March 2011. This use case will investigate integrating the energy storage device with the FPP platform.

Locations

Integration with existing UKPN LCNF T1 trial at Martham *"Demonstrating the benefits of short-term discharge energy storage on an 11 kV distribution network"*

Key Components

Existing energy storage system (Li-ion battery and control system)
Open-standards IP communications platform

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Integration of the energy storage system at Martham substation with the FPP platform using open standards. Ensure the visibility of the energy storage device across the IP network. Explore the interoperability of storage with other IEDs.	A conceptual trial through virtual linking of the energy storage system to power flows recorded in the FPP area. This would provide a means of testing the energy storage system against other profile backgrounds, e.g. power flow profiles at 33 kV or 132 kV or the output of larger wind farms. These profiles will have different shapes to those observed on the 11 kV network at Martham and therefore extend the learning to be gained from the existing battery project. Test the control of the energy storage system to meet a range of objectives: ▪ Smooth the output of intermittent generation ▪ Smooth the power input to varying demand ▪ Reduce curtailment of generation by using storage as an adjunct to power flow or voltage constraint management (which is basically a more specific type of profile smoothing) ▪ Assess storage requirements (power and energy rating) for different applications	The potential capabilities and limits of energy storage on 33 kV networks in the FPP area. Design, installation, configuration and management processes associated with the integration of energy storage data into an interoperable open standards based environment. The capabilities and limits of the communications platform in supporting different types of battery operation. Requirements in terms of configuration and data schema to integrate an energy storage system into an open standards environment.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
If the physical communication infrastructure of FPP provided by CWW and SSN does not stretch to Martham substation then some other comms media could be used.	Trial the use of other comms such as microwave links or satellite that follow the same IP-based philosophy as the core FPP WAN.	Valuable learning with regards to integration of other alternative comms solutions The bandwidth and latency of alternative other comms solutions

High-level Roles and Responsibilities

CWW and SSN will provide design guidance and support on the use of the open standards IP communications platform.

UK Power Networks will design and undertake the trials, including the integration of energy storage data into the interoperable open standards based environment.

Dependencies

Depends on all preliminary systems integration activities in WS8

Depends on establishment of the communications platform in WS1

U02.6 – Generator Controllers

Generator Controllers are required to enable localised data communication with, and control of, existing and new renewable generators that lack the necessary compliance with open standards IP-based interfaces.

Locations

Generator controllers will be required on all generators that are subject to active network management. This will depend on further analysis and all necessary commercial agreements being settled but is anticipated to include the existing and new renewable generators in the project area.

Key Components

Generator controllers
Open-standards IP communications platform
Substation LANs
Active power flow management application
Active voltage management application

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Make use of the communications platform to control generators and thereby remove barriers to RG.	Integrate the generator controllers with the communications platform and prove interoperability with other devices and systems. Test the collection of data from the generator controllers to support network operation, smart applications and data archiving.	The capabilities and limits of the communications platform in supporting generator control.
Interoperability between generator controllers and devices and applications running on remote systems. Integrate generator controllers with active power flow management. Integrate generator controllers with active voltage management.	Modify and direct generator controllers from a remote location using the communications platform. Test different levels of data provision from the generator controllers to remote systems.	The capabilities, limits and requirements of other devices and applications in controlling generators.

High-level Roles and Responsibilities

Smarter Grid Solutions to design, supply, install and commission generator controllers and provide applications support for the voltage management application and power flow management application.

CWW and SSN will provide design guidance and support on the use of the open standards IP communications platform.

UK Power Networks will design and undertake the trials.

Dependencies

Depends on all preliminary systems integration activities in WS8

Depends on establishment of the communications platform in WS1

Provision of the active power flow management application and the active voltage management in WS4

Supports Use Case 4.1 (active power flow management) and Use Case 4.2 (active voltage management)

U02.7 – Quadrature boosters

Quadrature boosters (QB) provide a means of controlling the flow of power through multiple circuits. By controlling the relative phase angles, power flow can be reduced on overloaded circuits and moved to circuits with spare capacity. Thus, QB offer one possible solution to the relief of constraints that present a barrier to the connection of new renewable generation. This use case will involve the first application of such technology at distribution voltage levels in GB.

Locations

Potential locations:

- Existing 33 kV NOP near Funthams Lane and Whittlesey tee
- New 33 kV NOP near the Chatteris tee
- 33 kV NOP at Bury

Key Components

33 kV Quadrature booster
Open-standards IP communications platform
Substation LAN
Active Power Flow Management application and Active Voltage Management application

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Use quadrature boosters to actively manage power flows and thereby remove barriers to renewable generation.	Quadrature booster to relieve thermal constraints. Quadrature booster to relieve voltage constraints or improve voltage performance.	The scope for quadrature boosters to enhance network performance and remove barriers to renewable generation
Make use of the FPP communications platform to improve operation and flexibility of the quadrature booster and thereby remove barriers to renewable generation	Integrate the quadrature booster with the communications platform and prove interoperability with other devices and systems. Test the collection of data from the quadrature booster to support network operation and smart applications	The capabilities and limits of the communications platform in supporting quadrature boosters.
Interoperability between quadrature booster and devices and applications running on remote systems. Integrate quadrature booster with active power flow management. Integrate quadrature booster with active voltage management.	Modify and direct quadrature booster from a remote location using the communications platform. Test different levels of data provision from the quadrature booster to remote systems.	The capabilities, limits and requirements of other devices and applications in supporting quadrature boosters.

High-level Roles and Responsibilities

Alstom to design, supply, install, commission the quadrature booster and provide applications support.

CWW and SSN will provide design guidance and support on the use of the open standards IP communications platform.

UK Power Networks will design and undertake the trials.

Smarter Grid Solutions will provide applications support for the Active Voltage Management application and Active Power Flow Management application.

Dependencies

Depends on all preliminary systems integration activities in WS8

Depends on establishment of the communications platform in WS1

Provision of the active voltage management application and active power flow management application in WS4

Supports Use Case 4.1 (Active Power Flow Management) and Use Case 4.2 (Active Voltage Management)

Use Case 03 (U03): SMART COMMERCIAL ARRANGEMENTS

When facilitated by the deployment of the smart devices and applications on the FPP platform it is expected that network access for participating generators will vary between interruptible and firm access rights for all or some of each generator's export capacity. This will require new commercial arrangements to be established and proved with participating generators that will form the basis for new connection agreements.

The project must therefore consider the potential for a two-tier system of access:

- Firm generation (business as usual)
- Interruptible contracts (smart commercial arrangements)

New processes will be required regarding the offering of terms for new or upgraded generator connections, these new processes will need to take into account discussion of the above options with the relevant generator developers. Such arrangements will need to consider the impact on Use of System charging of offering interruptible connections versus firm connections.

Use Case 3 will include the investigation of principles of access for the implementation of interruptible contracts with generators. These principles of access will determine the order in which the output of multiple generators is regulated and controlled by the smart applications deployed in the FPP project.

U03.1 – Explore Principles of Access to be Implemented in FPP Project

This use case will involve the review of existing work undertaken by UK Power Networks and in other projects worldwide (including other LCNF projects) in the area of Principles of Access (PoA). The PoA will determine the order in which participating generators in the FPP project have their real or reactive power output increased or decreased in order to keep the distribution network within thermal and voltage constraints. Options include, but are not limited to, shared access for all, last in first out, largest first, technical best and greatest carbon benefit.

Locations

New commercial agreements will be required for all generators that are subject to active network management in the FPP trial area.

Key Components

This use case will not include any technical components but will be dependent on literature reviews, meetings within UK Power Networks and consultation with key stakeholders, including generators and Ofgem.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Engage with key stakeholders regarding the adoption of PoA in connection agreements.	Literature review of relevant reports, regulatory information and outcomes of other projects. Review of work undertaken by UK Power Networks on this topic to determine candidate PoA options. Engage with key stakeholders to better understand the requirements of the UK Power Networks business, generators and Ofgem.	Understanding of the requirements of key stakeholders regarding PoA, including the consideration of the impact on the economic viability of generation projects and the impact on the effective utilisation of the FPP trial area network.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Identify and perform a multi-criteria assessment of the various PoA available to be used in the FPP project.	Based on stakeholder requirements, perform a multi-criteria assessment of the various PoA options and rank in order of preference.	Identification of candidate options for PoA to be included within template connection agreements.

High-level Roles and Responsibilities

UK Power Networks will be responsible for pulling together all associated materials and communicating such material to key stakeholders. UK Power Networks will be responsible for performing the multi-criteria assessment of PoA options.

Generators will be engaged to better understand the implications of establishing PoA within connection agreements and the potential impact on the ability of generator projects to raise project finance.

Dependencies

This use case will have a dependency on WS5 (U05) concerned with stakeholder engagement and will support WS6 (U06) concerned with the strategic investment model.

U03.2 – Create Template Connection Agreements to Support Interruptible Generator Connections

This use case shall create template connection agreements that permit the connection of new RG to the FPP network, according to the PoA options identified in U03.1. These template contracts will be widely applicable and will be written to be generic in that they will not be specific to the technology aspects of the FPP project.

Locations

New commercial agreements will be required for all generators that are subject to active network management in the FPP trial area.

Key Components

This use case will not include any technical components but will be dependent on literature reviews, meetings within UK Power Networks and consultation with key stakeholders, including generators and Ofgem.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Generate template connection agreements that provide the legal basis for interruptible connections of new generators.	UK Power Networks will generate template contracts that are commensurate with the ability to fully consider smart grid technology as an alternative connection solution to traditional network reinforcement.	The new contractual arrangements that are required to facilitate new types of generator connections and permit UK Power Networks to offer alternative connection solutions.
Implement new connection agreements with generator developers in the FPP trial area.	UK Power Networks will produce and agree connection agreements with generator developers that include, as standard, provisions for interruptibility according to the PoA options available.	The practicalities of implementing new contracts that support interruptible connections.

High-level Roles and Responsibilities

UKPN will undertake the key activities in this workstream, in order to maximise the learning potential for UKPN and to ensure that this learning can be disseminated to other DNOs in a suitable form. The key roles will include the production of connection offers and the management of connection offers.

Dependencies

This use case will have a dependency on WS5 (U05) concerned with stakeholder engagement and on U03.1 to provide the PoA to be used in the FPP project. This use case will support WS6 (U06) concerned with the strategic investment model.

Use Case 04 (U04): SMART APPLICATIONS

Use Case 4 is concerned with investigating and trialling smart applications. Some of these will co-ordinate and control the smart devices implemented in workstream 2 (U02), according to the smart commercial arrangements established in workstream 3 (U03). These will exploit the communications platform established in workstream 1 (U01). Each use case is concerned with trialling a different type of smart application.

U04.1 – Active Power Flow Management

An active power flow management application will be deployed to manage multiple thermal constraints on the distribution network in a co-ordinated manner. The application will monitor system parameters, dynamic line ratings and frequent use switches and autonomously calculate and issue control instructions to coordinate generators and quadrature boosters to maintain the network within limits.

Locations

The active power flow management application will monitor network locations within the FPP trial area where power flows could exceed system limits. These locations will be identified through prior analysis of the network and new generator and/or smart device connections. The application will control the real and reactive power of generators contributing to power flow constraints and any other smart devices that offer a means of alleviating those constraints.

Key Components

Application software
Network parameters and status indications from RTUs
Generator controllers
Dynamic line rating devices and weather stations
Frequent use switches
Quadrature boosters
Substation LANs
Open-standards IP Communications platform

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Demonstrate the control of generator real and reactive power as part of an active power flow management application at 33 kV.	It is anticipated that the connection of new RG will result in power flow limits on the 33 kV network in the FPP trial area being breached. The reverse power flow through 132/33 kV transformers also presents a limit. New RG (expected to include wind and other renewable technologies such as biomass) will be subject to active control as part of the active power flow management application. This will monitor power flows on the network and adjust the real and reactive power of the generators according to real-time conditions to ensure limits are satisfied. Control will be implemented according to the agreed commercial arrangements. The trial will test and confirm the feasibility of using generators to control power flows on a typical GB 33 kV distribution network.	The capabilities, limits and requirements of generator control (different types of generators or different manufacturers) as part of an active power flow management application.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Demonstrate the control of a quadrature booster as part of an active power flow management application on a 33 kV network.	The quadrature booster to be connected at 33 kV in the FPP trial area will be subject to active control as part of the active power flow management application. This will adjust the operating point of the quadrature booster according to real-time conditions to ensure limits are satisfied. Control will be co-ordinated with generator control according to the agreed commercial and network operating arrangements. The application and control interface will be configured to translate the required changes in power (at 33 kV constraint locations) into required changes in real and reactive power flows at the quadrature booster and then into required changes in the controllable settings of the quadrature booster. The trial will test and confirm the feasibility of using a quadrature booster to control power flows on a typical GB 33 kV distribution network.	The capabilities, limits and requirements of a quadrature booster as part of an active power flow management application.
Demonstrate monitoring of the status of frequent use switches and the resultant impact on the operation of the active power flow management application.	The status and position of frequent use switches deployed in the project will be monitored and incorporated within the operation of the active power flow management application. When a frequent use switch changes position, the active power flow management application will update the relationships between the constraints and the controllable devices (including generators) to reflect the new network running arrangements.	Demonstrate the ability of an active power flow management application to adapt to different network running arrangements. Demonstrate the value of frequent use switches when deployed with an active power flow management application.
Demonstrate monitoring of DLR devices and the thermal ratings estimations application and the resultant impact on the operation of the active power flow management application.	DLR devices will provide indications of overhead line ratings to the active power flow management application. These values will be used by the application to calculate the control set-points to coordinate generators and other smart devices to meet these limits. The active power flow management application will interact with the thermal ratings estimation application and receive estimates of the rating of a critical circuit section or component. These values will be compared with the DLR values to validate the thermal ratings estimation application outputs and the active power flow management application will calculate the control set-points to coordinate generators and other smart devices to meet these limits.	Demonstrate the ability of an active power flow management application to adapt to different network ratings as provided by DLR devices or by a thermal ratings estimation application. Demonstrate the value of DLR and thermal ratings estimation when deployed with an active power flow management application.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Demonstrate interaction with an active voltage management application and the resultant impact on the operation of the active power flow management application.	The active voltage management application could be required to manage generator real and reactive power and quadrature booster settings. There could be times when both the active power flow management and active voltage management applications will be required to control the same devices and in this situation there will be a requirement for arbitration between the applications. This approach to arbitration will also be necessary to ensure that the operation of either application does not pose an operational challenge to the other, e.g. the action of one application should not result in unnecessary action of the other.	Demonstrate the value of active voltage management and active power flow management coordination.
Test the use of the communications platform in supporting active power flow management and interoperability.	Test the bandwidth, latency, reliability and the robustness of the application given variations in tasks being performed by the application and the numbers of controllable devices and network constraints being managed.	The capabilities and limits of the communications platform to support the evolving needs of active power flow management.

High-level Roles and Responsibilities

Smarter Grid Solutions shall design, supply, install, and commission the SGi power flow management application and provide applications support.

Generators will be engaged to ensure the interfaces for control and data exchange with each generator operate effectively. Their involvement will be a condition of their connection agreement.

Alstom will be engaged to ensure the interfaces for control and data exchange with the quadrature booster and the data exchange with DLR devices operate effectively.

S&C Electric will be engaged to ensure the interfaces for data exchange with the frequent use switches operate effectively.

CWW and SSN will provide design guidance and support on the use of the open standards IP communications platform (WAN).

UK Power Networks will design and undertake the trials.

Dependencies

Systems integration activities in WS8 (U08)

Establishment of the communications platform in WS1 (U01)

Deployment of controllable smart devices in WS2 (U02)

Smart commercial arrangements in WS3 (U03)

U04.2 – Active Voltage Management

An active voltage management application will be deployed to manage multiple voltage constraints on the distribution network in a co-ordinated manner. The application will monitor system parameters and frequent use switches to autonomously calculate and issue control instructions to coordinate generators and quadrature boosters to maintain the network within statutory voltage limits.

Locations

The active voltage management application will monitor all locations were voltage limits on the 33 kV network could be exceeded. These will be identified through prior analysis of the network and new connections of smart devices or generators. The application will control the generators contributing to voltage constraints and any other smart devices that offer a means of alleviating those constraints. The application will exchange voltage limits and targets with transformer tap changer relays as appropriate to co-ordinate voltage control.

Key Components

Application software
Network parameters and status indications from RTUs
Generator controllers, Frequent use switches, Quadrature boosters, Substation LANs
Open-standards IP Communications platform

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Demonstrate the control of generator real and reactive power as part of an active voltage management application on a 33 kV network.	It is anticipated that the connection of new RG will result in voltage limits on the 33 kV network in the FPP trial area being breached. New RG (expected to include wind and other renewable technologies such as biomass) will be subject to active control as part of the active voltage management application. The active voltage management application will adjust the real and reactive power of the generators according to real-time conditions to ensure limits are satisfied. Control will be implemented according to the agreed commercial arrangements. The trial will test and confirm the feasibility of using generators to control voltages on a typical GB 33 kV distribution network.	The capabilities, limits and requirements of generators (different types of generators or different manufacturers) as part of an active voltage management application.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Demonstrate the control of a quadrature booster as part of an active voltage management application.	The quadrature booster will be subject to active control as part of the active voltage management application. The application and control interface will be configured to translate the required changes in voltage into required changes in real and reactive power flows at the quadrature booster and then into required changes in the controllable settings of the quadrature booster. The trial will test and confirm the feasibility of using a quadrature booster to control voltages on a typical GB 33 kV distribution network.	The capabilities, limits and requirements of phase shifting transformers as part of an active voltage management application. Demonstrate the value of quadrature booster control when deployed with an active voltage management application.
Demonstrate the integration of tap changer relay control with the active voltage management application to maintain network voltages within limits.	The FPP trial will include the deployment of smart transformer tap changer relays at substations. These relays will help to manage voltages on the trial network, which could breach statutory limits due to the connection of new RG. The requirements placed on the operation of transformer tap changer relays may change at different times. Effective data exchange between the transformer tap changer relays and the voltage management application is necessary to ensure any conflicts are resolved. The trial will test and confirm the feasibility of integrated control of transformer tap changer relays with an active voltage management application on a typical GB 33 kV distribution network.	The capabilities, limits, requirements and value of transformer tap changer relays as part of an active voltage management application.
Test the use of the communications platform in supporting active voltage management and interoperability.	Test the bandwidth, latency, reliability and the robustness of the application given variations in tasks being performed by the application and the numbers of controllable devices and network constraints being managed.	The capabilities and limits of the communications platform to support the evolving needs of active voltage management.

High-level Roles and Responsibilities

Same as U04.1

Dependencies

Same as U04.1

U04.3 – Thermal Ratings Estimation

The thermal ratings estimation application estimates the ratings of circuit sections and components across the FPP trial area based on weather information, terrain and a thermal model of the distribution network. This will include locations where DLR devices are deployed and other locations where DLR is not deployed. Estimates of real-time rating can be validated by comparing values from DLR devices with estimates provided by the thermal ratings estimation application. Thermal rating estimates can be used in active power flow management to maximise utilisation of the network, while minimising the need for new DLR device deployments.

Locations

The thermal ratings estimation application will receive data from weather stations across the FPP area and will produce ratings estimates for all circuits and components in the area.

Key Components

Application software
Dynamic line rating devices and weather stations
Substation LANs
Open-standards IP communications platform

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Demonstrate the use of a thermal ratings estimation application to increase the useable rating of constrained lines in the FPP trial area.	Provide real-time ratings for a defined set of circuits and components in the trial area and identifying the circuit section or component that is the limiting factor. The circuits and components will be identified during the project as appropriate to address power flow constraints. The thermal ratings estimation application will provide validated estimates of network ratings to be used to ensure the active power flow management application maintains power flows within the actual ratings of the network at any point in time. The impact on the performance of the thermal ratings estimation application will be explored for the loss of weather station data or DLR device data.	The capabilities, limitations and requirements of a thermal ratings estimation application. The performance of a thermal ratings estimation application during the loss of measurements and/or communications.
Prove interoperability of a thermal ratings estimation application with other applications and smart devices.	The thermal ratings estimation application will require monitored parameters and/or calculated values from DLR devices and weather stations to perform and validate thermal ratings estimations. The thermal ratings estimation application will provide a set of ratings, detailing the critical circuit sections or components, to the active power flow management application. These ratings will then be utilised in constraint satisfaction calculations to determine control instructions to be sent to smart devices and generators under the control of the active power flow management application.	The capabilities, limits and requirements of other devices and applications in supporting and utilising thermal ratings estimation.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Test the use of the communications platform to support thermal ratings estimation and interoperability.	Test bandwidth, latency, reliability, etc. and the robustness of the application given variations in tasks being performed by the application and the number of weather stations deployed in the trial area.	The capabilities and limits of the communications platform to support the evolving needs of thermal ratings estimation.

High-level Roles and Responsibilities

Smarter Grid Solutions shall design, supply, install, and commission the SGrtr thermal ratings estimation application and provide applications support.

Alstom will be engaged to ensure the interfaces for data exchange with DLR devices and weather stations operate effectively.

CWW and SSN will provide design guidance and support on the use of the open standards IP communications platform (WAN).

UK Power Networks will design and undertake the trials.

Dependencies

Systems integration activities in WS8 (U08)

Establishment of the communications platform in WS1 (U01)

Deployment of controllable Smart Devices in WS2 (U02)

Summary of Relationship between Smart Devices and Smart Applications

The table below summarises the relationship between Smart Devices and Smart Applications.

Smart Device	Smart Application
Transformer tap changer control relays	Active voltage management
Dynamic Line Ratings device and weather stations	Active power flow management Thermal ratings estimation
Frequent use switches	Active power flow management
Generator controllers	Active power flow management Active voltage management
Quadrature booster	Active power flow management Active voltage management
RTU	Active power flow management Active voltage management Thermal ratings estimation

Use Case 05 (U05): STAKEHOLDER ENGAGEMENT

The stakeholder engagement workstream shall ensure that the issues and concerns of involved and interested parties are indentified early and incorporated into the FPP project. The FPP stakeholder community is expected to include generators, local and national Government, community interest groups, DNOs, trade associations and customers in the FPP project area.

Due to its role as a facilitating workstream for the purposes of eliciting stakeholder requirements, WS5 does not lend itself to use cases. However, WS5 does present several challenges and therefore opportunities to attain valuable learning on the identification of the technical and commercial requirements of stakeholders and the incorporation and assessment of these requirements within a set of real world trials. This section provides an overview of project challenges relevant to WS5 and highlights the opportunities for learning that present themselves and will be harnessed through the FPP project.

WS5 will seek to build on the approach to stakeholder engagement already developed and in use within UK Power Networks as part of its preparations for RIIO ED1, in order to ensure that successful methods and lessons learnt from that process are adopted within this workstream.

As part of this workstream the key stakeholders of the FPP project will be identified and the likely impact of the FPP project on each stakeholder documented and where possible quantified. The impact assessment will be issued to each stakeholder. Following this, a series of questionnaires will be formulated to gauge the receptiveness of each stakeholder to the FPP project, and responses procured. The questionnaire will be designed to draw attention to the impact of the FPP project on each stakeholder and elicit responses that will identify the issues and concerns of each stakeholder. It is expected that learning on the best means and methods of engaging with stakeholders on the topic of connections to FPP networks will be developed in the FPP project.

On completion of the questionnaire phase of the workstream, discussion papers will be produced highlighting the key issues for each stakeholder. The discussion papers will include mitigation strategies and quantify the impact of the mitigation strategy on project costs and timescales where applicable. For each stakeholder the discussion paper will build a consensus view on what the key issues are and what mitigation strategies should be adopted. This will inform the activities undertaken in WS3 on smart commercial arrangements and WS6 on the strategic investment model.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Real-time control of generator real and reactive power will enable the use of smart applications in the FPP trials.	Generator developers will be consulted with a view toward the production of an agreed set of technical interface specifications for generators connecting to the FPP platform. These specifications will detail the interfaces required to enable the exchange of data and control signals to new or existing generators taking part in the trials.	A set of standard interface specifications to enable the real-time control of generator real and reactive power for different types and manufacturers of renewable generators.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
A more detailed understanding of the commercial requirements of renewable generators when considering an interruptible connection offer.	If new or existing renewable generators are to accept the terms of a connection agreement that permits the DNO to control generator real and reactive power then the generation developer will need to understand the technical and economic consequences for the generation project. As part of the stakeholder engagement, various generators will be consulted as to the details of this information and to gauge their interest in participating in the project.	The requirements of generator developers in order to assess an interruptible connection option. The requirements of generator developers in order to satisfy the concerns of the investor community. Learning on how best to engage with renewable generators.
Ensure that local and national authorities are fully engaged with the FPP project.	Gauge local Government interest in the project and seek participation. Gauge national Government interest in the project and seek participation. Assess the ability of the local authority to support the project with regards to planning activities, etc.	The specific needs and documented concerns of local/national Government and possible mitigation strategies. Understand the content of any relevant local plans and their impact on the project, particularly with respect to renewable energy developments and consents for overhead lines and substations. Learning on how best to engage with local and national authorities.
Ensure community interest groups are fully engaged with the FPP project.	Identify community interest groups of relevance to the FPP project, including renewable energy groups and other organisations. Gauge community interest groups' interest in the project and seek participation.	The specific needs and documented concerns of the community interest groups and possible mitigation strategies. Learning on how best to engage with community interest groups.
Ensure trade associations are fully engaged with the FPP project.	Gauge the trade associations' and their members' interest in the project. Identify specific issues or concerns of trade associations and participate in any organised events relevant to the FPP project.	The specific needs and documented concerns of trade associations and possible mitigation strategies. Learning on how best to engage with trade associations.

High Level Roles and Responsibilities

UK Power Networks will sponsor stakeholder engagement activities and will have overall authority for all stakeholder engagement.

Garrad Hassan will undertake detailed design and delivery of stakeholder engagement activities.

Dependencies

This use case is dependent on the willingness of all stakeholders to participate in questionnaires and discussions (both private and public).

Use Case 06 (U06): STRATEGIC INVESTMENT MODEL

The FPP project will address one of the key challenges faced by Distribution Network Operators (DNOs) in enabling the development of a low carbon energy sector. The FPP project will demonstrate how, through the innovative integration of technological and commercial solutions, the most cost effective connection of renewable generation to a distribution network can be achieved.

The trialling of smart devices (U02), smart commercial arrangements (U03) and smart applications (U04) aims to address some of the technical and commercial challenges that UKPN is facing today in the FPP trial area, and which are also common elsewhere in GB. Technical and commercial learning from the FPP trials will be captured and disseminated throughout the project, and will be used as an input to the development of a strategic investment model. The objective of the strategic investment model is to identify the most cost-efficient and low carbon solution to connect renewable generation to the distribution network based on what can be technically and commercially achieved using the latest advances in smart grid technology being trialled on the FPP project. The model will also incorporate and build upon (but not duplicate) learning from LCNF projects being undertaken by other DNOs that are currently underway, representing a significant learning opportunity for all GB DNOs. The model will provide DNOs with a validated toolbox to make informed planning and strategic decisions, delivering a cost efficient network solution that will benefit those parties wishing to connect renewable generation to the distribution network.

The FPP Strategic Investment Model will be developed in such a way that will enable other DNOs to make use of it by easily adapting it to the characteristics of their own network.

This section aims to describe the key features of the proposed FPP Strategic Investment Model.

Model Description

Inputs

The FPP strategic investment model will be developed as an extension to the Load Related Investment (LRI) model that Imperial College is currently developing for UK Power Networks. The LRI model uses real 33 kV network data and models specific demand and generation points. It also allows for different demand and generation growth scenarios to be evaluated. The FPP strategic investment model will build on this and will incorporate the following:

- Generation growth scenarios. This includes the feature of adding different numbers, locations, dates of connection and types of renewable generators connected to the distribution networks
- Modelling of smart devices described in U02
- Modelling of smart commercial arrangements described in U03
- Modelling of smart applications described in U04
- Modelling of other smart solutions from other LCNF projects
- Costs of the above smart solutions
- Consideration of costs and timescales of traditional reinforcement solution(s)
- CO_2 reduction associated with different renewable generation technologies
- Carbon intensity of grid mix

Capabilities and Outputs

The FPP strategic investment model will use the above inputs in order to provide the following capabilities and outputs:

Outputs

- Cost and carbon benefits of different technical and commercial solutions (adjusting for EU ETS and Carbon Price Floor)
- Prioritisation of different technical and commercial solutions for different demand and generation scenarios, in order to identify the most cost-efficient and low carbon solution to connect renewable generation to the distribution network
- Triggers for network reinforcement based on what can be technically and commercially achieved using the latest advances in smart grid technology

Capabilities

- Optimisation of generation connections across various locations and time horizons. This includes, but is not limited to, modelling of:
    - Coordination of renewable generation connection applications (time, location, technologies);
    - Different scenarios of firmness of connection;
    - Option value of investment in flexibility in order to understand the value of increasing network flexibility as opposed to increasing network capacity;
    - Strategic network investment versus incremental network reinforcement;
    - Option value of strategic network reinforcement in order to better understand the risk associated with uncertainty of future renewable generation connections.
- Modelling the coordination of actions for real time network constraint management. This includes modelling and the use of smart devices and smart applications to perform preventive (pre-fault) and corrective (post-fault) control actions at local and wider area levels.
- Modelling the allocation of network reinforcement costs amongst connecting renewable generators, taking into account location, technology, rating and firmness of connection
- Value of offering load related incentives to loads for local load management.
- Modelling of the revenue risk exposure arising from commercial solutions and the impact of offering contracts for differences that offer insurance to renewable generators.
- Evaluate the expected costs and carbon benefits of the trials

The outputs of the FPP strategic investment model will enable the costs and benefits (including carbon benefits) of flexible connection options for renewable generation to be assessed on a consistent basis. This will allow DNOs to consider different connection options and will enable the DNO to develop their network to better accommodate renewable generation developers' choices.

Moreover, the outputs of the FPP strategic investment model will support the identification of possible regulatory constraints that prevent the optimal connection solution to be presented to renewable generation developers.

The FPP strategic investment model will allow for a more informed investment requirement for the inclusion of low carbon technologies and smart solutions in regulatory submissions and for a more informed selection of options for the Long Term Development Statement.

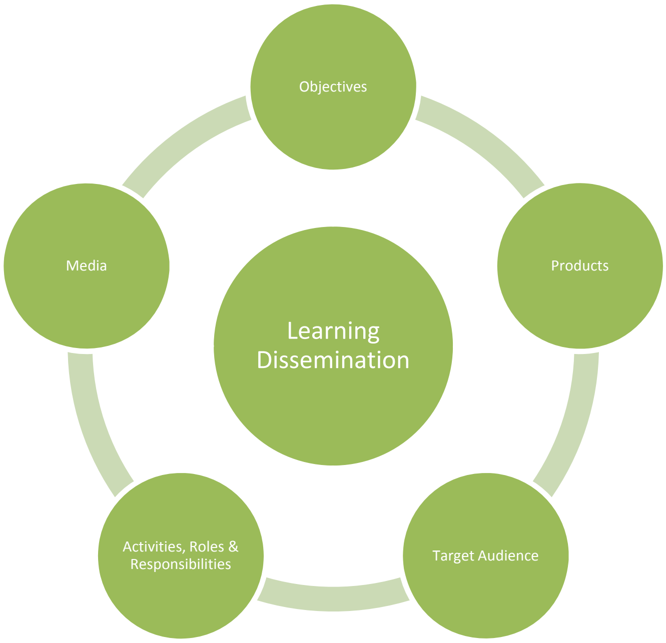
Validation

The FPP strategic investment model will be developed, tested and validated against the outcomes of the FPP trials. Other GB DNOs will be consulted regarding the validation of the strategic investment model.

Use Case 07 (U07): LEARNING AND DISSEMINATION

The FPP project will generate extensive learning opportunities for UK Power Networks, the wider DNO community, renewable generation developers, national and international standards bodies, academia, local authorities and other key stakeholders such as the ENA, DECC and Ofgem. In order to ensure that learning is effectively disseminated, a workstream will be established for this purpose. Workstream 7: "Learning and Dissemination" will focus on both internal and external learning and knowledge dissemination activities. This workstream will build on the knowledge dissemination synergies with other relevant LCNF projects such as Low Carbon London and the Low Carbon Hub.

A knowledge dissemination roadmap will be developed at the start of the FPP project in order to produce a clear and effective dissemination plan. The goal of this dissemination plan is to ensure accessibility to, and dissemination of, the FPP project results. The knowledge dissemination plan will adopt a well-structured methodology in order to define:



Dissemination Objectives

Ensure the provision of appropriate and reliable information to stakeholders regarding the FPP project, using appropriate methods to maximise the effectiveness of dissemination activities.

Dissemination Products

This will include but not be limited to the following items:

- Report on introduction to open standards Information and Communication Technology platforms for distribution networks;
- Report on Active Network Management of distribution networks to facilitate increased renewable generation;
- Report on innovative technical and commercial aspects of actively managed renewable distributed generator connections;
- Report on stand-alone operation of smart devices;

- Tutorial for all relevant UK Power Networks staff and representatives from other DNOs on the FPP communications platform and open standards implementation;
- Workshops for Infrastructure Planners on the Strategic Investment Model and new processes and procedures for providing smart connection solutions for renewable generation;
- Workshops on the operation of the deployed smart devices and applications (including the interaction of the deployed FPP solutions with Control Room and Operations staff).

Target Audience

The target audience for dissemination activities is anticipated to include:

- UK Power Networks staff
- All GB DNOs
- The Energy Networks Association (ENA)
- Industry and Government led working groups such as those overseen by the Smart Grid Forum and Smart Grids GB
- Ofgem
- DECC
- Academic Institutions
- The IET
- Local Government Authorities
- Local Communities
- Trade Associations (including the Renewable Energy Association and Renewable GB)
- Media
- Renewable generation developers

Dissemination Activities Roles and Responsibilities

The dissemination of learning and knowledge gained by the FPP project will receive support from across UK Power Networks business and Project Partners:

- Learning will be coordinated through the Future Networks division within UK Power Networks which will ensure that all learning generated by the FPP and other UK Power Networks LCNF projects is disseminated effectively and that successful trials are translated to business-as-usual solutions. Central to this function is the process of seconding staff from the business to work on the FPP project. These staff will subsequently return to functional, operational roles and act as champions of change within the business;
- The Future Networks division will be responsible for dissemination activities involving: other DNOs; industry and Government led working groups; Ofgem; DECC; and the ENA.
- The Future Networks division will also coordinate dissemination activities with Universities, The IET, Government Authorities and Local Communities, Trade Associations and renewable generation developers. This activity will be supported by Garrad Hassan who will be responsible for stakeholder engagement activities across the FPP project;
- Dissemination activities will receive the full support of FPP Project Partners throughout the duration of the project.
- FPP will utilise the IET's communities model in order to disseminate learning to IET members while exploring other opportunities and working closely with the Institution

Dissemination Media

The learning obtained through the project will be disseminated within UK Power Networks and to the external world using a variety of methods and communications media, including:

- Internal Communication:
  - Future Networks Quarterly Newsletter;
  - Intranet site dedicated to all LCNF project activities;
  - Internal workshops;
  - Internal reports;
  - Development of internal business champions;
  - The learning from the FPP project will inform the UK Power Networks business plan to be submitted to Ofgem as part of the new RIIO regulatory framework.
- External Communication:
  - The IET's communities model
  - Development and production of a project website;
  - Use of internet platforms such as Linkedin and Webinars;
  - Conferences and workshops, in addition to the LCNF annual conference;
  - The FPP Strategic Investment Model will be made available to all GB DNOs, including instructions on the use and application of the model;
  - The FPP project may identify areas of existing technical and regulatory standards (e.g. Distribution Code, ETRs and the DG Connections Guide) which are impacted by the trials or where the implications of a GB wide roll-out will have such an impact. These areas will be documented in reports and presented to other DNOs through the Energy Networks Association;
  - International Standards Committees, expected to include the IEC;
  - Contributions to and communication with relevant Industry Working Groups such as the IET, ENA, Smart Grid GB and Smart Grid Forum;
  - Workshops with renewable generator developers;
  - Magazine articles;
  - Scientific papers.

Use Case 08 (U08): SYSTEMS INTEGRATION

WS8 is the series of activities on the FPP project that focuses on bringing the technical workstreams (WS1, WS2 and WS4) and their respective use cases together under the auspices of a well-coordinated technical project delivery lifecycle. WS8 incorporates the following key elements:

- Development/confirmation of user requirements
- Overall cyber security requirements
- Development of cyber security management framework
- Solution architecture design
- Development of functional specifications
- High level IEC 61850 data modelling/engineering approach definition
- Development of test approach and test specifications
- Detailed design of trials
- Pre-production testing and production testing

Due to its role as a coordinating workstream for the purposes of technical project delivery, WS8 does not lend itself to use cases. However, WS8 does present several challenges and therefore opportunities to attain valuable learning on technical project delivery for smart grid projects involving significant communications and information technology elements to solve power systems problems. This section provides an overview of project challenges relevant to WS8 and highlights the opportunities for learning that present themselves and will be harnessed through the FPP project.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Technical project delivery of smart grid projects.	Implement the project using a formal technical project delivery lifecycle to co-ordinate activities across all technical workstreams.	Skills and experience in delivery and integration of smart grid applications and devices in order to solve power systems problems, leveraging the latest ICT solutions. Development of a technical project delivery framework for smart grid projects as a re-usable, mature process.
Due to the immaturity of cyber security requirements and frameworks for smart grids, there is an opportunity to explore overall cyber security requirements for smart grids.	The FPP project will investigate best practice from security sensitive IT and engineering businesses in order to develop a set of cyber security requirements that are fit for the future smart grid.	Skills and experience in understanding and developing cyber security requirements for smart grids are enhanced. Development of a cyber security management framework for smart grids projects which can be re-used. Skills and experience in activities such as cyber security risk assessment are developed.

Sample of envisaged experiments and associated learning points		
Challenges/Opportunities	Sample of envisaged experiments	Learning points
Data modelling for interoperability.	Develop a data modelling approach, including developing/implementing tools for use in detailed data modelling in other workstreams.	Skills and experience in data modelling for smart grid systems are developed. Development of a data modelling framework for smart grids projects which can be re-used. Development/implementation of tools for data modelling for interoperable smart grid systems.
Testing multiple technology layers and types over a geographically distributed area.	Development of detailed test specifications and trials covering power systems functional testing and information and communications technology type testing, including interoperability testing. Careful design of trials to de-risk trial stages.	Skills and experience in testing and trialling of smart grid systems are developed.

High-level Roles and Responsibilities

UKPN will undertake the key roles in this workstream, to maximise the learning potential for UKPN and to ensure that this learning can be disseminated to other DNOs in a suitable form. The key roles will include:

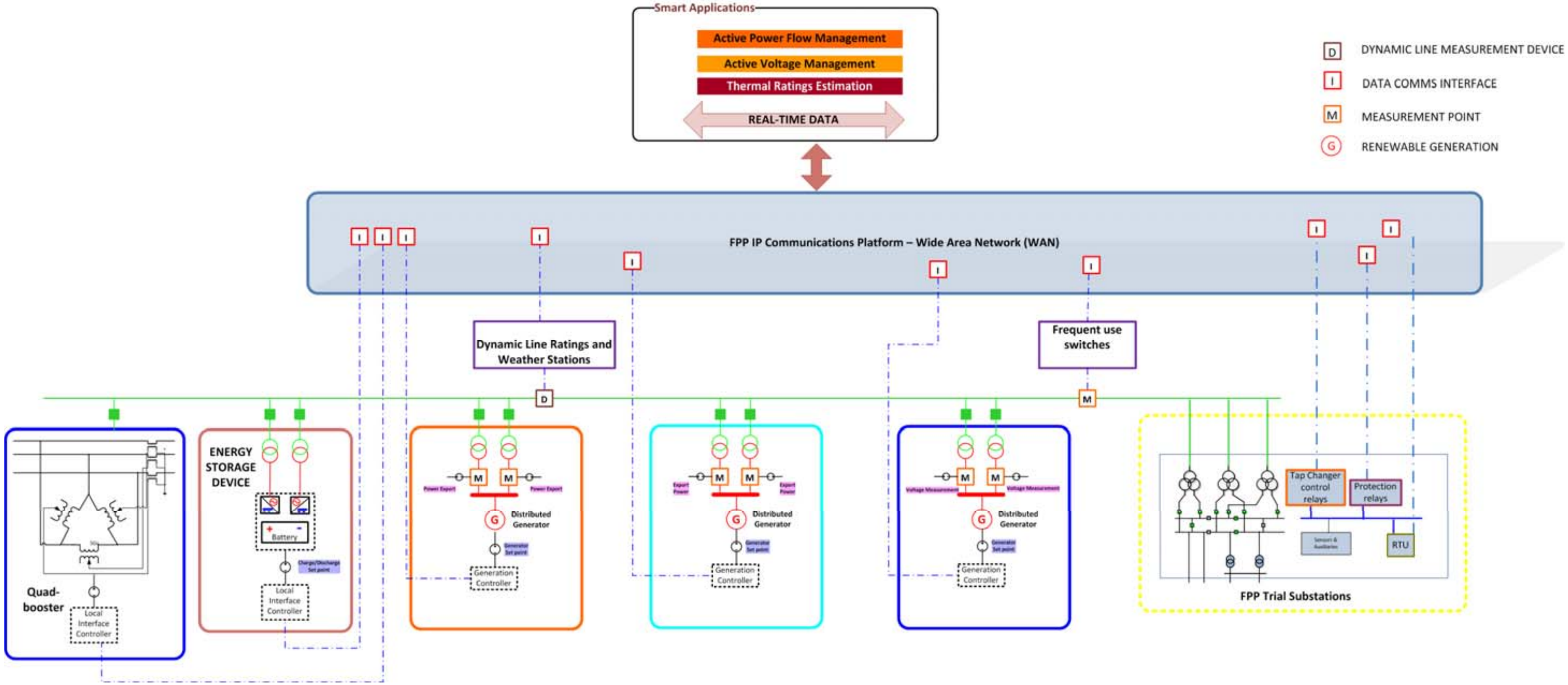
- Technical design authority
- Cyber security manager
- Data modeller
- Trial designer

These roles will be supported by the partners in the other technical workstreams.

Dependencies

Systems integration will be interdependent on the delivery of workstreams concerned with the practical elements of the project: WS1 concerned with the FPP communications platform (as described in U01), WS2 concerned with smart devices (as described in U02) and WS4 concerned with smart applications (as described in U04).

Flexible Plug and Play Low Carbon – High-level Concept Diagram



Appendix 2

Carbon Calculation Methodology

Carbon emissions savings calculations and assumptions

The FPP project will deliver 242 thousand tonnes of CO_2 emission savings by 2020. These savings will be achieved by enabling an additional 188 MW of wind generation through implementing the project, thereby displacing generation from higher carbon emission intensive sources. The calculation of these savings assumes a load factor of 33% and uses a carbon intensity of the grid mix taken from the MARKAL scenarios (2009) in the Analytical Annex of the UK Low Carbon Transition Plan published by DECC.

By rolling out the FPP platform across Great Britain, further wind generation will be efficiently connected to distribution networks. Based on forecasts for onshore wind generation that is anticipated to be connected in England, Wales and Scotland in the ENA report *"Evaluating the case for introducing locational DUoS charges for CDCM generators"*, it has been assumed that an additional 2.1 GW of wind generation could be connected by 2021 through the rollout of the FPP platform. The ENSG document also includes an addendum extrapolating analysis to 2030. This document presents estimates for the growth in distribution connected generation in the period between 2020 and 2030. It estimates a combined growth in distribution connected generation of 11 GW over that period. From this we have assumed a further 1.9 GW can be efficiently connected through the FPP platform by 2030. This will lead to further carbon emission savings of 4.8 million tonnes of CO_2 between 2016 and 2030. Using DECC non-traded shadow carbon prices the combined savings from the project and the national rollout of the project solutions could deliver a total saving of £192 million NPV.

These emissions reductions have been conservatively estimated by only taking account of the emission savings in the year of connection. The cumulative impact of connecting this wind generation has not been taken in to account though clearly efficient connection of wind generation will have some cumulative benefit.

The CO_2 emissions saving have been calculated using the following formulae:

CO_2 (in tonnes)= (A x 0.3 x 8760 x Carbon intensity of grid mix)/1000

Where

- A = the rated capacity of the wind energy development in MW (note this is not the same as its declared net capacity or dnc)
- 0.3 = a constant, the capacity factor, which takes into account the intermittent nature of the wind, the availability of the wind turbines and array losses
- 8760 = the number of hours in a year
- Carbon intensity of grid mix = MARKAL scenarios (2009) in the Analytical Annex of the UK Low Carbon Transition Plan published by DECC

Table of wind generation assumed for CO2 calculation

Year	Project wind generation capacity in MW	GB wind generation capacity in MW	MARKAL Carbon Intensity in Grid mix
2011			0.52231324
2012			0.51684656
2013	15		0.51137987
2014	14		0.50591318
2015	29		0.50044649
2016	18	350	0.49497980
2017	18	350	0.48951311
2018	32	350	0.48404642
2019	32	350	0.47857973
2020	32	350	0.47311304
2021		350	0.46764636
2022		211	0.46217967
2023		211	0.45671298
2024		211	0.45124629
2025		211	0.44577960
2026		211	0.43495352
2027		211	0.42412745
2028		211	0.41330137
2029		211	0.40247530
2030		211	0.39164922
Total	188	4,000	

Sources:

Carbon intensity of grid mix has been taken from the Analytical Annex to the UK Low Carbon Transition Plan:
http://www.decc.gov.uk/assets/decc/white%20papers/uk%20low%20carbon%20transition%20plan%20wp09/1_20090727143501_e_@@_uklctpanalysis.pdf

Carbon Valuation has been undertaken using the DECC non-traded shadow carbon prices, taken from:
http://www.decc.gov.uk/assets/decc/what%20we%20do/a%20low%20carbon%20uk/carbon%20valuation/1_20090901160357_e_@@_carbonvaluesbriefguide.pdf

Appendix 3

Letters of Support

My ref: AP/JGYC908
Your ref:

Date: 17th August 2011

Contact: Alex Plant
Direct dial: 01223 715660
E Mail: alex.plant@cambridgeshire.gov.uk

Cambridgeshire County Council

Environment Services
Executive Director, Alex Plant

Box No. CC1307
Castle Court
Shire Hall
Castle Hill
Cambridge
CB3 0AP

John Hayling

UK Power Networks
Newington House
237 Southwark Bridge Road
London
SE1 6NP

Dear John,

Plug & Play Low Carbon Networks proposal

I am writing in relation to your bid to OFGEM for support from the Low Carbon Network Fund for your Plug & Play Low Carbon Networks proposal.

Given the high levels of new development planned for Cambridgeshire over the coming years, it will become ever more important that we can facilitate the effective connection of different types of renewable energy sources into the network.

I am therefore very pleased to confirm that Cambridgeshire County Council is supportive of your initiative in this area.

I wish you success with your project and please keep me updated on this.

Kind Regards,

Alex Plant
Executive Director: Environment Services

John Hayling
Investment, Policy & Low Carbon Development Manager
Future Networks
UK Power Networks
Newington House
237 Southwark Bridge Road
London SE1 6NP

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0191 512 5835
07875 11 2363
10th August 2011

Dear John

Plug & Play Low Carbon Networks Project

I refer to your recent correspondence with my colleague Trevor Gait regarding your proposed Plug & Play Low Carbon Networks' project.

EDF ER supports this initiative as we consider that it could have significant benefits in helping to role out renewable projects in the UK, as other than general planning approval access to a cost effective grid connection is the major constraint we have to overcome.

We hope you are successful with you application and please keep us informed on progress.

Yours sincerely

Tony Scorer

Tony Scorer
Head of Onshore Wind Development

Cc: Mr T Gait, EDF ER

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John Hayling
Investment, Policy & Low Carbon Development Manager
Future Networks
UK Power Networks
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237 Southwark Bridge Road
London
SE1 6NP

By email: john.hayling@ukpowernetworks.co.uk

11th August 2011

RE: UKPN Year-2 LCNF Tier 2 Proposal, Flexible Plug & Play Low Carbon Networks

Dear John,

Thank you for giving West Coast Energy, WCE, the opportunity to comment on your Low Carbon Network Fund Proposal. As an active wind farm developer in the UK, consenting over 600MW of wind power to date, WCE is all too aware of the constraint that limited grid capacity on the UK's existing distribution networks can and is having to wind farm and other renewable energy generation developments.

If the UK is to meet its ambitious renewable energy targets it must look at ways to more efficiently connect distributed generation to its existing electricity distribution networks. Projects such as UKPN's Flexible Plug & Play Low Carbon Networks, funded through the Low Carbon Network Fund are an essential part of proving new technologies and techniques to allow us to do this.

Yours sincerely,

C. S. Thomas

Chris Thomas
Project Manager
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Future Networks
UK Power Networks
Newington House
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SE 1 6NP

11th August 2011

Dear Sirs

Flexible Plug & Play Low Carbon Networks Project Application

We are delighted to learn of the project application that UK Power Networks are making under the Low Carbon Network Tier 2 funding arrangements from Ofgem. This project which is looking to develop and prove the use of Smart Grid Technologies and other means for improving the cost and ability of providing connections for renewable generation to the distribution grid is of particular interest to us. The use of this type of technology will greatly benefit renewable generation developers like ourselves.

Through our investment in Fenpower Ltd we completed in two phases in 2008 the development of a 10MW wind farm at Ransonmoor in the Cambridgeshire Fens. We are currently in the process of developing the Boardinghouse project, a new wind farm in the same locality. This will comprise five 2 MW generators and will connect to the local 33KV distribution network.

We believe that this project will offer significant long term benefits to aid and improve the connection of renewable generation to distribution networks across the UK. We very much hope that UK Power Network's bid is successful and we look forward to working with them again in the future.

Yours faithfully

PP Tim Kirby
Managing Director

Renewable Energy Systems Limited
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E info@res-group.com www.res-group.com

Mr. John Hayling
Investment, Policy and Low Carbon Manager
Future Networks
UK Power Networks
Newington House
237, Southwark Bridge Road
London
SE1 6NP

Our Ref: 01464-018806

12 August 2011

Dear John,

Re: Flexible Plug and Play Low Carbon Networks Project

The RES group of companies are major developers of wind farms both in the UK and overseas.

We fully support the UKPN Plug and Play Low Carbon Networks Project, using Smart Grid Technologies in order to facilitate the connection of Renewable Generation.

We believe that this is the right way to go in order to maximise the grid potential for increased renewable energy which is needed in order for the UK to achieve its renewable energy targets.

Yours sincerely,

P Scrimshaw

Peter Scrimshaw
Grid Engineer
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SCOTTISH renewables
The Forum for Scotland's Renewable Energy Industry

Cristiano Marantes
UK Power Networks
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Newington House
237 Southwark Bridge Road
London
SE1 6NP

18 August 2011

Dear Cristiano

Letter of Support for Proposed FPP Project

Scottish Renewables would like to signal its support for the Flexible Plug and Play project proposed by UK Power Networks. Scottish Renewables recognises that this innovative and ambitious project is focused on the types of distribution network issues commonly faced by our members, whether they are generation developers, network operators or others engaged in pushing forward the low carbon transition. While based in the east of England, this project is the only one in the current round of LCNF bids with an emphasis on connecting significant volumes of renewables, which remains a challenge right across the UK but in Scotland in particular. Scottish Renewables notes the inclusion of a dedicated stakeholder engagement work stream, which will ensure that all interested parties can influence the outcomes of the project.

We believe that this project could promise long term benefits to Scottish Renewables members and the industry in general, and we look forward to seeing UK Power Networks deliver learning for all network operators.

Yours sincerely

Catherine Birkbeck
Policy Manager
Grid & Markets

Flexible Plug and Play Low Carbon Networks (FPP)

Addendum

The FPP revised submission includes the following changes or additions:

1- Section 9 of the pro-forma ('Successful Delivery Reward Criteria') has been updated with a revised set of SDRC. These had been submitted to Ofgem as part of our response to question 17 (A17_2002).

2- The FPP project plan (Appendix C) has also been updated to reflect the revised SDRC. The SDRC delivery dates have not been changed apart from SDRC 9.5 (Successful completion of the FPP Strategic Investment Model including validation and testing of the model utilising data captured within the FPP trials), which will be completed by the end of Q4 2014 instead of Q4 2013 as per the initial submission.

3- Appendix F (Additional details on project Partners) – revised version includes letters of support from project Partners. These demonstrate the level of support and commitment to the delivery of the FPP project from the FPP project Partners.